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Gender and Affect in Intertemporal Choice

by

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Abstract

Individuals discount future costs and benefits in a manner consistent with their rate of impatience. Empirically, the actions of decision-makers reflect the underweighting of future events. The present study is centered on the measurement of individual discount rates. In a series of laboratory experiments, individual discount rates were elicited and the effects of affect, gender and age on discounting were measured. Age and an interaction term between gender and affect were shown to contribute significantly to explaining the variation in discount rates. In the same experiments, subjects were also asked to predict the discount rates of third parties described by demographic information (age and gender). Using this technique, significant gender stereotypes regarding intertemporal discounting are identified. Further, an investigation of dynamic consistency is conducted.

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Chapter 1

Introduction

There are those who plan, save and invest for the future, and there are those who do not. Those in the latter category may jeopardize their well-being through welfare-reducing choices in areas such as health care, education and retirement planning. Anywhere that an individual makes a decision involving intertemporal choice, discounting future costs and benefits has the potential to lead the individual to inferior outcomes. It is highly likely that in a tradeoff between consumption today and saving for retirement, discounting will sway the individual towards consumption today. In areas such as health care and education discounting the future can lead individuals to choose sub-optimal investments in future health and earning power.

Choice over time has been approached in theoretical and empirical economics in the past. Neoclassical economic theory assumes that people do not measure future costs and benefits the same way they measure present costs and benefits. That is, individuals discount future costs and benefits in a manner consistent with their rate of impatience. Empirically, the actions of decision-makers reflect the underweighting of future events. People will give up future time, money and other sources of utility to obtain utility in the present. However, individuals' perceptions of and decision making regarding future events is varied and complex. Rates of discounting vary between individuals, and it is not uncommon for one individual to have various discount rates for different choices, depending on the choice and the way it is framed (e.g. discounting losses differently than gains).

A recent example of where a better understanding of intertemporal choice may assist policy design is video poker gambling in Australia (CBC, 2004). Problem gambling itself is a perfect example of an intertemporal choice issue: To many, the gains of playing the game in the present outweigh the costs of financial challenges in the future. Apparently, video poker machines in Australia are becoming a big problem, especially for women. Numerous examples of impulsive behavior on the part of women in the country, including stealing, violent crime, and murder have been tied to gambling addictions.

A deeper understanding of how people discount the future would be invaluable to informing policy in many areas, including those mentioned above. Therefore, it is essential to understand the decision processes behind such choices. To this end, the following research explores decision making in an intertemporal context.

The research outlined in this thesis was directed at a number of questions regarding intertemporal choice. The experiment was conducted over an eight week period with a group of 60 participants who returned bi-weekly and had their discount rates measured. Of primary interest were the effects of age, gender and affect[1] on intertemporal choice. I find that both gender and an interaction effect between gender and affect had an influence on discount rates. In particular, males had significantly higher discount rates overall, females primed with negative affect were shown to be more impulsive and males primed with negative affect were shown to be less impulsive.

Of secondary concern was identifying stereotypes regarding intertemporal choice. Interestingly, some inferences identified in the data are supportive of popular stereo-

[1] In this context, the word 'affect' is interchangeable with 'mood'.

types regarding discount rates. I find that participants expected younger people to have higher discount rates, while males an females were divided on the difference in discount rates between genders.

Further, given the long-term aspect of the experiment, questions regarding dynamic consistency can also be addressed using the data. That is, I was able to look at how rates of discount over a specified time period change as that time period approaches. The results indicate that individuals tend towards dynamic inconsistency.

The paper is organized as follows: Chapter 2 surveys the relevant literature, both theoretical and empirical. Chapter 3 presents the experiment, the hypotheses of interest, and the econometric issues in the data. The results from the econometric analysis of the data are reported in Chapter 4 on a hypothesis-by-hypothesis basis. Chapter 5 concludes.

Chapter 2

Literature Review

The purpose of this chapter is to review the economic research in intertemporal decision making related to the present experiment. I begin with basic theories of decision making over time, expanding to more recent theoretical developments. Next, applied work in this area is covered in order to give the reader an idea of where the present research fits in to the current literature.

2.1 Economic Theories of Intertemporal Choice

Early Accomplishments

A complete history of the study of intertemporal discounting is provided by Frederick, Loewenstein and O'Donoghue (2003). According to the authors, economists have been interested in how people (and even nations) discount the future since the beginning of the discipline. Originally, Smith (1776) cited intertemporal discounting as a determinant of national wealth, a subject which Rae later expanded on in 1834. The subject was picked up by numerous economists thereafter, culminating with Samuelson's idea of discounted utility (1937).

Samuelson proposed the following utility function:

$$U_\tau = \sum_{t=\tau}^{T} u(x_t)e^{-\pi t} \tag{2.1}$$

where $\pi = \log e(I + p)$, p is the rate of discount, τ represents the current period,

$u(x_t)$ represents the instantaneous utility function at time t and (x_t) is the amount of consumption at time t (Samuelson, 1937). Note that the rate of discount is the rate at which an individual discounts the future: a dollar tomorrow is valued less than a dollar today by an amount proportional to the discount rate.

According to this utility function, an individual is dynamically consistent (i.e. has a consistent discount rate). As a result, once an individual has made a consumption plan in period t, $(x_t,\ x_{t+1},\ x_{t+2},\ldots)$, they will not revise the consumption plan in any future period (ceteris paribus). For a closer look at dynamic consistency, note that the constrained maximization of utility over time requires equating discounted marginal utilities.

