A Cognitive Model of Individual Well-Being*

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Abstract

This paper offers a model of individual well-being that takes into account cognitive factors. It postulates that individuals compare payoffs to aspiration levels. The latter are determined by past experiences (adaptation), by other people's performance (interpersonal comparison), as well as by reasoning (justifications and excuses). We axiomatize a measure of well-being defined on real-valued vectors of various lengths. It is a linear combination of differences between payoffs and aspiration levels, where the aspiration level at each instance is a linear function of past payoffs.

1. Introduction

Modern microeconomic theory is behavioral in nature. For the most part, it relies on the neo-classical utility function, which is in principle derived from observed preferences, for both descriptive and normative applications. Further, this utility function is often defined on product bundles, disregarding psychological factors that individuals seem to relate to in describing their well-being.

For descriptive purposes, this approach is consistent and it may be tested for empirical validity. By contrast, it is doubtful that a behaviorally-defined utility function is sufficient when normative considerations are involved. Welfare economics ultimately deals with cognitive concepts such as "well-being," "happiness," and "satisfaction." These relate to notions such as aspirations and needs, contentment and disappointment. The literature does not seem to offer a convincing justification for substituting revealed preference for these concepts. Moreover, the notion of "well-being" involves too many cognitive variables to allow us to infer their values from choice data. For instance, if we accept the view that one's satisfaction is determined by one's consumption relative to one's needs, we are faced with two subjective, cognitive variables, namely, "needs" and "satisfaction," that cannot be disentangled based on objective consumption data alone.

The goal of this paper is to suggest a model of individual well-being that explicitly introduces some of the relevant cognitive variables. Specifically, the key assumption is that an individual's well-being depends on her aspirations, where these are endogenously determined. One may identify three major factors that participate in the determination of an individual's aspiration level for a given experience at a given time. First, people adapt to circumstances. Hence the individual's own history of payoffs affects her aspirations. For instance, when an individual is accustomed to a certain standard of living, her well-being depends mostly on deviations from it. Second, people compare themselves to others in what they perceive to be their peer group. Thus, other people's payoffs are also determinants of an individual's aspirations. An increase in one's income may make one worse off if it is accompanied by a decrease in one's income-ranking in society. Finally, various facts that do not directly relate to any single agent's performance may give an individual reasons to expect higher or lower payoffs. For instance, if the economy is predicted to boom, individuals may be led to expect higher income. The fact that one grows old may decrease one's aspirations

regarding one's health. Aging is a fact that directly (and negatively) affects one's well-being. But it also helps one to accept, say, a decline in one's physical fitness. Similarly, being discriminated against has a direct negative impact on an individual's well-being. But it can also account for perceived failures. By adjusting the individual's aspiration level, an "excuse" can mitigate the impact of low payoffs.

These considerations call into question some of the accepted tenets of welfare economics. For instance, it is not obvious that more choices or more opportunities necessarily make an individual better off. Choice comes with responsibility, and it may result in regret. Opportunity generates expectations, and may lead to low self-esteem. More generally, welfare analysis should take into account subjective aspirations as well as objective performance. While having more choices and opportunities may improve the latter, it also tends to raise the former. Its net effect therefore need not always be positive.

For a concrete example, consider an integrative educational system, in which children of different neighborhoods and of different socio-economic status (SES) are put in the same school class. Such a system presumably allows children of lower-income families to have the same level of education as those of higher-income families, thereby giving them an equal opportunity to succeed in their future careers. Undoubtedly, some children may benefit from the system in terms of their objective performance. However, many may experience a reduction in their subjective well-being for two reasons. First, the mere exposure to lifestyles of higher-income families may make lower SES children view their life differently. Their neighborhood, house, and consumption opportunities are likely to be seen as less satisfactory than prior to their exposure to those of high SES children. Second, the semblance of "equal opportunity" deprives them of potential justifications for low performance on objective scales. Should a child end up with a low-paying job, believing that she indeed had "equal opportunity" leaves her with no one but herself to blame for her "failure." Overall, it is not clear that such a system does more good than harm. It does seem clear, however, that economic theory lacks the language to address this question.

A clarification is due before it becomes too late. We do not intend to suggest that people are better off in slavery than in liberty, that competition should be abolished, or that all students should always get "A" grades. Our goal is merely to offer a theoretical framework within which some of the above phenomena can be discussed.

To this end, we suggest the following model. An individual's history consists of a sequence of facts. Some are events that have a temporal aspect. Some are atemporal, such as religious or national identification. Each fact t has an "objective" payoff attached to it, denoted x_t. The individual's instantaneous payoff is defined as $x_t - a_t$, where a_t is the individual's aspiration level pertaining to that fact. Overall well-being is defined as a weighted sum of these instantaneous payoffs. However, the aspiration levels a_t are themselves linear functions of preceding objective payoffs. Explicitly, given a history $x = (x_1,..., x_T)$, the measure of well-being is

$$U(x) = \sum_t w_t (x_t - a_t)$$

for given weights w_t, where

$$a_t = \sum_{i=1}^{t-1} s_{it} x_i$$

for given coefficients s_{it}.

Suppose that x is the individual's income stream. An increase in income at period i has a direct effect on the individual's well-being. The larger is w_i (assumed positive), the happier will be the individual. However, with positive coefficients s_{it} for $t > i$, the aspiration levels in future periods will be higher. If the individual will not experience high payoffs in these periods, she may be disappointed. Moreover, if the aspiration level is an average of recent periods' payoffs, a permanent increase in income will have an effect mostly in the first periods, whereas in later ones the aspiration level will be correspondingly adjusted and the instantaneous payoff will diminish.

