On Empirical Measures of the Social Rate of Discount

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For decades economists have debated the existence of a social rate of time preference distinct from the private, market determined, rate. Although competitive markets, under the assumptions of general equilibrium analysis, have been shown to allocate resources in a Pareto efficient manner, one criticism of this solution is that the analysis is static and does not consider the growth of the economy over time. At the center of this issue has been the question of whether capital markets function in the interest of society over periods which span multiple generations.

Economic debate surrounding the social rate of discount has been divisive. While some economists have argued for discount rates below market values, others have concluded that market rates are appropriate. Whatever the argument, theories have been largely deductive without any collection of empirical information. The purpose of this paper is to explore ways in which further research may provide empirical insights into what has largely been a theoretical debate. In order to develop hypotheses amenable to empirical testing, we begin by reviewing the literature on the divergence between private and social discount rates and continue the deductive tradition by adding to the pool of theoretical reasons for market failure in capital markets. We then turn our attention to an empirical method which involves the construction of choice sets which contain several income paths. The choice of one path over another reveals a range of rates of time preferences for the individual.

In this study we examine several factors which are hypothesized to affect the choice of the discount rate and attempt to design an experiment to isolate these factors. Different types of goods (forests and farms), managed by different agents (public and private) are used, as well as several forms of time paths (cyclical, declining and constant) and two types of decision mechanisms (individual and group). The empirical technique used in this paper is not unique. Pope and Perry (1989) employed this methodology in their analysis of social versus private rates of discount. Similar procedures have been tested by Benzion, *et al.* (1989). We conclude with a discussion of the implications of the possible divergence between public and private interest rates and plans for further research.

Theoretical Debates

Aggregation Over Individuals

Investigations into diverging social and private rates of time preference may be structured around classic sources of market failures including: distributional considerations (altruism), public goods externalities, imperfect knowledge, and stability. While investigating reasons for the hypothesized divergence between social and private rates, a constant theme emerges regarding the inability of markets to aggregate the desires of individual consumers.

Distributional Concerns

Discussions regarding growth externalities, or externalities in intertemporal consumption decisions, have been frequently centered around concerns over distributions between present and future generations (see for example Pigou, 1932). Pareto efficiency, in static analysis and over time, is said to fail to consider whether resource allocations result in distributions which are "ethical". Page (1977, 1988) argued that discounting is an ethical

issue because of its important influence on intergenerational equity. Thus, the distributional problem is modelled by considering axioms which distribute utility among current and future generations.

Implicit in the distributional approach is the assumption that a benevolent government is necessary to assess and regulate markets to accommodate concerns of equity. The approach assumes altruism (involving either present members or future generations[1]) cannot be depended on to adequately provide, in aggregate, for an equitable society. Maximizing behavior, under the Rawlsian veil of social status, creates a crucial role for regulatory institutions to provide for social concerns of equity (Heal, 1981). However, the presence of the Rawlsian view begs the question: what member(s) of society can see through the veil in order to make decisions for the welfare of future generations? If one assumes that decision makers are more capable of seeing clearly through the veil than other members of society, then the democratic view of the state suffers from elitist policy making by authoritarian politicians (Marglin, 1963).

Despite the prevalence of distributional concerns in discussions of social rates of time preference, Marglin (1963) pointed out that the welfare of future generations must be part of current utility functions for these arguments to be of any relevance.[2] If future generations are completely external to utility functions of existing generations, then they are of no interest to society. Under such conditions, individuals, by maximizing utility atomistically and in aggregate, would be on an optimal social welfare path regardless of their effect on future generations. Providing for the welfare of future generations will only increase social welfare to the extent that society is defined to include future generations.[3] However, empirical observations of socially sanctioned redistributional tax structures suggest that there must be some market failure affecting distributions which must be corrected with institutions. Thus, the relevant question becomes: is there something about distributional concerns for future generations which prevents the market aggregation of individual utility functions from promoting social welfare?

Future Generations as Public Goods

One answer to the above question is that the welfare of future generations is external to individuals because it has public good properties (Sen, 1961, 1967; Marglin, 1963). Future generations are considered as a part of individual utility functions, however the non-exclusive and non-rival nature of the welfare of future generations is believed to create

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1 The arguments which follow regarding distributions between generations may be extended to apply to distributional arguments in general.

