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Hicksian Welfare Measures Within a Regret Theory Framework

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Introduction

For many years the neoclassical economic paradigm for consumer theory has been based on axioms of rational behavioral equivalent to utility maximization for decisions under complete certainty, and another set of axioms equivalent to expected utility (EU) maximization for decisions under risk (von Neumann and Morgenstern). Recently, however, this theory has come under fire both from within the economics profession and from outside due to a growing body of evidence suggesting that actual choices display consistent and predictable violations of the behavioral implications of these axioms, particularly within the context of risk and uncertainty. At least since the 1950's, with Simon's work on bounded rationality, alternative models of behavior have been proposed. In the past few years this area has received increasing emphasis. Notable contributions include the work of Akerlof and Dickens on cognitive dissonance, Kahneman and Tversky on prospect theory, Heiner on reliability theory, Bell (1982) and Loomes and Sugden on regret theory and Machina on local approximations to EU functions.

To date, work on these alternative theories has focused on empirical testing of their predictions and their abilities to explain the observed violations of expected utility theory. No attempt has yet been made to study the implications of these alternatives for welfare analysis and the definition and measurement of the costs or benefits resulting from projects or events[2]. Yet, since the estimates of such costs or benefits often play an important role in public decisions, it is important to know whether the standard welfare results based on the EU model continue to hold under what appear to be more realistic theories of choice under uncertainty.

This paper explores this question in the context of one particular theory[3], namely regret theory. Regret theory was chosen from among the different alternative theories because it has intuitive appeal, it contains EU theory as a special case, and it is capable of explaining some observed forms of behavior that are inconsistent with EU theory but that are observed consistently in various empirical contexts. In addition, decisions under regret theory can be formulated within a mathematical optimization framework similar

to that used for EU theory. Thus, many of the same tools that are used in EU theory can be applied to regret theory as well.

Since a consumer choice problem of maximizing utility or expected utility subject to a budget constraint underlies many of the concepts and results used in standard welfare economics, the first part of the paper is devoted to exploring the implications of regret theory in this context. To date, the work on regret theory has been limited to discrete choice problems, generally with only two alternatives[4]. However, consumer demand functions under EU are based on a continuous choice problem. A necessary first step in extending the standard results to allow for regret is, then, to formulate the regret theory model as a continuous choice consumer problem and to explore its properties.

Given the solution to the individual's choice problem, an indirect objective function analogous to the indirect utility function can be formulated and used to define Hicksian welfare measures in a regret theory framework. This is examined in the second part of the paper, where alternative definitions are presented and their properties discussed.

Overview of the Regret Theory Model

The now traditional expected utility (EU) maximization literature assumes that, when facing decisions within an environment characterized by risk, an individual associates probabilities, either objective or subjective, with each outcome and the individual chooses that alternative which maximizes the mathematical expectation of the utility function. The key behavioral assumption is that the ex-post level of consumer satisfaction depends only on the final position and not on how that position was reached or on alternative positions that were possible.

Regret theory, on the other hand, is based on the observation that individuals experience utility or disutility not only from what they get, but also from what they don't get (Loomes and Sugden, Bell, 1982)[5]. It extends EU theory by modifying the utility function to allow for feelings of regret or rejoice for alternatives which were not chosen. For example, an individual who chooses between two alternatives and as a result of his choice receives the top prize of $1,000 rather than the alternative of $1 would be ecstatic, while the same individual would not be so happy if his choice resulted in a $1,000 prize when the alternative selection would have led to a prize of $1 million.[6]

Regret theory represents a generalization of utility theory. It assumes that preferences can be represented by a modified utility function, which includes not only direct utility derived from an alternative, but also the regret or rejoice which is experienced ex-post for alternatives not chosen. Thus, given the choice among two alternatives, X and Y, the modified utility function under regret theory can be formulated as:

$$MU(X;Y) = U(X) + R^*[U(X)-U(Y)]$$

where MU(·) represents the modified utility function, U(·) represents the ordinary neoclassical utility function, which Loomes and Sugden called the choiceless utility function, and R*[·] represents the rejoice/regret function. U(·) is a choiceless utility function in the sense that, if there are no alternatives to choose among, no regret or rejoice will be associated with the outcome so that in a choiceless situation the modified utility is simply equal to U(·). Thus, rejoice/regret is assumed to be simply a function of the difference between the utility of the alternative chosen minus the utility which would have been realized by choosing the other alternative. This rejoice/regret may be of little or no concern for some decisions but may be significant for others.

