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When normative and descriptive diverge: how to bridge the difference

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Abstract

Revealed preferences are not consistent. Many anomalies have been found in different contexts. This finding leads to a divergence between normative and descriptive analyses. There are several ways of facing this problem. In this paper we argue in favour of debiasing observed choices in such a way that the "true" preferences are discovered. Our procedure is based on quantitative corrections derived from assuming the descriptive validity of prospect theory and the normative validity of Expected Utility. Those corrective formulas were first applied by Bleichrodt et al. (2001). We explain here how such formulas can be used to avoid inefficient allocation of health care resources. This approach shares the philosophy of Libertarian Paternalism (LP). However, it reduces some of the potential problems of LP: the definition of error (and the need to nudge people) is more clear and objective. In this sense, it reduces the chances that the regulator tries to nudge people toward behaviour based on her preferences and not on subject's own preferences.

The orthodoxy: the revealed preference approach

Public decision making tries to allocate resources efficiently. In order to reach this objective many public agencies use individual preferences as inputs so as to decide how to allocate resources. In practice, this implies conducting large surveys to find out how members of society value risks, time, nature, health, and so on. One of the main problems in incorporating individual preferences in social decisions is that there is a significant body of evidence (Camerer, 1995; Starmer, 2000) showing many "anomalies" both in experimental and field work. Preferences elicited in these surveys do not seem to conform to standard normative assumptions. We sometimes find that people are insufficiently sensitive to theoretically relevant factors giving rise to a host of embedding effects (e.g., people saying that they are willing to pay the same for two goods even if one clearly dominates the other). Sometimes people are sensitive to theoretically irrelevant factors giving rise to violations of procedure invariance (e.g., order effects, discrepancies between matching and choice, between certainty and probability equivalents). The question is what we can do in order to use preferences in public decision making if we observe such anomalies.

The response to this question depends on the explanation we give for these anomalies. For some researchers, anomalies seem to suggest that individuals do not have well established underlying preferences on some issues in such a way that revealed or stated preferences will always show anomalies. There are different kinds of reactions to this problem. One is Libertarian Paternalism (LP). As Sunstein and Thaler (2003, p. 1159) say "often people's preferences are ill-formed, and their choices will inevitably be influenced by default rules, framing effects, and starting points" (Sunstein and Thaler, 2003, p.1159). They conclude that “If the arrangement of the alternatives has a significant effect on the selections the customers make, then their true "preferences" do not formally exist” (Sunstein and Thaler, 2003, p.1164). The second justification (Thaler&Sunstein, 2008, p.5) is that LP, “tries to influence choices in a way that will make choosers better off, *as judged by themselves*”. Although the justification of LP is different in both cases they seem to have something in common. In both justifications they seem to suggest that “true” preferences are those that subjects would have “if they had complete information, unlimited cognitive abilities, and no lack of willpower” (Sunstein and Thaler, 2003a, p. 1162; Thaler and Sunstein, 2003b, p. 175). That is, Sunstein and Thaler seem to suggest that even if preferences (revealead or stated) are influenced by details of the context that are theoretically irrelevant (e.g., default rules, framing effects, starting points) some kind of true preferences exist. True preferences would then be those of subjects with complete information, unlimited cognitive abilities, and no lack of willpower. LP would be Libertarian in the sense that it would help people to get what they really want (“judged by themselves”), that is, their true preferences. LP would not impose preferences. It would only help people to have what they would choose under some kind of ideal conditions. Incomplete information, cognitive abilities and lack of willpower would be biases that would lead people to make wrong choices. In summary, LP could be considered an approach to decision making characterized by the assumption that subjects have true preferences that are not always revealed since they are unduly influenced by biases.

However, Libertarian Paternalists are not very specific about how to identify those situations where choices do not revealed true preferences. As Sugden (Sugden, 2009, p. 370) points out "The concepts of full attention, perfect information, unimpaired cognitive ability and complete self-control do not have objective definitions; they are inescapably normative". Under these circumstances "any intervention that a paternalist sincerely judges to be in the individual's best interests can be justified in this way if the paternalist is allowed to define what counts as attention, information, cognitive ability and self-control" (Sugden, 2009, p. 370). Maybe for this reason Bernheim and Rangel (2005: p. 3) write "Once we relax this doctrine (revealed preference), we potentially legitimize government condemnation of almost any chosen lifestyle on the grounds that it is contrary to a "natural" welfare criterion reflecting the individual's "true" interests."