2 Some economists do not believe that the utilitarian framework is sufficiently robust to accommodate all types of values (see for example Sen, 1979).

3 Similar arguments are frequently presented in debates considering distributional concerns regarding non-human values in natural systems. It is frequently argued that the ethnocentric approach of economics fails to sufficiently recognize values of other living creatures (see for example Rolston, 1988). However, in response to such concerns, others have pointed out that natural systems must provide satisfaction to humans if their values are to be relevant to decision making (see for example Riley, 1988). Values are perceived as human phenomena which guide management decisions. To the extent that humans perceive value in other living creatures, such creatures will be considered in decisions.

incentives for individuals to become free riders in providing for future generations. As public goods, future generations are thus under provided by private markets, and gains may occur from public regulation which would increase the rate of saving.[4]

The presence of public good externalities has led to hypotheses about members of society which have differing individual and social utility functions. Marglin (1963) proposed two possible reasons for differing utility functions. The first reason, following Sen (1961, 1967), is that utility functions are interrelated so that individual decisions are dependent on decisions of others. That is, individual utility functions governing atomistic behavior are not additive causing higher levels of aggregation to lead to market failure. The second reason is explained by schizophrenic behavior of individuals. Individuals have aspects of "economic man" and "social citizens" and as such do not have unique time preferences. Atomistically, individuals maximize personal utility functions while in aggregate, individuals prefer to have governments provide for the overall welfare of society. Individuals see it as their role in society to maximize their personal utility subject to the constraints which governments impose on their actions. Thus, there are two rates of time preference, both of which are part of a socially optimal scheme. One rate of time preference reflects the concerns of the individual, and the other is indicative of society's concerns for future generations.

Research conducted by other economists (Runge, 1984; Sugden, 1984), on what has become known as the "assurance problem", provides an explanation which may be used to merge the hypotheses of interrelated utility and schizophrenic behavior. Individuals operate as self interested consumers because they are aware of the potential for free riding behavior by other members of society. If they are assured that all other individuals will not free ride (in terms of provision of goods for future generations) then transfers to the future may occur. Thus, a self interested "economic man" may become a "social citizen" if he is assured other individuals will not free ride. If groups of individuals are more homogeneous it is more likely that the assurance problem will be solved. Similarly, if more individuals join the "assurance club" the likelihood of the socially conscious outcome being observed by others increases.[5]

Utility functions which change with the level of social aggregation suggest interesting questions about socio-psychological phenomena relating to time preferences. Do individuals prefer to have institutions act as conscientious social watchdogs so that they may maximize their selfish utility void of ethical concerns? Is this schizophrenic behavior a result of a second best world where the government is viewed as a necessary regulator, or is it caused by a lack of peer pressure or assurance clubs which internalize public good externalities at higher levels of social aggregation? At what level of aggregation do individual preferences become non-additive? The schizophrenic dual function hypothesis would suggest a discrete social level at which an alternative social citizen function would "kick in" and dominate the

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4 Bergstrom *et al* (1986) following Warr and Wright (1981) argue that social rates should be lower than private rates only for large public investments. When public investments make up only a modest portion of the economy, public supply of a public good is shown to crowd out private supply resulting in no net increase in the supply of the public good. However, Newberry (1990) criticizes this conclusion on the grounds that the perfect displacement results are based on the unrealistic assumption that individuals voluntarily subscribe to public goods. Indeed, these results have assumed away the crux of the public good problem.

5 These explanations of the movement from self interest to social cooperation are largely re-interpretations of the literature applying game theory to free rider problems (see, for example, Axelrod and Dion, 1988).

economic man function. However, the explanations of interdependent utility functions and assurance problems suggest that higher levels of aggregation continuously increase the internalization of public good externalities.

Imperfect Knowledge: Uncertainty and Irreversibility

Another source of market failure exists due to the lack of perfect knowledge which causes uncertainty, or risks, in capital markets. One argument discusses the role of regulatory institutions as risk poolers (see for example Samuelson, 1964, or Arrow, 1966). Risk pooling occurs if the government can invest in many projects and use portfolio effects to decrease risk. Thus, the discount rate for governments, who may pool risks for society in general, are lower than privately determined rates. Such an argument assumes levels of aggregation in the private sector which cannot pool risk. However, Baumol (1968) points out that large numbers in the private sector also pool risk from a social point of view, so that the private discount rate is actually reflective of the social rate.

