Measuring multidimensional well-being when preferences differ: a non-parametric approach*

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Abstract

In this paper, we present a multidimensional well-being measure that respects individual preference heterogeneity, even when these preferences are incomplete. We discuss how the proposed well-being measure can be implemented in a non-parametric way, using the Adaptive Bisectional Dichotomous Choice (ABDC) method (Decancq and Nys, 2021). the ABDC method consists of two steps. In the first step, respondents are presented with a series of dichotomous choices between pairs of life situations that consist of their actual and hypothetical life situations. The hypothetical life situations are obtained using the adaptive bisectional algorithm. This algorithm proceeds iteratively and generates, in each iteration, a hypothetical life situation that is situated in the middle of the interval where the indifference curve should be, based on the responses to previous choices. Considering three dimensions of well-being (income, health, and social relationships) we measure well-being for a final sample of 2288 Dutch citizens.

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About 27 percent of respondents indicate to have incomplete preferences over these three dimensions, by selecting the response category "I don't know" in the algorithm. On average, respondents spent 2.9 minutes answering the ABDC and went through up to 8 iterations of the algorithm before saying "I don't know". We found that health has a negative effect on the probability of answering "I don't know" (meaning that the closer the health of a respondent is to a reference situation characterized by the absence of health problems, the less likely the individual answers "I don't know"), which is interpreted as evidence that people have more complete preferences towards life situations similar to their current life. Other variables associated with a lower probability of answering "I don't know" are: being a woman, not having a university degree, being a pensioner, declaring not having found the questionnaire difficult or unclear, and not stating that the questions made them think. Our results show that (on average) respondents are willing to sacrifice 24% of their income to live a life with perfect health and social relationships (although the variability is large). The identification of the worst individuals (those in the bottom 10%) is extremely sensitive to the well-being measure used. Our data allow us to compare different methods to obtain preferences to construct our measure of well-being, the results are sensitive to the method used.

JEL-classification: I30, I31, D63.
Keywords: Multidimensional well-being, Interpersonal well-being comparisons, Preferences heterogeneity

1 Introduction

Convincing arguments exist to understand well-being as a complex multidimensional phenomenon, in particular one that is imperfectly measured solely through income. In recent decades, a certain consensus has been reached regarding the necessity to approximate it beyond income. In their influential report [Stiglitz et al., 2009] argues the importance of addressing well-being from a multidimensional perspective. The evaluation of (distributive) policies, resource allocation, as well as the identification of the worst-off individuals in a society, and more in general the measurement of well-being requires a suitable indicator. While is generally accepted the importance of addressing well-being from a multidimensional perspective, it does remain an open question of how to measure it. The latter responds to the many normative and instrumental challenges this task faces.

Assuming we know the relevant well-being dimensions, one possibility is to compute an indicator for each dimension separately. This approach can reveal useful information about the performance in the different dimensions of individual well-being, but it comes with an important drawback: it ignores the correlation between dimensions and the potential problem of cumulative deprivation (when the same individual(s) consistently perform badly in several dimensions at the same time). Neglecting this last point is not appealing if we are concerned about inequality of well-being. Moreover, the evaluator might be including dimensions that are not relevant to the individual's idea about well-being.

An alternative is to aggregate the different dimensions into one index, which requires imposing a scheme of relative weights among dimensions. Often, equal weights are adopted claiming neutrality. This is the route followed in most empirical applications of the capability approach [Sen, 1980], such as the Human Development Index. In practice is frequent to have imperfect information, which might require the use of more than one indicator for some dimensions, as well as the combination of continuous and discrete variables. In this scenario, a scheme with equal weights generates asymmetries between dimensions. In addition, the trade-off imposed among dimensions indirectly assumes some kind of preferences homogeneity. While one individual i could evaluate situation A as better than

situation B, another individual j could prefer B to A. It is desirable that the well-being assigned to individual i under situation A is superior to situation B, but this should not be the case for individual j. Unfortunately, nothing ensures the fulfillment of this intuition when the relative weights are imposed on everyone. As individuals are heterogeneous, so are their preferences. Hence imposing preferences homogeneity might violate a basic notion of individual sovereignty.

A method to measure multidimensional well-being respecting preference heterogeneity is the so-called Equivalence Approach. This method (see [Decancq et al., 2015a]) employs as well-being measure individuals' income, once their willingness to pay to live in a situation of reference has been subtracted. Incorporating preferences heterogeneity into well-being measurement is not free of challenges. The last decades have witnessed an increasing body of evidence challenging the idea that individual preferences are rational as defined in [Mas-Colell, 1995] i.e. they fulfill the axioms of completeness and transitivity.[1] If individual preferences are not rational, how can we incorporate them into well-being measurement?

This paper presents and discusses a multidimensional well-being measure that respects individual preference heterogeneity, even when these preferences are incomplete. We discuss how the proposed well-being measure can be implemented in a non-parametric way, using the Adaptive Bisectional Dichotomous Choice (ABDC) method [Decancq and Nys, 2021]. the ABDC method consists of two steps. In the first step, respondents are presented with a series of dichotomous choices between pairs of life situations that consist of their actual and hypothetical life situations. The hypothetical life situations are obtained using the adaptive bisectional algorithm. This algorithm proceeds iteratively and generates, in each iteration, a hypothetical life situation that is situated in the middle of the interval where the indifference curve should be, based on the responses to previous choices.

Considering three dimensions of well-being (income, health, and social relationships) we measure well-being for a sample of 2288 Dutch citizens. About 27 percent of respondents indicate to have incomplete preferences over these three dimensions, by selecting the response category "I don't know" in the algorithm.

[1] Formally, a preference ordering $\succeq$ is said to be complete if for any two alternatives a and b, either $a \succeq b$ or $b \succeq a$ or both. A preference ordering $\succeq$ is said to be transitive if given three alternatives a, b and c for which $a \succeq b$ and $b \succeq c$ is true that $a \succeq c$.

On average, respondents spent 2.9 minutes answering the ABDC and went through up to 8 iterations of the algorithm before saying "I don't know". The time spent making a choice is the highest on average when individuals indicate to have incomplete preferences, suggesting their responses are reliable and not a shortcut to end the questionnaire. The results achieved allowed us to estimate with a high degree of precision the equivalent incomes for most respondents.

We found that health has a negative effect on the probability of answering "I don't know" (meaning that the closer the health of a respondent is to a reference situation characterized by the absence of health problems, the less likely the individual answers "I don't know"), which is interpreted as evidence that people have more complete preferences towards life situations similar to their current life, or in other words, completeness is more likely to be observed among similar alternatives. Other variables associated with a lower probability of answering "I don't know" are: being a woman, being old, not having a university degree, declaring not having found the questionnaire difficult or unclear, and not stating that the questions made them think.

Our results show that (on average) respondents are willing to sacrifice 24% of their income to live a life with perfect health and social relationships (although the variability is large), and the evidence suggests that on average more relative importance is attributed to health than to social relations for individuals' well-being. When different well-being measures are used, the identification of the worst-off individuals varies greatly. These results illustrate how the well-being concept adopted is relevant not only from a conceptual perspective but also from an empirical point of view.

Finally, our data allows us to compare different methods to elicit preferences. The evidence suggests that the results are sensitive to the method employed, suggesting more work is needed to address potential problems associated with the elicitation mechanisms employed.

The paper is structured as follows. In Section 2 we discuss the virtues and challenges of considering (incomplete) heterogeneous preferences when measuring the well-being of individuals. In Section 3 we introduce the ABDC, the instrument used to elicitate preferences and briefly discuss other methods available to elicitate

preferences. Section 4 describes the data and the experimental design. Section 5 presents the empirical results. Finally, Section 6 discuss our main conclusions.

2 Well-being and Preferences

We aim to construct a well-being measure W to perform interpersonal well-being comparisons. This measure is an index, summarising the situation of an individual in the relevant life dimensions. Let the outcomes of individual i in the m relevant life dimensions be described by the m-dimensional vector ℓ_i. For simplicity, the set of all possible life situations $\mathcal{L}$ is assumed to be non-negative, i.e. $\ell \in \mathcal{L}$ and $\mathcal{L} \in \mathbb{R}^m_+$. If $m \geq 2$, the comparison of two alternatives ℓ and ℓ' (except in the rare cases where one vector dominates the other i.e. has the same or more in all dimensions) requires the use of some scheme of relative weights among dimensions. Respecting individual preferences implies using relative weights reflecting each individual's own idea about what is important in life.

Let $\succeq_i$ denote the preferences relation of individual i. Standard welfare economics typically defines the weak and strict revealed preference relations as follows: $\ell R \ell'$ if ℓ is weakly preferred over ℓ' and $\ell P \ell'$ if ℓ is strictly preferred over ℓ'. For an individual i, her well-being is a function of her outcomes and her preferences $WB(\ell_i, \succeq_i)$. Preferences may differ among individuals i.e. $\succeq_i \neq \succeq_j$.

What principles a well-being measure suitable to perform interpersonal comparisons should accomplish? Let us introduce first a Dominance Principle.

Dominance Principle: $W(\ell_i, \succeq_i) \geq W(\ell_j, \succeq_j) \Leftrightarrow \ell_i \geq \ell_j$; $\quad W(\ell_i, \succeq_i) \gg W(\ell_j, \succeq_j) \Leftrightarrow \ell_i \gg \ell_j$.[2]

This principle states that if the situation described by the vector ℓ_i weakly dominates (has more or the same) in all m-dimensions compared to ℓ_j, then the well-being assigned to $W(\ell_i, \succeq_i)$ is at least the same as $W(\ell_j, \succeq_j)$. If ℓ_i strictly dominates ℓ_j (has more in all dimensions) then $W(\ell_i, \succeq_i)$ is greater than $W(\ell_j, \succeq_j)$.

[2]Let $\geq$, $>$ and $\gg$ denote the standard vector relations, where $\ell \geq \ell'$ if the vector ℓ has more or the same in the m-dimensions, $\ell > \ell'$ if the vector ℓ also has more in at least one dimension, and $\gg$ if the vector ℓ has more in all m dimensions.

Note how, the dominance principle only looks at the space of outcomes, not being affected by preferences. If the only dimension of life considered is income ($m = 1$), the application of the dominance principle is reduced to making interpersonal comparisons based on income levels. However, the greater the number of dimensions considered, the more unlikely will be to observe dominance.

In the absence of dominance, it turns necessary to aggregate dimensions to perform interpersonal comparisons. Let us introduce a Preference Principle to be imposed on the procedure of aggregating dimensions.

Preference Principle: $W(\ell_i, \succeq_i) \geq W(\ell_j, \succeq_i) \Leftrightarrow \ell_i R_i \ell_j; \quad W(\ell_i, \succeq_i) > W(\ell_j, \succeq_i) \Leftrightarrow \ell_i P_i \ell_j$.

The Preference Principle states that if according to individual i's preferences $\succeq_i$, ℓ_i is (weakly) preferred over ℓ_j, then the well-being measure should assign greater well-being to $(\ell_i, \succeq_i)$. Respecting preference heterogeneity implies admitting the possibility that the well-being of two individuals with the same objective situation might differ i.e. $W(\ell_i, \succeq_i) \neq W(\ell_j, \succeq_j)$ with $\ell_i = \ell_j$ and $\succeq_i \neq \succeq_j$.[3]

Unfortunately, these two principles are incompatible as the following example by [Brun and Tungodden, 2004] illustrated in Figure 1 shows. In the example is assumed for simplicity ($\mathcal{L} \in \mathbb{R}^2_+$) and preferences $\succeq$ are represented with indifference curves.[4]

From the figure we observe how ℓ_i dominates ℓ_j. Applying the Dominance Principle: $W(\ell_i, \succeq_i) \geq W(\ell_j, \succeq_j)$. By the Preference Principle ℓ'_i is ranked better than ℓ_i given the preferences $\succeq_i$, which leads to $W(\ell'_i, \succeq_i) > W(\ell_i, \succeq_i)$. Then, according to the Dominance Principle we have: $W(\ell'_j, \succeq_j) > W(\ell'_i, \succeq_i)$. If we apply the Preference Principle once again, we obtain $W(\ell_j, \succeq_j) > W(\ell'_j, \succeq_j)$. By transitivity we obtain $W(\ell_j, \succeq_j) \succ W(\ell_j, \succeq_j)$ which is not possible.

[3] As it is discussed in [Decancq et al., 2015b] the use of subjective well-being measures like happiness or satisfaction with life, does not accomplish the Preference Principle (nor the Dominance Principle).

[4] To represent preferences using indifference curves completeness and transitivity must be assumed (see [Mas-Colell, 1995]). In this paper, we do not assume completeness as will be discussed later in this section, but to simplify the exposition of the Equivalence Approach we will first assume completeness which allows representing preferences through indifference curves. The arguments outlined under this assumption can be extended to our setting with incomplete preferences, where contour sets will be used to represent preferences instead of indifference curves.

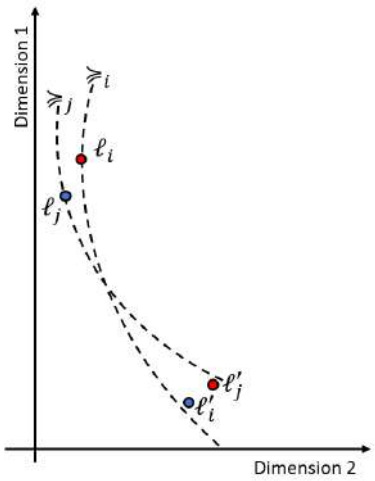


Figure 1: Incompatibility between Preference Principle and Dominance Principle

As long as more than one dimension of life is considered, if preferences differ is always possible to obtain an incompatibility as the one illustrated. To avoid such incompatibles we need to weaken one of the principles. In this paper, we follow the route proposed by [Decancq et al., 2015a] of weakening the Dominance Principle keeping preferences untouched. Let $\mathcal{B}$ be a subset of $\mathcal{L}$ which is a monotone path (i.e. $0 \in \mathcal{B}$, $\mathcal{B}$ is unbounded and connected) and for every pair of vectors ℓ and ℓ' in $\mathcal{B}$: either $\ell \geq \ell'$ or $\ell \leq \ell'$. Instead of requiring that our welfare measure complies with dominance in $\mathcal{L}$, we require it only in a subset $\mathcal{B}$, as the following principle establishes.

Restricted Dominance Principle: For all $\ell_i, \ell_j \in \mathcal{B}$, $W(\ell_i, \succeq_i) \geq W(\ell_j, \succeq_j)$ if $\ell_i \geq \ell_j$ and $W(\ell_i, \succeq_i) > W(\ell_j, \succeq_j)$ if $\ell_i \gg \ell_j$.

As shown in [Decancq et al., 2015a] combining the Restrict Dominance Principle with the Preference Principle characterizes the well-being ordering that compares individuals in terms of their equivalent incomes. The equivalent income is defined as the solution x_i^{1*} to the equation:

$$W(\ell_i, \succeq_i) \sim W(\ell_i^*, \succeq_i)$$

Where $\ell_i = [x_i^1, x_i^2, ..., x_i^m]$ describes the situation of individual i, the first dimension of well-being listed (denoted with a superscript x^1) is income (hence the name *equivalent income*), and ℓ_i^* is an alternative situation, where $\ell_i^* = \left[x_i^{1*}, \widehat{x^2}, ..., \widehat{x^m}\right]$ means that in the vector ℓ_i^* the other $m-1$ dimensions of life are set in a reference value. If we set the reference situation at an optimal level, equivalent incomes can be used as an interpersonal multidimensional well-being measure that respects individual preferences.[5] It takes into account the current situation of the individual in all relevant life dimensions and subtracts from income the individual's willingness to pay for the reference situation. Equivalent incomes are a useful practical tool to map the situation of individuals from an m dimensional space into a one-dimensional space using individuals' preferences to do so. Being a uni-dimensional measure, with both an ordinal and a cardinal interpretation, it has several practical advantages. For instance, we can calculate standard measures of well-being inequality using equivalent incomes as the argument.

Let us illustrate how equivalent incomes work through an example. Figure 2 assumes two dimensions of life, income and health (x^1, x^2), but the idea can be easily extended to more dimensions (in fact the empirical part of this paper works with three dimensions). The bundle represented by ℓ_i in Figure 2 determines the outcomes (income and health) of individual i while the indifference curve $(\succeq_i)$ determines her preferences. The subset $\mathcal{B}$ contains all the bundles where the health level is fixed in an optimal situation $\widehat{x^2}$. Note first how, while individual i is better than individual j in terms of income, the opposite is true in terms of health, which turns impossible comparing their well-being using only the dominance principle.

We use the indifference curves of each individual ($\succeq_i$ and $\succeq_j$) to map their current situation to a reference situation in $\mathcal{B}$. Because every point in $\mathcal{B}$ has the reference optimal level of health, we can now compare the well-being of individuals

[5]The choice of the reference level is a normative question and has crucial implications on the resulting equivalent incomes.