Libertarian paternalism is not the only way of approaching the problem that the presence of "anomalies" generates. Other people (Plott, 1996) think that these anomalies mainly happen in contexts in which subjects have little previous experience with the task. In fact, it has been shown (Shogren et al., 1994; Cox and Grether, 1996; Plott and Zeiler, 2005; Van de Kuilen, 2009) that some anomalies disappear or decay in repeated choice environments or when subjects are given better incentives or when they are given the possibility of learning from bad decisions. They assume that there is a "true" preference and these anomalies are a manifestation of errors that can be corrected with learning. As Plott (1996: p. 228) says "with practice and experience, under conditions of substantial incentives, and with the accumulating information that is obtained from the process of choice (…) the final preferences show no evidence of being labile"[1]. We are aware that although Plott's hypothesis is supported by some

[1] There is a further view on preferences which claims that even in the absence of anomalies, preferences are wrong. This criticism to the modern welfare economics (Dolan and Kahneman, 2008) is based on the argument that the relevant notion of utility is not that which is provided by the assumption of maximization of preferences or desires for an outcome (decision utility), but by the maximization of the

evidence there are also studies whose findings run against the idea that (market) experience is refining (Knetsch et al., 2001; Loomes et al., 2003; Braga et al., 2009).

It seems that if Plott is right and if we like consumer sovereignty, it would be a better strategy (unless we are definitely paternalistic) to use in social policy the "true" preference that shows up after consumers have had some opportunity of practicing and experiencing the good to be valued. That is, we would use what Sugden (2005: p. 154) calls "measures of long-run surplus"[2] or what Beshears, Choi, Laibson & Madrian (2008: p. 1791) call "asymptotic choice"[3]. Mitchell (2005) claims that another alternative to LP is to use debiasing techniques like "reframing choices" or "greater reflection and deliberation". All these alternatives to LP implicitly accept that there is some kind of "true" preference. That is, when there is an anomaly, some kind of discrepancy in people's preferences, we can find out which is the "true" preference. This would be equivalent to the preference that is observed in the "long-run" or the option that is chosen by the subject once debiasing techniques are used.

However, in many of those surveys that governments use in order to inform social policy there are not enough resources (time and money) in order to reach the stage where preferences are not labile. Researchers cannot use debiasing techniques at the individual level as Mitchell (2005) suggests. Quite often, it is not easy to observe long-run preferences either. There are cases (e.g., medical decisions) where repetition, learning and incentives cannot be used in order to reduce anomalies and it is not clear

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hedonic experience of that outcome (experienced utility). According to this view when people reveal or state preferences by means of real or hypothetical choices they are expressing what they want at the time of the assessment (ex ante), but they are mistaken in their forecasts of the utility they will experience in the future (ex post). Hence even if preferences are well-defined and no anomalies show up at the time of decision they should not be the objective function of welfare economics because people are not aware that their tastes change as the time goes by. We do not deal with this in this paper since the objective of our paper is to deal with problems caused by inconsistencies at the moment of taking a decision.

2 "In most cases, I suggest, CBA (Cost-Benefit Analysis) should use measures of long-run surplus".

3 "In most stationary economic environments, short-run choices are likely to be further from normative optimality that long-run choices".

what we mean by "long-run" or "asymptotic" preferences. So what can we do if we want to use preferences to inform public decisions but when, at the same time, it is not feasible to work with subjects until they reach a stage where they have discovered their true preferences?

In this paper we want to explain how to deal with this issue in a practical context: how to allocate resources in the health sector. We will present a method that can be applied in practice that relies on the assumption that "true" preferences exist but they are not always revealed in choices (real or stated) given the presence of biases. In this respect our method has some common features with LP. However, contrary to LP our method proposes a clear and objective way to separate the true component of preferences from the biases. In that respect, we think that our method cannot be critized on the grounds that "any intervention that a paternalist sincerely judges to be in the individual's best interests can be justified". First, we will describe the problem that we want to address and then we will proceed to present our proposal.

Resource allocation in the health sector

One of the main reasons why health care expenditure tends to rise concerns the cost of new health technologies. Since treatments, medical devices, and medicines become more and more expensive, some countries have created public bodies which have to ensure *good value for money*. These bodies are usually called "fourth-hurdle" agencies, since pharmaceutical companies have to pass the mandatory "hurdle" of the economic evaluation in order for their medicines to be reimbursed by the Health Care System. Examples of fourth-hurdle agencies are the Common Drug Review in Canada, the

Pharmaceutical Benefits Advisory Committee in Australia, or the National Institute for Clinical Excellence in England and Wales. Most agencies recommend that economic evaluations of new medicines are made on a cost-utility basis. The outcome measure used in cost-utility is called the quality-adjusted life-year (QALY). It is assumed that health benefits amount to the number of QALYs gained and the objective of health care resources is to maximize the numbers of QALYs.