In a situation of complete certainty, an individual is assumed to choose X over Y if:

$$MU(X;Y) > MU(Y;X) \Rightarrow U(X) + R^*[U(X)-U(Y)] > U(Y) + R^*[U(Y)-U(X)]$$

Given this formulation, it is immediately obvious that under complete certainty that identical preference orderings are implied by the modified utility function and the choiceless utility function so long as R'[·] > 0, so that regret theory and utility theory imply identical behavior in a certain environment.

An assumption placed on the modified utility function is that R"[ε] > R"[-ε], for ε>0. This implies that the regret/rejoice associated with a single large difference between consequences exceeds the sum of the regret/rejoice that would be experienced if that difference were divided into two smaller parts (Loomes). Loomes and Sugden show that with this assumption regret theory can

explain certain classes of behavior that violate expected utility theory and have been observed in various empirical contexts[7].

One important implication of regret theory is that preferences over alternatives depend upon the entire choice set available to the decision maker. In the above definition of EMU where there were assumed to be only two alternatives, the choice set was simply S={X,Y} and preferences were defined over the pairwise choices[8]. However, preferring X to Y when the choice set is S = {X,Y} does not guarantee that X will be preferred to Y when the choice set is S' = {X,Y,Z} (Loomes and Sugden). As will be seen below, this complicates the definitions of welfare measures when more than two policy options are available.

Continuous Consumer Choice Under Regret Theory

Most valuation problems involve two types of decisions, policy decisions generally made by the government, such as whether or not to build a dam, and individual decisions that are contingent on the policy decision, such as how many acres of corn to plant given that a dam is built. The lower level decision represents continuous choices made by individuals at the disaggregate level. Welfare evaluation will occur at the higher level decision, which is generally a choice among a discrete number of alternatives. The lower level decision represents choice of private goods by an individual, while the second level decision is the choice among discrete alternative policies. The goal then is to define and examine welfare changes for the individual resulting from a proposed policy and to evaluate the social desirability of the policies given that individual behavior is characterized by the regret formulation discussed above.

Regret can be experienced at both levels of decision making, but for simplicity we assume that the two decision problems are separable[9]. This assumption allows us to solve first for the continuous individual decisions conditional on the policy choice and then use an indirect objective function to define welfare measures relating to discrete policy options conditional on the optimal individual response.

The continuous consumer choice problem can be viewed as an extension of the multiple alternative problem to the case where there is a continuum of alternatives. When there are multiple but finite alternatives, Loomes and

Sugden suggest that overall regret should be a weighted average of the regret felt over each option not chosen[10]. They do not, however, suggest how the weights should be determined. Below we show how using the weighted average of regret over alternatives can be extended to the continuous case and suggest an approach for specifying the weights to be used.

Assume that there are two purchased goods, X_1 and X_2, and that the set of feasible combinations of X_1 and X_2 is given by the budget constraint $M=P_1X_1+P_2X_2$. Then the general primal problem in regret theory is:

$$\underset{X_1,X_2}{\text{Max}} \; U(X_1,X_2) + \int_0^{(M-P_2x_2)/P_1} \int_0^{M/P_2} B(x_1,x_2)\, R^*[U(X_1,X_2)-U(x_1,x_2)]\, dx_2\, dx_1$$

$$\text{Subject to } M = P_1 X_1 + P_2 X_2$$

where $B(\cdot,\cdot)$ represents the weights placed on the regret the individual feels for alternatives not chosen. The determination of the weights is based on psychological factors and is ultimately an empirical issue. However, intuitively, we might expect the degree of regret felt to be related to 'how close' the individual came to choosing the alternative before it was ruled out[12]. We suggest that the idea of 'how close' the individual came to choosing that alternative can be captured by the level of choiceless utility which the individual would get from the alternative[13]. Thus, if two alternatives are 'close' in terms of choiceless utility, then the individual is presumed to be 'close' to choosing each of those two. The weight which the individual places on the regret/rejoice function is then assumed to be proportional to this choiceless level of utility. Thus, we suggest the following function for the weights:

$$B(x) = \frac{U(x_1,x_2)}{\iint U(x_1,x_2)\, dx_2\, dx_1}$$

where the denominator is simply a normalizing constant. Under this assumption, the modified utility function becomes:

$$\int_0^{(M-P_2x_2)/P_1} \int_0^{M/P_2}$$

$$MU(X;S) \equiv U(X_1 X_2) + \int_0^{(M-P_2x_2)/P_1} \int_0^{M/P_2} \frac{U(x_1,x_2)}{\iint U(x_1,x_2)\,dx_2\,dx_1} R^*[U(X_1,X_2)-U(x_1,x_2)]\,dx_1\,dx_2 .$$

where S is the set of all feasible alternatives defined by the budget constraint. If the income constraint holds as an identity and we set $P_2=1$ by normalization, then the consumer's choice problem can be rewritten as:

$$\underset{X_1}{\text{Max}}\ U(X_1, M-P_1X_1) + \int_0^{M/P_1} U(x_1, M-P_1x_1)\ R[U(X_1, M-P_1X_1)-U(x_1, M-P_1x_1)]\,dx_1 ,$$

where

$$R[\cdot] \equiv \frac{R^*[\cdot]}{\int U(x_1, M-P_1x_1)\,dx_1}$$

We can now introduce uncertainty by assuming state dependent utility and regret functions, U_i and R_i, with N possible states of the world. Thus, expected modified utility resulting from the choice, X, is:

$$EMU(\cdot) = \sum_{i=1}^{N} \left[U_i(X) + \int U_i(x)\ R_i[U_i(X)-U_i(x)]\,dx \right] p_i \qquad (2)$$

The optimal choice can then be determined by maximizing (2) with respect to X subject to the budget constraint. In theory, given prices and income the first order conditions resulting from the corresponding Legrangian could be solved for the optimal ex-ante continuous choice of X, resulting in demand functions for optimal individual level decisions conditional on a price and income vector or a policy choice. These demand functions would take the form $X^*(P,M,\Theta;S)$ where Θ is a discrete variable representing the policy choice. Substituting X^* back into the modified utility function then gives an indirect modified utility function

$$V_i(P,M,\Theta;S) \equiv MU_i(X^*;S)$$

that can be used in deriving Hicksian welfare measures for different policy options.

Hicksian Welfare Measures in a Regret Theory Context

The previous section focused on the continuous consumer choice problem associated with the lower level of the two-tiered decision problem outlined above. We turn now to the second level of decision-making where the choice is among a discrete number of policy options. Suppose the government has two policy options, A_0 and A_1. For example, A_1 may represent the decision to build the dam or impose acid rain controls, while A_0 may represent do not build the dam or do not impose controls. Alternatively, this framework may be used to represent welfare effects of price changes where A_0 represents the initial price vector faced by consumers while A_1 represents some alternative price vector. In this two alternative case a compensating variation measure (CV) measure of benefits of choosing A_1 over A_0 can be straightforwardly defined as an individual's willingness-to-pay (WTP) for the project, i.e. the maximum amount of money that could be taken away from the individual if A_1 were chosen such that the individual would be indifferent between losing the money by having A_1 (denoted A_1-C_1) and not losing the money and having A_0. In terms of the indirect modified utility function V_1, it is the amount C_1 such that

$$EMU^*(A_1-C_1;A_0) \equiv EMU^*(A_0;A_1-C_1) \tag{11}$$

where

$$EMU^*(A_1-C_1;A_0) \equiv \Sigma p_1\{V_1(M-C_1,A_1) + R[V_1(M-C_1,A_1)-V_1(M,A_0)] \tag{12}$$

and

$$EMU^*(A_0;A_1-C_1) \equiv \Sigma p_1\{V_1(M,A_0) + R[V_1(M,A_0)-V_1(M-C_1,A_1)] \tag{13}$$

and $EMU^*(A_0;A_1-C_1)$ is defined analogously and the P and S arguments of V_1 have been suppressed for simplicity. Thus, the individual would be indifferent between having A_1 and paying C_1 and the alternative of having A_0.[14]

The corresponding equivalent variation, E_1, which would make the individual indifferent between having A_1 and the alternative of having A_0 and being paid E_1, is implicitly defined by

$$EMU^*(A_1;A_0+E_1) \equiv EMU^*(A_0+E_1;A_1) \tag{14}$$

where the definitions of the left and right hand sides of (14) are analogous to (12) and (13). E_1 is then a measure of the minimum amount the individual would be willing to accept (WTA) to forgo A_1.