Another argument maintains that governments can spread risk over all of the individuals in society and therefore can discount projects at rates lower than the private sector because of the lack of risk spreading ability in the private sector. Arrow and Lind (1970) show that if a public project is small relative to GNP and is uncorrelated with GNP then the cost associated with risk per person decreases as the number of people in the society increase. In the limit the cost of risk is zero.

Uncertainty problems associated with irreversible decisions, no matter how much they have been pooled or spread, are also said to result in market failures (Krutilla and Fisher, 1985; Fisher and Hanemann, 1986). The asymmetry of irreversible actions has led to the recognition of values associated with maintaining options over time, or quasi-option values. Without perfect knowledge, individuals may rationally choose to adopt decisions which allow for "learning by doing" strategies. Such strategies avoid actions which are irreversible so that as more knowledge is gained, strategies may be adjusted. The recognition of an additional value associated with avoiding irreversible decisions (quasi-option value) is essentially identical to shifting preferences toward the future, thereby reducing the social rate of discount for those items which have potential irreversibilities.

Despite potential losses of social welfare associated with irreversibility, many irreversible actions are not considered to be of high risk atomistically. Depletions of all stock resources are, in some respects, irreversible. Yet individual consumers choose to burn fossil fuels and consume mineral products despite the realization that the resource, once consumed, is irreversibly depleted. In aggregate, such actions have led to concerns over potentially irreversible phenomena such as the greenhouse effect. Thus, while atomistic decisions affecting irreversible resources may not appear to be a large social concern, aggregate irreversibility, where the welfare of the planet may be at stake, is increasingly finding its way into the welfare of society.[6]

At the core of risk issues are the shapes of individual and aggregate utility of income functions, about which there is considerable disagreement.[7] Do individuals possess one

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6 There is also evidence that concerns over the welfare of the planet are finding their way into atomistic utility functions as markets are increasingly characterized by producers scrambling to meet consumer demands for environmentally friendly products.

7 The arguments made above are based on the somewhat controversial expected utility hypothesis (Schoemaker, 1982).

rate of risk aversion while an aggregated society (perhaps due to risk pooling or spreading) has another rate? Or, conversely, is the social utility of income function more concave because the government is ultimately responsible for the perpetuation of a greater portion of the planet causing decisions made to have a larger effect on society in general? Similarly, can gains and losses of income be treated as reversals of the same utility of income functions (Kahneman and Tversky, 1979)? A myriad of experiments in a variety of disciplines have shown that individuals react differently to gains versus losses and to perceptions of probabilities under gain and loss scenarios (Kahneman, *et al.*, 1990). While these types of behavior may be difficult to explain, the result is that irreversible losses may have to be considered even larger, in terms of welfare loss, than we currently estimate.

Stability

Casual observation suggests that individuals desire stable environments. In the context of intertemporal choice, this suggests that the pattern of consumption may be as important as the temporal weighting of present and future utilities. Consumption paths which imply equal rates of discount may be assessed differently by consumers depending on the stability of the path. Assessing the role of stability as part of individual time preferences allows us to approach a finer degree of resolution in our definition of time preferences. Questions regarding consumption over time may not merely be reflections of how far in the future a consumer must wait until utility is derived but also a function of the stability of consumption.

Adding stability considerations to analyses of social rates of discount raise several issues. What types of consumption patterns do consumers prefer and why? Do desired patterns vary depending on whether a resource is irreversible, publicly managed, or individually owned? Can desires for specific patterns which are relatively constant be explained by the lack of perceived self discipline in savings and consumption habits? Alternately, are indifference curves asymmetric in gains and losses (Kahneman, *et al.*, 1990) resulting in increased utility from stability?