A QALY is an outcome measure that combines duration and quality of life. Assume that quality of life can be measured on a scale between 0 (death) and 1 (full health). Let us call this index the "utility" of a health state. The QALY is a measure of health that weights the duration of a health problem with the utility associated to this health state. For example, one year in full health would be 1 QALY and one year in a health state worse than full health would be less than 1 QALY. Assume, a patient is going to be 1 year with a health problem that has a utility of 0.7. We would say that this patient will enjoy 0.7 QALYs next year, that is, 0.3 QALYs less than somebody without health problems. If a medical treatment avoids this health problem it would produce a benefit of 0.3 QALYs. Combining this benefit with the cost of the medical treatment we can estimate the cost per QALY ratio and allocate resources accordingly.

The main problem in estimating the benefit of a medical treatment is how to estimate the "utility" of a health state (the value we associate to health-related quality of life). Many regulatory agencies have produced guidelines that give advice on how to read out the utilities from standardized instruments. Two of these instruments are the so-called Health Utilities Index (Feeney et al., 2002) and the SF-6D (Brazier et al., 2002). These instruments generate utilities for thousands of different health states. All these utilities are based on the preferences of the general population elicited by means of a technique which is commonly called the *standard gamble* in the context of health. We will use the more informative term *probability equivalence* (PE).Let us introduce some notation to explain how the PE method measures health state utilities. Consider health outcomes of type (Q, T) , which means living in health state Q for T years, followed by death. For example, (back pain, 5 years) stands for living 5 years with back pain, followed by death. In this section, which reviews standard methods of measuring utilities of health states, we assume that preferences are reference-independent, as implied by expected utility theory. Weak preferences are denoted by $\succeq$. Strict preferences are denoted by $\succ$ and indifferences by ~.

Consider binary prospects denoted by $((Q_1, T_1), p; (Q_2, T_2))$, yielding outcome (Q_1, T_1) with probability p and outcome (Q_2, T_2) with probability $1-p$. If $p = 1$ or $p = 0$ the prospect is riskless, otherwise it is risky. Preferences over outcomes coincide with preferences over riskless prospects. Throughout the paper we use the notational convention that risky prospects are rank-ordered. That is, when we write $((Q_1, T_1), p; (Q_2, T_2))$ we assume that $(Q_1, T_1) \succeq (Q_2, T_2)$. Expected utility holds if preferences over gambles of the form $((Q_1, T_1), p; (Q_2, T_2))$ are represented by $pU(Q_1, T_1)+(1-p)U(Q_2, T_2)$, where U is a real-valued utility function over outcomes that is unique up to scale and location.

Consider the problem of eliciting the utility of some health state Q^* which is less preferred than full health (denoted FH) but which is preferred to death. The PE method asks for the probability p_{PE} that leads to indifference between the outcome (Q^*, T) and the gamble $((FH, T), p_{PE}; (Q', 0))$, where Q' can be any health state, and $(Q', 0)$, which from now on will be written as *Death*, represents immediate death.

It is a common view (though not unanimous) that expected utility (EU) is the right model for normative analysis (e.g., Savage, 1954; Harsanyi, 1955; Kahneman and Tversky, 1979). Critics include Allais (1953) and Ellsberg (1961). This perceived normative superiority has traditionally led economists to assume that expected utility is also the right model to describe preferences for risky prospects (which Bleichrodt et al. 2001 call *the classical elicitation assumption*). According to this classical elicitation assumption the typical indifference reached by a PE question:

$$((FH, T), p_{PE}; Death) \sim (Q^*, T) \qquad (1)$$

should be evaluated as:

$$p_{PE}U(FH, T) + (1-p_{PE})\, U(Death) = U(Q^*, T) \qquad (2)$$

A common way in medical decision analysis of computing the utility of pairs (Q, T) is by assuming multiplicativity of the two-attribute utility function, i.e., $U(Q, T) = H(Q)L(T)$, and scaling in such a way that $U(Death) = 0$ and $H(FH) = 1$. Assume L(T)=T. This gives rise to the linear QALY model, widely used in health economics[4]. If we assume multiplicativity, Eq. (2) yields

$$H(Q^*) = p_{PE} \qquad (3)$$

[4] Theoretical foundations for the linear QALY model have been provided by Pliskin et al. (1980) and Bleichrodt and Quiggin (1997) among others. Even though linearity in duration is a disputable assumption, this model underlies most of utility measurements in health economics because of its simplicity. We assume it for the same reason at this stage. Later on we will introduce utility curvature for life years.

Thus both the Health Utilities Index and the SF-6D assume that $H(Q^*)$ is equal to p_{PE} because that is the way by which utilities are calculated with the PE method[5]. This is how the two instruments have estimated the utilities of health states. These utilities are used to compute QALYs and the cost-effectiveness of medical interventions. For example, if somebody is indifferent between (back pain, 5 years) and next gamble ((FH, 5years), 0.8; Death) then H(back pain)=0.8 and U(back pain, 5years)=4 QALYs. The benefit of the health improvement from (back pain, 5years) to (Full Health, 5years) is 1 QALY.