These definitions of C_1 and E_1 in the two alternative case are logical extensions of the definitions based on the EU model to a regret theory context where the individual anticipates possible ex-post feelings of regret or rejoicing over the policy choice. Note that, in general, these possible regret or rejoice feelings influence the amount the individual is willing to pay for A_1 and the amount that would be demanded for accepting A_0. In addition, both the alternative and the benefit measure enter both sides of (11) and (14), rather than just one side as would be true in the EU model. This implies that the level of expected modified utility for the "base case" depends on the alternative being considered and its valuation.

The extension of the EU welfare measures is more complicated when there are more than two policy options. For example, dams of different sizes can be built or the stringency of controls on acid rain precursors can be varied. Let A_0, A_1, and A_2 be three possible options with A_0 again corresponding to the "do nothing" alternative. As before we could define the compensating variations for A_k (k=1,2) to be the amount of money that would make the individual indifferent between having A_k while paying C_k and having A_0. However, it is now important to specify precisely the choice set over which this indifference is defined. To ensure consistency, the choice set must be $T=\{A_0, A_1-C_1, A_2-C_2\}$ with C_1 and C_2 defined so that the individual is indifferent between these three options. In terms of expected modified utility, this requires that

$$EMU^*(A_1-C_1; A_0, A_2-C_2) \equiv EMU^*(A_0; A_1-C_1, A_2-C_2) \tag{15}$$

and

$$EMU^*(A_2-C_2; A_0, A_1-C_1) \equiv EMU^*(A_0; A_1-C_1, A_2-C_2) \tag{16}$$

where

$$\begin{aligned} EMU^*(A_k-C_k; A_0, A_j-C_j) \equiv \Sigma\, p_i \{ & V(M-C_k, A_k) + \beta_{k0} R[V_i(M-C_k, A_k) - V_i(M, A_0)] \\ & + \beta_{kj} R[V_i(M-C_k, A_k) - V_i(M-C_j, A_j)] \end{aligned} \tag{17}$$

and β_{k0} and β_{kj} are the weights attached to the regret/rejoice associated with choosing A_k over A_0 and A_j. $EMU^*(A_0; A_1-C_1, A_2-C_2)$ is defined analogously.

Note that (15)-(16) is a set of two equations that implicitly define the two unknowns C_1 and C_2 that would have been defined from the pairwise choice problem defined above, i.e. the values that would ensure indifference between A_0 and A_k-C_k when these are the only two alternatives[15]. The pairwise valuation measures cannot be used when there are multiple alternatives since under regret theory, pairwise preferences are not transitive. Without transitivity, valuation measures do not necessarily reflect an individual's preferences over alternatives[16]. In addition, C_k as defined by pairwise choice cannot be interpreted as the willingness-to-pay for A_k given that there are in fact three alternatives. These problems can be solved by using the above definition of C_k based on the expanded choice set, T. However, since use of this measure requires that C_1 and C_2 be determined simultaneously, it suggests that the valuation problem may be much more complex than supposed in the expected utility model; the benefits of one option now depend on the other options being considered, and the tradeoffs the individual is being asked to envision can no longer be made in a pairwise manner. Eliciting such values would provide a difficult challenge to researchers using direct methods such as contingent valuation to obtain estimates of project benefits.