The marginal utility of consumption in period t is:

$$\frac{\partial U_\tau}{\partial x_t} = u'(x_t)e^{(\pi-r)t} \tag{2.2}$$

where r can be seen as the market interest rate.

The marginal utility of consumption in period $t+1$ is:

$$\frac{\partial U_\tau}{\partial x_{t+1}} = u'(x_{t+1})e^{(\pi-r)(t+1)} \tag{2.3}$$

Equating the above marginal utilities, we get:

$$\frac{\partial U_\tau}{\partial x_t} = u'(x_t)e^{(\pi-r)t} = u'(x_{t+1})e^{(\pi-r)(t+1)} = \frac{\partial U_\tau}{\partial x_{t+1}} \tag{2.4}$$

This can be re-written as:

$$u'(x_t) = u'(x_{t+1})e^{(\pi-r)} \tag{2.5}$$

Consecutive time periods differ by the discount factor $e^{(\pi-\tau)}$, which is invariant with respect to time. This invariance reflects dynamic consistency: The way an individual applies the rate of discount does not vary as the current time period changes, resulting in the individual's optimal decision path remaining unchanged over time.

Thereafter, discounted utility became the main vehicle for economists incorporating intertemporal choice into economic analysis. Unfortunately, the popularity of the discounted utility model was due to its simplicity, not its validity (Frederick et al., 2003). Discounted utility fails to reflect many empirical findings. For instance, individuals have been found to discount different choices at different rates, varying their discounting when faced with different sums of money, different time frames, and gains versus losses (Frederick et al., 2003). As expected, a model where one discount rate can describe every choice that a person makes lacks empirical validity.

The more realistic concept of present-biased preferences was developed by Strotz (1956). Present-biased preferences stem from the idea that instead of using a constant discount rate over time (as in the case of exponential discounting in equation 2.4), it is more intuitive to think of people weighting events more highly as they move closer in time (Strotz, 1956). Strotz' model incorporated a utility function with two important features: (i) dates were more heavily weighted as they approached in time, and (ii) there was a separate weighting for the inherent importance of a date (e.g. a birthday). The utility function proposed is along these lines:

$$U_\tau = \sum_{t=0}^{T} u[x_t, t]\lambda(t-\tau) \tag{2.6}$$

where $u[x_t, t]$ is the utility of consumption at time t and $\lambda(t-\tau)$ is the weighted discount function.

A direct implication of this model is that as preferences change over each period (due to changes in the weighting of upcoming events), individuals' optimal consumption paths change. That is, any one plan is only followed for one period. As such, this model highlights dynamic inconsistency: an optimal path in one period ceases to be optimal in the next due to the fact that the discount rate applied to any one period changes over time. Maximization in time $\tau = 0$ results in the following relation of discounted marginal utilities for time periods t and $t+1$:

$$\frac{\partial U_{\tau=0}}{\partial x_t} = u'[x_t, t]\lambda(t-0) = u'[x_{t+1}, t+1]\lambda(t+1-0) = \frac{\partial U_{\tau=0}}{\partial x_{t+1}} \tag{2.7}$$

where u' is the derivative of the utility function with respect to consumption.

This may be written as:

$$\frac{\lambda(t-0)}{\lambda(t+1-0)} = \frac{u'[x_{t+1}, t+1]}{u'[x_t, t]} \tag{2.8}$$

Maximization in time $\tau \neq 0$ results in the following relation of discounted marginal utilities for time periods t and $t+1$:

$$\frac{\partial U_{\tau}}{\partial x_t} = u'[x_t, t]\lambda(t-\tau) = u'[x_{t+1}, t+1]\lambda(t+1-\tau) = \frac{\partial U_{\tau}}{\partial x_{t+1}} \tag{2.9}$$

This may be written as:

$$\frac{\lambda(t-\tau)}{\lambda(t+1-\tau)} = \frac{u'[x_{t+1}, t+1]}{u'[x_t, t]} \tag{2.10}$$

It is apparent that while both $\frac{\lambda(t-0)}{\lambda(t+1-0)}$ and $\frac{\lambda(t-\tau)}{\lambda(t+1-\tau)}$ are equal to the marginal rate of substitution between periods, it is not necessary that the marginal rates of substitution be constant as the discount function may have shifted. Equality of marginal rates of substitution will only hold in the special case of an individual having a constant rate of discounting, whereby the optimal path will be stayed (Strotz, 1956). Mathematically, this special case is be represented by $\lambda(t-\tau) = k^{t-\tau}$, where k is a constant.[1] In the instance that this equality does not hold, this model shows dynamic inconsistency – the relative weights assigned to the marginal utilities in future periods will change as the time period changes, resulting in variance of the optimal path.

Individuals may or may not recognize that they have present-biased preferences. However, upon their recognition, Strotz (1956) suggested two coping strategies. First, individuals may use precommitment devices (e.g. a penalty) to help them to stay on their original path, making it costly to deviate from this path in the future. Second, individuals may compensate for an expected deviation in the future by making changes to their path today.