Assume now that x describes experiences of consumption of various goods, including meals, entertainment, social life, and so forth. Within each category, similar logic applies. Many of the coefficients s_{it} may be null, reflecting the fact that the individual's aspiration level for a certain experience depends only on experiences of the same kind. Yet, the measure of overall well-being is an aggregation of all such experiences.

Note that, in the present formulation, current payoffs only affect future aspiration levels. The individual does not re-assess past experiences in view of current payoffs or aspirations. Thus, an individual who has a constant high income

will still be better off than one who has a constant low income, even though both have become adjusted to their respective circumstances. One may wish, however, to consider a more general model, according to which aspirations are adjusted retrospectively as well.

To capture the impact of interpersonal comparison, we incorporate into the model facts involving protagonists other than the individual in question. For instance, assume that we are measuring the well-being of an individual A, who knows that another individual, B, has a certain annual income. Suppose that fact i is that B has income x_i. The weight w_i assigned to this payoff in the measurement of A's well-being reflects A's attitude toward B. Should it be positive, A would rejoice at B's successes and lament her failures. Naturally, a negative w_i would reflect a less benevolent attitude. Finally, if w_i is zero, B's income has no direct impact on A's well-being.

However, even if w_i is indeed zero, or if one maintains that, for normative purposes, w_i should be assumed zero (see Harsanyi (1992)), B's income may affect A's aspiration level, and thus his well-being, via the coefficients s_{it}. A positive value of s_{it} would make A aspire to have a higher income, the higher is B's income. Further, this social aspect may interact with the process of adaptation discussed above. Assume that every two weeks both A and B get their pay checks, and that A knows B's previous payoffs. We obtain a sequence of facts, in which the odd-numbered ones are, say, A's salary, whereas the even-numbered ones reflect B's salary. Assume that A's salary is lower than B's, and that the aspiration level is a weighted average of past periods' payoffs. If left alone, A would have adjusted to his income, and his U measure would tend to zero. However, in the presence of the constant reminder of B's higher income, A's U measure remains negative.

Observe that our interpretation of "aspiration level" is emotional rather than rational. That is, the aspiration level does not attempt to capture the individual's reply to "What do you think you will get?" but rather "What would make you content?" In the example above, A cannot fail to notice that, pay period after pay period, B gets a higher salary. If asked, A would certainly be able to correctly predict his next paycheck. However, to the extent that A has not come to terms with this salary difference, to the extent that he is bothered by it, feels that he is discriminated against, and so forth – his aspiration level is affected by B's income.

Next consider examples of mental accounting. An old woman finds that her mental capacities are becoming limited. She faces problems remembering names, numbers, tasks, and so forth. Of course, this is not good news. However, she might not be as unhappy about it as she would have been had these phenomena occurred when she was young. In our model, "growing old" would be one of the facts in the woman's memory. This fact is associated with a low payoff, and it reduced well-being. But, to the extent that the woman comes to terms with aging, this low payoff also reduces her aspiration levels regarding her memory's performance. This would make future failures less painful, and mediocre successes – a source of joy.

Mental accounting also applies to one's self-esteem. Consider a prospective student who belongs to a minority group, say, defined by religion. He is not admitted to a top school, and he suspects that he might have been discriminated against. Being denied admission is not good news. As in the previous example, discrimination also means that the student suffers from unfavorable interpersonal comparison. Every equally qualified candidate who was admitted makes the rejection more painful. Moreover, the injustice of discrimination is infuriating in and of itself. However, *given* that one is not admitted, there may be some consolation in the fact that this failure is not a reflection of one's true merit. As far as responsibility and self-esteem are concerned, the student may "deduct" his religion from his objectively poor performance. He is only responsible for the unaccounted part of this low payoff.

The phenomena we attempt to capture in our model have been discussed in the past. Indeed, some of these discussions date back to religious thinkers of previous millennia, and some have pervaded popular culture to the point of banality. To the extent that this paper makes a contribution, it is in offering a simple, formal model that allows to discuss well-being and that captures the various determinant of aspirations in a unified way.

The rest of this paper is organized as follows. Section 2 presents the model and an axiomatization of the evaluation rule. It also discusses monotonicity. Section 3 discusses the relationship of our model to existing theories, and the extent to which it can describe some empirical psychological findings. We devote Section 4 to a discussion of welfare economics in light of our model. Section 5 concludes.

2. Model and Result

A "fact" is a pair, of circumstances and payoff. To simplify notation, we assume that the circumstances are ordered, and identify them with the natural numbers. It should be borne in mind that they are not necessarily repetitions of identical situations. For instance, "circumstance" 3 may be belonging to a minority group, "circumstance" 5 may be having a meal, and so forth.

The objects of comparison are histories, represented by real-valued vectors, with generic notation $x^T = \left(x_1^T, ..., x_T^T\right)$. Since histories of different lengths are involved, we will use superscripts to denote their lengths. Thus, a symbol such as x^T denotes a real-valued vector of length $T \geq 1$, with generic component x_i^T. We will use this notation also for real-valued vectors that are not interpreted as histories (for instance, vectors of coefficients). Finally, $\left(x^T, y^{T'}\right)$ denotes vector concatenation.

When considering different values of x_i^T, we refer to different possible facts, all of whom share the circumstances, and vary only in the objective payoff. For instance, x_3^T may take a low value if the individual in the example above was discriminated against because he belonged to a minority group. It would take a high value if the individual still belonged to the same group, but benefited from this identification. In the sequel we assume that any real-valued payoff can be attached to any circumstance, generating a meaningful fact.

Implicit in this notation is the assumption that all possible histories agree on the order of circumstances. That is, for any two histories, the vector of circumstances of the shorter history is a prefix of the corresponding vector for the longer one. The model can be extended to deal with functions on arbitrary sets of circumstances. Yet, the present set-up contains sufficient information to derive the functional form we are interested in, and its notation is simpler. Further, no loss of generality is involved in assuming that facts are linearly ordered, as opposed to partially ordered.