There are, however, other elicitation methods which we could also use since they should lead to the same value for $H(Q^*)$., given the linear QALY model. For example, assume that the individual is asked to state the duration T_{CE} that makes him/her indifferent between the sure outcome (Q^*, T_{CE}) and the risky prospect $((FH, T), p; Death)$, where p is some fixed probability. This way of eliciting preferences is called the *certainty equivalence* (CE) method. Under EU we should elicit the same $H(Q^*)$ using SG or CE. Likewise, the same utility should be elicited if the subject was asked for the duration T_{VE} that makes him/her indifferent between (Q^*, T) and the risky prospect $((FH, T_{VE}), p; Death)$, where T is the fixed duration of health state Q^* and p is some fixed probability; the subscript VE stands for *value equivalence.*

However, it is typically not the case that these methods lead to the same value of $H(Q)$. Indeed Bleichrodt et al. (2007) showed that utilities elicited using the VE were consistently higher than both CE and PE utilities. For example, for the same health state the utility ranged from 0.51 (elicited by the CE) to 0.67 (VE).

[5] Note that the SG imposes no restriction on the shape of the utility function for life years $L(T)$. Therefore, Equation (3) holds even if $L(T)$ is not linear. This does not hold for the other two elicitation methods introduced below.

In order to see the practical relevance of this variability we note that the benefit of a medical treatment that restores people to full health, would radically change if the utility of the health state is 0.51 or 0.67. If it is 0.67 the benefit would be 0.33 QALYs each year and if we use 0.51 the benefit would be 0.49 QALYs per year. Almost a 50% difference emerges. This has enormous implications for resource allocation. If the benefit is estimated as 0.49 QALYs then we could justify spending almost 50% more money on a medical treatment than if the benefit is estimated as 0.33. The violations of procedure invariance observed, imply that very different allocations of health resources may be prescribed by the HUI and the SF-6D depending on the elicitation method used. Obviously this is a serious problem since, in one way or another, some resource allocation has to be decided on.

So, given that we observe clear violations of procedure invariance: how can we allocate resources based on preferences? The LP approach would suggest that we identify what subjects would choose "if they had complete information, unlimited cognitive abilities, and no lack of willpower". However, we do not think this is very helpful in this case since, as Sudgen suggested, they are normative (and very vague) concepts. Also, it is not clear how "measures of long-run surplus" or "asymptotic choice" can be implemented in this case since subjects cannot learn from practice and experience as most of these decisions are not taken repeatedly. Our proposal is next.

Our proposal: debiasing

We propose to deal with these anomalies using the idea of "debiasing". There is a large literature on debiasing methods (Larrick, 2004). Most of these methods involve, in one way or another, working with people in order to improve their decisions, as Mitchell (2005) suggested. In the case study that we are presenting in this paper this option is not considered feasible. We are talking about large surveys that try to be representative of the preferences of the general population. Of course, another option would be to conduct in depth interviews with a subset of the population. However, the surveys that are used to estimate utilities for health states are not conducted this way because we would need a very large budget (and a huge time investment by researchers) in order to do in depth interviews with representative samples of the general population.

Our objective is to debias judgements about the relative value of different health states that people express in large surveys so that we can elicit *aggregate* preferences for the general population. In most cases, the kind of questions that are asked in these surveys are unfamiliar for the subjects that are interviewed. We can think that the responses reflect a combination of basic (maybe stable) preferences about health and the effect of the method – PE, CE, or VE – we use to elicit preferences. Our approach accepts that eliciting preferences for health states is a difficult task and that it is going to be difficult to avoid inconsistencies. However, this does not lead us to reject individual preferences. Some people have more precise preferences and some others have less well defined preferences but all responses provide some input that can be used to inform public policy. What we need is a descriptive model that "incorporates all of the economic and psychological motives that shape behavior" (Beshears et al., 2008). Once we understand the reasons for the disparities between elicitation methods we can try to isolate the effect of the peculiarities of each method and the effect of basic preferences (for health, in our case).

We claim that, given the state of the literature, the most commonly used sophisticated descriptive theory for decisions under risk is Cumulative Prospect Theory (CPT), the updated version of the original Prospect Theory (Kahneman and Tversky, 1979), that was introduced by Tversky and Kahneman (1992). In the rest of the paper we will assume that subjects respond to questions posed by elicitation methods such as the PE, CE or VE according to the operationalization of CPT provided in Bleichrodt et al. (2007). Details of the model are provided in the next section. We will show how utilities for health states can be elicited assuming such a model. We will see that by using CPT, disparities between utilities for the same health state elicited by alternative methods are greatly reduced. Before proceeding we want to clarify that we are not claiming that all subjects behave according to CPT. Probably for individual decision making our approach would be unreliable, that is, we could make mistakes at the individual level since individuals undoubtedly are different and can respond to our survey questions using different mental processes. However, we claim that the empirical evidence shows that CPT is a better (but not perfect) descriptive theory of risky choice than EU. For this reason, we think it makes sense to assume that population preferences are better modelled using CPT than EU.