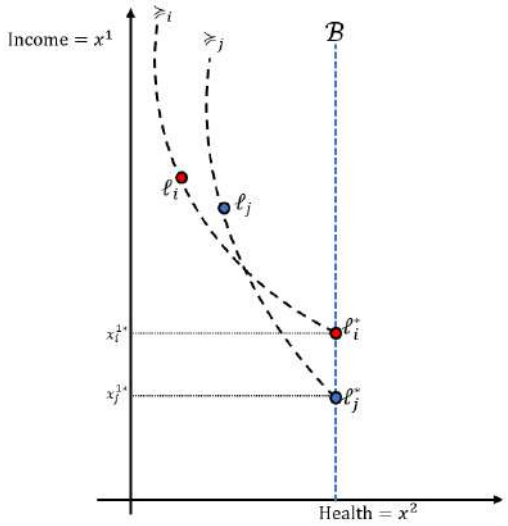


Figure 2: Example Equivalence Approach

restricting our attention to the red points ℓ_j^* and ℓ_i^*, which implies comparing their equivalent incomes x_i^{1*} and x_j^{1*}, concluding $W(\ell_i, \succeq_i) > W(\ell_j, \succeq_j)$.

We have not discussed yet what assumptions we impose on the preferences relations $\succeq$. We assume that $\succeq$ is **monotonic** (if $\ell \geq \ell'$, then $\ell \succeq \ell'$, if $\ell > (\gg)\ell'$, then $\ell \succ \ell'$) and **transitive** (if $\ell \succeq \ell'$ and $\ell' \succeq \ell''$ then $\ell' \succeq \ell''$).

Imposing monotonicity implies that all the relevant life dimensions $\mathcal{L}$ are seen by individuals as desirable goods for which they do not experience satiety (at least up to the optimal value which characterizes $\mathcal{B}$). This assumption seems reasonable in our empirical application, where $\mathcal{L}$ is conformed by three dimensions: income, health, and social relationships. We will discuss these dimensions and our data in greater detail in section 4.

Key evidence exists challenging the idea that individuals' preferences are always transitive (see for instance [Tversky, 1969] and [DellaVigna, 2009]). We will follow the route proposed by [Bernheim and Rangel, 2009] of 'pruning' the welfare-relevant domain and work only with individuals who exhibit transitive preferences

under the frame of our empirical application. Violations of transitivity are seen as changes in the frame of choice experienced by the individual not perceived by the observer. We believe that restricting our attention to individuals who fulfill transitivity under the proposed choice framework is a reasonable assumption.

We do **not** assume **completeness** of preferences. Incompleteness in preferences happens when an individual is unable to decide which option to prefer between two alternatives. Take the case of a young person who enjoyed her whole life in perfect health but in poverty, and is asked to make a decision under a hypothetical scenario where she would be suffering from a terminal disease but would also be a millionaire. This person could be unable to make a choice because the proposed alternative looks too abstract for her and simply has no formed preferences about it. As Nielsen (forthcoming) argues, many anomalies in preferences could be understood as the result of assuming completeness of preferences and forcing individuals to choose between alternatives where their preferences are incomplete.

Leaving the assumption of complete preferences implies that indifference curves are no longer adequate to represent preferences. More suitable is the use of Contour Sets.

Let $\mathcal{D}$ represent the domain of preferences relations that satisfy monotonicity and transitivity, with $\succeq_i \in \mathcal{D}$ for all i. Given a bundle ℓ, and a preference relation $\succeq$, there exists a subset of $\mathcal{L}$ containing those ℓ' preferred to ℓ according to $\succeq$. This set is called the Upper Contour Set. In the same way, the Lower Contour Set contains all the alternatives that are not preferred. More formally:

$$UC(\ell, \succeq) = \left\{\ell' \in \mathcal{L} | \ell' \succeq \ell\right\}.$$

$$LC(\ell, \succeq) = \left\{\ell' \in \mathcal{L} | \ell P_i \ell'\right\}.$$

We do not assume preferences to be complete. Those alternatives ℓ' that $\succeq$ is not able to rank, belong not to $UC(\ell, \succeq)$ nor to $LC(\ell, \succeq)$. In this case we say that the alternative belongs to the Non Comparable Set, denoted $NC(\ell, \succeq)$, which is formally defined as:

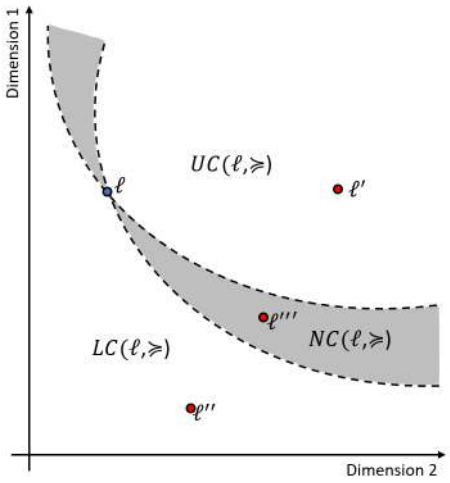


Figure 3: Example Contour Sets

$NC(\ell, \succeq) = \mathcal{L} \setminus (UC(\ell, \succeq) \cup LC(\ell, \succeq))$.

As preferences are assumed to be monotonic and transitive, the size of the $NC(\ell, \succeq$) is restricted. In particular, the NC becomes smaller as the $UC(LC)$ expands.

Figure 3 illustrates how incomplete preferences can be represented using Contour Sets, assuming $\succeq \in \mathcal{D}$. In this example, according to the preference relation $\succeq$: $\ell' P \ell$ i.e. $\ell' \in UC(\ell, \succeq)$, $\ell P \ell''$ i.e. $\ell'' \in LC(\ell, \succeq)$ and $\ell D \ell'''$ i.e. $\ell''' \in NC(\ell, \succeq)$.

3 Elicitating Equivalent Incomes

Estimating equivalent incomes is relatively demanding in terms of information. This is because observing the vector of outcomes ℓ is not enough, it is also necessary to have information about preferences $\succeq$. However, to compare the well-being of two individuals i and j, it is sufficient to estimate ℓ_i^* and ℓ_j^* (not being necessary to estimate the full Contour Sets). It is only the intersection with $\mathcal{B}$ that we need to

know. This can be done in a non-parametric way using the "Adaptive Bisectional Dichotomous Choice' algorithm (ABDC) proposed by [Decancq and Nys, 2021].[6]

Under our setting of assumption on $\succeq$, take any ℓ' in $\mathcal{L}$. For individual i with preferences $\succeq_i$ and a life represented by ℓ_i, it is possible to determine if ℓ' belongs to her Upper, Lower, or Non-Comparable Set by asking i to answer a succession of comparisons between her life and different $\ell' \in \mathcal{B}$. This procedure allows us to reasonably approximate ℓ^* and estimate x_i^{1*} (the level of income that: if combined with the level of health and social relationships in $\mathcal{B}$, makes the well-being of individual i equal to her actual level of well-being under ℓ_i).

This is precisely what the ABDC does. Individuals are presented with successive rounds of choices where they have to indicate if they prefer their actual life ℓ_i or a hypothetical alternative ℓ'. The algorithm proceeds iterative, in each round the hypothetical life is situated in the middle of the interval where ℓ^* should be, based on the responses to previous choices. As the preference relation $\succeq$ is assumed to be monotonic and transitive, each iteration allows to narrow the set of possible points where ℓ^* is estimated to be, provided that the respondent is able to rank the two alternatives i.e. has complete preferences among the alternatives presented.

In the first iteration we know ℓ^* lies somewhere in $\mathcal{B}$, being $\underline{\widehat{\ell^*}} = [0, \widehat{x^2}, \widehat{x^3}]$ the lower bound and $\widehat{\overline{\ell^*}} = [x^1, \widehat{x^2}, \widehat{x^3}]$ the upper bound, thus the alternative life (ℓ') will be located in the middle: $\ell' = [\frac{x^1}{2}, \widehat{x^2}, \widehat{x^3}]$. If $\ell' P_i \ell_i$, we can update the lower bound to $\underline{\widehat{\ell^*}} = [\frac{x^1}{2}, x^{2*}, x^{3*}]$ and the hypothetical life for the next iteration will be $\ell' = [\frac{3x^1}{4}, x^{2*}, x^{3*}]$. An analogous reasoning applies in case $\ell_i P_i \ell'$ is observed. If $\ell_i D_i \ell'$ is observed, then it is concluded that $\ell' \in NC(\ell_i, \succeq_i)$ and the algorithm stops.

The ABDC iterates K times, multiplying in each k the level of income presented in the hypothetical alternative by a ratio r_k, which is a function of the choice made by the respondent in $k-1$, as follows:

$$r_k = r_{k-1} + \frac{d_{k-1}}{2^k}$$

[6]The authors use the ABDC algorithm to fully chart the contour sets. In our case, we are only interested in the intersection with $\mathcal{B}$, which requires less demanding assumptions about preferences and fewer steps of the algorithm.

where:

$$\begin{cases} d_{k-1} = 1 & \text{if} \quad \ell_i P_i \ell' \quad \text{i.e. individual indicates she prefers her actual life} \\ d_{k-1} = -1 & \text{if} \quad \ell' P_i \ell_i \quad \text{i.e. individual indicates she prefers the alternative life} \\ end & \text{if} \quad \ell_i D_i \ell' \quad \text{i.e. individual indicates she does not know} \end{cases}$$

and $r_0 = 0$ and $d_0 = 1$. In the first iteration, $r_1 = 1/2$. In the second iteration ($k = 2$), $r_1 = 3/4$ if $d_1 = 1$ or $r_1 = 1/4$ if $d_1 = -1$. The ABDC is iterated 10 times unless a respondent answers "I don't know" or the income difference between two successive iterations is smaller than 1. We show an example of a screenshot showed to participants when answering the ABDC on Figure 7 in the Annex. Figure 4 illustrates the ABDC at work.[7]

To simplify the explanation, we suppressed one dimension in our graphical representation, but $\mathcal{B}$ actually is a plane in R^3 where both health and social relationships are set in an optimal reference situation.

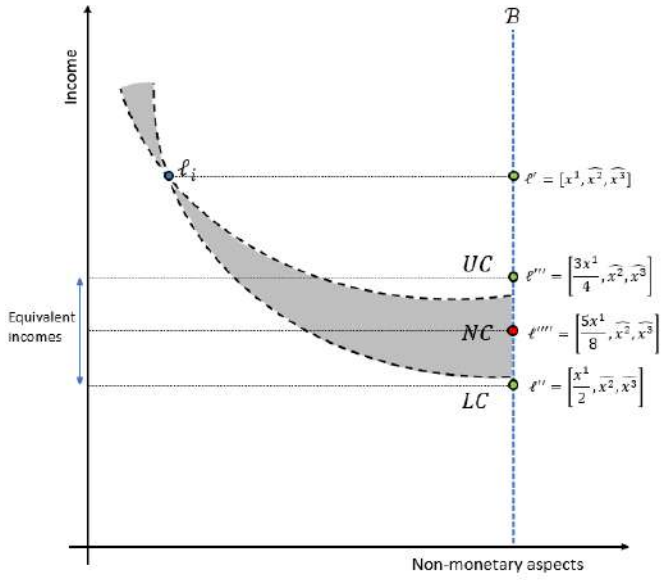


Figure 4: Example ABDC at work

[7]In this figure preferences are assumed to be convex. As we are interested in estimating only the points in $\mathcal{B}$, this assumption is not needed.

In Figure 4 individual i has a life represented by the vector $\ell_i = [x_i^1, x_i^2, x_i^3]$, where x_i^1 is her income (represented in the ordinate axis), while x_i^2 is her health and x_i^3 her social relationships. Her preferences $\succeq$ are represented by Contour Sets (the black shaded area represents the Non-Comparable Set (NC)).

In the first iteration of the ABDC the individual will be asked to state what life she would prefer if it was possible for her to choose between her life ℓ_i, and the hypothetical life ℓ'', where income is halved while health and social relationships are set in an optimal reference level. Given her preferences we will observe $\ell_i P_i \ell''$ which implies $d_1 = 1$. In the next iteration, the choice is between ℓ_i or ℓ''', and $\ell''' P_i \ell_i$ will be observed. In the third iteration, the hypothetical life belongs to the Non-Comparable Set, so $\ell'''' D_i \ell_i$. As a result, the individual will answer 'I don't know' and the ABDC will stop. We assume $\ell_i^* = \ell''''$ which is the middle point between ℓ'' and ℓ''' (in Burone and Decancq (forthcoming) we study alternatives to the middle-point approach). As long as the individual is able to compare the two alternatives, the ABDC will continue narrowing the segment $[\underline{\widehat{\ell^*}}, \widehat{\overline{\ell^*}}]$.

the ABDC is our main approach to estimating equivalent incomes. Additionally, we applied two other methods. Namely, the Contingent Valuation and Life Satisfaction approaches.

The Contingent Valuation (CV) method consists of directly asking individuals about the level of income that combined with perfect health and social relationships, would make their life equally good for them as their life at the moment through an elicitation format closer to an open-ended one. Under this approach, individuals are required first to indicate where that level of income would be by selecting intervals from a drop-down menu. In the second step, they are asked to provide a precise estimate. Finally, they have to confirm if the hypothetical life with the level of income chosen, combined with perfect health and social relationships is equally good for them as their actual life. Figure 8 provides screenshots for each step.

This method is more direct but in our view encompasses a higher risk to lead to less thoughtful responses, while the ABDC has the advantage of giving more time

for preferences to unfold. A drawback commonly cited in the literature regarding open-ended formats is the high proportion of extremely high values and 'protest zeros' observed ([Hoehn and Randall, 1987], [Arrow et al., 1993]).[8]

Finally, the Life Satisfaction approach to estimate equivalent incomes consists of retrieving information about preferences from life satisfaction data. We refer the reader to [Decancq et al., 2015a] for a detailed explanation of this approach. The general idea is to estimate an equation like the following:

$$S_i = \beta_0 + (\beta_1 + \gamma_1 \Lambda_i)' log(x_i^1) + (\beta_2 + \gamma_2 \Phi_i)' x_i^2 + (\beta_3 + \gamma_3 \Omega_i)' x_i^3 + Z_i \gamma_4 + \epsilon_i \quad (1)$$

Where S_i is the response of the individual to a life satisfaction question. In this specification, β_1 captures the direct effect income has on life satisfaction, γ_1 is a vector of interaction effects to be estimated, which combined with the matrix Λ (containing socio-demographic characteristics) gives interaction effects of income on S_i. Direct and interacted effects for the other relevant life dimensions x^2 and x^3 are also estimated. γ_4 captures the effect other socioeconomic characteristics (contained in the matrix Z) may have on life satisfaction, and ϵ_i is a disturbance term.[9]

Once the vectors of parameters $(\beta_0, \beta_1, \beta_2, \beta_3, \gamma_1, \gamma_2, \gamma_3, \gamma_4)$ are estimated in the previous equation, Marginal Rates of Substation of income with respect to the other life dimensions are computed to determine the equivalent income that combined with perfect health and social relationships would make the individual indifferent. Following these steps, we end up with the following expression:[10]

[8]The literature is divided regarding the best method to elicit stated preferences. While avoiding open-ended formats was strongly recommended by the NOAA report [Arrow et al., 1993], other authors have argued in favor of this format [Green et al., 1998] and are critical of the potential bias induced by Dichotomous choice formats. The state of the art in the literature seems to validate the use of stated preference techniques if good practices regarding the framing of the questionnaire are applied, but the best elicitation format remains as an open question, the answer to which is likely dependent on the research question at hand.

[9]It is advised in the literature to work with Panel Data to capture individual fixed effects. We explored this route, but for our empirical application working with cross-sectional data seems more adequate. Nevertheless, the results using Panel Data do not change substantially.

[10]To apply this method we need to assume that the consistency assumption holds (see [Decancq et al., 2015a].

$$x^{1*} = x^1 exp\left[\frac{(\beta_2 + \gamma_2\Phi_i)'(x_i^2 - \widehat{x^2}) + (\beta_3 + \gamma_3\Omega_i)'(x_i^3 - \widehat{x^3})}{(\beta_1 + \gamma_1\Lambda_i)'}\right]$$

A limitation of this approach is that it allows the identification of average preferences of subgroups determined by the socioeconomic characteristics described in Φ, Ω, and Λ, but is not possible to identify additional variation at an individual level.

Our preferred method to estimate equivalent incomes is the ABDC. We also applied the Contingent Valuation and Life Satisfaction approaches to compare and discuss the results in section 5.

4 Data

We made use of the LISS (Longitudinal Internet studies for the Social Sciences) panel, administrated by CentERdata (Tilburg University, The Netherlands). This online panel comprises a probability-based sample of Dutch-speaking households randomly drawn from the national population register.[11] The Panel has been in full operation since October 2007. Panel members are paid for each completed questionnaire.

A special questionnaire designed to apply the ABDC considering three dimensions of life was applied to a sub-sample of the LISS panel, where individuals aged between 25 to 75 years old were invited to participate. Each respondent was offered a reward of 2.5 € for completing the questionnaire. The first pilot was applied to 205 individuals in December 2020. The main data collection took place in February 2022. 3269 household members were invited to participate, with a response rate of 77.8%. In Table 2 we present the results from a Probit model estimated to explain participation. The evidence suggests a greater probability of rejecting participation for individuals who are: younger and female.