Thus the set of objects of comparison is $X \equiv \bigcup_{T=1}^{\infty} \Re^T$, and $\geq$ will denote a binary order on it. $x^T \geq y^{T'}$ is interpreted to mean that a history x^T makes an individual at least as happy as a history $y^{T'}$. While we are perfectly content with a cognitive interpretation of this ordering, it can also be interpreted behaviorally. For

instance, one may prefer that one's child (or oneself) would experience x^T rather than $y^{T'}$, and may take actions that reflect such preferences.

One may wonder, how can histories of different lengths be compared? For instance, if $T < T'$, x^T may appear "better" than $y^{T'}$ simply because we are not told what happens in history x after T. Shouldn't we first find out what x entails? The answer is no. If the interpretation of $\geq$ is cognitive, there is no difficulty in comparing well-being or happiness at different times. Indeed, many people feel that they were happier in their youth than in old age. But even if $\geq$ is behaviorally interpreted, "facts" in our model need not be temporally defined, nor are they required to be a complete description of one's life. Rather, they are the subjectively relevant facts.

We are interested in the following axioms on $\geq$ ($\leq$, $>$, $<$, and $\approx$ are defined as usual):

A1: $\geq$ is a weak order.

A2 (Continuity): For every $T, T' \geq 1$, and every x^T, the sets $\left\{ y^{T'} \mid x^T > y^{T'} \right\}$ and $\left\{ y^{T'} \mid x^T < y^{T'} \right\}$ are open (in the standard topology) in $\Re^{T'}$.

A3 (Additivity): For every $T, T' \geq 1$, and every $x^T, y^{T'}, z^T, w^{T'}$, if $x^T \geq y^{T'}$ ($x^T > y^{T'}$) and $z^T \geq w^{T'}$, then $x^T + z^T \geq y^{T'} + w^{T'}$ ($x^T + z^T > y^{T'} + w^{T'}$).

A4 (Neutral Continuation): For every $T \geq 1$ and every x^T there exists $a \in \Re$ such that $x^T \approx \left(x^T, a\right)$.

A1 and A2 are standard. A3 is a straightforward additivity assumption. It makes sense mostly when the payoffs are interpreted as if they were measured in "utiles." Finally, A4 guarantees that for every history there is a continuation that does not affect its desirability. Intuitively, the value a reflects the individual aspiration level following the experience x^T. Should the individual now experience the payoff a, she would be just as content as before. In the presence of A2, one can derive A4 from the assumption that any history can be continued in a way that would improve it, as well as in a way that would impair it.

Our main result is

Theorem: The following are equivalent:

(i) $\geq$ satisfies A1-A4;

(ii) There are real numbers $(w_t)_{t\geq 1}$ and $(s_{it})_{t>i\geq 1}$ such that for every $T, T' \geq 1$, and every $x^T, y^{T'}$,

$$x^T \geq y^{T'} \qquad \text{iff} \qquad U(x^T) \geq U(y^{T'})$$

where

$$U(x^T) = \sum_{t=1}^{T} w_t \left(x_t^T - a_t(x^T)\right)$$

and

$$a_t(x^T) = \sum_{i=1}^{t-1} s_{it}\, x_i^T .$$

Furthermore, in this case the weights $(w_t)_{t\geq 1}$ are unique up to a multiplication by a positive number, whereas, for every $t>1$, $(s_{it})_{t>i\geq 1}$ are unique whenever $w_t \neq 0$ (and arbitrary otherwise).

The proof is relegated to an appendix.

Under A1–A4, U need not be monotone with respect to the instantaneous payoffs. Indeed, since some of the payoffs may reflect other agents' experiences, there is no need to assume that U is always monotone. However, if we restrict attention to facts that relate to the individual under consideration, lack of monotonicity may be theoretically troublesome. For instance, it allows that an individual be better off not to get a one-time increase in income, due to future disappointments. Similarly, an individual might be better off when discriminated against, or at least when believing he is. While such rankings may be observed, most people would not consider it ethical to rely on them in decision making regarding other people's welfare. For example, it is not very convincing to argue that one should not give charity to homeless people, in order not to expose them to future disappointments, or that all cases of discrimination are made up by weaklings who cannot confront their own inadequacies. We are therefore interested in the following:

A5 (Monotonicity): For every $T \geq 1$ and every x^T, y^T, if $x_t^T \geq y_t^T$ for all $t \leq T$, then $x^T \geq y^T$.

Observation: Under the assumption of the Theorem, $\geq$ satisfies A5 iff

$$(*) \qquad w_i \geq \sum_{t=i+1}^{T} s_{it} w_t \qquad \text{for all } i \leq T$$

(in particular, $w_T \geq 0$ for all T).

Condition $(*)$ states that the direct (positive) impact a payoff x_i has outweighs the potential indirect (negative) impact it has on future aspiration levels. In view of the uniqueness result in the Theorem, this condition does not depend on the specific numbers chosen to represent $\geq$.

Monotonicity does not imply that the coefficients s_{it} are nonnegative. On the contrary, the lower are s_{it}'s, the larger is the cone of $(w_t)_{t\geq 1}$ that define a monotone relation. A negative value of s_{it} may result from several reasons. First, payoff in circumstance i may be perceived to be negatively correlated with performance in circumstance t. For instance, one may be happy that one is honest, but consequently one may not expect to be considered very polite. Second, an individual may experience satiation. In this case, high payoffs in some early circumstances may reduce her aspiration level in later ones. (This may also result in changing the coefficients w_T. Such dependencies are beyond the scope of the linear model.)