Eliciting preferences under prospect theory

If subjects conduct a descriptive task (like responding to PE questions) using CPT, it is wrong to value health outcomes assuming that subjects are EU maximizers. CPT deviates from EU in three main respects. First, under CPT outcomes are evaluated as gains or losses relative to a reference point (reference dependence). Second, people are more sensitive to losses than to gains (loss aversion). Third, subjects do not treat probabilities linearly, but cumulative probabilities are transformed in a rank-dependent fashion (probability weighting with rank-dependence)[6]. If these features of CPT are influencing the response to SG/CE/VE questions *H(Q*)* should be elicited using CPT. Otherwise *H(Q*)* will be biased since it would be reflecting other elements (psychological factors) apart from (intrinsic) utility of the health state. We then proceed to show how we should estimate utilities for health states assuming that subjects behave according to CPT.

Quantitative formulas for debiasing

Notation and outline of the CPT model

We consider binary prospects of the general form $(x_1, p; x_2)$ where x_1 and x_2 are outcomes and where p is the probability of outcome x_1 (the probability of x_2 being $1 - p$). Let r (an outcome) denote the reference point. The reference-dependence of preferences *over prospects* is expressed by a preference relation $\succeq_r$, where $(x_1, p; x_2)$ $\succeq_r$ $(y_1, q; y_2)$ means that "$(x_1, p; x_2)$ is at least as preferred as $(y_1, p; y_2)$ when judged from reference point r". Preference relations $\succ_r$ and $\sim_r$ are established in the same way.

We identify outcomes with corresponding degenerate prospects, i.e. $(x, p; x) \equiv x$. We assume that preferences *over outcomes* are reference-independent. That is, for any outcomes x_1 , x_2 and for any reference points r, s, $x_1 \succeq_r x_2$ implies $x_1 \succeq_s x_2$. We use $\succeq$, $\succ$ and $\sim$ to denote such reference-independent preferences. When defining a binary prospect of the form $(x_1, p; x_2)$, we use the notational convention that $x_1 \succeq x_2$.

[6] Rank-dependent transformation of probabilities avoids violations of stochastic dominance occurring under original Prospect Theory for gambles with more than two outcomes. For the gambles considered in this paper, which yield only two outcomes, original Prospect Theory is in fact rank-dependent (Kahneman and Tversky, 1979, Equation 2), so our analysis covers both original and CPT.

For any outcome x and any reference point r, if) $x \succ r$ r then x is a gain, and if $r \succ x$, then x is a loss. A prospect that involves both a gain and a loss outcome (i.e. $x_1 \succ r \succ x_2$) is called *mixed*, otherwise it is *nonmixed*. A nonmixed prospect takes one of two forms: either $x_1 \succeq x_2 \succeq r$ (a *nonloss* prospect) or $r \succeq x_1 \succeq x_2$ (a *nongain* prospect),

Tversky and Kahneman (1992) assumed one fixed reference point with utility equal to zero. On the contrary, in this paper we assume that the reference point varies as the decision maker's opportunity set (the set of available options) does. This is the same hypothesis that Hersey and Schoemaker (1985) assumed to explain the discrepancy between the CE and the PEwith money outcomes, though they did not provide a formal model. Shalev (2000) introduced a model for game theory considering variations in the reference point. Bleichrodt et al. (2001) used a similar modelling strategy in utility elicitation for life years. Later on Bleichrodt et al. (2007) applied the same model to health state utility measurement. The main feature of these operationalizations of CPT is that risk attitude is decomposed into three distinct components: basic utility, probability weighting, and loss aversion. Köbberling and Wakker (2005: p. 124) emphasize that such a separation "is crucial if variations in the reference point are considered". The same decomposition is performed by Wakker (2010: p. 239 and chapter 9) for the case of a fixed reference point

Specifically, we assume that the CPT utility of a gamble may be decomposed into the components: a) a basic utility function U, that captures the intrinsic utility of outcomes; b) a nonlinear transformation of probability reflected by means of two strictly increasing probability weighting functions $w^i(.)$, where $i = +$ for gains and $i = -$ for losses, each of which assigns a probability weight to each probability and satisfies $w^i(0) = 0$ and $w^i(1) = 1$; and c) loss aversion which is captured by means of a loss aversion parameter λ. This decomposition combines the psychology of CPT with the utility function U of Expected Utility. An implication of this model is that psychological factors such as numerical perceptions of outcomes (Wakker et al., 2007) contributing to diminishing sensitivity for outcomes (i.e. the impact of a given change in an outcome diminishes with its distance from the reference point) are ignored. It is hard to measure and correct this bias since both intrinsic value (normatively relevant) and numerical perceptions (non-normative) jointly determine the utility of health outcomes as we observe it. Diminishing sensitivity for probabilities, on the contrary, may be reflected through a probability weighting function that is concave near zero and convex near one. Risk attitude would be explained by the conjunction of utility curvature (not as a function of the reference point), probability weighting and loss aversion[7].