We excluded from our analysis incomplete responses, inconsistent responses, or suspicious patterns of response (based on the time spent answering or the behav-

[11] For more information, please visit www.lissdata.nl/about-panel

ior through the questionary). Table 3 presents all the details regarding the cleaning data process. In total, the discarded observations represent 10% of the total accepted invitations. The final number of observations included in our analysis is 2288.

Below we explain in greater detail how we captured the relevant life dimensions considered in our empirical application: Income, Health, and Social Relationships.

4.1 Personal Income

For personal income, we computed the net per capita income of the household measured in €. We describe the life of each individual by per capita income and not by household income, even in cases where the respondent is the only member of the household who receives an income.[12]

The reason to consider personal income is that we are interested in how much income individuals are willing to give up for a situation of reference in their personal sphere, when they are not concerned about how a certain change in their income might affect other members of the household. We therefore ask participants to abstract from how a change in their per capita income might affect the well-being of other household members by assuming that the level of income they are being asked for, only affects their life and not other members of their household. This consideration does not affect individuals who live alone. For those who live with more people the following extra explanation was provided.

> "*We have computed your income as ... . Your income is the part of your family income that goes to you (to pay for food and clothing, but also to pay for your share of the shared costs such as internet, heating or rent). When choosing between the two situations, always assume that a reduction in your income only applies to you and not to other family members* "

[12] Another possibility could have been to use equivalence scales to calculate personal income. This idea was discarded to ensure the correct understanding of respondents using a concept more intuitive and easier to communicate.

In addition, in each screen of the ABDC the following message was also included:

> "*Remember, we assume that changes in your income only affect you (and not other members of your household)* "

In the questionnaire the net household income and the number of household members were pre-loaded, but participants were asked to confirm if this information was correct or adjust it in case it was not updated. 70,85% of respondents agreed with their pre-computed per capita income, and those who performed adjustments in general applied small changes.[13] Descriptive Statistics for personal income are presented in Table 1, together with an histogram of the distribution in Figure 5.

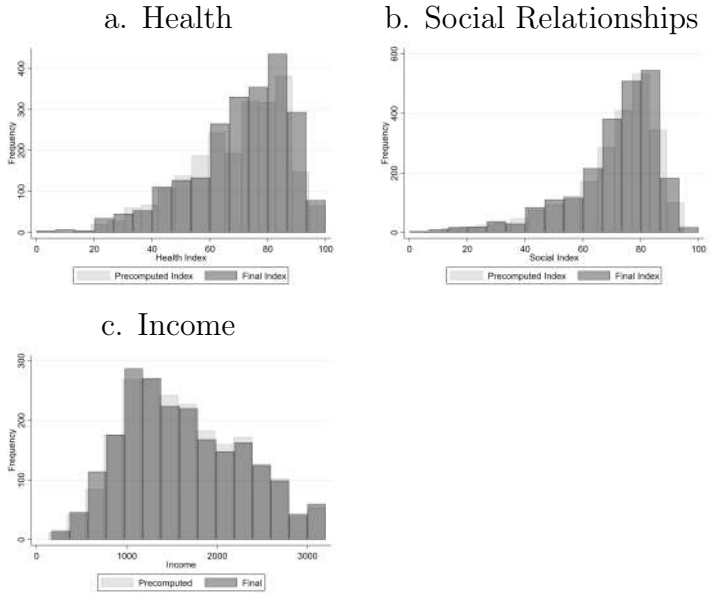
In the rest of the paper, when we refer to income we are referring to the net per capita income of the household after adjustments.

Table 1: Descriptive statistics dimensions of well-being

	Mean	**p50**	**p25**	**p75**	**Min**	**Max**	**SD**	**N**
Income (final)	1788	1585	1,125	2229	165	73708	1866	2288
Income (pre-computed)	1771	1607	1150	2220	133	73708	1708	2288
Health (final)	69	72	58	83	13	100	17	2288
Health (pre-computed)	70	74	60	83	0	100	18	2288
Social (final)	70	74	63	81	5	95	16	2288
Social (pre-computed)	71	75	65	81	0	100	16	2288

[13] On average the adjustments implied a reduction of 57 € (Std. Dev. 1469), and the median adjustment was a reduction of 37.5 €. If we consider the absolute value of the adjustments made, the mean is 525 (Std. Dev. 1372), and the median 200. No significant differences were found in the socioeconomic characteristics of individuals who corrected their income compared to those who did not.

Figure 5: Distribution of health and social relationships indexes, and income



Notes: Vertical lines represent the absolute frequency. For health and social relationships the index ranges between 0 and 100. For income, we excluded from the graph the top 5%.

4.2 Health and Social Relationships

Health status was measured using information from the Health Core Module of the LISS Panel. We constructed an index to capture both physical and mental health, composed of 10 sub-dimensions (in Figure 9 we list the dimensions used).[14]

The index ranges between 0 (worst possible situation) and 100 (best possible situation). To construct the index we proceed in three steps. First, we re-scaled all the sub-dimensions so that they range between 0 and 10. In a second step, using all individuals from Wave 13 in the Health Core study (the data from this wave was collected in November and December 2020) we run a regression to explain the

[14]To choose the sub-dimensions we reviewed a standard battery of health questions, namely the 12-Item Short Form Health Survey (SF-12), and we picked our dimensions prioritising the use of similar objective information already contained in our data. A second criterion to adjust the final composition of the indexes was to avoid sub-dimension where most individuals had a similar score, to increase the variance in the distribution.

self-perceived health of individuals.[15] The estimated coefficients were used as relative weights for each sub-dimension in the index (the final weights are presented in the last row of Figure 9). Using information from Wave 14 (this information was collected during November and December 2021) we computed a health index for each respondent.

Finally, participants in the questionnaire were presented with their index and were informed about the sub-dimensions considered to construct it. They were asked to reflect on their health situation and indicate their level of agreement with the index on a scale from 1 (strongly disagree) to 5 (strongly agree). If the level of agreement was 1, 2 or 3, they were asked to correct the index so that it reflects their health situation according to themselves. Most respondents (80%) agreed with their index and did not perform corrections.[16] Figure 5 (Panel a) presents the final distribution of the Health Index. Descriptive statistics for both the original and adjusted indexes are presented in Table 1.

To construct the social relationships index, we proceeded in a similar way. Using information from the Social relationships and Leisure Core study we constructed an index composed of 10 sub-dimensions (in Figure 10 we list the dimensions used).[17]

The index ranges between 0 (worst possible situation) and 100 (best possible situation). Firstly, we re-scaled all the sub-dimensions between 0 and 10. Then, using all individuals from Wave 13 (the data from this wave was collected in October and November 2020) we run a regression to compute relative weights of each sub-dimension (the final weights are presented in the last row of Figure 10).[18] Us-

[15]The dependent variable in the regression is self-perceived health on a scale from 1 to 5, and the explanatory variables are the 10 sub-dimensions contained in the index and demographic characteristics of individuals

[16]Those who did corrections in most cases applied small changes (on average the corrections applied to imply a reduction of 4.19 (Std. dev. 15.41).

[17]To choose the sub-dimensions we reviewed the literature that use social relationships indexes to measure Social relationships for the general population, and we picked our dimensions prioritising the use of similar objective information already contained in the LISS data. A second criterion to adjust the final composition of the indexes was to avoid sub-dimension where most individuals had a similar score, to increase the variance in the distribution.

[18]The dependent variable in the regression is satisfaction with social contacts on a scale from 1 to 10, and the explanatory variables are the 10 sub-dimensions contained in the index and demographic characteristics of individuals

ing information from Wave 14 (this information was collected during October and November 2021) we computed a social relationships index for each respondent.

Respondents were presented with their Social index and informed about the sub-dimensions considered to construct it. They were asked to indicate whether they agreed with the index or correct it otherwise. Most respondents (88%) agreed and did not perform corrections. Those who did corrections in most cases applied small changes (on average the corrections applied, imply a reduction of 4.6 (Std. dev. 17.35). Figure 5 (Panel b) presents the final distribution of the social relationships index. Descriptive statistics are also presented in Table 1.

4.3 Experimental Design

Our sample of participants was divided into three groups differentiated with respect to the block(s) of experimental questions answered. The assignment to each group was randomised. 80% of respondents were assigned to Group A, this group only completed the ABDC (our main method). 10% of respondents answered the block of questions corresponding to the ABDC first, and the Contingent Valuation block of questions later, we call this Group B. Finally, Group C completed first the Contingent Valuation questions and after that the ABDC. As the ABDC and the Contingent Valuation questions estimate the willingness to pay for the same situation of reference, being asked first by one method may influence the answers in the second block of questions faced by respondents. Note however, that respondents in Group B faced the exact same questionnaire up to the point when they finished answering the ABDC which makes their responses regarding the ABDC fully comparable with those from Group A.

To simplify the exposition, we discuss the results including only observations from groups A and B (unless indicated differently). In general, the results are robust to the inclusion of observations from Group C, but to avoid presenting every result twice we exclude them from the main analysis. Only in those cases in which the results of group C are of interest by them-self (section 5.4), or important differences in results were observed, we will refer to them.

One first version of the questionnaire was applied to 205 respondents in December

2021. In this version of the questionnaire, many open-text questions were included to obtain qualitative information about the understanding of respondents and identify potential problems in our questionnaire.

The average time spent by respondents completing the full questionnaire was 8 minutes (the median time was 6 minutes).[19] The complete questionnaire can be consulted on the LISS Panel website.[20]

The questionnaire begins with an introductory screen explaining the purpose and objective of the research. After the introduction, respondents were requested to confirm/adjust their situation in each of the well-being dimensions (as explained in the previous section).[21] Next, an introductory instructive screen was shown where the income concept was explained followed by an example of a hypothetical dichotomous choice, in which income was reduced by one euro while health and social relationships were set in our reference optimal level (both dimensions on a score of 100).[22] Individuals were explained that several similar questions were going to be asked in which they would have to compare their own life to hypothetical alternatives and choose which life they would prefer to live for the next twelve months, assuming that all other aspects of life remain unchanged.

Then, a 'training' dichotomous choice was presented in which income remained unchanged whereas health and social relationships were set at an optimal level. Given that the alternative life presented in this screen dominates the actual life of the individual, respondents are expected to choose the alternative life provided they have monotonic preferences in the relevant dimensions of well-being and that they understood the logic of the question. 83% of the respondents choose the alternative life in this first training question. For those respondents who choose either, "I don't know' (3%) or "My life' (14%), an extra explanation was provided

[19]This excludes 92 respondents who completed the questionnaire on different days. For respondents in Group A (excluding Group B), the average time spent was 7.83 minutes (median 6 minutes).

[20]See [link forthcoming]

[21]Respondents were said that the sub-dimensions listed should be used as reference only if they considered them important for themselves, but that they did not have to take these dimensions into account in case they find them irrelevant for their health or social relationships.

[22]During our pilot we provided many open text boxes so that respondents leave their comments, the results suggest that respondents did not have difficulties understanding the concept of income handled in the questionnaire.

in which they were explained that they were being asked if a zero-cost improvement in their health and social relationships means an improvement for them.[23]

After these training questions, intended to make respondents familiar with the task to be completed, the successive dichotomous choices based on the ABDC were presented. On average, respondents spent 9.13 seconds on each screen of the ABDC. Descriptive statistics about the time spent on each screen are presented in Table 4. The average time spent answering the rounds of the ABDC was 1.33 minutes (1.48 for respondents who answered up to 10 rounds). If we consider the total time spent answering the ABDC, including the time spent reading the instructions and the training questions, the average time spent was 2.87 minutes (2.98 for respondents who answered up to 10 rounds). More detailed information regarding the time spent completing the ABDC can be found in Tables 4 and 5 and in Figure 14. On average, individuals answered 8 rounds of the ABDC. Figure 11 and Table 6 summarise the choices made by participants.[24]

For Groups B and C, an extra block was presented with the Contingent Valuation questions. Individuals assigned to Group C, first saw a training question to make them familiar with the Dichotomous Choice questions, as for them this was the first block of questions answered. Respondents from Group C spent on average 63 seconds answering the training questions. 73% of respondents from Group C answered correctly the first training question, the remaining 27% (66 individuals) were presented with an extra explanation and the question was re-asked. 37 individuals indicated again that they prefer their life (for them the CV block of questions ended here).[25] For the remaining respondents the CV block of questions took on average 54 seconds (55 if we only consider individuals from Group C).[26]

[23]Some respondents indicated to be fully satisfied with their current situation (they experience satiety) which means that they do not have monotonic preferences as assumed. Others indicated not knowing, which could be consistent with our assumptions about preferences provided that they remain consistent with this statement in their behavior answering the first round of the ABDC. In those cases where inconsistencies were observed, the respondents were excluded from our analysis as their preferences do not satisfy our assumptions (see Table 3)

[24]The results do not change if we include also Group C. Table 6 presents the detailed information also for Group C.

[25]28 of these 37 individuals indicated that the reason why they choose their life was that they are totally satisfied with their current life at the moment so they do not see the alternative as an improvement.

[26]For respondents from Group C, the CV block of questions including also the training ques-

At the end of the questionnaire, participants were asked a standard battery of questions regarding their impressions of the questionnaire. This information is presented in Figures 12 and 13. Most participants found the questions interesting and clear. However, there seem to be some differences for respondents in Group C. In this regard, the evidence suggests that answering first the CV block of questions made the experience slightly less enjoyable and a bit more difficult.

Now, we turn to the main part of our paper and we analyse multidimensional well-being taking into account preferences heterogeneity.

5 Results

This section is structured as follows. First, in subsection 5.1 we analyze respondents who exhibited incompleteness of preferences by selecting the option "I don't know' in the ABDC. In section 5.2 we apply the *Equivalence Approach* to analyze the well-being of individuals using the ABDC. In section 5.3 we study what are the main differences when we apply different well-being measures to identify the worst-off individuals. In section 5.4 we analyse the sensitivity of the results to variations in the method used to estimate equivalent income. Finally, we propose a parametric approach to perform policy analysis in a multidimensional setting with respect for individual preferences (combining the Equivalence Approach with the use of the ABDC) in section 5.5.

5.1 Probability of answering 'I don't know'

In this subsection, we are interested in analyzing if certain groups of respondents are more likely to indicate that they do not know which alternative they prefer. A first test, to rule out that indicating 'I don't know' is a strategic behaviour adopted to finish the questionnaire with minimum effort, is checking the time spent by participants answering. Figure 14 presents the average time spent by respondents answering the ABDC, differentiated by round and option chosen. Those rounds

tions took on average 119 seconds.

where respondents choose the option 'I don't know', are the ones in which more time is spent looking at the screen (this is consistent for every round). Although not conclusive, this result suggests that it is the incomplete nature of preferences that leads participants to choose this option, and not a strategic behavior to finish the questionnaire with minimum effort.[27]

We estimated a Probit model where the dependent variable equals one if the respondent chooses the option 'I don't know' at any round of the ABDC. The results are presented in Table 7.[28] Based on this analysis, we observe that among the dimensions of life considered, health seems to be the only significant dimension of well-being to explain answering 'I don't know', showing a negative effect (the greater the level of health, the lower the probability of answering I don't know). In this regard, individuals seem to have more complete preferences toward hypothetical situations that result more familiar to them i.e. similar to their actual life.

Being female was found to be associated with a lower probability of answering 'I don't know'. This effect is contrary to what was found by Nielsen and Rigotti (forthcoming). A similar negative effect was observed for being old, which could be associated with a greater reflection on the trade-offs raised in the problem of choice when aging. Regarding the effect of education, we observe an interesting result. Having a university education is associated with a higher probability of answering 'I don't know'. One possible interpretation is that college-educated respondents reflect more on their responses, although this explanation is preliminary and needs to be further investigated.[29] Being a pensioner is also associated with

[27]Deciding to choose the status quo ('My life') takes on average less time than choosing the alternative life, although the difference between these two options is not statistically significant in most rounds.

[28]Other specifications of the model as well as Ordered Probit models to predict choosing 'I don't know' at each round of the ABDC were estimated finding robust results.

[29]We explored some possible explanations to understand why having a university degree is associated with a greater probability of answering 'I don't know'. In the first ABDC training question where a zero cost improvement was proposed, while 18.47% of respondents in the group with no university education answered wrong (according to our assumptions of preferences), this number was only 8.5% in the group of respondents with university education. Restricted to the group of respondents who choose 'I don't know' at some point, the difference is even greater: 12.7% for respondents with no university education and only 1% for those with collegue-education. The time spent answering the first training question was also lower for the university-

a lower probability of showing incompleteness of preferences. It is likely that pensioners enjoy a greater level of certainty regarding their income and therefore have more certainty regarding the amounts they are willing to sacrifice if the proposed alternative was possible to be chosen. These were the only socioeconomic variable that showed significant effects.