3. Psychological Evidence and Related Theories

The term "aspiration level" is borrowed from Simon (1957), who argued that people "satisfice," rather than optimize in decision making. A payoff that exceeds the aspiration level makes the decision maker "satisficed," and thereby prone to retain the status quo, whereas a payoff that falls below it prods her to experiment. Gilboa and Schmeidler (1995) suggest a model of decision under uncertainty that provides a behavioral definition of "aspiration levels." However, we do not focus on the decision-making aspect in this paper, and the present interpretation of "aspirations" differs from the behavioral one. A rational decision maker may behave as if she were satisficed because she knows that she has no better option than her current choice. Yet, if she is unhappy, she is below the "emotional" aspiration level we use in this paper.

Adaptation level theory, developed by Helson (1964), suggests that people adjust to various stimuli. The theory deals with phenomena ranging from perception to happiness and to learning and creative thinking. It postulates that the adaptation level is a geometric average of a "background" level and a series of stimuli. (These terms are borrowed from the case visual perception.) Since we focus on aspiration level adjustments, the formal concept of "aspiration" in our model bears kinship to adaptation level. Specifically, on a logarithmic scale, Helson's formula for the adaptation level becomes very similar to the linear one we use for the aspiration level.

Adaptation level theory focuses on the measurement of an instantaneous sensation, rather than on the concept of overall well-being. It thus corresponds to expressions of the type $x_t - a_t$ in our model, and does not deal with aggregation thereof. In contrast, our overall measure of well-being, U, is cumulative in nature. It attempts to measure how happy an individual is throughout a sequence of experiences, or how desirable such a sequence is. Correspondingly, two individuals who are fully adjusted to their respective income levels might be equally happy according to adaptation level theory, while the richer individual would still have a higher U value in our model. Still, the assessment of instantaneous payoffs relative to an adapting aspiration level finds support in the psychological literature on adaptation level theory. (See Appley (1971).)

Brickman, Coates, and Janoff-Bulman (1978) studied lottery winners and their self-reported happiness. They found that recent winners were not happier than were control subjects. They explain this phenomenon using adaptation level theory, by the concepts of contrast and of habituation: shortly after the lottery, in contrast to the moment in which the winners were informed of their gains, they were no longer as happy. Similarly, it is postulated that they became habituated to their new wealth level. In our model, habituation is captured by the adjustment of the aspiration level. In order to satisfactorily model contrast, however, one may wish to extend the model by allowing the weights $(w_t)_{t\geq 1}$ to depend on the instantaneous payoffs: a single period in which the payoff was exceptional may, because of this payoff, play a more major role in the determination of future aspiration levels. (Other studies relating to aspiration level adjustments include Payne, Laughunn, and Crum (1980, 1981), March (1988) and Mezias (1988).)

There is ample evidence that subjective well-being can hardly be approximated by real income. Campbell (1981) argues that "people react to the world as they perceive it, not as it objectively is" (p. 23), and studies self-reported happiness

across various income and education levels in the US over time. For instance, from 1957 to the early 1970's, the proportion of American population who were prepared to describe themselves as "very happy" declined from 35% to 24%; by 1978, it has risen to 30%. These shifts "are in direct opposition to the national economic trends" (p. 28). Perhaps more significantly, these proportions are at a very low correlation with income and with education levels. (See also Schoemaker (1982), Diener (1984), Duncan (1975), and Easterlin (1974).) This evidence is consistent with our model: a high-income individual is likely to be better off than a low-income one, but, since the aspiration levels of both adjust over time, measures of their long-run well-being need not be drastically different.

Kahneman and Varey (1991) discuss adaptation level theories, and suggest that utility may be derived from transitions no less than, and perhaps more than from states (see also Kahneman (1994)). Relatedly, Fredrickson and Kahneman (1993) find that the way people retrospectively evaluate affective episodes (viewing film clips in their studies) is barely related to their duration. They dub this phenomenon "duration neglect." Moreover, Kahneman, Fredrickson, Schreiber and Redelmeier (1993) have found that, due to duration neglect, people may choose more pain over less: they exposed subjects to a painful experience (60 seconds of holding one's hand in water at 14°c), and then to the same experience followed by a better, but still painful, end (additional 30 seconds of holding the hand in water that gradually warmed up to 15°c). A significant majority of the subjects preferred to repeat the longer experience.

Duration neglect is captured by our model if the aspiration level is adjusted fast enough. Fredrickson and Kahneman (1993) also report that individuals' retrospective evaluations of affective episodes significantly depend on the peak and the end levels of affect. End effects are compatible with our model.[1] However, peak effects (as the concept of "contrast" mentioned above) call for a generalization according to which the weights $(w_t)_{t\geq 1}$ depend on the instantaneous payoffs. It should be noted that Kahneman and his colleagues discuss the effects of memory, as well as one's ability to predict one's taste. It is not clear that the way experiences are remembered is the yardstick by which well-being should be measured. Yet, the evidence provided by these studies supports the principle on which our model is based.

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[1] This may be more clearly seen from an equivalent mathematical representation of the evaluation functional. See Appendix.