2.2 Economic Theories of Intertemporal Choice Modern Developments

O'Donoghue and Rabin (1999) build on early attempts to model present-biased preferences by making two important distinctions. First, they distinguish between immediate rewards (which are pleasant and "rushed") and immediate costs (which are unpleasant and procrastinated). Second, they make a distinction between sophisticated agents (who predict their present-biases) and naive agents (who do not predict

[1]This special case would be consistent with a general version of equation 2.4.

their present-biases). Their model can be represented by the following:

$$U_t = \sigma^t u_t + \beta \sum_{\tau=t+1}^{T} \sigma^\tau u_\tau \tag{2.11}$$

where β represents the present-bias ($1 \geq \beta > 0$) and σ is a time-consistent discount rate.[2] Put simply, the individual weights the present more heavily than the future, but discounts all future time periods consistently. For instance, at time t, the individual's discounted marginal utilities for periods $t+1$ and $t+2$ are equated as follows:

$$\frac{\partial U_t}{\partial x_{t+1}} = \beta\sigma^{t+1}u'_{t+1} = \beta\sigma^{t+2}u'_{t+2} = \frac{\partial U_t}{\partial x_{t+2}} \tag{2.12}$$

where, as in the traditional model, the only difference between the two periods is the factor σ. However, when the above discounted marginal utilities are evaluated at time $t+1$, the equality becomes:

$$\frac{\partial U_{t+1}}{\partial x_{t+1}} = \sigma^{t+1}u'_{t+1} = \beta\sigma^{t+2}u'_{t+2} = \frac{\partial U_{t+1}}{\partial x_{t+2}} \tag{2.13}$$

The present-bias emerges through the two discounted marginal utilities now differing by $\beta\sigma$. That is, an individual will view a choice between March 1 and 2 differently depending on whether the choice is being made on February 1 (when the rate of discount between the dates is σ) or March 1 (when the rate of discount between the dates is $\beta\sigma$).

The results of the model provide a number of insights into behavior. First, sophisticated agents may partially negate the effects of their present-bias under certain

[2] Note that if $\beta = 1$, this equation represents exponential discounting consistent with equation 2.4.

circumstances. Knowing their tendency for present-biased preferences, sophisticated agents partially compensate for this. For example, sophisticated agents may limit their choice set to prevent themselves from deviating from their long-run optimum (e.g. signing up for automatic RRSP contributions). Interestingly, for both rewards and costs, the model predicts that naive agents will never choose to undertake an activity before sophisticated agents. In the case of rewards, sophisticates understand that they will eventually give in to temptation and so may not try to resist at all. In the case of costs, sophisticates are able to predict self-control problems in the future and so undertake the task sooner. Naive agents' incorrect beliefs about themselves will lead them to put off rewards (believing that they will be able to wait) and put off costs (believing that they will undertake the task in the next period).

Second, rewards and costs have different welfare effects for different types of agents.[3] When presented with immediate costs, the welfare losses associated with choices made by naive agents are greater than those associated with a sophisticated agent's choices. This follows from the finding that a naif will never undertake an activity before a sophisticate. Welfare losses accrue because of repeated decisions by the naive agents to procrastinate 'one more day,' while sophisticated agents are able to make the decision to procrastinate only once. That is, the welfare losses associated with procrastination are only felt once for the sophisticate, but tend build into a much larger aggregate loss for the naif. However, when looking at immediate rewards, this relationship can be reversed. Sophisticates' tendency not to resist temptation will result in a larger number of small welfare losses (a loss in each period) whereas naifs will only resist until a certain point. Most importantly, the authors stress that even

[3]The measure of welfare the authors use is long-run utility.

a small degree of present biased discounting (via β) can lead to a large amount of procrastination and, as such, large welfare losses.

O'Donoghue and Rabin (2001) continue this line of research, introducing a model of procrastination in a multiple task setting.[4] In this model, an agent may choose among a menu of activities, all of which involve incurring a cost in the current period and receiving future benefits. When an agent chooses to procrastinate, they do so because they wish to delay this current cost. As such, there are two types of decisions that the agent must make: (i) which task to undertake and (ii) when to undertake the chosen task. When faced with the first decision, the agent will choose the task yielding the greatest future benefits. When faced with the second decision, the agent will weigh the costs and benefits of delaying the task, possibly choosing to procrastinate until a future period.

The model makes two main predictions. First, the presence of a new option may increase procrastination (and, in extreme cases, produce no action whatsoever). That is, given that the new task is more desirable than an initially chosen task (i.e. of greater future benefit), the new task should be chosen by the agent. However, if the cost of the new task is significant, the agent may choose to procrastinate even more than they would have with the initial task.

Secondly, the more important a task is to an agent, the more likely that the agent will choose to procrastinate. Given that more important goals usually require more effort, the costs of completing the task are usually higher and yield greater procrastination (O'Donohue and Rabin, 2001).

Laibson (1997) also examines time inconsistent preferences, focusing on the con-

[4]The utility function used in this analysis is identical to equation 2.11.

sumption pattern of an agent whose income in each period depends on their asset holdings. In this model there are two types of assets: liquid assets (agents can sell the assets to receive funds within the period) and illiquid assets (agents can borrow against the assets to receive funds in the following period). In each period the agent chooses the share of liquid and illiquid assets to hold in the following period. This choice gives the agent the option of strategically constraining future choices in order to regulate their future selves (i.e. the agent is able to compensate for the long-run welfare-reducing effects of discounting). Laibson uses a utility function of the following form:

$$U_t = E_t[u(x_t) + \beta \sum_{\tau=1}^{T-t} \sigma^{\tau} u(x_{t+\tau})] \tag{2.14}$$

where $E_t[\cdot]$ is the expectations operator. As in the analysis of O'Donoghue and Rabin (1999), the preferences in equation 2.14 also display dynamic inconsistency.