The same complexity arises if an equivalent variation (EV) measure of valued is used. In this case the choice set must be viewed as $T'=\{A_0+E_1;A_0+E_2,A_1,A_2\}$ with E_k defined so that the individual is indifferent between the option A_0+E_k and A_k. In terms of expected modified utility, this requires that

$$EMU^*(A_1;A_0+E_1,A_0+E_2,A_2) \equiv EMU^*(A_0+E_1;A_0+E_2,A_1,A_2) \qquad (18)$$

and

$$EMU^*(A_2;A_0+E_1,A_0+E_2,A_1) \equiv EMU^*(A_0+E_2;A_0+E_1,A_1,A_2) \qquad (19)$$

Again, these two equations simultaneously define the two unknowns, E_1 and E_2. However, as is the case with the EU model (Chipman and Moore), the above EV measure of valuation has an advantage over the CV measure in that it can be used to rank projects. In other words, $E_1>E_2$ if and only if A_1 is preferred to A_2 when the choice set is T'. Thus, the numerical ranking of the E_k's provides the preference ranking over the A_k's[17]. An analogous claim cannot be made for the CV measure of value.

It is well-known that, if income effects are small, CV and EV measures of value should be close in magnitude. (Willig). Yet, persistent differences between these measures have been consistently observed (Knetsch and Sinden, Coursey et al). Knetsch and Sinden mention in passing that the difference may be attributable to anticipated feelings of regret. The above definitions can be used to show that regret theory cannot explain the discrepancy if the based case is viewed symmetrically with other alternatives as an option freely chosen from the choice set. However, it could provide an explanation if the base case is viewed as "choiceless", as suggested by Knetsch and Sinden, and thus generates no regret of rejoice feelings.

To show these results, we limit our discussion to the case of two alternatives, A_0 and A_1, and assume that the indirect choiceless utility function from the individual choice problem is linear in income, i.e.

$$V_i(M,A_k) = M + h_i(A_k)$$

for some function h. Under the EU model, this assumption implies that CV and EV measures of value are identical since the marginal utility of income is constant. The question to be asked is whether they would also be identical if the choice between A_0 and A_1 were based on regret theory.
Consider first the definitions of C_1 and E_1 given above for the two-alternative case. If V_i is linear in M, then (11) and (14) imply

$$\Sigma p_i \{M-C_1+h_i(A_1)+R[M-C_1+h_i(A_1)-M-h_i(A_0)]\} \equiv$$
$$\Sigma p_i \{M+h_i(A_0)+R[M+h_i(A_0)-(M-C_1)-h_i(A_1)]\} \qquad (21)$$

and

$$\Sigma p_i \{M+h_i(A_1)+R[M+h_i(A_1)-(M+E_1)-h_i(A_0)]\} \equiv$$
$$\Sigma p_i \{M+E_1+h_i(A_0)+R[M+E_1+h_i(A_0)-M-h_i(A_1)]\}. \qquad (22)$$

A comparison of (21) and (22) shows that $E_1=C_1$ when V_i is linear in M. Thus, with the above formulation of the regret theory model and the corresponding CV and EV measures of value, anticipated regret does not provide a solution to the puzzle over observed disparities between the two measures.

This formulation of the model, which is consistent with the approach suggested by Loomes and Sugden and by Bell (1982), treats the base case as an alternative in the choice set that, if chosen, would generate regret or rejoicing. Knetsch and Sinden suggest, however, that the base case might not generate such feelings since it might not be viewed as being deliberately chosen. Under this interpretation, (21) and (22) would become:

$$\Sigma p_i \{M-C_1+h_i(A_1)+R[M-C_1+h_i(A_1)-M-h_i(A_0)]\} \equiv \Sigma p_i \{M+h_i(A_1)\} \quad (23)$$

and

$$\Sigma p_i \{M+h_i(A_1)\} \equiv \Sigma p_i \{M+E_1+h_i(A_0)+R[M+E_1+h_i(A_0)-M-h_i(A_1)]\}. \quad (24)$$

with the "base case" being A_0 for the CV measure and A_1 for the EV measure. From (23) and (24) it is clear that if $R(x) \neq -R(-x)$, i.e. if R is not symmetric, then $E_1 \neq C_1$ even when V_1 is linear in M. Thus, if the base case should, in fact, be viewed as choiceless, then anticipated regret could provide a possible explanation for observed disparities between CV and EV measures of value. However, viewing the base case as choiceless doe not allow C_k to be defined solely in terms of preferences over a choice set[18]. It requires, in addition, the introduction of some notion of a reference point, such as that used by Kahneman and Tversky in prospect theory. Whether or not this is an appropriate representation of consumer choice is ultimately an empirical issue that warrants further study.