Interpersonal comparisons of income, status, and utility have probably received economists' attention more than other determinants of an individual's aspiration level. Veblen (1899) has already discussed conspicuous consumption (see also Leibenstein (1948)). Duesenberry (1949) has formulated the relative income hypothesis, stating that saving rates depend on a family's percentile position in the income distribution. Hirsch (1976) further emphasized the role of relative social status. Hayakawa and Venieris (1977) discuss the consumer's "reference group" in this context. Interpersonal comparisons are also at the basis of the concept of "envy-free" allocations introduced by Foley (1967) (see also Schmeidler and Vind (1972), Pazner and Schmeidler (1974), and Varian (1974)). Frank (1985a, 1985b, 1989) argues that an individual's consumption is compared to that of others, as well as to past consumption, thus combining adaptation with interpersonal comparisons. Kapteyn, Wansbeek, and Buyze (1980) and Kapteyn and Wansbeek (1982, 1985) argue that utility is completely relative. Ng and Wang (1993) present a model that captures aspiration level and interpersonal comparisons effects, as well as environmental factors. (Other studies include Rainwater (1974), Layard (1980), Tomes (1986), Seidman (1987), Congleton (1989), and Persky and Tam (1990).) In this context, the present paper suggests a formal, axiomatically-based model that captures interpersonal comparisons as well as other factors affecting aspirations, in a unified way.

Another phenomenon our model attempts to capture is that one's well-being depends on reasons, justification, and excuses one may have for objectively poor performance. When pushed to an extreme, this cognitive phenomenon may be reflected in behaviorally observed preference for situations in which one is constrained, or "objectively" disadvantaged. Such preferences are called "self-handicapping" in the psychological literature. For instance, Berglas and Jones (1978) have conducted an experiment in which subjects were administered a drug prior to engaging in a problem-solving task. The subjects were asked to choose between two drugs. One was described as enhancing performance, whereas the second was allegedly interfering with performance. Some subjects (mostly male) chose the drug that was alleged to induce poorer performance. According to Berglas and Jones, the only plausible explanation for this choice is to provide oneself with an excuse for failure to solve the problem. (See also Tice and Baumeister (1990)). In our model, such a choice is explained by a higher U value in the presence of a fact that may

serve as an excuse. (Note, however, that this type of preference violates the monotonicity axiom.)

Berglas and Jones also allowed subjects to choose the level of difficulty of the task. They found that "subjects high in fear of failure show a tendency to prefer either very simple or very difficult tasks, tasks typically low in diagnosticity" (pp. 405-6). McClelland (1961) has argued that not everyone wants to have "concrete knowledge of results of choices and actions" (p. 231). (See also Sedikides (1993) and Trope (1979) regarding preference for diagnosticity.)

The tendency to choose a task that would not provide much information regarding one's abilities may be explained by our model: failing on a task that is known to be difficult is less painful than failing on one that is supposed to be manageable. The fact that the task is difficult reduces one's aspiration level regarding one's performance on it. Thus, in case of failure, the resulting U value would be higher in case of a difficult task than it would be in case of a simpler one.

4. Welfare Economics

Measuring well-being by a "utility" index introduces the temptation to adopt various axioms that are well accepted in the context of the neo-classical utility function, or of income. For instance, Pigou (1920) has introduced an axiom of social welfare, according to which a transfer of income from a high-income individual to a low-income one, that does not reverse their income ranking, enhances equality. Applying this axiom to our model verbatim may result in the suggestion that a satisficed individual be taxed in order to subsidize an unsatisficed one.

Such a suggestion is patently absurd as a general principle. The satisficed individual may be much poorer than the unsatisficed one. In this case, the transfer, which is Pigouvian on a subjective scale, is clearly non-Pigouvian on an objective one. It hardly seems just to tax someone simply because they happen to have a low aspiration level. Further, this policy is easily manipulable, since it provides individuals with an incentive to overstate their aspirations.

However, in some cultures it is not uncommon to observe transfers from elderly parents to adult children that follow this pattern, and appear to be viewed as morally acceptable by both sides. Especially if the parents have consumption habits and aspiration levels that were shaped in less affluent periods, they may find that they "have no use" for part of their income, whereas their children, despite their higher income, can easily spend more. (For a related phenomenon regarding

consumption patterns, see a front-page story in the Wall Street Journal of July 8, 1996.)

Moreover, any reference to a "status quo" as a basis for a moral right or claim may be viewed as an implicit recognition of (adjusted) aspiration levels as an ethical reference point. Specifically, the legal system appears to accept a divorced spouse's claim for a certain standard of living, a tenant's right to a certain bound on rent increase, and so forth.

Aspiration levels in their original psychological meaning may be too subjective and too easily manipulable to serve as a basis for normative arguments in interpersonal interactions. But they do seem to capture some intuitive notions of "what is fair" that economic theory tends to ignore.

Another dangerously simplistic conclusion that may be associated with our model is that, since aspirations adapt, there is no point in attempting to improve objective conditions of human life. Indeed, based on adaptation level theory, Brickman and Campbell (1971) make a similar point, and argue that "there is no true solution to the problem of happiness" but "getting off the Hedonic Treadmill." (See also Thurow (1971, 1973, 1975, 1980) and Ittleson, Proshansky, Rivlin, and Winkel (1974).)

While many philosophers and religious preachers have offered similar arguments over the years, this is a rather dangerous position for a social scientist. First, as noted by Kahneman and Varey (1991), not all experiences are subject to adaptation. On the contrary, some aversive experiences escalate with time. Examples such as hunger and other forms of physical deprivation illustrate. Second, adaptation and habituation are constrained by the social context. An agent may never be satisficed with a given level of income should all around her enjoy higher levels of income. Finally, a distinction should be drawn between a normative recommendation for an individual and for a society. An individual may choose to step off the "Hedonic Treadmill"; but one can hardly be excused for pushing others off it, leaving more space for oneself.

Yet, aspiration levels can be modified by education, exposure to information, and adaptation. Further, it is sometimes easier to reduce aspirations than it is to improve objective payoffs. The psychological literature provides evidence that people typically are not fully aware of potential effects of adaptation and of aspiration level adjustments. Studies such as Kahneman and Snell (1990, 1992), and Loewenstein and Adler (1995) conclude that, partly due to these processes, many

individuals are poor predictors of their own future tastes. It follows that normative economics should take these considerations into account. (See also Scitovsky (1976) who argued that consumers need not know "what's best for them.")