Using this model, Laibson offers an explanation as to why consumption paths follow income patterns so closely: an agent in $t-1$ chooses an investment in illiquid assets to constrain her consumption in time t . As such, consumption will be closely related to income in each period. Laibson's model also explains capital accumulation despite income-consumption co-movement. Because the share of illiquid assets the agent holds at time t is fixed, the only tradeoff entering the agent's decision calculus at time t is consumption in all future periods. It follows that discounting enters the decision to invest in illiquid assets (e.g. capital) less prominently. An interesting argument that arises from this model is that the decrease in savings rates in the United States in recent decades could be due to financial innovation (specifically, instantaneous credit). The existence of instantaneous credit effectively increases liquidity, thereby decreasing the effectiveness of illiquid assets as constraints on consumption (Laibson, 1997).

Loewenstein and Prelec (1992) draw parallels between flaws in the discounted utility model proposed by Samuelson (1937) and flaws in the expected utility model. However, while the empirical illustrations of flaws in the expected utility model are often times complicated, empirics have found that the discounted utility model is violated in a number of relatively simple ways. Studies have shown that behavior is dynamically inconsistent, small payoffs are discounted more than large payoffs, gains are discounted more than losses, and delays are weighted more than accelerations. As Kahneman and Tversky (1979) incorporated the anomalies of the expected utility model into prospect theory, Loewenstein and Prelec incorporate these intertemporal choice anomalies into a new model:

$$U_\tau = \sum_{t=\tau}^{T} v(x_t)\phi(t_t) \tag{2.15}$$

where $\phi(t) = (1+\alpha t)^{\beta\alpha}$, $\alpha\beta > 0$, is the discount function consistent with hyperbolic discounting.[5] The function $v(x_t)$ incorporates the idea that agents see outcomes as deviations from a reference point (i.e. the status quo) and that agents are loss averse (the value function is steeper for losses). Further, the gains component of the value function has a higher elasticity than the losses component and the value function is more elastic the larger the payoff.

The authors draw a number of conclusions from this model. A person whose preferences are consistent with the above model would show a range of discount rates for one situation, depending on how it is presented or framed. For example, a person

[5]Note that as α approaches zero, the discount function is equivalent to that of equation 2.4.

is expected to discount borrowing (a current benefit with future costs) more than saving (a current cost with future benefits). As well, the discount rate an individual attaches to rushing gains and procrastinating losses is greater than that of procrastinating gains and rushing losses. The reference point itself is important in that it may be comprised of an individual's expectations. Therefore, actual losses or gains are measured relative to what was expected. With respect to the optimal consumption path, this model predicts that people's consumption will be more heavily weighted to the short and long run, with less weighting in the medium run. However, given that this plan is dynamically inconsistent, constant re-optimization will result in a short-run bias.

2.3 Experimental Findings in Economics

Frederick et al. (2003) detail the assumptions needed to properly measure intertemporal discounting. The assumptions, as noted in their paper, are as follows:

1. All utility from each payoff must be gained the instant the payoff is received.
2. Individuals do not weigh outside options in financial markets.
3. The utility function is linear.
4. Individuals are not skeptical about receiving the payoff.
5. Individuals do not calculate inflation into their choices.
6. Individuals have constant utility functions.

7. Individuals lack projection bias.[6]

There are a number of examples of experimental elicitation of discount rates in the economic literature. Among the most thorough is a series of experiments by Coller and Williams (1999), whose sole focus is on the methodology of extracting economically valid discount rates. They note that past empirical studies agree on two findings: zero support for the discounted utility model (equation 2.4) and high discount rates relative to market interest rates.

Coller and Williams (1999) use a well-known procedure for eliciting discount rates. Each individual is given a number of choices between \$500 in one month and $\$500 + x$ in three months, where the implied discount rate varies from 2% to 100%. Each individual's rate of time preference is calculated at the point where the individual is indifferent between the two options. The authors deviate from previous studies by including information on current market interest rates and the interest rates implied by each choice. This was done to control for outside influences and arbitrage. In this experiment, choices were incentive compatible as participants were informed that there was a probability (approximately 2.9%) they would receive their chosen option. In the end, the paper finds that reported discount rates become smaller with the inclusion of information on interest rates. The authors believe that this may be due to individuals' awareness of arbitrage opportunities when making decisions about discounting. Among other things, the authors find that both gender and race are significant determinants of individuals' discount rates.[7]

[6]Projection bias is the observation that agents mis-predict their own future utility by incorrectly assuming that their current preferences will remain stable in the future (Loewenstein et al., 2003).

[7]Specifically, they find that males exhibit higher discount rates than females and non-whites show much higher discount rates than whites.

Harrison, Lau and Williams (2001) use the same method, analyzing how discount rates differ across households and time horizons. They find evidence that discount rates differ significantly across households, but not over time horizons.[8]

Chesson and Viscusi (2000) take the study of time preference one step further, looking at measures of risk together with a measure of the discount rate. That is, they incorporate risk into their variable of interest, and measure the resulting discount rate. Significantly lower discount rates were found for smokers, low income individuals, younger individuals, and those with relatively less education. Many of these results are remarkable, given the casual characterization of smokers and the young as more impulsive.