A series of variables were also included to capture the evaluation of the questionnaire made by the respondent. We observed that reporting that the questionnaire made them think and that the questions were clear is associated with a greater probability of answering 'I don't know', while finding the questionnaire interesting is associated with a lower probability. Finally, the time spent looking at the screen in the last round answered has a positive effect on the probability of answering 'I don't know', suggesting that individuals who struggled with their answers are the ones whose preferences are incomplete.

In total 547 individuals from Groups A and B chose 'I don't know' at some round of the ABDC (100 did it at the first round). We asked them why. The main reasons are summarised in Table 8. Most of them indicated that their income is already too low to imagine lowering it even more (45%). The second most selected reason was that both situations were equally good for them (23%), while 14% stated that the difference between both alternatives was too small. For each of these reasons, we explored whether the objective data could support differences among respondents who did not choose the option 'I don't know'. We did not find significant differences, which suggests that the reason lies more in the subjective sphere (preferences) than in the objective sphere (outcomes).[30]

educated group. Regarding the evaluation of the questionnaire, no relevant differences were observed despite a slight tendency in the university-educated group to choose neutral levels of agreement with the statements. Despite the evidence does not allow us to find an explanation for why university-educated respondents are more likely to choose 'I don't know' as an answer, it does seem to suggest that it was not a lack of understanding that lead them to answer in this way. In fact, this is the group that seems to have understood better the questions asked. Perhaps, their educational background drives them to reflect more deeply about the questions asked, and this effect explains why more often they do not know exactly what option to choose.

[30]For respondents who indicated their income was already too low, we did not find significant differences in their level of income compared to the rest of the sample (despite being on average slightly lower). This result is robust to the concept of income used (per-capita or household level). For respondents who chose that both situations were equally good for them, we checked if their situation was closer to the hypothetical alternative (for instance because they were healthier)

An interesting feature to notice is how the marginal contribution of each successive round of the ABDC to the total number of 'I don't know' decreases (see Panel a in Figure 11). One could expect that as the ABDC progresses and the intervals become smaller, the proportion of 'I don't know' would increase since the participants are being asked for something more and more precise. However, we do not observe this pattern in the data. This could be interpreted as evidence suggesting that individuals with complete preferences are capable to answer with precision, while those who have incomplete preferences unfold their incompleteness even when the sucessive alternatives do not imply a 'just-noticeable difference' (see [Dziewulski, 2020]).

Our results suggest that respondents who choose 'I don't know', on average spent more time thinking about their responses, found the questionnaire more difficult, and more frequently report that it made them think. On average, they are also in a worse situation in terms of health and social relationships, but their incomes are not statistically different. The latter may suggest that it is easier to compare situations in individuals whose current life is closer (i.e. similar) to the reference life.

5.2 Individual well-being

In this section, we analyze our multidimensional measure of well-being, the equivalent incomes. As explained in Section 3, our strategy allows us to estimate intervals $\left[\underline{\ell^*}, \overline{\ell^*}\right]$ where the precise value is located, and we take the midpoint of these intervals as the precise value of equivalent income. Because most respondents answered several rounds before choosing the option 'I don't know', the estimation is highly precise in most cases i.e. in 62% of cases the width of the intervals is smaller than 2 (see Figure 15).

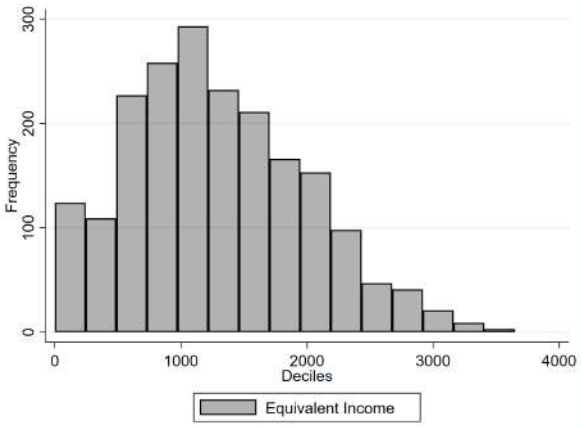
In Figure 6 we present histograms for Equivalent Incomes: Panel a shows the distribution of Equivalent Incomes only and Panel b overlaps it with personal income. The distribution of Equivalent Incomes is shifted to the left, which is expected given that the equivalent income is the income minus the willingness to pay for

than the average, again no significant differences were found in this respect.

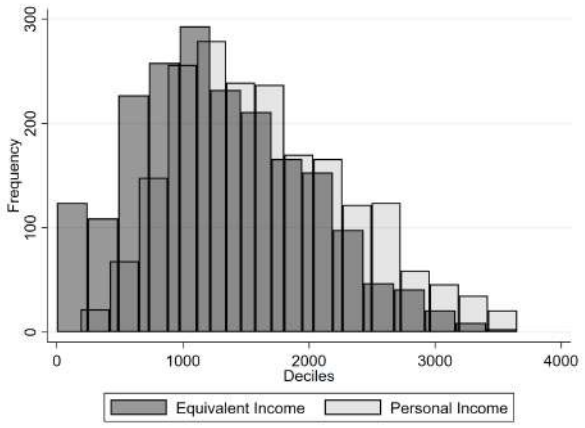
the reference situation according to each individual's preferences. Nonetheless, it is notable the mass of equivalent incomes' distribution in the interval 0-500, given that almost zero observations have a personal income that falls in this interval.

Figure 6: Histograms Equivalent Incomes

a. Equivalent Incomes



b. Overlap Equi. Incomes and Pers. Incomes



Notes: Panel a presents a histogram of equivalent incomes. Panel b presents the same information and also overlaps with a histogram for personal income. In both cases we excluded from the graph the top 1%.

For a given individual i, with an income given by x_i^1 and an equivalent income x_i^{1*}, we define the willingness to pay for the situation of reference as: $WTP_i = 1 - \frac{x_i^{1*}}{x_i^1}$. Panel a in Figure 16 shows the average WTP by Equivalent Income deciles.[31] From this Figure we learn that respondents who are in the first deciles by equivalent incomes are indeed those with the greater WTP for the situation of reference. However, the decreasing tendency on average WTP by equivalent income decile is not observed by income deciles (Panel b in Figure 16). In fact, we observe a U-shaped tendency for average WTP with respect to income deciles (despite this pattern is not statistically significant).

Panels c and d in Figure 16 present the average WTP by health and social relationships deciles. In general, in both figures, we observe that individuals in worse

[31] In general the results do not change if we include also Group C. They are also robust if we restrict the sample to include only equivalent incomes estimated with at least 4 rounds of the ABDC. These Figures were not included in the document due to extension but are available upon request from the authors.

health and worse social relationships are the ones with the greatest willingness to pay respectively, while the lowest willingness to pay is observed for those individuals in better health and who enjoy better social relationships. For deciles 2-8, we observe a decreasing tendency (stronger for health), but statistically significant differences are not always observed.

One first simple straightforward way to understand how our well-being measure depends on the well-being dimensions considered is analyzing the correlation coefficients. This information is provided on the left side in Table 9. As can be observed, equivalent incomes are positive and highly correlated with income (which is not a surprise). We observe also a positive and strong correlation with the Health Index. This correlation was expected to be observed, individuals in better health also have greater equivalent incomes, that is, they score better in our well-being measure. The same positive and significant effect is observed for the social index, but the correlation, in this case, is less strong.[32]

Given that Equivalent Incomes are the actual income of individuals after their willingness to pay (WTP) for the situation of reference is subtracted, it is interesting to analyze how the willingness to pay correlates with these three well-being dimensions. The correlation coefficients for each dimension are presented on the right side in Table 9. While income is not statistically correlated with WTP, health and social relationships are. Again, the correlation coefficients suggest a stronger effect on health than social relationships. Note how the correlations are negative because the better the health (social relationships) of an individual, the less willingness to pay for a situation where this dimension is set at an optimal level.

Perhaps more interesting is to analyze these correlations controlling for socioeconomic variables and study how these variables also influence Equivalent Incomes (and WTP). We performed a regression analysis to explain equivalent incomes and WTP, this information is provided in Table 10.

The results obtained show some interesting patterns. In Models 1-4 the dependent variable is the Equivalent Income of the respondent whereas in models 5-8 the dependent variable is the willingness to pay as defined previously. Models (1) and

[32]These results are robust to the sample group analyzed (including or not group C).

(5) include all three well-being dimensions as regressors. As significance is not observed for social relationships when health is included, models (2) and (6) exclude social relationships while models (3) and (7) exclude health. These results suggest that Health has a stronger effect on Equivalent Incomes than Social relationships do. To account for the high correlation between health and social relationships (pairwise correlation coefficient 0.39) in models (4) and (8) instead of including both indexes as regressors, we used the Euclidean 2-dimensional distance from the situation of the individual to the reference situation (note that the more deprived in these dimensions the individual is, the greater the value of this variable).

In all eight models, the effect of health and social relationships is consistent with what is expected i.e. the better individuals score in these dimensions, the more well-being they have, and the variables negatively affect the willingness to pay for the situation of reference. Note that, for an individual with almost perfect health and social relationships, makes sense to observe less willingness to pay for improvements on these dimensions.

Also, higher equivalent incomes are expected to be observed at higher income levels (as observed in Models 1 to 4), but it is interesting to notice how the average WTP is not affected by the absolute level of income (Models 5 to 9), confirming the pattern observed on Panel b in Figure 16.

To capture the different effects of these well-being dimensions we included interaction effects for the variables old and health, old and social relationships, and declaring to enjoy friends a lot and social relationships. The results show that older individuals enjoy higher levels of well-being, have a lower willingness to pay for the situation of reference, but also are less affected on average by their situation in these dimensions. This is true despite on average older individuals being in worse health and having worse social relationships (p-value mean-comparison t-tests 0.000 for both dimensions of well-being), which suggests an adaptation effect. For individuals who declare to enjoy their friends a lot (dummy variable enjoying friends), we observe that their aggregate willingness to pay for the situation of reference is higher (Models 5 and 7).

The household size affects positively the willingness to pay. Besides, being head of the household is associated with higher equivalent incomes and lower willingness

to pay. Despite not being conclusive, this evidence suggests that our messages intended to make respondents imagine that in the hypothetical life, only their income and not that of other members of the household would be affected worked in the expected way.[33]

Other interesting results arise when we study the dummy variables to control for taking medicines and wearing glasses. We observe that these variables are associated with a lower willingness to pay. An individual who takes medicines (or wears glasses) has a lower disposable income to spend because part of their income is intended to buy said medicines. Thus, it makes sense to observe that (everything else constant) these variables are associated with a lower willingness to pay for the reference situation. We also included a dummy to capture suffering from a serious disease, finding in this case a positive effect on the willingness to pay.

Other socioeconomic variables included in the regression models are: having a university degree (associated with higher willingness to pay), being a pensioner (associated with higher equivalent incomes and lower willingness to pay), and being a paid employee (similar effects to being pensioner). These variables are particularly interesting as they could potentially give hints about determinants of individual well-being that (in contrast to most of the other variables analyzed so far) can be affected by changes in public policies.

The last two variables included in the regressions are included to control for the effects associated with the elicitation mechanisms (having answered first the CV questions or answering wrong the first training question).

The main takeaways we learn from the regression analysis in Table 10 are the positive effects health and social relationships have on equivalent incomes, where health shows a greater impact than social relationships, and the heterogeneity observed when we include interaction effects.

[33]Otherwise, one could expect individuals in bigger households to show a lower willingness to pay as they would be concerned about how income changes affect other members of the household. However, for respondents who are heads of the household, there is a positive (negative) effect on their equivalent income (willingness to pay) which could be associated with greater relative income losses under the hypothetical scenario (with per percapita household income) with respect to the actual intra-household distribution.

As equivalent incomes are uni-dimensional, we can analyze inequality by computing standard inequality measures. This exercise is presented in Table 11, together with regular income to compare. We observe a considerable increase in inequality when it is measured by equivalent incomes compared to personal incomes. This result is robust through every inequality index computed. If we focus on the Atkinson indices, it is particularly interesting to note how the increase at higher values of inequality aversion is much stronger for equivalent incomes than for incomes, showing stronger asymmetries in the low tail of the equivalent income distribution.

We can also decompose inequality by subgroups, provided that we use an inequality measure decomposable by subgroups. Table 12 presents the Generalised Entropy index decomposed by subgroups using different values of the so-called Theil measure of inequality. From this table, we learn how much differences in inequality can be attributed to differences between subgroups and within subgroups. Inequality between subgroups explains a small share of total inequality (when we group by married, education and individuals who score above or below 40 on the health (social) index.).[34]

5.3 Identifying the Worst-off

In this section, we use the equivalence approach to identify the worst-off individuals i.e. those whose well-being scores in the worst 10%. We performed the same identification using objective measures of well-being (income/health/social relationships) and a subjective one (life satisfaction). The similarities and differences are discussed below.

To identify the worst-off individuals using purely objective measures we ordered respondents according to their incomes/health/social relationships and computed deciles. Respondents in the first decile are identified as the worst-off. The same strategy but using equivalent incomes as measure of well-being was followed to identify the worst-off individuals using the equivalence approach. Lastly, to classify the worst-off using life satisfaction, we considered respondents who indicated a level

[34]We used these subgroups as they are common drivers of inequality. Gender is also a common driver of inequality, but in our data, most of the effect of gender inequalities is cleaned out when we compute the per capita income of households.

between 0 to 5 in a standard question about overall life satisfaction on a scale from 0 to 10.[35] Respondents whose answer belongs to the range 0 to 5 are actually at the bottom 7,61% (not exactly the bottom 10%), but, including one more level implies clustering 15,56% of respondents.

Figure 17 presents the overlap between the worst-off individuals as identified by incomes, equivalent incomes, and life satisfaction. There is a striking but clear message: the overlap is low. Among the total number of respondents, only 0.8% are in the worst-off group according to all three well-being measures. The overlap is slightly greater for income and equivalent incomes (4% of total respondents are identified as the worst off at the same time by income and equivalent income) than for income and subjective Life Satisfaction (1.5% of total respondents). These results evidence how the well-being measure used to identify the worst-off individuals matters not only from a theoretical but also from an empirical point of view.

Additional insights can be learned from Table 13, where descriptive statistics are presented for individuals identified as the worst-off by the different well-being measures. Descriptive statistics for the full sample are presented in column (1). By comparing with the second column (respondents in the bottom 10% by personal incomes) we observe a decrease in the three relevant life dimensions, especially in income (health and social relationships of individuals are slightly below the average). Columns (3) and (4) characterize the worst-off according to their health or social relationship, in these identifications respondents are particularly deprived on their health and social relationships, but their incomes are only slightly below the average. If we have a look at individuals ranked at the bottom 10% by Life Satisfaction (column (5)), we can see how this group of respondents have an intermediate level of health, social relations, and income, in a similar manner to what was observed when we identified individuals according to their equivalent incomes. While the identification of the worst according to life satisfaction seems to be explained mainly by health and social relations, in the case of equivalent income, greater weight is attributed to income compared to other dimensions of

[35]The responses to life satisfaction are included in the Personality Module of the LISS Core Study. This module is carried out during May and June each year. We made use of information from Wave 14, which corresponds to 2022. The results are robust if we use Wave 13 which was collected in May and June of 2021.

well-being (although health is almost 17% worse than the average, social relations are 10% worse and income 37% worse than the average).

When only personal income is used to identify the worst-off individuals, the importance of health and social relationships as relevant life dimensions is relegated, while income is mainly relegated if we focus only on health or social relationships, and is less important in a purely subjective approach like Life Satisfaction. Equivalent Incomes seem to achieve a more balanced weighting of the three dimensions jointly.

If we focus on individuals identified as the worst off by equivalent incomes but not by other well-being measures, we observe respondents more unhealthy and with higher incomes.[36] Besides, we know that they are not only more unhealthy, but they also have stronger preferences for living a healthy life so they are willing to give up considerable amounts of income to improve their health situation (recall Figure 16). This group of respondents ends at the bottom 10% of equivalent incomes due to strong preferences to live a healthy life i.e. their well-being is strongly affected by their deprivation in the sphere of health given their preferences.

Table 14 illustrates the correspondence between deciles by income and equivalent incomes. An interesting pattern to notice from the transition matrix is the number of zeros on the lower triangle. The maximum number of deciles an individual climbs when ranked by equivalent income, with respect to their decile when ranked by income, is 2.[37] However, when we study the transition the other way around, greater mobility is found. When we use equivalent incomes to rank individuals instead of incomes, respondents can go down in the rankings, but the possibility to go up is clearly limited.

5.4 Is the preference elicitation method relevant?

Different approaches can be used to retrieve the information about preferences needed to compute equivalent incomes (see Section 3). In this section, we study

[36] This analysis is not presented in this table but is available upon request from the authors

[37] Except for one observation ranked in the second decile by income and the fifth decile by equivalent income.

the robustness of equivalent incomes to the method used. First, we compare the results obtained using the ABDC and the Life Satisfaction approaches for Groups A and B. Then, we compare the results obtained by the ABDC and the Contingent Valuation (CV) methods, within and between individuals.