Summary and Conclusions

This paper has discussed issues related to welfare measurement under regret theory. Regret theory represents a method for explaining behavior which has been observed in various experimental environments and which violates expected utility maximization. Regret theory extends utility theory by including possible ex-post feelings of regret or rejoice for alternatives not chosen, in addition to utility received for the chosen alternative. In so doing, regret theory defines a modified utility function, which includes the usual neoclassical utility function, termed the choiceless utility function plus a regret/rejoice function which depends on the difference between the utility of the chosen alternative and the utility which would have been achieved had the other alternative been chosen.

This paper extends regret theory by examining the case of decision making given a choice among a continuous set of alternatives. To do so, the paper provides a hypothesis for construction of the action weights which determine the extent to which individuals weigh regret/rejoice for options not chosen. The paper hypothesizes that the more seriously an option is considered before it is chosen, the more regret/rejoice the individual will feel towards that option, ex-post. To quantify this, the action weights are presumed to be proportional to the level of choiceless utility derived from the alternative.

The continuous choice framework is used to define indirect modified utility function, which in turn is used for constructing compensating and equivalent variation under regret theory. Welfare measurement in considerably more complicated under regret theory, since all available alternatives enter the regret function. Thus, evaluations cannot be made simply by comparing a subset of available alternatives, but rather must consider all options available both in terms of choosing among alternatives and in welfare measurement. For welfare measurement with n alternatives results in n-1 simultaneous equations which, in general, must be solved when evaluating benefits between any pair of alternatives. This will tend to greatly complicate matters when considering a significant number of alternatives. When attempting to apply regret theory through the use of contingent valuation, one must, in general, specify and evaluate all available alternatives even if one only wants to measure benefits related to some pair of options.

While regret theory has considerable intuitive appeal, the implication that utility depends not only on the chosen alternative, but also on all available alternatives which are not chosen. The finding of this paper is that this greatly complicates modelling with regret theory and makes it difficult or impossible mimic the modelling of standard utility theory.

Our hope in embarking on this effort was that the duality framework, which provides the structure for utility theory, could be extended to regret theory. We hoped that this would allow modelling of decisions within a regret theory framework comparable to the extensive work which has been done in utility theory. Unfortunately, this does not seem to be a straightforward task. The primary difficulty seems to arise due to the need to consider all available alternatives when evaluating an individual option. This implies that given n

possible options, comparison of any subset of alternatives requires solution of n-1 simultaneous equations. Note, however, this is analogous to specification and estimation of demand functions within the ordinary utility theory context, where simultaneous solution to n first order conditions are required to derive demand functions, and in general, demand estimation requires inclusion of prices of all other goods. Nevertheless, a regret theory modelling of the decision process results in a significant complication compared to the results of utility theory, given that in any realistic situation many possible alternatives exist. This additional complexity of decision making further strains credibility given limited cognitive skills. Thus, the Simon-Heiner arguments concerning cognitive shortcuts in complex decision environments may be even more appropriate under regret theory than utility theory.

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Footnotes

[1] The authors are, respectively, Associate Professor in the Department of Resource Economics at the University of Rhode Island and Assistant Professor in the Economics Department at the University of Connecticut. Note that senior authorship is not assigned.

[2] Several authors have suggested that one of the alternative theories might provide an explanation for some of the observed anomalies of welfare economics, such as the disparity between willingness-to-pay and willingness-to-accept measures of value. (see, for example, Brown, Coursey et al., Gregory, Knetsch and Sinden.) However, none have provided a formal analysis of welfare measures under an alternative model.

[3] By focusing on regret theory, we do not mean to imply that the various paradigms are mutually exclusive. For example, a decision-maker may feel regret after choosing an alternative which, due to random factors, turns out to be the wrong choice ex-post, even though it might have been the best ex-ante choice. The individual may, at the same time, exhibit biases in the perception of probabilities, as discussed by Kahneman and Tversky or may use rules of thumb in dealing with complex situations, as discussed by Simon and by Heiner. For simplicity we restrict our attention to the implications of regret.

[4] Allowing multiple alternatives complicates the decision problem considerably, even in the case of discrete choice problems. This is discussed in more detail below.