Consider any binary prospect $(x_1, p; x_2)$ and any reference point r. Let $V((x_1, p; x_2), r)$ be the reference-dependent valuation of this prospect given by CPT. If the prospect is mixed:

$$V((x_1, p; x_2), r) = U(r)+w^{+}(p)(U(x_1) - U(r)) - \lambda w^{-}(1-p)(U(r) - U(x_2))))$$

(4)

If it is a nonloss prospect:

$$V((x_1, p; x_2), r)=U(r) + w^{+}(p)(U(x_1 - U(r))+(1-w^{+}(p))(U(x_2) - U(r))$$

(5)

If it is a nongain prospect:

$$V((x_1, p; x_2), r) = U(r) - \lambda w^{-}(p)(U(r) - U(x_1)) -\lambda(1-w^{-}(p))(U(r) - U(x_2))$$

(6)

[7] For further explanation of this version of CPT for varying reference points see Shalev (2000: p. 272), Bleichrodt et al. (2001: 1501-1502), Köbberling et al. (2005: p. 124 and 126) and Bleichrodt et al. (2007: p. 470-471).

If $w^{+}(p) = w^{-}(p) = p$ for all p, and if $\lambda = 1$, (4), (5) and (6) all reduce to

$$V((x_1, p; x_2), r) = pU(x_1) + (1 - p)U(x_2) \tag{7}$$

as implied by expected utility theory.

The most commonly found weighting function (Wakker, 2010: p. 204, footnote 2, and p. 264) has an inverse S-shape with the inflection point where the function changes from overweighting probabilities, i.e., $w(p)>p$, to underweighting probabilities, i.e., $w(p)<p$, lying around 1/3. Several parametric specifications of the probability weighting function have been proposed in the literature accounting for that pattern (Tversky and Kahneman, 1992; Prelec, 1998; Gonzalez and Wu, 1999). We will employ the one-parameter specification suggested by Tversky and Kahneman (1992), which is the functional form extensively used in the domain of the health outcomes (Bleichrodt and Pinto, 2000; Bleichrodt et al., 2001; Bleichrodt et al. 2007; Abellan-Perpiñan et al., 2009):

$$w(p) = \frac{p^{\gamma}}{\left[p^{\gamma} + (1-p)^{\gamma}\right]^{1/\gamma}} \tag{8}$$

Tversky and Kahneman found a median value of γ^{+} (the parameter for gains) equal to 0.61 and γ^{-} (the parameter for losses) equal to 0.69, and a median value of λ equal to 2.25. Although comparable median parameter values were obtained in later studies, they were far from being identical. For example, median value of λ for different stimuli reported by Bleichrodt et al. (2007) range from 1.53 to 2.13. In general there is more variability in the loss aversion parameter than in the parameters that determine the shape of the probability weighting function (Booij, Van Praag & Van de Kuilen, 2010) . In addition, all studies found wide variation in parameter estimates at the individual level.

A practical application of debiasing

To show the practicality of correcting biases by assuming the descriptive validity of prospect theory we will correct the discrepancy between the PE, CE and VE methods used by Bleichrodt et al (2007).

The predictions made by CPT depend on the location of the reference point. In the absence of a general theory of reference points "hypotheses about their location have to be based on pragmatic heuristics in applications" (Wakker, 2010: p. 241). In this way, Hershey and Schoemaker (1985) and Bleichrodt et al. (2001) conjectured that when indifference between a gamble and a sure outcome is obtained by varying a probability (like the PE does) or outcome level of the gamble (as in the CE and VE methods respectively, the decision maker will take the sure outcome (that remains constant throughout the elicitation) as the reference point. This hypothesis is supported by empirical evidence (Stalmeier and Bezembinder, 1999; Bleichrodt et al., 2001; Robinson et al., 2001) and implies that for both the PE and the VE the reference point is *(Q*, T)*. In the CE, it is less plausible that the sure outcome is taken as the reference since it is not given in advance. Hence, the reference point is plausibly either (FH, T) or *Death*. The findings reported by Bleichrodt et al. (2001) suggested that people take *Death* as their reference point in CE questions. In short, we will assume that *(Q*, T)* is the reference point for PE and VE tasks whereas *Death* is the reference point for CE tasks.