Aggregation Over Goods

Investigation into the social rate of discount has traditionally been performed using simple models of an economy with various modifications for corporate tax rates, capital productivity rates or other macroeconomic or "large scale" considerations. However, the social rate of discount can also be analyzed from an individual utility perspective. Lind (1990) points out that inferences from the analysis of capital markets or shadow prices of private capital do not necessarily provide much understanding of the consumer's intertemporal choices. Lind (1990, p. S-20.) states, "Therefore, market rates that determine consumer's potential rates of transformation may tell us nothing about people's rates of time preference." The analysis of individual rates of time preference requires a more "micro" analysis of choice, one that involves individual utility functions and consumption paths. This trend toward individual behavioral analysis reveals even more complexity in the choice of rates of time preference. Below we turn to one of the individual factors affecting choice -- aggregation over goods.

In modeling consumer choice, separability in temporal utility functions is often assumed. For example, if the individual maximizes the utility of two goods (A,B) over two time periods (1,2) the maximization problems is

$$\text{Max } U(A(1),B(1), A(2),B(2))$$

$$\text{subject to } P(1)X(1) + P(2)X(2) = Y(1)+Y(2)$$

where the numbers in parentheses indicate the time period in which the good is consumed, X(i) is a vector of (A(i),B(i)), P(i) is the price vector and Y(i) is income in each period (i). A form of temporal separability is often imposed on this analysis so that utility is assumed to be additive over time periods (eg. Phlips, 1983). The result is to adjust the maximization problem to be

$$\text{Max } U(A(1),B(1)) + \gamma U(A(2),B(2))$$

$$\text{subject to } P(1)X(1) + P(2)X(2) = Y(1)+Y(2)$$

where γ is the *pure rate of time preference* which measures the marginal rate of substitution of goods between time periods. The marginal rate of substitution between goods in two different time periods at the point of equal consumption of the two goods (ie. at the 45 degree line in consumption space) is $-1/\gamma$ (see Boadway and Bruce, 1984).

The assumption of temporal separability is often accepted without question. However, an assumption which is seldom considered, is that of separability over goods (or groups of similar goods) and time.[8] If goods A(i) and B(i) are separable, the utility maximization process can be written as

$$\text{Max } U(f\{ A(1), A(2) \}, g\{ B(1), B(2) \})$$

$$\text{subject to } P(1)X(1) + P(2)X(2) = Y(1)+Y(2)$$

In this case the consumer may allocate income over time to each "sub-utility" maximization problem, such that the intertemporal consumption of each good is treated individually. For example, imposing goods and temporal separability results in

$$\text{Max } f\{ A(1) \} + \gamma_a f\{ A(2) \}$$

$$\text{subject to } P(1)X(1) = Y_a(1)+Y_a(2)$$

and

$$\text{Max } g\{ B(1) \} + \gamma_b g\{ B(2) \}$$

$$\text{subject to } P(1)X(1) = Y_b(1)+Y_b(2)$$

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8 In static analysis separability over goods is almost always assumed.

where Y_a and Y_b indicates income allocated to separable branches "A" and "B". The maximization of these individual goods problems can provide different marginal rates of time preference parameters γ_a and γ_b depending on the good in question. It seems possible that an analysis which requires equal γ parameters across goods is overly restrictive.

The "upshot" of the preceding analysis is that individuals may associate different goods with different rates of time preference. As outlined by Lind (1990), individuals appear to simultaneously manage funds in several accounts with different rates of interest, revealing different rates of time preference for different goods or services. While Lind attributes this phenomenon to a lack of "self-control" one could likely discover other reasons for this apparent asymmetry. A similar example of separability is presented by Stiglitz (1982) for the choice between public and private goods. The implication for our empirical analysis is that the choice of the reference "good" may have an impact on the rate of time preference indicated by the consumer. The relevant questions become: Do consumers have different rates of time preference for different goods, or groups of goods with similar attributes?; Does the composition of separable groups change over time?; Can one reveal the rates of time preference for the different groups of goods?

Empirical Procedures to Elicit the Social Rates of Time Preference

Traditionally, analyses dealing with the social rate of discount have relied on deductive arguments. Recently, several individuals are linking the hypotheses of deductive arguments with the empirical findings in the areas of applied psychology and economics (ie. Lind, 1990; Moore and Viscusi, 1990). These micro level studies may reveal interesting facts about the rate of time preference. In the following empirical analysis we attempt to investigate the effect of various "structuring issues" (ie. public versus private management, the choice of goods, stable versus unstable flows, group versus individual decisions) on an empirically revealed rate of discount. The basis for this type of revelation procedure is the analysis by Pope and Perry (1989). Below we discuss two phases of empirical analysis, a first phase which essentially replicates Pope and Perry's results and a second phase which extends the analysis to include different goods, cyclical paths and group decisions.