[5] On a philosophical basis, regret theory can be viewed from two alternative perspectives. First, the feeling of regret/rejoice for alternatives not received may be argued to be inappropriate or irrational behavior. Nevertheless, people may still experience regret/rejoicing and anticipate these feelings in choosing their actions. In this case, the axioms of expected utility theory are viewed as a normative definition of rational behavior. Within this context, regret theory can be thought of as a positive or descriptive approach, since it describes how people behave, but is not a normative approach in the sense of judging how people should behave. Alternatively, if we accept the concept of consumer sovereignty we would have to argue that these feelings may be legitimate, so that it is appropriate to consider feelings of regret as part of a rational decision making process. Finally, particularly for decisions which are scrutinized by others, it may be rational to consider regret/rejoice within certain types of organizational decisions, as job performance may be judged by factors such as lost opportunities ex-post, even if they do not reflect a preferable choice a priori. This is similar to the concept of the Monday morning quarterback, where a bad decision before the fact may look good ex-post, and the individual may be criticized on this ex-post basis. The remainder of this paper will be formulated under the consumer sovereign assumption that if individuals do indeed feel regret/rejoice then these feelings are presumed legitimate, and it is appropriate for the individual to modify actions so as to account for this feeling when making decisions.

great deal of regret. On the other hand, if some other number was chosen which was not considered at all, one would expect that no regret would be felt. Similarly, if the individual were carefully considering three alternatives, he would likely feel regret towards the two non-chosen options, but not options which were not given serious consideration.

[13] Ideally, one would want to use modified utility, rather than choiceless utility to capture how close the individual was to choosing the alternative. However, this would complicate the definition of EMU considerably, since the weight placed on regret for each alternative would depend on total regret, which in turn depends on the weight. We, therefore, chose to use the simpler formulation based only on choiceless utility.

[14] The definition in (11) assumes that having the base case A_0 is a deliberate choice that could generate regret or rejoicing. If the base case is instead viewed as choiceless, as suggested by Knetch and Sinden, C_1 would be defined by

$$EMU^*(A_1-C_1;A_0) \equiv EU(A_0).$$

This is, in fact, a special case of (11) where it is assumed a priori that

$$R[V_i(M,A_0)-V_i(M-C_1,A_1)] \equiv 0$$

for all i. The discussion below of the disparity between compensating and equivalent variation measures of value highlights one implication of restricting attention to this special case.

[15] Note that if C_1 were defined by the single equation

$$EMU^*(A_1-C_1;A_0,A_2) \equiv EMU^*(A_0;A_1-C_1,A_2)$$

This would imply that for purposes of defining C_1 the choice set would have to have been $\{A_0,A_1-C_1,A_2\}$, implying that the individual could have chosen option A_2 without paying an associated CV, C_2. Similarly, in evaluating option A_2, the choice set would be $\{A_0,A_1,A_2-C_2\}$, which implies that the individual could choose A_1 without paying the associated CV, C_1. This implies, among other things, that the resulting preference ordering would not be transitive. That is:

$$EMU(A_0;A_1-C_1,A_2) = MU(A_1-C_1;A_0,A_2)$$

and

$$MU(A_2-C_2;A_0,A_1) = MU(A_0;A_1,A_2-C_2)$$

does not ensure that

$$MU(A_1-C_1;A_0,A_2) = MU(A_2-C_2;A_0,A_1)$$

using the single equation definitions of C_1 and C_2. Due to this inconsistency, it seems more reasonable to define a single choice set $\{A_0,A_1-C_1,A_2-C_2\}$ for all evaluations, which implies that C_1 and C_2 must be derived from solution of the two equation system, (15) and (16).

[16] See, for example, the literature on the well-known "preference reversal" phenomenon, especially Slovic and Lichtenstein, Gather and Plott and Machina.

[17] Note that this would not be true if the definition of each E_k were based on pairwise choice because of the lack of transitivity of preferences over pairwise choices.

[18] In other words, one could not define preferences and indifference over an arbitrary set of alternatives and then apply that general definition to the

specific case of the two alternatives A_k–C_k and A_0 to define C_k. Instead, one would have to identify which alternative is being viewed as the "base case" (A_0 for a CV measure and A_k for an EV measure) and then define the preference ordering relative to that base case using the assumptions that regret/rejoice is zero for that base case.