The Life Satisfaction approach to compute equivalent incomes requires estimating a life satisfaction regression, as explained in Section 3. The outcomes from this exercise are presented in Table 15. Using the estimated coefficients, we computed the Marginal Rates of Substitution (MRS).[38] Once obtained the MRS, we calculate equivalent incomes.

A boxplot for the equivalent incomes distribution obtained by this method is presented in Figure 18 together with income distribution, and equivalent incomes estimated using the ABDC and CV.[39] Equivalent incomes estimated using the Life Satisfaction approach are extremely low. This is not surprising given the estimated coefficients in the life satisfaction regression for income (0.260) health (0.0787) and social relationships (0.0312). For an individual who is female, older than the median age, and, works as a paid employee with average health and average social relationships (an index of 70), her equivalent income is 0.033% of her personal income. Nevertheless, the magnitude of these coefficients is in line with the literature, and the MRS are similar to those found in previous applications of the method [Decancq et al., 2015a]. These results evidence that equivalent incomes estimated using this strategy are not comparable in magnitude to those obtained using the ABDC. However, in ordinal terms, the differences are not that

[38] In the regression we used Satisfaction Data from Wave 14, which corresponds to 2022. The results presented correspond to the best specification found to explain Life Satisfaction in terms of the relevant well-being dimensions given the available data. We estimated interaction effects for income health and social relationships to capture preferences heterogeneity between groups of respondents. We also explored, as it is suggested in the literature, the specification of a fixed effects model using panel data, taking advantage of the fact that the satisfaction module is asked every year. However, the variability in our well-being dimensions in the period of time available is not enough to observe significant effects, unless we include at least five waves. Nevertheless, including more waves also turns more challenged the assumption that the preferences remained stable over the years. We also explored the possibility to estimate a model identifying respondents who are 'adjusters' i.e. they performed more changes to the original health and social relationships indexes, but we did not find significant differences in the estimated coefficients. Finally, we also estimated a model using data from Wave 13 (corresponding to 2021) but the results using data for 2022 outperformed.

[39] The CV distribution is computed using Group B only

big. When we cluster respondents by deciles of Equivalent Incomes computed by both methods (Table 16), we observe 18% of cases ranked in the same decile (the ones on the diagonal of the matrix). If a more flexible criterion is adopted and is considered as an agreement between methods if an individual is classified in the same decile $\pm$ 1, then 45% would be the rate of agreement. In Figure 19 we can see a scatter-plot for every observation where the pattern already mentioned is illustrated. Finally, in columns (6) and (7) in Table 13 we can compare the main socioeconomic differences in the worst-off group by each method. The worst-off individuals identified by equivalent incomes using the life satisfaction approach compared to the worst-off identified using the ABCD, are individuals with slightly higher incomes and a worse situation in terms of health and social relations.

Now we compare equivalent incomes estimated using the ABDC and the Contingent Valuation methods. Because answering first one block of questions may affect responses in the other, we first checked if the order affected respondents' behavior. We define r_i^{max} as the maximum number of rounds in the ABDC that individual i answered, and we compute the mean $r_i^m ax'$. For Groups A and B, this value is 8.3, while it is 7.8 for Group C (p-value two sample t-test 0.0134). For groups B and C, different behaviors were observed when answering the CV block of questions. While in the first group, 58% were able to provide an exact answer, only 39% did so in Group C (p-value two sample t-test 0.000). These results seem to indicate that answering the ABDC before the CV block gave participants greater clarity and guided them to give an exact estimate more easily (another interpretation is that it framed them).

In Table 17 we compare the equivalent incomes estimated by the ABDC for Groups A and B with those estimated using the CV for Group C (as the assignment to each group was randomized, the estimated equivalent incomes using each method should be comparable if the results are robust to the methodology employed). The mean equivalent incomes estimated by each method (1378 vs 1565) are statistically different.[40] However, if we restrict both samples to individuals who were able to provide an exact answer (answering 10 rounds in the ABDC for Groups A and B, and providing an exact answer in the CV for Group C) no evidence is found to

[40]P-value two sample Welch's t-test 0.0058.

reject that both means are different from zero at the usual levels of confidence. Similar conclusions are reached if we analyze the mean WTP by each method. Although not conclusive, these results suggest that for the general sample, the equivalent incomes are not robust to the estimation method applied (ABDC vs CV), but when we restrict the sample to include only respondents who were able to answer with precision, no significant differences are observed by each method.

For Groups B and C, we can also compare the differences in equivalent incomes by each method within individuals. This exercise is presented in Figure 20, in Panel a for group B and Panel b for Group C. Despite being some correspondence, most observations are below the 45-degree line, indicating higher equivalent incomes when they are estimated using the CV method than the ABDC. For respondents in Group B, a higher agreement between both methods is observed, confirming how the order in which the methods were answered matters. Figure 21 summarises the distribution by group and method. In Table 18 we compute statistics for the differences in equivalent incomes computed by each method.

In sum, equivalent incomes did not show to be robust to the method used. In magnitude, the life satisfaction approach computes extremely high WTP, the contingent valuation method computes the lowest WTP, while the ABDC method seems to be somewhere in between. A drawback of the life satisfaction approach in contrast with the other methods is the limited variability allowed. Despite differences found when comparing the results from the ABDC and CV methods, these differences do not hold if we restrict the sample to respondents who provided an exact answer. For these individuals, the results achieved by the different methods are more consistent. Although not conclusive, our results suggest that the estimations of equivalent incomes using the ABDC or CV are consistent for individuals with complete preferences, while for those who do not have complete preferences and thus could not provide precise responses in the questionary, answering the ABDC first helped them providing an answer in the CV block of questions (for Group B).

5.5 Using Equivalent Incomes to evaluate policies

6 Conclusion

We discussed the importance of evaluating well-being in a multidimensional way and the implications of respecting individuals' preferences heterogeneity. We showed how the Equivalence Approach can be applied in a non-parametric manner for a sample of 2288 individuals living in The Netherlands, using the LISS Panel. Our main method to estimate equivalent incomes (i.e. the ABDC) took an average of 2.87 minutes (including the training questions and reading the instructions) for respondents to be completed, and for the majority of respondents (74.98%) delivered a high degree of precision while allowing for incompleteness of preferences.

Around a quarter of respondents revealed to have incomplete preferences by indicating at some point not to know which of the alternatives presented to choose. Leading a life similar to the hypothetical life proposed (with perfect health and social relations) is associated with a lower probability of having incomplete preferences. Being a female, older, pensioner, and having fewer years of formal education is also associated with a lower probability of showing incompleteness. Furthermore, if incompleteness in preferences arises, this occurs in the early stages of the questionnaire, while those with complete preferences are able to answer with a high degree of accuracy. Accounting for the incompleteness of preferences in well-being analysis is key to attaining more consistent results.

On average, respondents in our sample revealed stronger preferences for health than for social relationships. Ceteris paribus, older individuals exhibit higher levels of well-being and less willingness to pay for improvements in their health and/or social relationships (which could be explained by an adaptation effect). Other variables associated positively with higher well-being levels are: being a paid employee, being a pensioner, and having a university degree.

Well-being distribution showed to be much more unequal than personal income distribution, with even stronger inequalities in the lower tail of the distribution.

The identification of the worst individuals (those in the bottom 10%) is extremely

sensitive to the concept of well-being used, which shows the relevance from an empirical point of view of choosing an appropriate measure to assess well-being and correctly targeting policies for those who need them more.

Despite several advantages from a theoretical and practical point of view, our estimates of equivalent income did not turn out to be robust to the method used to obtain preferences. A higher degree of consistency was observed between the ABDC and CV methods for individuals who have complete preferences, but more research is needed to improve the elicitation mechanisms under incomplete preferences.

References

[Arrow et al., 1993] Arrow, K., Solow, R., Portney, P., Leamer, E., Radner, R., and Schuman, H. (1993). *Report of the NOAA panel on Contingent Valuation*, volume 58. Journal Abbreviation: Federal Register Publication Title: Federal Register.

[Bernheim and Rangel, 2009] Bernheim, B. D. and Rangel, A. (2009). Beyond Revealed Preference: Choice-Theoretic Foundations for Behavioral Welfare Economics*. *The Quarterly Journal of Economics*, 124(1):51–104.

[Brun and Tungodden, 2004] Brun, B. C. and Tungodden, B. (2004). Non-welfaristic theories of justice: Is ?the intersection approach? a solution to the indexing impasse? *Social Choice and Welfare*, 22(1):49–60.

[Decancq et al., 2015a] Decancq, K., Fleurbaey, M., and Schokkaert, E. (2015a). Happiness, Equivalent Incomes and Respect for Individual Preferences. *Economica*, 82(s1):1082–1106. _eprint: https://onlinelibrary.wiley.com/doi/pdf/10.1111/ecca.12152.

[Decancq et al., 2015b] Decancq, K., Fleurbaey, M., and Schokkaert, E. (2015b). Inequality, income, and well-being. *Handbook of Income Distribution*, 2:67 – 140.

[Decancq and Nys, 2021] Decancq, K. and Nys, A. (2021). Non-parametric well-being comparisons. *European Economic Review*, 133:103666.

[DellaVigna, 2009] DellaVigna, S. (2009). Psychology and Economics: Evidence from the Field. *Journal of Economic Literature*, 47(2):315–372.

[Dziewulski, 2020] Dziewulski, P. (2020). Just-noticeable difference as a behavioural foundation of the critical cost-efficiency index. *Journal of Economic Theory*, 188:105071.

[Green et al., 1998] Green, D., Jacowitz, K. E., Kahneman, D., and McFadden, D. (1998). Referendum contingent valuation, anchoring, and willingness to pay for public goods. *Resource and Energy Economics*, 20(2):85–116.

[Hoehn and Randall, 1987] Hoehn, J. P. and Randall, A. (1987). A Satisfactory Benefit Cost Indicator from Contingent Valuation. *Journal of Enviromental Economics and Managment*, 14:226–247.

[Mas-Colell, 1995] Mas-Colell, A. (1995). Microeconomic theory/Andreu Mas-Colell. *Michael D. Whinston and Jerry R, Green*.

[Sen, 1980] Sen, A. (1980). Equality of What? *Cambridge: Cambridge University Press*, The Tanner Lecture on Human Values,:197–220.

[Stiglitz et al., 2009] Stiglitz, J., Amartya, S., and Fitoussi, J.-P. (2009). Report by the Commission on the Measurement of Economic Performance and Social Progress, mimeo. Technical report.

[Tversky, 1969] Tversky, A. (1969). Intransitivity of preferences. *Psychological Review*, 76:31–48.

7 Annex

7.1 Figures

Figure 7: Screenshot of a dichotomous choice of the ABDC

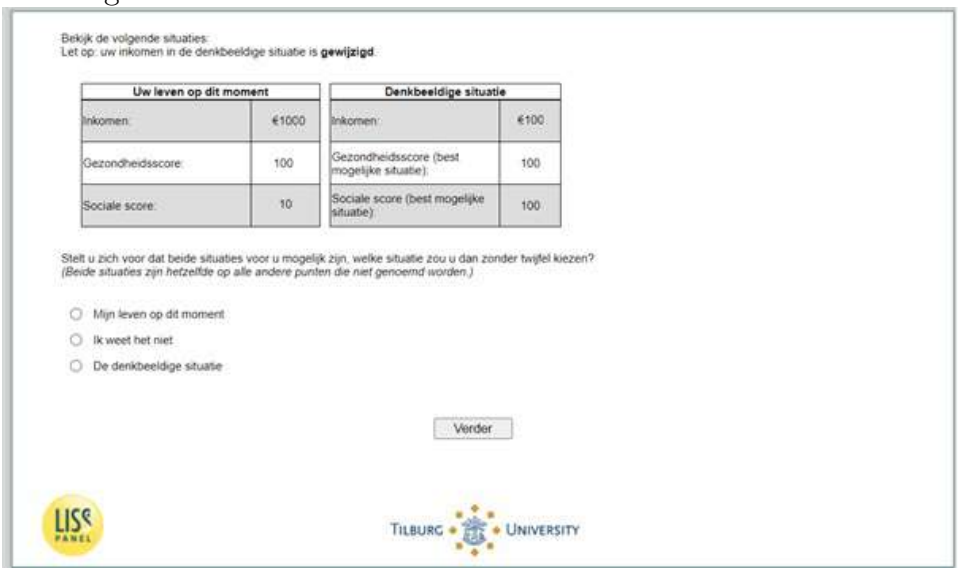
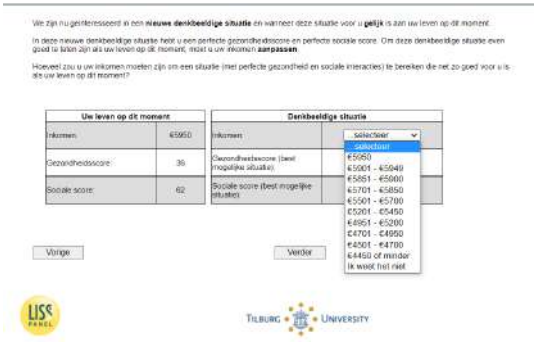


Figure 8: Screenshot of the Contingent Valuation questions

a. First question: Intervals



b. Second question: Precise estimate

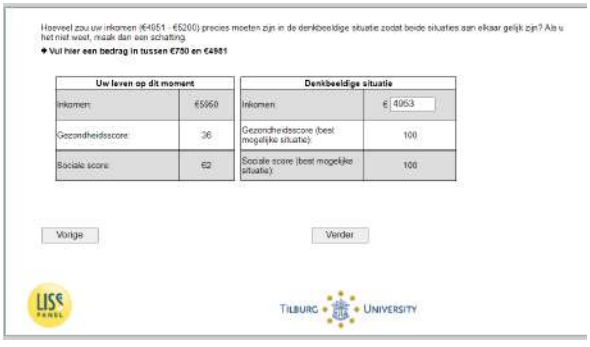


Figure 9: Items of the Health Core Study used to construct the Health sub-dimensions

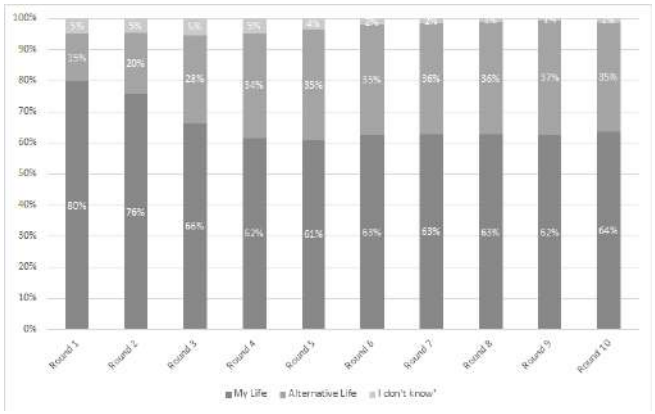
Question LISS	Description	Weight
ch20m020	Did your physical health or emotional problems hinder your daily activities over the past month, for instance in going for a walk, walking up stairs, dressing yourself, washing yourself, visiting the toilet?	1,401148
ch20m022	To what extent did your physical health or emotional problems hinder your work over the past month, for instance in your job, the housekeeping, taking care of the children, doing volunteer work, or in school?	1,22084
ch20m025	Getting up from a chair in which you sat for some time	0,409095
ch20m028	crouching, kneeling, crawling on all fours	0,654557
ch20m015	How often did you felt happy during the last month	2,336027
ch20m080-ch20m097	Has a physician told you this last year that you suffer from one of the following diseases / problems? (list of diseases)	0,4525199
ch20m169 – 183	Are you currently taking medicine at least once a week for: [list of health problems]	0,7293664
ch20m018	Do you suffer from any kind of long-standing disease, affliction or handicap, or do you suffer from the consequences of an accident?	0,4568589
ch20m233	How is your eyesight? How well do you see with glasses?	1,457886
ch20m070-ch20m078	Do you regularly suffer from: [list of health problems like headeache, fatigue, intestinal problems, pain, etc]	0,8817022

Figure 10: Items of the Social relationships and Leisure Core Study used to construct the Social relationships sub-dimensions

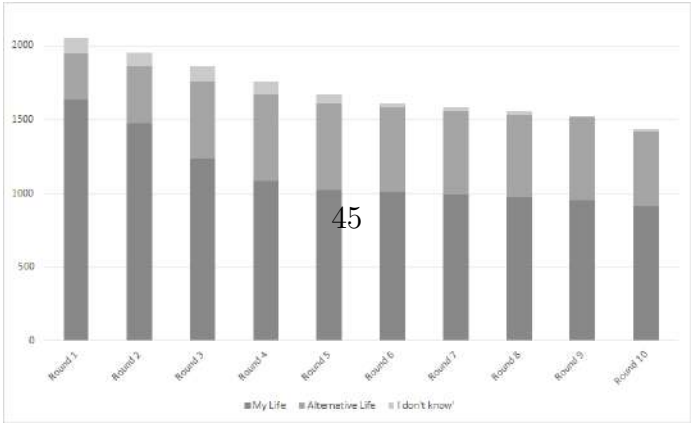
Question LISS	Description	Weight
cs20m288	I miss having people around me.	2,738655
cs20m285	There are enough people I can count on in case of a misfortune.	0,969568
cs20m287	There are enough people to whom I feel closely connected	1,932012
cs20m290	How often do you spend an evening with your family (other than members of your household)	0,7279637
cs20m291	How often do you spend an evening with someone from the neighborhood	1,228174
cs20m292	How often do you spend an evening with someone from the neighborhood	0,7819538
cs20m003 to cs20m057	How often do you spend an evening with someone outside your the neighborhood	0,2437033
aantalhh & woonvorm	Being single and living with other people	0,2437033
belbezig	Work/study	0,7243121
cs20m436	How often did you make use of social media in the past 2 months?	0,4109544

Figure 11: Performance ABDC. Groups A and B.

a. In percentages



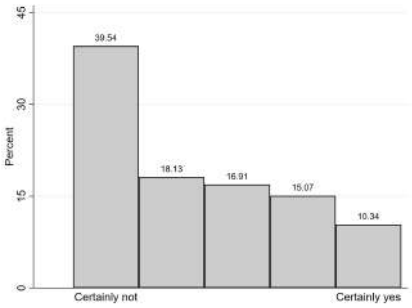
b. Absolute



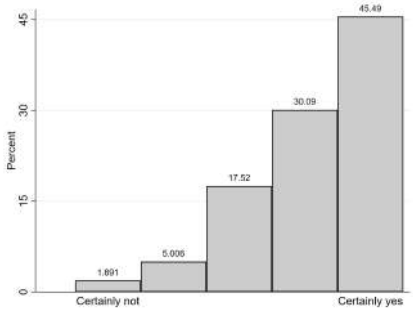
Note: results are robust to the inclusion of Group C. These figures were not included due to space. They are available upon request.