Experimental Procedures

The experiment involved the presentation of five time paths of net income over 1000 years. The individuals were told that they would own the resource which produces these paths of income and that there was no financial risk and no inflation. The individuals were then asked to choose one path from the five. Next the respondents were told that the resource was managed by a public resource management agency, and that net revenues would accrue to the state. The respondents were then asked to choose a time path which they feel the resource management agency should follow. The questionnaire was presented to two groups (one large and one small) of undergraduate students at the University of Alberta. Both groups were students in natural resource economics classes.[9] The questionnaire is presented in Appendix A.

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9 We thank Rob Nicholl for his assistance in administering and tabulating the results from group I. He also provided us with the impetus to continue and consider other forms of time preference questions.

The time paths presented in the Phase 1 experiments were all declining and thus represented positive rates of time preference. In an attempt to describe more realistic situations, a second phase of the experiment was performed using cyclical time paths as well as declining paths. The cyclical paths represented flows from a renewable resource, such as a forest. The option of sustained yield was also made available to the respondents. Once again the paths corresponded to specific discount rates. In this second phase an "irreversible" path was also presented (eg. this path declined steadily until it reached zero and then remained constant at zero).

As described above, another potential influence on the choice of a rate of time preference is group influence. In an attempt to determine the effect of group influence on the discount rate chosen, the respondents in this second phase were first asked to respond individually and then were asked to form groups and collectively arrive at a decision. The rate of time preference may also differ for different goods, especially if the goods are perceived to offer different services. In an attempt to identify this effect the respondents in Phase 2 were asked to choose time paths for a forest and a farm. The Phase 2 questionnaire is presented in Appendix B.

In the results that follow the sample sizes are small, precluding sophisticated statistical analysis. Therefore, the results should be considered tentative or in the nature of a pre-test for further research.[10]

Results: Phase One

The results from two groups are presented in Table 1. In the large group (n=36) there is a clear reversal of time preference for the public versus private management scheme. In the private goods scheme 1/3 of the students chose the income stream which reflected the highest rate of return (10%). In the public management scenario no students chose the stream representing the highest or the second highest rate of return. The majority of the students (26 of 36) chose the path of revenues which reflected the lowest discount rate available (< .5%).

The smaller group (n=19) provided somewhat different results. Most students chose the income stream which represented the lowest discount rate for both the private and social scheme. However, in this group a few students chose a higher discount rate for the publicly managed project. When asked why they chose a more skewed path of returns for the public project the students indicated that the returns would help reduce the large government deficit. This rather unusual result raises the question of external influences on the rate of time preference.

Results: Phase Two

This phase of the experiment was administered to two groups of undergraduate students. Table 2 contains the combined results for both groups. The results confirm several findings. First, as above in phase 1, the rate of time preference differs between privately and socially managed goods. As discussed in the theoretical presentation, the divergence between private and social rates may be due to a variety of reasons including risk considerations, interrelated utility functions, or the schizophrenic dual function hypothesis.

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10 Sample sizes were small because the experiment was initially conceived as a teaching tool to provide an understanding of discounting and resource use.

Table 1: Results of the Time Preference Experiment, Phase 1
Number of Individuals Choosing Each Time Path

	Group I		Group II	
Time Path (Implied Rate of Time Preference)	Privately Managed Resource	Publicly Managed Resource	Privately Managed Resource	Publicly Managed Resource
A (< .5 %)	7	26	13	14
B (.5% - 1%)	6	7	1	0
C (1% - 2%)	10	3	3	1
D (2% - 5%)	1	0	1	1
E (5% - 10%)	12	0	1	3
TOTAL	36	36	19	19

Second, the change in the rate of time preference does not seem to depend on the good being evaluated. For example, in Table 2-A, nearly one third more people chose a zero discount rate for the socially managed resource as compared to the privately managed resource for both forests and farms. Although we presented a theoretical argument which suggests that rates of time preference may differ over goods, the choice between farms and forests did not appear to result in different rates of time preference. However, this result may have occurred because of the many similarities between farms and forests in that both resources are subject to "land ethics" or "stewardship values".