2.4 Affect and Decision Making

Previously absent from economic literature, the effects of visceral factors on behavior are explored by Loewenstein (1996).[9] He points out that visceral factors (e.g. hunger, pain) are separate from tastes in a number of ways. For example, an individual's environment can influence visceral factors; visceral factors are often fleeting; how the human brain deals with visceral factors is unique. Loewenstein's concern is in how visceral factors influence, and even dominate, decision making.

Visceral factors are incorporated into decision theory in the following way:

[8]Differences across households were attributed to differing demographic characteristics: Gender had no apparent effect on discount rate, but age did in that the older the respondent, the smaller the discount rate. With respect to time, the authors find that over the three years studied, each households' discount rates do not appear to change.

[9]Loewentstein defines drive states, moods, emotions, and pain as visceral factors.

$$U_\tau = \sum_{t=\tau}^{T} u(v_1(x_{t1}, \alpha_{t1}, t), ..., v_n(x_{tn}, \alpha_{tn}, t)) \tag{2.16}$$

where $v_k(.)$ is the value of consuming good $k \in \{1 \ldots n\}$ when experiencing visceral factor α_k. For example, $v_k(.)$ could be the value in period t of consuming a donut, x_{tk}, given a certain level of hunger, α_{tk}. The model suggests that current visceral factors can be excessively involved in the decision making process and individuals may underestimate the effect of visceral factors on future and past behavior (Loewenstein et al., 2000).[10] For example, a pregnant woman may choose pre-labor to forgo anesthetic, yet change her mind when actually experiencing the pain of labor. As well, a prisoner may have trouble recalling why he felt so compelled to confess during past questioning since he may underestimate the effect of visceral factors during questioning.

Specific to discounting, this model accounts for the fact that discount factors can be context-specific. That is, people will weight current visceral factors more heavily than future ones. Thus, these factors may influence decisions regarding the future despite the fact that these factors may not be present in the future (Loewenstein, 1996).

C. Monica Capra (2004) studies affect and decision making in dictator, ultimatum and trust games. After first inducing mood through memory elicitation or feelings of success or failure, Capra looks at decisions made in these games. Those in good moods were found to be more helpful, more strategic, less trustworthy and gave lower offers. This is evidence that affect has influence over decision making, even in an experimental context.

[10]This is related to projection bias in decision making.

2.5 Evidence from Neuropsychology

Much research in psychology has centered on the relationship between affect and cognition. There is a great deal of evidence in the neuropsychology literature drawing ties between affect and intertemporal choice. Most recently, Manuch et al. (2003) relayed evidence on the neuroscience and brain chemistry behind intertemporal choice. Evidence centered on the functioning of the prefrontal cortex associated with planning, working memory, temporality, attention, and impulsive behavior. Of particular interest is the ventromedial prefrontal cortex, responsible for emotion. The authors cite evidence that the improper functioning of the prefrontal cortex, particularly with respect to emotion, has been linked to sub-optimal intertemporal decision making in both humans and animals. Specifically, prefrontal patients are more impulsive, even when confronted with much less appealing rewards (Manuch et al, 2003).

In other studies, the neurotransmitter serotonin appears to be highly influential in the prefrontal cortex, and relatedly, intertemporal decision making. Sub-optimal serotonin regulation has been linked to suicidal behavior (the authors note the impulsive nature of suicide) and aggression (also related to impulsiveness). In these and other studies, serotonergic activity has been connected to the inhibition of impulsion. Specifically, using the Barratt Impulsiveness Scale (see Patton et al., 1995) researchers were able to find a negative correlation between a measure of impulsivity and serotonergic activity. In addition, strong correlations were found between the Barratt Scale and certain alleles linked to serotonin (Manuch et al, 2003).

In the search for ties between serotonin and intertemporal choice, experimenters have found that the administration of serotonin reuptake inhibitors (enhancing serotonergic activity) in rats increases their preference for delayed rewards, while drugs that inhibit serotonergic activity have been shown to have the opposite effect (see Manuch et al, 2003).[11]

Recently, ideas from neuropsychology have been directly combined with behavioral economics. Researchers used magnetic resonance imaging to look at brain activity while subjects played ultimatum games (Sanfey et al., 2003).[12] When subjects were given a low offer, heightened activity in certain areas of the brain reflected the triggering of negative emotions. As well, the more responsive such brain activity was to the low offer, the more likely the subject rejected the offer. These findings provide neural evidence linking emotions to economic decision-making.

2.6 Gender and Decision Making

A number of articles point to gender differences in decision making. Eckel and Grossman (forthcoming) note that past experiments have differed in the interactions of risk and other incentives with the decision environment, so it is hard to find consistency in their results. Specifically, there is substantial variation regarding the effects of gender in public goods games. However, consistent results arise in ultimatum games (the literature finds no gender difference regarding offers) and stylized dictator games (overall, women were found to be more generous than men).

Given the symmetries between theories of intertemporal decision making and decision making under uncertainty, Eckel and Grossman (2002) report findings from

[11]The authors note that among neurochemical processes serotonin is not alone in its influence over intertemporal choice.