Figure 12: Evaluation of Questionnaire. Group A.

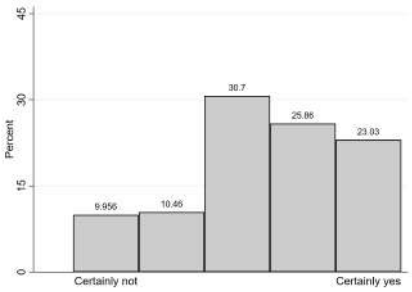
a. Difficulty



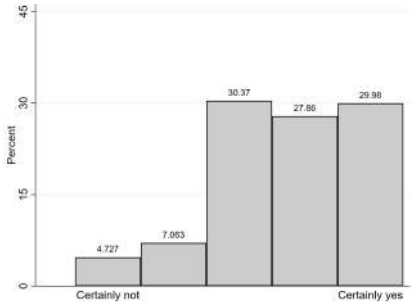
b. Clarity



c. Made you think



d. Interesting



e. Enjoyable

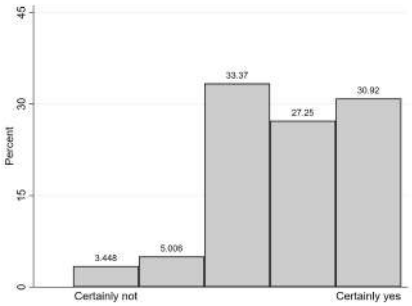
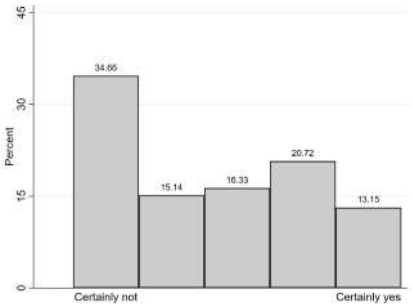
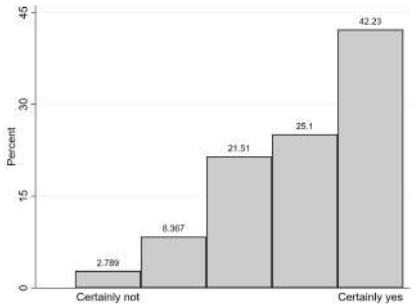


Figure 13: Evaluation of Questionnaire. Group B.

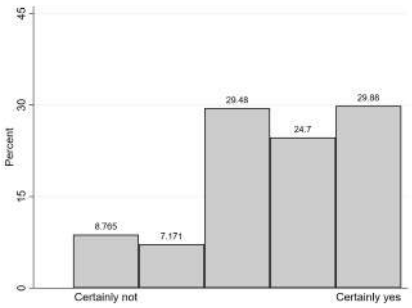
a. Difficulty



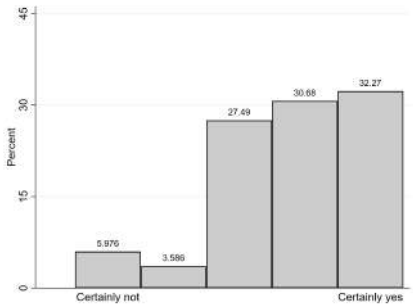
b. Clarity



c. Made you think



d. Interesting



e. Enjoyable

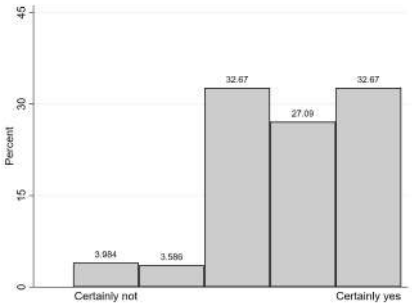
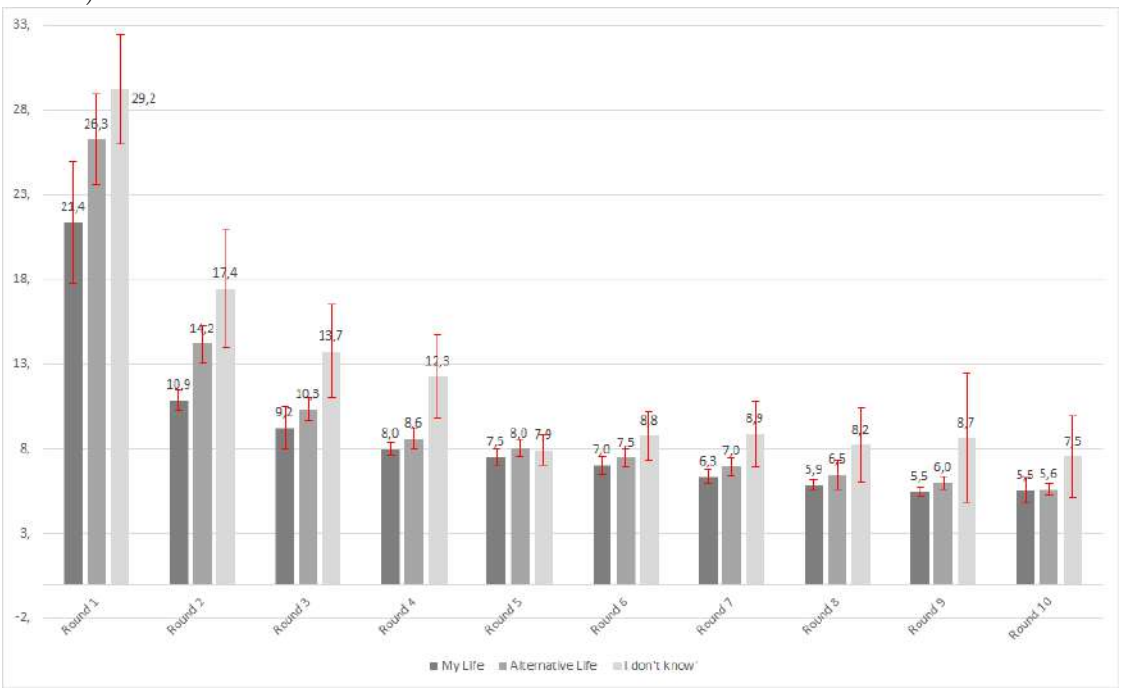
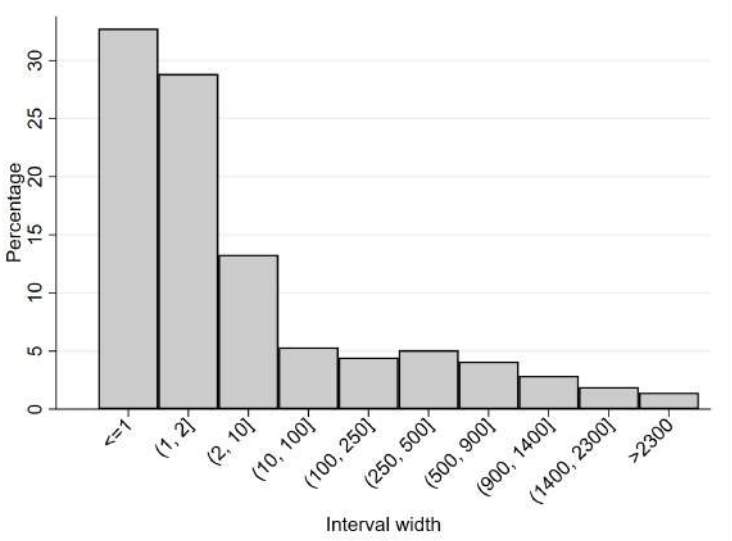


Figure 14: Details time spent on each round ABDC by response given (Groups A and B)



Note: Average time spent on each round of the ABDC (in seconds) differentiated by response given. 95% confidence intervals computed by bootstrap (1000 repetitions).

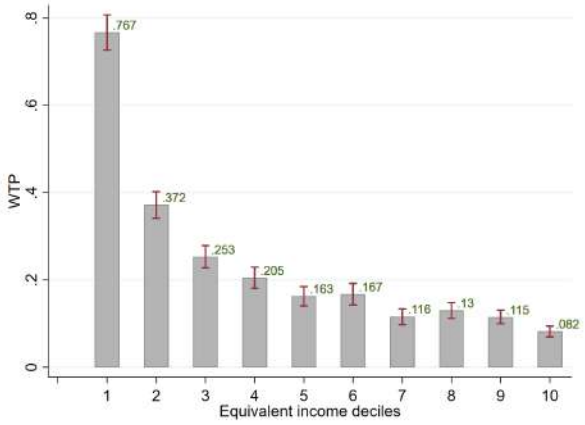
Figure 15: ABDC precision



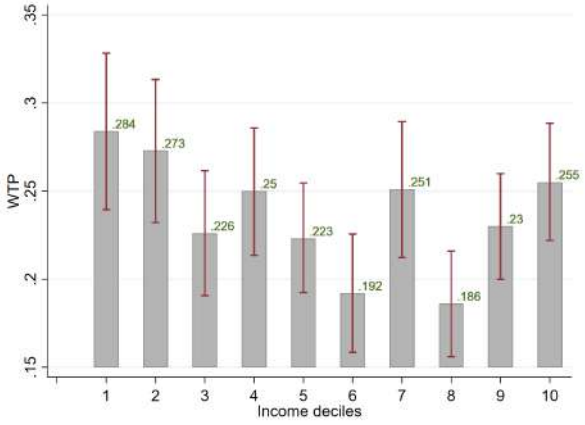
Note: This figure presents an histogram with the intervals precision for the equivalent incomes obtained from the ABDC

Figure 16: Average WTP by deciles of well-being dimensions (Groups A and B)

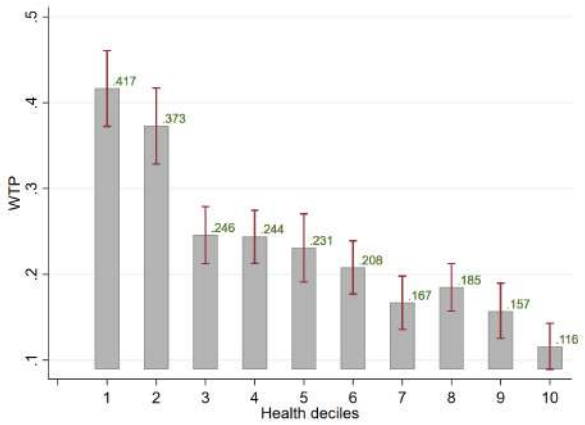
a. Equivalent Income



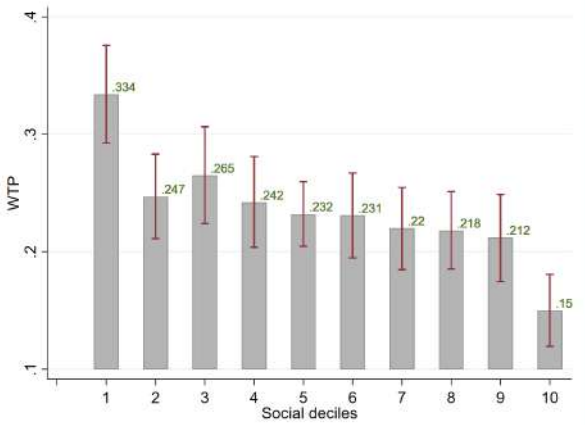
b. Income



c. Health

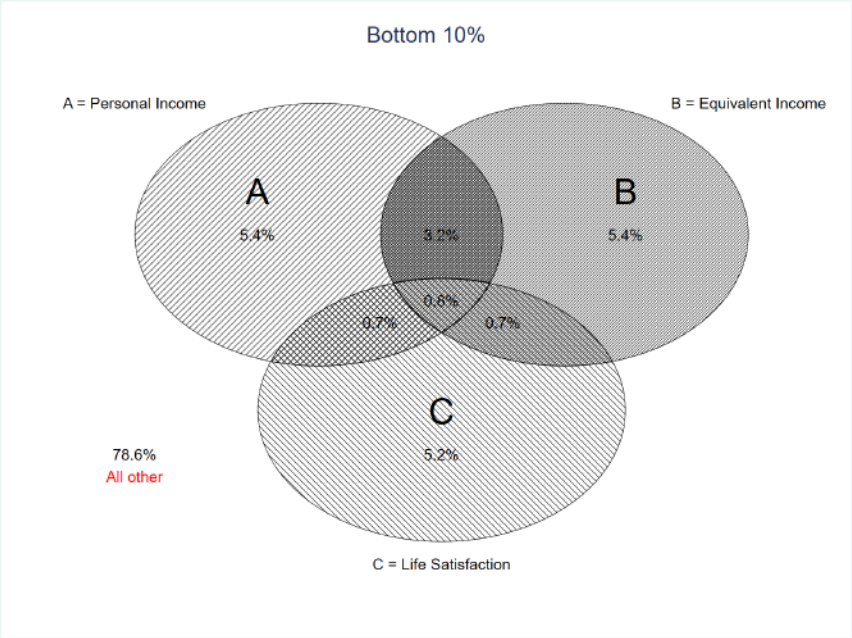


d. Social



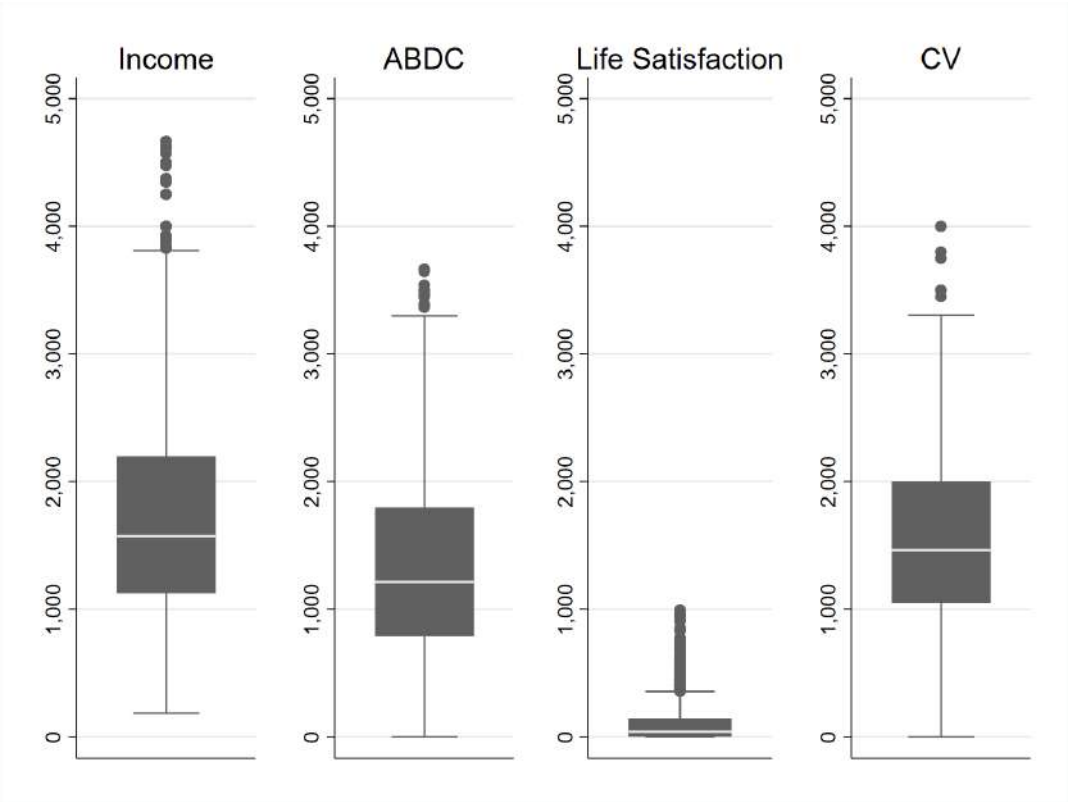
Note: In these figures the sample was restricted to respondents from Groups A and B. Confidence Intervals were estimated by bootstrap with 1000 repetitions.