As noted in Section 2 we assume that *U(Q, T) = H(Q)L(T)*. Next, to be able to calculate H(Q*) from the responses to PE, CE and VE questions we need to assume a specific form for L(T). Although the linear QALY model assumed in section 2 offers the advantage of being very simple, there is a substantial body of evidence rejecting that utility is linear in life duration (Dolan, 2000). Several parametric forms for $L(T)$ have been used in medical decision analysis. We will assume that L is a power function: $L(T) = T^{\beta}$. This function is probably the specification most frequently assumed, outperforming other competing functional forms (e.g. Abellan-Perpiñan et al., 2006).

We use $H_{PE}(Q^*)$, $H_{CE}(Q^*)$ and $H_{VE}(Q^*)$ to denote the values of $H(Q^*)$ elicited by the PE, CE and VE methods respectively. Given the assumptions made about the location of the reference point, from the application of Equations (4-6) to the indifferences established by PE, CE and VE questions, we have that:

$$H_{PE}\left(Q^*\right) = \frac{w^+(p)}{w^+(p) + \lambda w^-(1-p)} \quad (9)$$

$$H\left(Q_2^*\right) = w^+(p)\left(\frac{T}{T_{CE}}\right)^{\beta} \quad (10)$$

and

$$H_{VE}\left(Q^*\right) = \frac{w^+(p)}{w^+(p) + \lambda w^-(1-p)}\left(\frac{T_{VE}}{T}\right)^{\beta} \quad (11)$$

The median responses to PE, CE and VE questions, for T = 38 years and a health state labelled as state B[8], were 0.59, 44 years, and 43 years respectively. Therefore, by assuming the validity of the linear QALY model and Expected Utility (henceforth linear EU) we have $H_{PE}(Q^*)$ =0.59, $H_{CE}(Q)$=0.51, and $H_{VE}(Q^*)$=0.67. Using the median

[8] This health state was described as having some problems walking about and performing self-care activities (e.g. dressing), being unable to perform usual activities (e.g. work), suffering from moderate pain or discomfort, and feeling moderately anxious or depressed.

estimates obtained in Bleichrodt et al. (2007) for parameters γ^+, γ^-, λ and β (0.77, 0.80, 1.53, and 0.65) and applying Equations (8-10) the same utilities are now $H_{PE}(Q^*)=0.46$, $H_{CE}(Q^*)=0.49$, and $H_{VE}(Q^*)=0.5$. The absolute range of the utilities reduced from 0.16 under linear EU (= 0.67-0.51) to 0.04 under CPT with a power function for life years (= 0.5-0.46). It has to be emphasized that this result does not rely on parameter values estimated in other studies (e.g. Tversky and Kahneman's estimates); the values used are the medians of the individual estimates that minimized the sum of squared differences between the elicited utilities in our sample. To test to what extent equations 9-11 are able to reduce the differences among utilities for acceptable ranges of the parameters, we computed utilities changing the values of γ^+, γ^-, λ and β until the absolute range of the utilities under CPT was equivalent to that of EU. We varied γ^+ between 0.47 and 1.27, γ^- between 0.5 and 1.3, λ between 1.23 and 2.03, and β between 0.35 and 1.15. For this range of parameters CPT was descriptively better than EU.

Bleichrodt et al (2007) reported considerable variation in the estimates at the individual level. Specifically, the mean lengths of the interquartile range were 0.32, 0.4, 1.51, and 0.45 for γ^+, γ^-, λ and β. However, if we impose on each individual the median optimal parameters, and then examine which model minimizes the sum of squared errors between the different elicitation methods, we find that linear EU fails to fit individual data (0% of the sample) whilst CPT with the parameters estimated from our data is the best model for 80.5% of the sample. EU with a power function for life years and CPT with Tversky and Kahneman's (1992) estimates fitted best for 13% and 6.5% of the participants, respectively. In summary, the result that CPT describes preferences better than EU seems very solid.

As a result when we no longer assume that subjects are EU maximizers the "anomaly" is largely reduced at the aggregate level. The results that we have reported level clearly show that CPT is a better descriptive theory at the individual level. The relevance for resource allocation in the health sector is quite large. We have to think that the popular HUI would have estimated *H(Q*)* as 0.59 while the corrected utility is 0.46. This implies that the benefit of a health improvement is being underestimated by almost 30%.

Concluding remarks

There is a significant body of evidence showing many "anomalies" (i.e., deviations from the standard assumptions) both in experimental and field work. These anomalies have initiated a vast literature on new descriptive theories of decision making. However, as Braga and Starmer (2005) point out "the significance of these efforts at the foundations of economics has yet to fully percolate through to practical questions of policy formation" (p. 56). In this paper we have tried to show that these efforts can readily "percolate" into practical questions of policy formation.