[12]For a complete description of the ultimatum game, see Camerer (2003).

an experiment in which participants were first tested for their own risk aversion and then asked to predict the risk aversion of others. The authors find that the risk aversion of women was higher than that of men. Further, while individuals often overestimate the risk aversion of others, this problem was more pronounced when participants were estimating the risk aversion of women.

Chapter 3

The Experiment and Hypotheses

The following outlines my experiment in intertemporal choice. Given the findings mentioned in the previous chapter, a number of interesting questions can be addressed using my data. This chapter describes my experiment, lays out my hypotheses, and addresses my assumptions.

3.1 Experimental Protocol

The present study focuses on the measurement of individual discount rates in order to explore certain aspects of intertemporal choice. Experiments were conducted at the University of Calgary's Behavioral and Experimental Economics Laboratory using participants from the undergraduate student body at the university. The experiments were conducted over a computer network and programmed in Z-Tree (Fischbacher, 1999). In order to enrich the data set, I designed the experiment so that each participant would return every two weeks to participate in a new session, for a total of four sessions.[1] I have up to four sets of observations over seven weeks for each participant (after incomplete answers were removed, this left 259 observations in all).[2]

Each session began with copies of the consent form and instructions being dis-

[1]Repeated observations on each participant controls for unobserved heterogeneity as well helping to collect evidence on dynamic consistency.

[2]The average age of participants was approximately 20, and the gender distribution was 40% female and 60% male.

tributed.[3] The experimenter read through both items, emphasizing that the participants were not being deceived in any way. Each experimental session consisted of five stages.

In the first stage of each session participants were asked to complete the Barratt Impulsiveness Scale. The Barratt Impulsiveness Scale (specifically, BIS-11) is a series of 30 statements of personal characteristics (see Patton et al., 1995).[4] Participants were asked to indicate the extent to which the qualities applied to them using a four-point scale ranging from rarely/never to always/almost always. The impulsiveness measure is the sum of the scores of these responses (the larger the sum, the more impulsive is the participant).

The second stage of each session consisted of a simple game. The games used over the four sessions included two dictator games, a public goods game and a stylized ultimatum game.[5] In each game roles and groups were randomly assigned and games were played only once. The purpose of using these games was that the payoffs were designed to induce feelings of success or failure. These games were chosen based on the emotive contexts that emerge from them (particularly emotions associated with negative reciprocity and having been treated unfairly).[6]

Note that it is not the games themselves that are of interest in this experiment, but the affect that results from the payoff of the game. Thus, the treatment variable

[3]Please see examples of these documents in appendices C and D.

[4]All thirty statements comprising BIS-11 are listed in appendix A.

[5]For a complete survey of these types of games see Camerer, 2003. See appendix B for a detailed description of the games used. A sample of the instructions (from one week) is provided in appendix C.

[6]There is evidence on the robustness of negative reciprocity across elicitation methods in the ultimatum game (Oxoby and McLeish, 2004). It follows that feelings of success or failure resulting from such games should be as reliable.

in the experiment concerned the reporting of payoffs. In each session, subjects were randomly assigned to either the *control treatment* or the *affect treatment.* Those participants in the affect treatment were informed of their payoff from the game before they continued with the next stage of the session. Those in the control treatment were not informed of their payoffs until after the last stage of the session.[7] The games were incentive compatible in that participants received their payoffs from the game at the end of each session.

In stages three and four, questions along the lines of those discussed in Coller and Williams (1999) and Eckel and Grossman (2002) were used to elicit individual discount rates. In stage three, participants answered a question presenting a choice between \$40 in two weeks and $\$40 + x$ in five weeks (referred to as Table A; see figure 3.1). In stage four, and a similar question was asked involving the choice between \$100 on the last day of the experiment or $\$100 + x$ five weeks thereafter (referred to as Table B; see figure 3.2). Discount rates were proxied by the place at which they ceased choosing the first payment option and began choosing the second payment option. The three-week interest rates corresponding to each payment alternative range from 2% to 30% in 2.5% increments.[8] Participants were aware that they were making decisions that resulted in real payoffs with some probability. In each session, several people were randomly chosen to receive one of their choices from Table A (in which case they were notified at the next session) and several people were randomly

[7] The payoffs of all group members were reported to each individual in the group at the same time that the individual payoff was reported. This was done so that individuals were able to compare their payoff to others in the group. If individuals' preferences included concern for inequity aversion (Fehr and Schmidt, 1999) or reciprocity (Dufwenberg and Kirchsteiger, 2003), information on others' payoffs may have intensified feelings of success or failure.

[8] One exception is the first increment, which is a 3.0% jump. The equivalent yearly interest rates range from 34.8% to 521.4%

chosen to receive one of their choices from Table B (in which case they were notified on the last day of the experiment).

While there is a three-week difference between the choices in Table A and a five-week difference between the choices in Table B, the daily interest rate for each choice is the same (e.g. the fifth choice from Table A and the fifth choice from Table B both reflect a daily interest rate of approximately 0.6%). The discount rate found using Table A is referred to as ARate, while the discount rate found using Table B is referred to as BRate. Note that the higher ARate or BRate, the higher the individual's discount rate (e.g. the more they discount the future).