In our model, the lower are an individual's aspiration levels, the happier she is. One may conclude that, given the choice, as, say, in the case of educating a child, we should select the lowest aspirations possible. But this would be premature. First, due to adaptation and interpersonal comparisons, aspiration levels are never fully controlled. Hence we cannot claim to have found a "shortcut to happiness" that is independent of objective payoffs. Second, the latter are not independent of the aspiration levels. Specifically, higher aspiration levels prod experimentation, which may lead to objectively higher payoffs. Indeed, Gilboa and Schmeidler (1993) shows that ambitious but realistic aspiration level adjustments lead to objectively optimal choice. Thus, reducing a person's aspiration level makes her happier given the same objective payoffs, but may also negatively affect the payoffs she is likely to get. Striking the balance between the positive and the negative effects of ambition is therefore a delicate matter.

Our model highlights welfare implications that information might have. For example, information about other agents' income may have direct effects on one's well-being. Moreover, if aspiration levels are more readily adjusted upward than they are downward, one may argue that, on average, people are better off knowing less; or that a more segregated society would allow more people to feel that they are "Number One." This is a dangerous idea. It may serve various political causes. As explained above, it may also hinder objective progress. But it would be wrong to pretend that information has no subjective cost.

Similarly, one may argue, with various degrees of honesty, that segregation and even discrimination are beneficial to disadvantaged, or discriminated-against populations. Again, an outrageous notion. Yet, it is a mistake to avoid such arguments by choosing a theoretical model that does not even allow their formalization.

To conclude, there appear to be many more claims that we are not willing to make than that we are. It is entirely possible that, from a normative point of view, little can be said at this level of generality. We hope, however, that the model presented here may be of help in discussing some specific normative issues.

5. Concluding Comments and Further Research

5.1 According to cognitive dissonance theories (Festinger (1957)), people tend to provide post-hoc explanations for various facts. For instance, when a certain activity results in a low monetary payoff x_t, the individual may attempt to believe that there were other reasons to engage in this activity. In our model, this can be viewed as an adjustment of the coefficients s_{it} for $i < t$. Assuming that preceding facts should have decreased the aspiration level for fact t, the individual's current well-being increases. (See also Shafir, Simonson, and Tversky (1993) on preferences for choices that can be more readily justified.)

5.2 When facts involve other agents as protagonists, they may be ordered in more than one way. In particular, one may wish to list a temporal fact according to its time of occurrence, rather than the time in which it became known to the agent. Alternatively, one can use an extension of the model in which, as above, the coefficients s_{it} may be adjusted retrospectively.

5.3 Another extension of this model would differentiate between upward and downward adjustments of the aspiration levels. It appears that people "get used" to higher payoffs more readily than to lower ones. In particular, this assumption may partly explain such economic phenomena as wage rigidity.

5.4 Under the assumption that aspiration levels adjust upward faster that they do downward, applying utilitarian criteria to our measure of individual well-being would result in preference for equality.

5.5 Modeling justifications explicitly allows to capture some aspects of regret theories. For instance, having less options may serve as a justification for a given choice and its outcomes. Correspondingly, it can reduce regret.

5.6 With normative applications in mind, one might wonder to what extent our theory describes "rational" evaluation of well-being. For instance, can such phenomena as minimization of cognitive dissonance be part of a rational evaluation model?

We tend to answer this particular question in the negative. Knowingly adjusting one's beliefs to match actual performance has a flavor of irrationality. Specifically, such an exercise may fail should the individual be fully aware of the analysis of her cognitive processes. (See Gilboa (1991) for a related definition of "rationality.") However, there appears to be nothing irrational in an individual taking into account her future habituation to, say, high income.

Our approach is to start out with a cognitively plausible descriptive theory, and to study within it the boundaries of rationality, and of practical normative recommendations.

5.7 The term "normative science" is used with more than one meaning. Should a normative scientist devise algorithms to obtain given goals? Or should she tell people what goals they should have? We find it useful to define the role of the normative scientist as separate from that of the engineer, as well as from that of the preacher. Rather than taking goals as given, or determining what they should be, we focus on the scientist's task of modeling and analyzing the moral and ethical preferences of decision makers, such as the preferences over societies one might belong to.[2] To the extent that our model might have normative implications, it is in this light that they should be construed.

[2] In this sense, normative theories are descriptive.

Appendix: Proofs and Related Comments

Proof of the Theorem

The necessity of the axioms and the uniqueness result are straightforward. We therefore prove only sufficiency, i.e., that (i) implies (ii). It may be convenient to prove this result in two steps. Noting that U is a linear functional, we first derive a more explicit linear representation. We then show that this representation is algebraically equivalent to U. Specifically, we state two propositions:

Proposition 1: Assume that $\geq$ satisfies A1-A4. There exist real valued vectors $\left(\beta^T\right)_{T\geq 1}$ such that:

(a) for every $T>1$, $\beta_T^T \neq 0$ or $[\beta_t^T = \beta_t^{T-1}$ for all $t<T]$;

(b) for every $T, T' \geq 1$, and every $x^T, y^{T'}$,

$$x^T \geq y^{T'} \qquad \text{iff} \qquad \beta^T \cdot x^T \geq \beta^{T'} \cdot y^{T'}$$

where $\cdot$ denotes inner product.

Proposition 2: For every $T \geq 1$, define $w_T = \beta_T^T$. For $T>1$, if $\beta_T^T \neq 0$, define

$$s_{iT} = \frac{\beta_i^{T-1} - \beta_i^T}{\beta_T^T},$$

and if $\beta_T^T = 0$, define $s_{iT} = 0$.