Third, individuals seemed to choose income streams which were stable rather than cyclical and they avoided the irreversible stream.[11] This may indicate a misunderstanding of discounting (ie. individuals feel that constant streams are more beneficial than declining streams even though the declining stream begins at a higher revenue) or it may indicate a preference for stability.

The group results presented yet another picture of the time preference pattern. The groups chose lower rates of time preference for the privately managed goods than the individuals. In fact, the highest discount rate chosen by the groups was 1.9%. There is little variation in the discount rates chosen by the groups and no apparent difference between forests and farms. The proportions of groups and individuals selecting each category of discount rates is also roughly similar. However, the unanimity of the 0% rate for social decisions by the groups is in contrast with the individual results. The group results may reflect the solution of the assurance problem in that individuals "conserve" when forced to respond in a group. Alternately, the group may serve to bring out the "social conscience" as described by Marglin (1963).

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11 However, this irreversible path also represented the path with the highest discount rate. Therefore it is difficult to determine whether respondents were avoiding irreversibility or high discount rates.

Table 2: Results of the Time Preference Experiment, Phase 2

A. Number of Individuals Choosing Each Time Path by Good

Good	Forests		Farms	
Time Path (Implied Rate of Time Preference)	Privately Managed Resource	Publicly Managed Resource	Privately Managed Resource	Publicly Managed Resource
A (< 0%)	4	1	3	0
B (0%)	27	42	27	42
C (.1% - 1.9%)	9	2	13	6
D (2% - 5.9%)	6	3	4	2
E (6% +)	4	2	3	0
TOTAL	50	50	50	50

B. Number of Groups Choosing Each Time Path by Good

Good	Forests		Farms	
Time Path (Implied Rate of Time Preference)	Privately Managed Group Resource	Publicly Managed Resource	Privately Managed Group Resource	Publicly Managed Resource
A (< 0%)	0	0	0	0
B (0%)	6	9	5	9
C (.1% - 1.9%)	3	0	4	0
D (2% - 5.9%)	0	0	0	0
E (6% +)	0	0	0	0
TOTAL	9	9	9	9

Implications

While the difference between the social and private rates of time preference may seem to be an academic issue to many, the implications of such a difference are far reaching. First, the difference will affect the choice of the discount rate in benefit cost analysis. As pointed out in Warr and Wright (1981), the selection of the discount rate is often the most important parameter in benefit cost analysis and resource allocation.

To resolve the problem of choosing an appropriate discount rate, the analyst must either attempt to adjust the market rate to correct for the various types of market failure or derive the social rate from the relevant foundational elements of the economy. The correct approach depends on the type of market failure causing the divergence. For example, if risk pooling is the only relevant consideration determining the difference between the social and private rates, the social rate can be derived from the market rate with risk adjustments. However, if aggregation problems cause the divergence, the determination of the optimal rate must be built up from microeconomic foundations and becomes considerably more difficult. Therefore, the source of market failure may be the most important element in the analysis of social versus private discount rates.

The finding that social rates of discount differ from private rates in experimental markets may arise for a number of reasons. In this paper we have examined a number of reasons for the difference and proposed some tests for these sources. First, the difference may result from the failure of markets in aggregating altruistic preferences. These reasons for the divergence suggest that social rates cannot be derived from market rates of interest as there is market failure in the determination of social rates. Such a situation would require investigation into the effects of altruism on market interest rate determination.

Second, the difference may arise because of the risk associated with public investments. In this case, analysis of the portfolio effects in public investment and analysis of the risk involved in public projects may lead to a better understanding of the social discount rate. Compounding factors include the presence of potentially irreversible change and the problem of risk perception versus objective risk measurement.

Third, the divergence may be affected by separate rates of time preference for different goods. The separability over goods case presents a larger problem as rates of time preference now need to be aggregated over goods and over consumers. The potential for market failure is large. Evidence of this difference over goods is appearing, (Lind, 1990; Tversky, Slovic and Kahneman, 1990) evoking questions about the merit of aggregate or macroeconomic analysis of the social rate of time preference. Additional research on individual level decision making will undoubtedly be required.