Figure 17: Venn Diagram Respondents identified in the Bottom 10% by different Well-Being measures



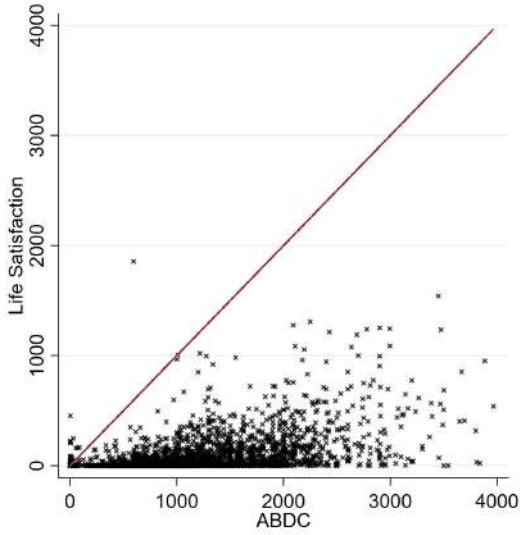
Note: This figure presents a Venn Diagram with respondents identified as the worst off using three different well-being measures, personal income (identified in the Diagram as Group A), Equivalent incomes computed using the middle point of the ABDC (identified as Group B) and Life Satisfaction (identified as Group C).

Figure 18: Box-plots Equivalent Incomes estimated by Different Methods



Note: This figure presents Box-plots of Incomes and Equivalent Incomes estimated using different methods. The sample was restricted to include only observations from Groups A and B.

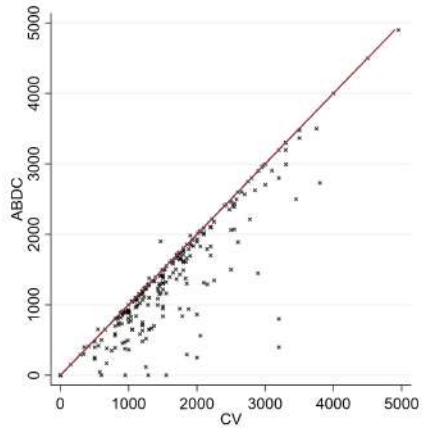
Figure 19: Scatter-plot Equivalent Incomes estimated byABDC and Life Satisfaction



Note: This figure presents a scatter plot with the Equivalent Incomes estimated by the ABDC on the horizontal axis and by the Life Satisfaction approach on the vertical axis (the sample is restricted to include only observations from Groups A and B).

Figure 20: Scatter-plots Equivalent Incomes estimated byABDC and CV

a. Group B



b. Group C

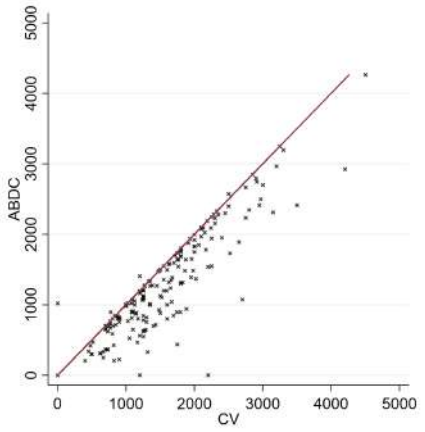
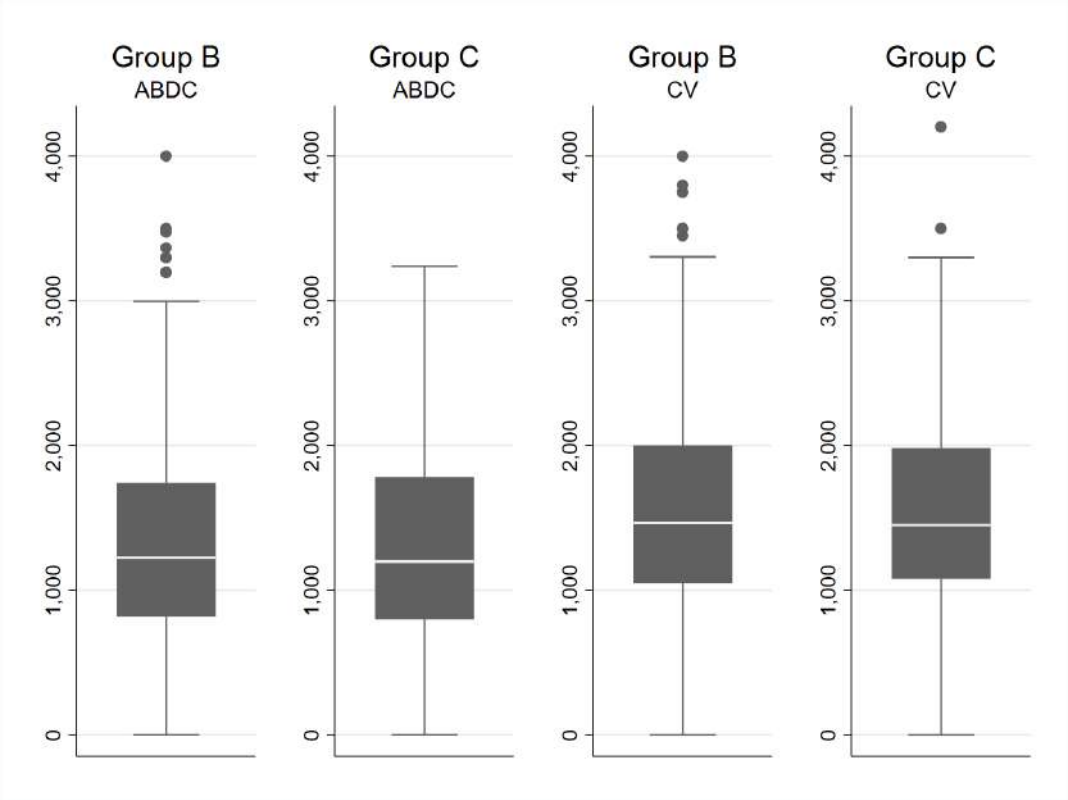


Figure 21: Box plots Equivalent IncomesABDC and CV (Groups B and C)



Note: This figure presents box plots for the equivalent incomes distribution estimated using the ABDC and the CV methods for groups B and C.

7.2 Tables

Table 2: Probit model to explain participation

	Coef.	**dy/dx**
Log(income)	-0.046	-0.012
Age	-0.016	-0.004
Age^2	0.001**	0.000**
Dummy: female = 1	-0.240***	-0.064***
Dummy: head household = 1	-0.060	-0.016
Dummy: married=1	0.080	0.022
Dummy: urban=1	-0.052	-0.014
Dummy: (education) primary school = 1	-0.281**	-0.075**
Dummy: (education) vocational school = 1	-0.034	-0.009
Dummy: (education) university = 1	0.095	0.025
Dummy: (occupation) pensioner = 1	0.069	0.018
Dummy: (occupation) paid employee = 1	-0.011	-0.003
Constant	0.854	0
Observations	3237	
R^2	0.1034	

Standard errors in parentheses
* p<0.1, ** p<0.05, *** p<0.01

Notes: results from a Probit model where the dependent variable equals one if the individual accepted to participate in the questionnaire. *Log(income)* is the log. of income. *Female* is a dummy equal one if the respondent is female. *Age* and Age^2 capture the age of the respondent and the age to the power 2 to capture non-linear effects of age. *Head* is a dummy that equals one if the respondent declares to be the household head. *Married* is a dummy that equals one if the respondent is married. *Urban* is a dummy that equals one if the household is located in an urban area. *Education* are dummies to capture the level of education. *Occupation* are dummies to capture the occupation distinguishing paid employee, pensioner or others (intercept). Significance levels * p<0.1, ** p<0.05, *** p<0.01

Table 3: Details cleaning data process

	Group A	**Group B**	**Group C**	**Total**
Initial sample	**2012**	**279**	**252**	**2543**
Comments	24	5	4	33
Incomplete	19	1	3	23
Income adjustments	5	0	0	5
Inconsistent	45	5	0	45
Response patrons	121	17	6	144
Final sample	**1798**	**251**	**239**	**2288**

Notes: the first row indicates the initial number of respondents who accepted to participate in the questionary. Columns indicate the experimental arm assigned (Groups A, B, or C and total). Rows 2-6 indicate the number of observations eliminated from the analysis due to the criteria indicated in the name of the row. Responses eliminated because of 'Comments' are individuals who left comments in the final open-ended questions indicating even not taking the questionary seriously or a critical lack of understanding. 'Incomplete' are individuals who did not complete the full questionary. 'Income adjustments' are individuals who adjusted their per capita income to zero. 'Inconsistent' are individuals whose responses are inconsistent with our assumptions of monotonic and transitive preferences. 'Response patrons' are individuals whose responses are suspicious (they spent too little time reading the instructions, or answering). The final row indicates the final number of observations included in the main analysis after the cleaning data process.

Table 4: Details time spent in the ABDC (in seconds). Groups A and B.

	Mean	**Median**	**Min**	**Max**	**SD**	**N**
Introduction	61.27	44.17	5.02	2785.92	100.83	1957
Training questions	31.04	19.61	2.70	1762.31	73.21	1957
Training questions + followup	62.42	56.90	13.75	167.45	31.08	91
Round 1 $\|k \geq 1$	22.48	15.26	2.32	1882.38	64.62	1957
Round 2 $\|k \geq 2$	11.83	9.35	0.81	362.23	12.51	1870
Round 3 $\|k \geq 3$	9.77	7.26	1.06	716.66	18.57	1788
Round 4 $\|k \geq 4$	8.40	6.61	1.39	76.62	6.89	1693
Round 5 $\|k \geq 5$	7.71	6.13	1.46	205.51	7.45	1610
Round 6 $\|k \geq 6$	7.22	5.65	1.36	166.69	7.43	1552
Round 7 $\|k \geq 7$	6.60	5.23	1.23	157.37	6.35	1514
Round 8 $\|k \geq 8$	6.10	4.74	1.20	198.23	6.92	1487
Round 9 $\|k \geq 9$	5.67	4.51	0.82	60.88	4.41	1461
Round 10 $\|k = 10$	5.58	4.38	1.21	330.07	9.51	1376
Follow-up	40.93	24.55	4.54	2777.50	142.39	420
Total 1	79.96	67.80	9.85	1905.49	78.90	1957
Total 2	111.00	92.46	15.47	1969.84	111.05	1957
Total 3	172.27	141.36	26.51	2900.18	159.20	1957
Total 4	181.06	148.91	32.44	2938.52	173.17	1957

Notes: descriptive statistics describing the time spent by respondents answering the ABDC are presented in this table. *Introduction* refers to the time spent reading the instructions of the ABDC. *Training questions* refers to the time spent answering the training questions, and *Training questions* + follow up also considers the time spent answering the follow-up questions when respondents answered wrongly the training question. *Round 1 - 10* refers to the time spent answering each round of the ABDC, conditional on having answered a maximum number of rounds k. *Follow-up* is the time spent answering the questions regarding why they choose 'I don't know' in the last round (if they do so). *Total 1* is the time spent answering only the ABDC's rounds. *Total 2* is the time spent answering the ABDC and the training questions. *Total 3* adds to *Total 2* the time spent answering reading the introduction. *Total 4* adds to *Total 3* the time spent answering the follow-up questions.

Table 5: Details time spent answering ABDC (in seconds) conditional to number of rounds answered

	Mean	**Median**	**Min**	**Max**	**SD**	**N**
Round 1 $\|k = 1$	29.86	26.38	10.20	83.36	15.73	90
Round 2 $\|k = 2$	38.10	31.52	9.85	169.28	25.39	85
Round 3 $\|k = 3$	50.02	39.41	13.15	236.52	37.37	96
Round 4 $\|k = 4$	81.08	48.00	17.75	1905.49	207.62	83
Round 5 $\|k = 5$	51.80	50.97	18.54	109.93	20.56	60
Round 6 $\|k = 6$	67.11	66.84	21.02	134.00	28.04	33
Round 7 $\|k = 7$	123.60	69.85	39.86	1373.15	255.81	26
Round 8 $\|k = 8$	73.60	65.86	22.67	209.66	42.68	24
Round 9 $\|k = 9$	76.08	65.34	22.16	245.44	38.88	84
Round 10 $\|k = 10$	88.90	76.99	17.58	1615.25	65.52	1376

Notes: total time spent by respondents answering the ABDC is presented in this table. In each row, we compute the time considering only respondents whose number of rounds completed equals the number of rounds indicated in the first column of the table. The last two rows compute the time spent answering the ABDC irrespective of how many rounds were answered. In every row (except the last one indicated with a star) we exclude the time spent answering the training questions and the reasons why they choose 'I don't know'.

Table 6: Details responses ABDC

	Groups A and B			**Group C**		
	My Life	Alternative Life	I don't know	My Life	Alternative Life	I don't know
Round 1	1634	315	100	192	30	17
Round 2	1474	386	90	171	37	14
Round 3	1235	525	100	134	58	16
Round 4	1084	592	84	127	52	13
Round 5	1022	591	63	117	55	7
Round 6	1009	571	33	108	59	5
Round 7	991	562	27	108	57	2
Round 8	972	561	19	112	53	0
Round 9	952	563	11	104	55	5
Round 10	916	502	20	93	56	4

Notes: details about the alternative chosen by respondents at different rounds of the ABDC are presented in this table. Columns represent the choice made by participants and rows represent the rounds. In each row. the number of observations equals the number of observations in the previous row minus the number of "I don't know", except in those cases in which the algorithm stopped before due to a difference lower than one euro among two consecutive rounds.

Table 7: Analysis "I don't know" responses

	Coefficient	dy/dx
Log personal income	0.0972	0.0216
	(0.0721)	(0.0160)
Social Index	-0.00346	-0.000769
	(0.00230)	(0.000510)
Health Index	-0.00849***	-0.00189***
	(0.00218)	(0.000482)
Dummy: female = 1	-0.258***	-0.0574***
	(0.0798)	(0.0178)
Dummy: old = 1	-0.336***	-0.0740***
	(0.0974)	(0.0210)
Dummy: head household = 1	-0.0359	-0.00801
	(0.0856)	(0.0192)
Dummy: (education) university = 1	0.252**	0.0592**
	(0.0988)	(0.0243)
Dummy: (occupation) pensioner = 1	-0.205*	-0.0440*
	(0.113)	(0.0234)
Dummy: (occupation) paid employee = 1	-0.0229	-0.00509
	(0.100)	(0.0223)
Dummy: (evaluation questionnaire) think = 1	0.287**	0.0602***
	(0.111)	(0.0219)
Dummy: (evaluation questionnaire) clear = 1	0.509***	0.129***
	(0.130)	(0.0365)
Dummy: (evaluation questionnaire) interesting = 1	-0.0771	-0.0175
	(0.135)	(0.0312)
Time (last round)	0.161***	0.0359***
	(0.00859)	(0.00142)
Constant	-1.603***	
	(0.527)	
Observations	2,049	
Pseudo R^2	0.307	

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: results from a Probit model where the dependent variable equals 1 if the individual choose 'I don't know' at any round of the ABDC are presented in this table. The sample in this regression is restricted to Groups A and B (we exclude Group C who answered the CV questions first). Coefficients are presented in the first column, robust standard errors are presented between parenthesis and marginal effects are presented in the second column. *Old:* is a dummy that equals one if the individual is older than the median age in our sample (older than 59 years old). For the dummies regarding the evaluation of the questionnaire, they capture if the individual indicated that found the questions made her think/were clear and if they found them interesting. The variable *Time last round* captures the time spent by the respondent answering the last round of the ABDC that she answered.

Table 8: Reasons to chose 'I don't know' in the ABDC (Groups A and B)

Why did you choose 'I don't know'?	**Freq.**	**Perc.**
Both alternatives are equally good for me so I can't choose one without a doubt	124	23
The difference between the two situations is too small	77	14
The question is too abstract. I don't understand what is meant by it	7	1
I am not interested/don't see the point in answering this kind of question	27	5
It is too hard for me to imagine how my life would look like with such a low personal income	248	45
Another reasons	43	8
No response	21	4
Total	547	

Table 9: Pairwise correlations among dimensions of well-being

	Equivalent Income			**WTP**		
Group	A and B	C	A, B and C	A and B	C	A, B and C
Income	0.936*	0.851*	0.934*	-0.015	0.060	-0.016
	0.0000	0.0000	0.0000	0.5093	0.3533	0.4454
Health	0.140*	0.226*	0.141*	-0.332*	-0.169*	-0.317*
	0.0000	0.0048	0.0000	0.0000	0.0088	0.0000
Social	0.113*	0.147*	0.113*	-0.144*	-0.145*	-0.145*
	0.0000	0.0232	0.0000	0.0000	0.0246	0.0000

Notes: WTP is the willingness to pay for perfect health expressed relative to income. Health represents the health index adjusted by the individual and Social represents the social index adjusted by the individual. The first row in the matrix presents the pairwise correlation and the second row the significance. One star denotes significance at 5%.