Then, for every $T \geq 1$, and every x^T,

$$U\left(x^T\right) = \beta^T \cdot x^T$$

where

$$U\left(x^T\right) = \sum_{t=1}^{T} w_t \left(x_t^T - a_t\left(x^T\right)\right)$$

and

$$a_t\left(x^T\right) = \sum_{i=1}^{t-1} s_{it}\, x_i^T .$$

Thus Proposition 2 guarantees that the numerical representation of Proposition 1 and that in part (ii) of the Theorem are equivalent.

Proof of Proposition 1

Assume that $\geq$ satisfies A1-A4. The proof proceeds in several steps.

Lemma 1: For every $T \geq 1$, and every x^T, y^T, and z^T, $x^T \geq y^T$ iff $x^T + z^T \geq y^T + z^T$.

Proof: A repeated application of A3.

Lemma 2: For every $T \geq 1$ there exists a vector β^T such that for every x^T, y^T,

$$x^T \geq y^T \qquad \text{iff} \qquad \beta^T \cdot x^T \geq \beta^T \cdot y^T .$$

Moreover, each β^T is unique up to a multiplication by a positive number.

Proof: Note that the restriction of $\geq$ to $\Re^T$ is a continuous weak order (by A1 and A2). In view of Lemma 1, the proof is standard.

Select a sequence of vectors $\left(\beta^T\right)_{T\geq 1}$ provided by Lemma 2. We wish to show that each can be re-scaled such that together they represent preferences across different $\Re^T$'s as well. To this end, we use a few auxiliary lemmata.

Lemma 3: For every $T, T' \geq 1$, the set $\left\{ \left(x^T, y^{T'}\right) \mid x^T > y^{T'} \right\}$ is open (in the standard topology) in $\Re^{T+T'}$.

Proof: Endow the set $X = \bigcup_{T=1}^{\infty} \Re^T$ with the topology whose base is the union of the standard topologies on each $\Re^T$. (Convergence in this topology requires that a net consist of vectors of identical lengths from some element on, and that they converge in the corresponding topology.) X is a separable metric space; a metric for it can be defined by

$$d\left(x^T, y^{T'}\right) = \begin{cases} \left| T - T' \right| & \text{if} \quad T \neq T' \\ l\left(\left\| x^T - y^{T'} \right\| \right) & \text{if} \quad T = T' \end{cases}$$

where $l(a) = \min(a,1)$ and $\|\cdot\|$ denotes the Euclidean distance in the appropriate space. Hence, by Debreu (1983) (Ch. 6, Theorem II, p. 109), $\geq$ admits a continuous real-valued representation. This implies the desired result.

In the following, 0^T denotes the origin in $\Re^T$.

Lemma 4: For every $T \geq 1$, $0^T \approx 0^{T+1}$.

Proof: If not, consider a pair x^T and y^{T+1} such that $x^T \approx y^{T+1}$. (The existence of which is guaranteed by A4.) Using A3, one obtains a contradiction.

Lemma 5: For every $T, T' \geq 1$, and every $x^T, y^{T'}$, $x^T \geq y^{T'}$ iff $-x^T \leq -y^{T'}$.

Proof: Otherwise, A3 would lead to a contradiction to Lemma 4.

Lemma 6: For every $T, T' \geq 1$, every $x^T, y^{T'}$, and every $\lambda > 0$, $x^T \geq y^{T'}$ iff $\lambda x^T \geq \lambda y^{T'}$.

Proof: It is sufficient to prove the "only if" part. Inductive application of A3 proves it for a natural λ. Similarly, A3 proves that $x^T > y^{T'}$ implies $nx^T > ny^{T'}$. Thus the "only if" part follows for every positive rational λ. Lemma 3 concludes.

Lemma 7: For every $T \geq 1$, if $\beta'^T \neq 0^T$, then $\beta'^{T+1} \neq 0^{T+1}$.

Proof: Otherwise, there is $x^T > 0^T$, but for all $a \in \Re$, $\left(x^T, a\right) \approx 0^{T+1} \approx 0^T < x^T$, contradicting A4.

Completion of the Proof of Proposition 1: We now turn to define the vectors $\left(\beta^T\right)_{T \geq 1}$ as positive multiples of the respective $\left(\beta'^T\right)_{T \geq 1}$. If all the β'^T vanish, then, by Lemmata 2 and 4, all vectors in X are equivalent, and the proof is complete. Let T_0 be the first number for which β'^T does not vanish. By Lemma 7, $\beta'^T \neq 0^T$ for every $T > T_0$ as well.

For $T < T_0$, $\beta^T = \beta'^T$ is uniquely defined (as the origin). For T_0, set $\beta^{T_0} = \beta'^{T_0}$. We now wish to show by induction on $T \geq T_0$ that there exists $\alpha > 0$ such that, by defining $\beta^T = \alpha\beta'^T$, the vectors $\left(\beta^t\right)_{t \leq T}$ represent $\geq$ for all vectors of length T or less

(where representation is defined as in part (b) of Proposition 1). Note that this claim holds for T_0.

Assume that the claim is true for $T(\geq T_0)$, and we prove it for $T+1$. In view of A4, it suffices to find $\alpha > 0$ such that $\beta^{T+1} = \alpha\hat{\beta}^{T+1}$ would satisfy

$$x^T \geq y^{T+1} \qquad \text{iff} \qquad \beta^T \cdot x^T \geq \beta^{T+1} \cdot y^{T+1} \quad .$$

Choose $\bar{x}^T > 0^T$. Let $\bar{y}^{T+1}$ satisfy $\bar{x}^T \approx \bar{y}^{T+1}$. (Again, existence of such $\bar{y}^{T+1}$ is guaranteed by A4.) By Lemmata 2 and 4, $\hat{\beta}^{T+1} \cdot y^{T+1} > 0$. We can therefore define

$$\alpha = \frac{\beta^T \cdot \bar{x}^T}{\hat{\beta}^{T+1} \cdot \bar{y}^{T+1}} > 0 \quad ,$$

so that $\beta^T \cdot \bar{x}^T = \beta^{T+1} \cdot \bar{y}^{T+1}$.