We have shown that the existence of "anomalies" does not necessarily imply that preferences do not exist. We suggest that they can be due to the (false) assumptions that we are using to analyze responses. Once we include better assumptions (probability transformation, loss aversion) we observe more consistent results. Our method is based on the assumption that CPT is a good descriptive theory of risky decision making. So it has a component that is purely descriptive, that is, probability distortion and reference dependence are just "facts".

However, our proposal has also a normative component that can be considered paternalistic. The method we propose to estimate utilities is based on the assumption that there is a “true” utility that is not directly observed. What we observe is a biased estimate of this utility. It is biased because it is affected by probability distortion and loss aversion. We are then assuming that probability distortion and loss aversion are biases, that is, they are not normatively desirable. The normative status of these two features has been debated in the literature. Some researchers think that the choice of a reference point is a framing effect. That is, if gains and losses are the same under different framings, the change in the reference point is arbitrary, so loss aversion is a mistake. However, other people consider that there could be “genuine empirical or pragmatic reasons” for intrinsic loss aversion (Köbberling and Wakker, 2005: p. 126). In the same vein, a pessimistic attitude described by probability distortion can be considered irrational if it comes from an “irrational belief that unfavorable events tend to happen more often, leading to an unrealistic overweighting of unfavorable likelihoods (Murphy’s law)”. On the contrary, it may be considered normative if it results “from consciously and deliberately paying more attention to unfavorable outcomes in decisions” (Diecidue and Wakker, 2001: p. 284).

The problem of giving normative status to probability distortion and/or reference dependent preferences is that we are going to elicit different utilities depending on the method we use to elicit preferences. In this case, it seems that the only alternative would be to decide which the better method is and we do not see that there is a method that is normatively the best. That is, paternalism would be inevitable.

We accept that our approach does not totally avoid paternalism for two reasons. First, we do not give people the opportunity to understand all these problems for themselves and to decide themselves how much they value health states. As we have said, the (usually large) surveys that are used to elicit preferences at the aggregate level cannot be combined with in-depth interviews. Second, we are then imposing on them a normative concept, namely, that probability distortion and reference dependent preferences are biases (mistakes). However, since these normative concepts are better defined than "complete information", "unlimited cognitive abilities" or "no lack of willpower" it is more difficult for a paternalist to define these concepts in such a way that she can justify any policy that she thinks is the best for others. If given the estimated utilities Treatment A is prioritized over Treatment B and the regulator thinks that this is mistake (because this does not coincide with her preferences) she has less discretionality with our method than with concepts such as "unlimited cognitive abilities". If Treatment B can only be prioritized over Treatment A under some implausible assumptions about the shape of the probability weighting function or about the degree of loss aversion the regulator will not be able to prioritize her preferred treatment unless she admits that she is simply paternalistic. Given the resource and time constraints that we have, this is as close as we can get to societal preferences.

Of course this proposal is far from perfect. It has limitations and requires further research. First of all it may be too optimistic to believe that one single model can explain all existing data. For example, in the study conducted by Bleichrodt et al. (2007) prospect theory could explain quite well the systematic discrepancies between three riskless-risk methods. However, the authors also used two risk-risk methods which did not produce discrepancies under expected utility. As the authors recognized (p. 479) this last finding is "harder to reconcile with prospect theory".

Secondly, to operationalize cumulative prospect theory we have to make assumptions about the location of the reference point. One of these assumptions is that individuals consider all outcomes in CE questions as gains. However, van Osch et al. (2006), using health outcomes, presented qualitative data providing evidence that the sure outcome offered by means of a choice-based task most frequently served as a reference point. The risky prospect involved in CE questions would then be a mixed prospect. Hence, more research is needed about the relationship that may exist between search procedures (i.e., mechanisms followed in order to reach indifference) and the location of the reference point.

Finally, our proposal relies on the assumption that people behave following CPT. If this is not the case, our results could be biased as well. In fact, other people (Birnbaum, 2008; Loomes, 2010) can explain these disparities using other approaches. The fact that the corrective formulas used reduce these inconsistencies does not guarantee that we are eliciting underlying "true" values. We think that it is a good indication that we are moving in the right direction because this is congruent with theory. However, we would be more confident with our conclusion if we could observe convergence towards our "true" values in cases where people would have had the opportunity to learn and to discover their "true" preferences. That is, assume we estimate the "true" preferences using our method and later on we estimate the "true" preferences in a process of learning and feedback. If both estimates coincide, then this would be a decisive argument in favour of our debiasing method. As far as we know, such evidence is still waiting to be provided. In the meantime, our method should be judged in comparison with current practice in health economics. Health economics deals with important practical decision problems that have to be made in some way or another. Today these decisions are taken based on assumptions (e.g. people behave according to expected utility) than do not seem supported by empirical evidence. We suggest that our approach compares favourably with the status quo even if it is not without problems.

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