Table A and Table B are directed at separate questions. The time frame of Table A remains unchanged over the entire experiment. As such, ARate is the proper dependent variable to use when looking at how consistent discount rates are over the experiment. ARate is also ideal for exploring how demographics and affect influence discount rates. The time frame of Table B moves forward by two weeks in each sequential session. Therefore, BRate can be used to look for evidence regarding dynamic consistency.

The fifth stage of each session involved the elicitation of inferred discount rates. Participants were asked to predict the discount rates of third parties described by demographic information (age and gender). Participants received information on the age and gender of four other individuals and were asked to predict these individuals' answers to a question identical to Table A. Each correct forecast earned the participant $2. The number of third parties of each gender encountered over the four sessions was approximately even, and the ages ranged from 16 through 49. The third party information used in this stage was collected during a previous unrelated

Table A:

Payoff Alternative	Payment Option A (pays amount below in 2 weeks)	Payment Option B (pays amount below in 5 weeks)	Payment Preferred (circle A or B)	
1	$40	$40.80	A	B
2	$40	$42	A	B
3	$40	$43	A	B
4	$40	$44	A	B
5	$40	$45	A	B
6	$40	$46	A	B
7	$40	$47	A	B
8	$40	$48	A	B
9	$40	$49	A	B
10	$40	$50	A	B
11	$40	$51	A	B
12	$40	$52	A	B

Figure 3.1: Table A used in the experiment.

Table B:

Payoff Alternative	Payment Option A (pays amount below on March 22)	Payment Option B (pays amount below on April 26)	Payment Preferred (circle A or B)	
1	$100	$103.33	A	B
2	$100	$108.33	A	B
3	$100	$112.50	A	B
4	$100	$116.67	A	B
5	$100	$120.83	A	B
6	$100	$125.00	A	B
7	$100	$129.17	A	B
8	$100	$133.33	A	B
9	$100	$137.50	A	B
10	$100	$141.67	A	B
11	$100	$145.83	A	B
12	$100	$150.00	A	B

Figure 3.2: Table B used in the experiment.

experiment.

At the end of each session, participants provided demographic information and were notified of their total payoff from the session. All payments were made in secret.

3.2 Hypotheses

The hypotheses formulated before designing the experiment were as follows:

Hypothesis 1 *The measure of impulsiveness elicited using the Barratt Impulsiveness Scale should be correlated with the traditional economic rate of discounting.*

As both the rate of discounting and the Barratt Impulsiveness Scale are measures of an individual's impatience, it seems reasonable that one would be reflective of the other.

Hypothesis 2 *Females will have a lower discount rate than males.*

This hypothesis is in contrast to the finding of Harrison et al. (2001) who found no apparent difference, but in support of the finding of Coller and Williams (1999). Wilson and Daly (2003) provide one possible reason for a gender difference in discount rates. They find evidence that evolutionary psychology (specifically with regards to mating and reproductive behavior) may be the cause of males having higher discount rates than women.

Hypothesis 3 *Younger people will have higher discount rates.*

This hypothesis follows the results found by Harrison et al. (2001), but contrasts with the findings of Chesson and Viscusi (2000).

Hypothesis 4 *Negative affect will induce a higher discount rate, while positive affect will induce a lower discount rate.*

This follows from the above noted neuropsychology research drawing links between emotion, serotonin, and intertemporal choice.

Hypothesis 5 *There will be an affect-sensitivity difference between genders.*

This hypothesis follows partially from the research of Eckel and Grossman (forthcoming) shedding light on general gender differences in decision-making.

Hypothesis 6 *Discounting over identical scenarios should be consistent over time.*

Specifically, this would imply that a choice made today regarding tomorrow and the same choice made tomorrow regarding the day after tomorrow would be looked at as identical (ceteris paribus).[9] This would be the result predicted by both dynamically consistent and dynamically inconsistent models of intertemporal choice.

Hypothesis 7 *Individuals exhibit dynamically inconsistent preferences.*

That is, when individuals are presented with choices over a time period that is approaching, their discount rate is expected to increase as the time period becomes sufficiently close. Evidence in support of this hypothesis yields credibility to the models of Strotz, 1956, O'Donoghue and Rabin, 1999, and others which formalize this behavior.

[9] Note that while participants return for sequential sessions every two weeks, it is impossible to control for all environmental factors that may be acting on the participants in making their decisions. However, the significance of these sorts of confounding factors should be minimized when the data set is looked at in aggregate.

Hypothesis 8 *When predicting the discount rates of other people only identified by age and gender, individuals will use age and gender stereotypes associated with time preference to make their predictions.*

This is an entirely intuitive hypothesis, based in common sense. A common stereotype of this kind are that the young are more impulsive, so the predicted discount rates of younger people are expected to be higher than that of older people. As well, a popular stereotype (also formalized in evolutionary psychology (see Wilson and Daly, 2003) is that females tend to have lower discount rates than males. As such, we may expect to see the predicted discount rates of females to be lower than those of men.

Hypothesis 9 *When predicting the discount rates of people only identified by age and gender, individuals will use their own discount rate as a reference point.*

This hypothesis stems from research showing that individuals readily use reference points in everyday decision making (see Slovic et al., 1988, and Camerer, 1995).