Table 10: Regression to explain Equivalent Incomes and WTP

	1-4: Dependent variable log equivalent income				5-8: Dependent variable WTP			
VARIABLES	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Log (personal income)	1.126***	1.132***	1.177***	1.125***	0.0105	0.00861	-0.00242	0.0126
	(0.0868)	(0.0850)	(0.0883)	(0.0867)	(0.0147)	(0.0147)	(0.0150)	(0.0147)
Health Index	0.0222***	0.0240***			-0.00536***	-0.00598***		
	(0.00420)	(0.00396)			(0.000592)	(0.000548)		
Social Index	0.00185		0.00901**		-0.000599		-0.00231***	
	(0.00419)		(0.00421)		(0.000726)		(0.000710)	
Euclidean distance				-0.199***				0.0545***
				(0.0368)				(0.00587)
Interaction: old*health	-0.00831	-0.0105**		0.000371	0.00150**	0.00226***		-0.000303
	(0.00518)	(0.00486)		(0.00415)	(0.000731)	(0.000673)		(0.000608)
Interaction: old*social	-0.00501		-0.00776*	-0.0104**	0.00179**		0.00223***	0.00311***
	(0.00476)		(0.00459)	(0.00425)	(0.000770)		(0.000722)	(0.000642)
Interacion: enjoy*social	0.00495		0.00447	-0.00110	-0.00178**		-0.00163**	-1.82e-05
	(0.00482)		(0.00490)	(0.00473)	(0.000763)		(0.000773)	(0.000714)
Household size	-0.00400	0.000452	0.0146	-0.00564	0.0177***	0.0163**	0.0130*	0.0188***
	(0.0382)	(0.0376)	(0.0387)	(0.0379)	(0.00668)	(0.00672)	(0.00684)	(0.00666)
Dummy: head household = 1	0.146**	0.146**	0.145**	0.141**	-0.0434***	-0.0434***	-0.0429***	-0.0418***
	(0.0717)	(0.0713)	(0.0728)	(0.0718)	(0.0129)	(0.0129)	(0.0134)	(0.0130)
Dummy: female = 1	0.0662	0.0724	0.0191	0.0398	-0.0251**	-0.0271**	-0.0131	-0.0188
	(0.0663)	(0.0650)	(0.0664)	(0.0654)	(0.0117)	(0.0115)	(0.0120)	(0.0116)
Dummy: old = 1	0.914**	0.717*	0.555	0.700*	-0.211***	-0.140***	-0.144***	-0.181***
	(0.443)	(0.389)	(0.353)	(0.419)	(0.0637)	(0.0523)	(0.0549)	(0.0602)
Dummy: medicine = 1	0.144*	0.144*	-0.0488	0.107	-0.0421***	-0.0420***	0.00891	-0.0355**
	(0.0843)	(0.0841)	(0.0824)	(0.0840)	(0.0141)	(0.0140)	(0.0140)	(0.0142)
Dummy: glasses = 1	0.110	0.108	0.0964	0.102	-0.0240*	-0.0230*	-0.0210	-0.0224*
	(0.0752)	(0.0752)	(0.0756)	(0.0759)	(0.0130)	(0.0131)	(0.0132)	(0.0131)
Dummy: serious_disease = 1	-0.0985	-0.0962	-0.301***	-0.144**	0.0259**	0.0252**	0.0779***	0.0336***
	(0.0660)	(0.0664)	(0.0691)	(0.0674)	(0.0122)	(0.0123)	(0.0123)	(0.0123)
Dummy: enjoy_friends = 1	-0.383	-0.0307	-0.337	0.000333	0.124**	-0.00248	0.110**	0.0123
	(0.350)	(0.0665)	(0.355)	(0.345)	(0.0548)	(0.0116)	(0.0551)	(0.0518)
Dummy (education): university = 1	-0.0471	-0.0402	-0.0158	-0.0429	0.0309**	0.0284**	0.0227	0.0304**
	(0.0737)	(0.0731)	(0.0751)	(0.0741)	(0.0138)	(0.0138)	(0.0144)	(0.0139)
Dummy: (occupation) pensioner = 1	0.315***	0.318***	0.351***	0.325***	-0.0402**	-0.0411**	-0.0490***	-0.0415**
	(0.104)	(0.104)	(0.105)	(0.104)	(0.0171)	(0.0171)	(0.0174)	(0.0170)
Dummy: (occupation) paid employee = 1	0.258***	0.272***	0.302***	0.266***	-0.0393**	-0.0440***	-0.0499***	-0.0396**
	(0.0935)	(0.0954)	(0.0955)	(0.0939)	(0.0157)	(0.0159)	(0.0164)	(0.0158)
Dummy: group C = 1	0.231***	0.232***	0.232***	0.232***	-0.0463***	-0.0466***	-0.0464***	-0.0464***
	(0.0847)	(0.0850)	(0.0846)	(0.0839)	(0.0159)	(0.0159)	(0.0160)	(0.0157)
Dummy: training wrong = 1	0.518***	0.520***	0.592***	0.536***	-0.187***	-0.187***	-0.206***	-0.190***
	(0.0436)	(0.0429)	(0.0448)	(0.0435)	(0.0104)	(0.0103)	(0.0102)	(0.0102)
Constant	-3.676***	-3.730***	-2.919***	-0.386	0.653***	0.672***	0.472***	-0.215
	(0.814)	(0.784)	(0.782)	(0.770)	(0.128)	(0.125)	(0.128)	(0.133)
Observations	2,237	2,237	2,237	2,237	2,237	2,237	2,237	2,237
R-squared	0.245	0.243	0.222	0.238	0.210	0.204	0.159	0.204

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: This Table presents the results from a regression analysis to explain Equivalent Incomes. In Models 1-4 the dependent variable is the logarithm of Equivalent Incomes. In Models 5- the dependent variable is the WTP. The variable *Distance** is the Euclidean distance from the situation of the individual in their actual life in the Health and Social Dimensions, to the perfect reference situation. The dummy variable *old* equals one if the respondent is older than the median age in the sample (older than 59 years old). The variable *medicine* equals one if the individual takes medicines and the variable glasses takes the value one if the individual needs to wear glasses or lenses to see. The variable *enjoy friends* equals one if the respondent indicated that he enjoys friends in the personality module of $LISS$. The dummy variable *training wrong* equals one if the respondent answered 'wrong' to the first training question. The rest of the variables are self-explanatory.

Table 11: Inequality Indices

		Gini	p90/p10	Atkinson 0.5	Atkinson 1	Theil
Income	A and B	0,28	3,28	0,08	0,13	0,19
	All	0,28	3,28	0,07	0,13	0,18
Equivalent Income	A and B	0,35	5,41	0,13	0,36	0,28
	All	0,34	5,41	0,07	0,35	0,27

Notes: this table presents inequality indices. The panel on top presents inequality indices for incomes. The panel on the bottom presents inequality indices for equivalent income (computed using the ABDC). On each panel the first row presents the indices restricting the sample to Groups A and B, whereas the second row also includes Group C. The inequality measures presented in the Table are the Gini Index, the ratio of the 9th decile and the 1st decile, the Atkinson Inequality index for different parameters of inequality aversion and the Theil index.

Table 12: Inequality Decomposition. Generalised Entropy.

		Equivalent Incomes	**Incomes**
	Total	**0.28**	**0.19**
Subgroups	# Groups	Share	Share
Health	2	3.932%	0.826%
Social	2	2.147%	1.028%
Education	3	2.344%	2.880%
Married	2	3.677%	2.532%
Social & health	4	5.016%	1.292%
Education & married	6	6.819%	5,639%
All	**24**	**12.420%**	**7.340%**

Notes: this table presents inequality decomposition by subgroups using the Generalised Entropy class (here we present the Thail index, where theGeneralizedof inequality aversion equals one). The sample is restricted to include only observations from groups A and B. We present the inequality decomposition both by incomes and equivalent incomes. The subgroups used for the decomposition are Health (being in good or bad health, a health index of more or less than 50), Social (having a social index of more or less than 50) Education (the first group clusters respondents with primary, intermediate and higher secondary education, second group clusters respondents with intermediate education and group 3 clusters individuals with higher vocational education and university education), and the subgroups Married (being married or not). The Share represents the share of inequality explained by the subgroup decomposition. For instance, 3.932% of equivalent income inequality is explained by differences between the groups of healthy and not healthy individuals.

Table 13: Descriptive statistics bottom 10% by different well-being measures

	All Sample	**Income**	**Health**	**Social**	**Life Satisfaction**	**Equivalent Income** ABDC	**Equivalent Income** Life Satisfaction
Mean Income	1797	645	1550	1443	1275	1133	1258
Mean Health	70	67	34	55	48	58	47
Mean Social	70	64	57	34	48	64	53
Mean Age	57	50	61	57	54	54	55
% Female	52	62	57	48	50	62	61
% migration background	16	23	20	30	33	25	26
% unemployed	2	5	3	6	8	7	13
Prim School	3	6	8	11	7	7	8
Prim School	18	19	29	22	22	22	26
vmbo	8	11	11	8	10	10	10
Havo	26	36	27	27	31	31	30
Hbo	30	21	18	22	20	20	17
Univ	15	7	7	10	11	11	9
N	2048	206	223	215	148	205	205

Notes: this table presents descriptive statistics for the full sample (excluding group C) in Column 1, and for the worst-off individuals (bottom 10%) by different well-being measures in columns 2 to 7.

Table 14: Transition matrix between Equivalent Income Deciles and Personal Income Deciles. Groups A and B.

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	Total
1	**79**	**31**	23	18	12	12	12	6	7	5	205
2	**86**	**37**	**14**	34	8	9	8	2	4	3	205
3	41	**68**	**34**	**12**	28	15	2	2	0	3	205
4	0	67	**61**	**28**	**9**	7	20	8	4	2	206
5	0	1	73	**54**	**32**	**15**	9	10	9	1	204
6	0	0	0	60	**63**	**28**	**20**	8	15	10	204
7	0	0	0	0	51	**98**	**28**	**12**	8	8	205
8	0	0	0	0	0	41	**75**	**45**	**31**	14	206
9	0	0	0	0	0	0	16	**102**	**62**	**25**	205
10	0	0	0	0	0	0	0	6	**71**	**126**	203
Total	206	204	205	206	203	225	190	201	211	197	2048

Notes: this table presents the absolute number of cases ranked in each decile using equivalent incomes (rows) or incomes (columns). The sample is restricted to respondents from Groups A and B only.

Table 15: Life Satisfaction regression used to estimate Marginal Rates of Substitution

VARIABLES	Model 1
Log (personal income)	0.260*
	(0.157)
Health Index	0.0787***
	(0.00723)
Social Index	0.0312***
	(0.00437)
Interaction: pensioner * Log(personal income)	0.545**
	(0.254)
Interaction: paid employee * Log(personal income)	0.374*
	(0.200)
Interaction: female * health	-0.0103*
	(0.00526)
Interaction: old * health	-0.0206***
	(0.00633)
Interaction: paid employee * health	-0.0175***
	(0.00614)
Interaction: pensioner * social	-0.0164*
	(0.00865)
Interaction: old * social	0.0107
	(0.00700)
Dummy: female = 1	0.929**
	(0.383)
Dummy: old = 1	1.179**
	(0.555)
Dummy: enjoy friends = 1	0.449***
	(0.104)
Dummy: medicines = 1	0.594***
	(0.114)
Dummy: rural area = 1	0.163*
	(0.0937)
Dummy: head household = 1	-0.216*
	(0.114)
Dummy: married = 1	0.764***
	(0.0982)
Dummy: (education) university = 1	-0.152
	(0.120)
Dummy: (occupation) pensioner = 1	-2.865
	(1.851)
Dummy: (occupation) paid employee = 1	-1.777
	(1.481)
/cut1	2.074
	(1.383)
/cut2	3.022**
	(1.253)
/cut3	4.242***
	(1.189)
/cut4	5.468***
	(1.193)
/cut5	6.343***
	(1.197)
/cut6	7.379***
	(1.200)
/cut7	8.541***
	(1.198)
/cut8	10.47***
	(1.203)
/cut9	12.86***
	(1.211)
/cut10	14.87***
	(1.225)
Observations	2151
Pseudo R^2	0.139
Robust standard errors in parentheses	
*** p<0.01, ** p<0.05, * p<0.1	

Table 16: Transition Matrix Equivalent Incomes Deciles byABDC and Life Satisfaction

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	Total
1	**70**	**42**	22	20	15	14	6	9	6	1	205
2	**34**	**34**	**38**	24	30	13	19	6	4	3	205
3	24	**26**	**26**	**37**	32	24	18	8	9	1	205
4	26	21	**23**	**22**	**22**	28	21	23	15	5	206
5	20	18	24	**21**	**22**	**27**	22	21	15	14	204
6	10	17	16	22	**23**	**20**	**26**	17	29	24	204
7	9	17	22	19	15	**21**	**20**	**34**	33	15	205
8	7	14	15	15	21	23	**32**	**33**	**30**	16	206
9	2	8	9	13	13	20	24	**33**	**38**	**45**	205
10	3	8	10	12	11	15	17	21	**26**	**80**	203
Total	205	205	205	205	204	205	205	205	205	204	2048

Notes: this table presents the absolute number of cases ranked in each decile using Equivalent Incomes computed using the Life Satisfaction Approach (columns) or the ABDC (rows). The sample is restricted to respondents from Group A and B only.

Table 17: Equivalent Incomes:ABDC and Contingent Valuation (analysis between individuals)

	Mean	**Median**	**SD**	**Min**	**Max**	**N**
x^{1*}_{ABDC}	1378	1225	1854,473	0,5	73672	2048
x^{1*}_{CV}	1565	1460	738,4068	0	4500	190
$1-(\frac{x^{1*}_{ABDC}}{x^1})$	0,237	0,126	0,263803	0	1	2048
$1-(\frac{x^{1*}_{CV}}{x^1})$	0,066	0	0,149834	0	1	190
$x^{1*'}_{ABDC}$	1514	1346	2150,983	0,5	73672	1437
$x^{1*'}_{CV}$	1641	1500	914,1436	0	4500	71
$1-(\frac{x^{1*}_{ABDC}}{x^1})'$	0,195	0,110	0,251802	0	1,000	1437
$1-(\frac{x^{1*}_{CV}}{x^1})'$	0,172	0,104	0,204754	0,001	1	71

Notes: this table presents descriptive statistics comparing equivalent incomes estimated using the ABDC (Groups A and B) denoted as x^{1*}_{ABDC} and equivalent incomes estimated using Contingent Valuation (Group C) x^{1*}_{CV}, the notation $'$ indicates that only observations from groups A and B from respondents who answered 10 rounds in the ABDC or from group C and provided an exact answer in the CV were considered. x^1 denotes personal incomes.

Table 18: Equivalent Incomes:ABDC and Contingent Valuation (analysis within individuals)

	Mean	**Median**	**SD**	**Min**	**Max**	**N**
x^{1*}_{ABDC}	1336	1200	792,23	0,5	4900	435
x^{1*}_{CV}	1597	1468	783,13	0	4950	435
$x^{1*'}_{ABDC}$	1499	1346	863,66	0,5	4900	139
$x^{1*'}_{CV}$	1664	1500	834,28	0	4950	139
$\lvert x^{1*}_{ABDC} - x^{1*}_{CV} \rvert$	272	127	365,24	0	2802	435
$\lvert x^{1*'}_{ABDC} - x^{1*'}_{CV} \rvert$	193	101	294,02	0	2199	139
$x^{1*}_{ABDC} - x^{1*}_{CV}$	-262	-126	372,58	-2801,5	1021	435
$x^{1*'}_{ABDC} - x^{1*'}_{CV}$	-165	-101	310,80	-2199	1021	139
$1 - (\frac{x^{1*}_{ABDC}}{x^1})$	0,241	0,169	0,24	0	1	435
$1 - (\frac{x^{1*}_{ABDC}}{x^1})'$	0,258	0,188	0,24	0	1	139
$1 - (\frac{x^{1*}_{CV}}{x^1})$	0,080	0,000	0,15	0	1	435
$1 - (\frac{x^{1*}_{CV}}{x^1})'$	0,165	0,108	0,20	0,000532	1	139

Notes: this table presents descriptive statistics comparing equivalent incomes estimated using the ABDC (denoted as x^{1*}_{ABDC}) and equivalent incomes estimated using Contingent Valuation (denoted as x^{1*}_{CV}) from Groups B and C, where the comparissons were made within individuals. The notation $'$ indicates that only observations who answered 10 rounds of the ABDC and provided an exact answer were included. x^1 denotes personal incomes. $||$ denote absolute values.