The important step to take from this point is to begin to identify the sources of the difference between social and private rates. Identifying the sources of the difference may lead toward economic solutions to the determination of the social rate of time preference. It appears that the difference is a phenomenon that carries over various forms of situations.

Conclusions: Problems in Revealing Time Preferences

While the analysis above has revealed some interesting patterns in choices of discount rates by individuals we realize that there are numerous problems which cloud the issues.

Perceptions of negative ownership externalities could cause consumers to temper their rates of time preference. Thus, individual's choices, whether reflecting atomistic or aggregate utility, could reveal factors other than time preferences. Also, the analysis above has discussed time preferences as a static concept for individuals and society. Dynamic time preferences create difficulties in eliciting data from income streams. Preferences over time could change because of changes in tastes, incomes or knowledge.

Another potential problem is that the survey questions ask individuals to choose time paths over long time horizons. The validity of their responses may be questionable given their ability to perceive resource use so far into the future and their ability to conceptualize the decision problem. One must be somewhat skeptical about the use of hypothetical questions in revealing discount rates. Most economists would prefer to use observed market data or at least experiments involving actual exchange. In some cases the analysis above can be carried out using market processes or experiments with money. While transactions with actual cash (Benzion *et al*, 1989) may be more reliable in retrieving rates of time preference in the short term, such actual market transactions are not possible in studying longer term, social discount rate problems. Nevertheless, the hypothetical approach followed here must be augmented by experimentation with a variety of methods.

Although one must retain a healthy measure of skepticism when interpreting the results of such a survey, patterns appear to present themselves in these few replications of the tests. The chosen rate of discount for publicly owned resources perceived by the respondent, however, appears to be lower than the rate for private control. While these results are certainly not convincing enough to affect public policy, they should be interesting enough to promote further research.

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Appendix A: Phase I Survey

1. Assume a hypothetical situation. Upon graduation you obtain a resource endowment such as a fishery, farm or a forest. This endowment can and will be passed on to your heirs. It can be managed in different ways to generate any one of five different net income streams to be utilized by you, your family and future generations. The five possible income streams are labeled A, B, C, D, and E in the Table and Figure. These values are measured in constant 1987 dollars. That is, the dollar values in all of the years will have the same purchasing power. Also these values are assumed to be known with certainty. There is no financial risk.

Based upon your own personal relative valuation of current versus future returns, select the income stream that would be preferred by you, the private owner and manager of the resource endowment.

Circle your selected income stream A B C D E

2. Now assume that this resource endowment is not owned by you. It is a public resource and is managed by a public resource management agency such as Environment Canada, The Alberta Forest Service or Parks Canada. Which income stream do you think should be selected by the public management agency?

Circle your selected income stream A B C D E

3. If the answers in questions 1 and 2 are different please explain why.

_____

_____

_____

4. What faculty are you enrolled in ?

_____

5. Please check one of the following to indicate your gender.

_____ MALE _____ FEMALE

Table 1

Alternative Income Streams from Endowment I

Year	Income Streams[a]				
	A	B	C	D	E
1	$14,485	$20,254	$25,290	$29,724	$31,569
2	14,479	20,170	25,091	29,348	31,052
3	14,473	20,086	24,893	28,974	30,537
4	14,466	20,002	24,696	28,601	30,023
5	14,460	19,919	24,500	28,230	29,510
10	14,429	19,511	23,539	26,401	26,970
15	14,498	19,116	22,608	24,620	24,480
20	14,368	18,732	21,707	22,891	22,056
25	14,339	18,359	20,836	21,221	19,713
30	14,311	17,998	19,996	19,614	17,468
40	14,255	17,309	18,407	16,609	13,331
50	14,202	16,662	16,940	13,908	9,766
60	14,151	16,056	15,593	11,534	6,869
80	14,056	14,956	13,242	7,786	3,162
100	13,969	13,995	11,316	5,276	1,628
150	13,782	12,098	8,015	2,584	963
200	13,631	10,766	6,217	1,981	933
250	13,510	9,838	5,275	1,856	932
1000	13,006	7,733	4,270	1,822	931

[a] All income streams are in real 1987 dollars.