Let there be given x^T, y^{T+1}. Distinguish among three cases:
(i) If $x^T \approx 0^T \approx 0^{T+1}$, i.e., $\beta^T \cdot x^T = 0$, then $x^T > (\approx, <) y^{T+1}$ iff $0^{T+1} > (\approx, <) y^{T+1}$. By Lemma 2, this is the case iff $\beta^T \cdot x^T = 0 = \beta^{T+1} \cdot 0^{T+1} > (=, <)\ \beta^{T+1} \cdot y^{T+1}$.
(ii) If $x^T > 0^T \approx 0^{T+1}$, i.e., $\beta^T \cdot x^T > 0$, there exists $\lambda > 0$ such that $\lambda x^T \approx \bar{x}^T$. By Lemma 6, $x^T > (\approx, <) y^{T+1}$ iff $\lambda x^T > (\approx, <) \lambda y^{T+1}$, i.e., iff $\bar{y}^{T+1} > (\approx, <) \lambda y^{T+1}$, which (by Lemma 2 again) is equivalent to $\beta^{T+1} \cdot \bar{y}^{T+1} > (=, <)\ \lambda\beta^{T+1} \cdot y^{T+1}$. Since $\beta^{T+1} \cdot \bar{y}^{T+1} = \beta^T \cdot \bar{x}^T = \lambda\beta^T \cdot x^T$, it follows that $x^T > (\approx, <) y^{T+1}$ iff $\beta^T \cdot x^T > (=, <)\ \beta^{T+1} \cdot y^{T+1}$.
(iii) Finally, if $x^T < 0^T \approx 0^{T+1}$, i.e., $\beta^T \cdot x^T < 0$, by Lemma 5, $x^T > (\approx, <) y^{T+1}$ iff $-x^T < (\approx, >) -y^{T+1}$. Using case (ii) above, this is equivalent to $-\beta^T \cdot x^T < (=, >)\ -\beta^{T+1} \cdot y^{T+1}$, and therefore also to $\beta^T \cdot x^T > (=, <)\ \beta^{T+1} \cdot y^{T+1}$.

Finally, we prove that the vectors $\left(\beta^T\right)_{T \geq 1}$ satisfy part (a) of the Proposition. For every $T \geq 1$, if $\beta_T^T \neq 0$, we are done. If, however, $\beta_T^T = 0$, use A4 to conclude that $y^T \approx \left(y^T, a\right)$ for every y^T and every $a \in \Re$. By the representation of $\geq$ as in part (b),

$$x^T \geq y^T \approx \left(y^T, a\right) \qquad \text{iff} \qquad \sum_{t=1}^{T} \beta_t^T x_t^T \geq \sum_{t=1}^{T} \beta_t^{T+1} y_t^T$$

for every x^T, y^T. This implies that $\beta_t^{T+1} = \beta_t^T$ for all $t \leq T$, and thus completes the proof of Proposition 1. $\langle\rangle$

Proof of Proposition 2

For every $a \in \Re$, $U(a) = w_1 a = \beta_1^1 a$. For $T > 1$, assume that $U\left(x^t\right) = \beta^t \cdot x^t$ has been proved for every $t < T$ and every x^t. Consider x^T, and denote its $(T-1)$-long prefix by x^{T-1}. Then

$$\begin{aligned}\beta^T \cdot x^T &= \sum_{i=1}^{T-1} \beta_i^T x_i^T + \beta_T^T x_T^T = \sum_{i=1}^{T-1} \beta_i^{T-1} x_i^T + \sum_{i=1}^{T-1} \left(\beta_i^T - \beta_i^{T-1}\right) x_i^T + \beta_T^T x_T^T \\ &= \sum_{i=1}^{T-1} \beta_i^{T-1} x_i^T + \beta_T^T \left[x_T^T - \sum_{i=1}^{T-1} \left(\frac{\beta_i^{T-1} - \beta_i^T}{\beta_T^T} \right) x_i^T \right] \\ &= U\left(x^{T-1}\right) + w_T \left[x_T^T - \sum_{i=1}^{T-1} s_{iT} x_i^T \right] = U\left(x^T\right) \ . \end{aligned}$$ ⟨⟩

Remark 1: By definition, w_T are linear functions of $\left(\beta^T\right)_{T \geq 1}$. Conversely, it can be seen that $\left(\beta^T\right)_{T \geq 1}$ are uniquely defined by $\beta^T \cdot x^T = U\left(x^T\right)$, and are linear functions of $\left(w_T\right)_{T \geq 1}$. Explicitly,

$$\beta_i^T = w_i - \sum_{t=i+1}^{T} s_{it} w_t \ .$$

Remark 2: In the absence of A4, the Theorem does not hold. For instance, $\geq$ may rank vectors lexicographically, first by length, and then according to β^T within each $\Re^T$.

Further, A4 cannot be replaced by assuming, say, that $0^T \approx 0^{T+1}$ for every T. To see this, define $\geq$ by the following function:

$$\begin{aligned} U(x) &= x && \text{for all } x \in \Re \\ U\left(x^T\right) &= 2x_1^T && \text{for all } x^T \text{ with } T > 1. \end{aligned}$$

$\geq$ satisfies A1-A3, and the condition $0^T \approx 0^{T+1}$, but does not satisfy A4.

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