Appendix B

Phase II Survey
Individual Survey

1. Assume a hypothetical situation. Upon graduation you are given a forest. It can be managed in different ways to generate any one of five different net income streams. This forest, and any income that you invest, can and will be passed on to your heirs. The five possible income streams are labeled A, B, C, D, and E in the Table and Figure. These values are measured in constant 1987 dollars. That is, the dollar values in all of the years will have the same purchasing power. Also these values are assumed to be known with certainty. There is no financial risk.

a. Based upon your own personal relative valuation of current versus future returns, select the income stream that would be preferred by you, the private owner and manager of the forest.

Circle your selected income stream A B C D E

b. Now assume that this forest is not owned by you. It is a public resource and is managed by The Alberta Forest Service. Which income stream do you think should be selected by the public management agency?

Circle your selected income stream A B C D E

c. If the answers in questions a. and b. are different please explain why.

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2. Now assume that you have been given a farm which produces wheat and supplies you with the same income streams as in Part 1.

a. Based upon your own personal relative valuation of current versus future returns, select the income stream that would be preferred by you, the private owner and manager of the farm.

Circle your selected income stream A B C D E

b. Now assume that this farm is not owned by you. It is a public resource and is managed by Alberta Agriculture. Which income stream do you think should be selected by the public management agency?

Circle your selected income stream A B C D E

c. If the answers in questions a. and b. are different please explain why.

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3. What faculty are you enrolled in ?

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4. Please check one of the following to indicate your gender.
_____ MALE _____ FEMALE

Group Survey

Please answer the following questions by reaching a consensus in your group.

1. Assume a hypothetical situation. Upon graduation your group is given a forest. The forest has been divided into shares and each member of your group holds an equal percentage of shares so that the dividends produced by this property will be divided equally between all group members. The forest can be managed in different ways to generate any one of five different dividend streams. The shares in this forest, and any dividends which you invest, can and will be passed on to your heirs. The five possible income streams are labeled A, B, C, D, and E in the Table and Figure. These values are measured in constant 1987 dollars. That is, the dollar values in all of the years will have the same purchasing power. Also these values are assumed to be known with certainty. There is no financial risk.

a. Based upon your group's relative valuation of current versus future returns, select the income stream that would be preferred by your group, the private owners and managers of the forest.

Circle your selected income stream A B C D E

b. Now assume that this forest is not owned by you. It is a public resource and is managed by The Alberta Forest Service. Which income stream do you think should be selected by the public management agency?

Circle your selected income stream A B C D E

c. If the answers in questions a. and b. are different please explain why.

_____

2. Now assume that your group has been given a farm which produces wheat and supplies each of you with the same dividend streams as in Part 1.

a. Based upon your group's relative valuation of current versus future returns, select the income stream that would be preferred by your group, the private owners and managers of the farm.

Circle your selected income stream A B C D E

b. Now assume that this farm is not owned by your group. It is a public resource and is managed by Alberta Agriculture. Which income stream do you think should be selected by the public management agency?

Circle your selected income stream A B C D E

c. If the answers in questions a. and b. are different please explain why.

_____

3. What faculties are you enrolled in ?

_____

4. Please indicate the number of males and females in your group.
_____ MALES _____ FEMALES

Table 2

Year	Option A	Option B	Option C	Option D	Option E
1	10000	10000	9500	15000	10000
10	10780	9217	12630	14190	10000
20	10950	9054	13290	11390	10000
30	10240	9761	10460	6590	10000
40	9312	10690	6749	0	10000
50	9018	10980	5570	0	10000
60	9626	10370	8004	0	10000
70	10580	9422	11810	0	10000
80	11000	9001	13500	0	10000
90	10500	9499	11500	0	10000
100	9542	10460	7670	0	10000
150	10720	9277	12390	0	10000
200	10870	9132	12970	0	10000
250	9769	10230	8577	0	10000
300	9002	11000	5506	0	10000
400	10810	9192	12730	0	10000
500	9643	10360	8070	0	10000
600	9792	10210	8667	0	10000
700	10710	9293	12330	0	10000
800	9022	10980	5588	0	10000
900	10930	9066	13240	0	10000
1000	9410	10590	7410	0	10000