3.3 Frederick at al. (2003) Assumptions

Due to the need for valid discount rates, the methods used in the experiment needed to be sensitive to a number of complications. Specifically, the assumptions mentioned by Frederick et al. (2003) must hold in order for extracted rates to be valid for empirical study. These assumptions are controlled for in the following ways:

1. *All utility from each payoff must be gained the instant the payoff is received.* This is controlled for in that the payoffs were sums of money, and the intrinsic

value of the money should be felt upon delivery of the payoff.

2. *Individuals do not weigh outside options in financial markets.* Given that the discount rates we elicited (recall that our three-week rates ranged from 2% to 30%) were so much higher than market interest rates at the time (a 3% annual rate would correspond with an approximately 0.11% three-week rate), financial market arbitrage was thought not to be prevalent.

3. *The utility function is linear.* This is a more difficult assumption to make, especially given some of the intertemporal choice models discussed above. However, we may be safe to assume that participants' utility functions are linear for the ranges in Tables A and B, given that they are relatively moderate sums of money and are all positive amounts.[10]

4. *Individuals are not skeptical about actually receiving the payoff.* It was made very clear in the verbal and written instructions for each session that the participants were not being deceived in any way. Each participant received their payoff from the game stage and the inferred discount rate stage in every session. As well, the randomization process made it probable that a participant would actually receive a payoff from Table A and/or Table B. Further, many participants were aware of others who disclosed that they had been randomly selected to receive payment. This added to the credibility of receiving a payoff.

5. *Individuals do not calculate inflation into their choices.* The choices made in the experiment were over ranges of three and five weeks. It seems appropriate

[10]Research has indicated that, over small gains, utility is "almost" linear. However, over losses (of even small amounts) the utility function may be convex (see Rabin, 1998).

that inflation (targeted at around 2% per year) would be absent from agents' decision making.

6. *Individuals have constant utility functions.* The longest time frame I asked individuals to consider was 13 weeks. (The first session's Table B was a choice between \$100 in seven weeks and $\$100 + x$ in 13 weeks.) As such, it may be reasonable to assume that each individual's utility function would be relatively fixed over such a short time span.

7. *Individuals lack projection bias.* Projection bias refers to the fact that agents mis-predict their own future utility by incorrectly assuming that their current preferences will remain stable in the future. However, this experiment involves monetary payoffs, and preferences over money are usually independent of visceral factors such as hunger and thirst. Mulligan (1996) argues that the fungibility of money precludes the possibility of an associated projection bias. It follows that participants should make good predictions over their future utility as their preferences over money should remain stable.

Chapter 4

Econometric Analysis

In this section, I utilize econometric techniques to explore the hypotheses laid out in the preceding section. I begin by describing the experimental data collected and surveying the econometric and statistical issues embedded in my data. Each hypothesis is then individually analyzed using the stated procedures.

4.1 Econometric Issues

The variable ARate (the discount rate proxied by the choices in Table A of the experiment) was chosen for much of the following analysis. This was because BRate (the discount rate proxied by the choices in Table B of the experiment) was more complex (the relative time period of the choice changed each session) and the effect of affect on ARate was more salient (it was elicited immediately after affect was primed). Moreover, ARate and BRate are highly correlated (the correlation coefficient between these two measures is 0.7644). The Spearman rank correlation coefficient is 0.8203, and as such we are able to reject the null hypothesis that the two measures are independent at the 99.99% significance level.

4.1.1 ARate

In order to choose the proper procedure for this analysis, let us first look at the properties of the dependent variable, ARate. ARate is comprised of the integer values 1 through 13 (13 being the instance where the participant's discount rate was so high they failed to begin choosing payment option B). Each integer corresponds to a small interval of discount rates where the difference between each consecutive value is a constant 2.5%, excepting values 1 and 2, where the difference is 3%. The skewness and kurtosis test for normality rejects the null hypothesis that ARate is normally distributed at $p = 0.0006$. As well, the same test rejects the null hypothesis that ARate is log normally distributed at $p = 0.0004$. These results are not surprising, as it is apparent that our distribution is censored at 1 and 13.[1] That is, participants were restricted to choosing integer values between 1 and 13, despite the possibility that they may have preferred to choose a value outside of this interval (e.g. an ARate of 1 would identify anyone with a discount rate less than or equal to 2%).

Given that there is a censored dependent variable, it is appropriate to use a tobit analysis specifically designed to account for censoring on both upper and lower bounds. That is, the likelihood function used by tobit analysis combines the regular regression equation (for uncensored observations) with an enhancement based on probabilities (for the censored observations) (Greene, 2003). A regression without the added enhancement to account for censoring (e.g. ordinary least squares) would result in inconsistent estimates, where the amount of inconsistency would depend on the degree of censoring. Note that a common tobit is based on the use of a continuous dependent variable. In this case, a tobit can be used to draw conclusions about a dependent variable made up of small intervals because the intervals are small and numerous enough that they approximate a continuous variable.

The experiment also produced panel data, with up to four observations for each

[1]The censoring of the distribution may not be the only factor causing normality to be rejected.

individual. This results in unobserved fixed effects specific to each individual. If un-accounted for, these fixed effects will cause our estimates to be biased and inconsistent, as in the case of an omitted variable (Greene, 2003).[2] The tobit model in Stata (Stata command: tobit) does not include a fixed-effects package. However, an equivalent method of accounting for fixed effects is to enhance the tobit regression with dummy variables for all but one individual (and, in the case of an unbalanced panel data set, to include dummy variables for all but one time period). This is the method used for much of the econometric analysis in the next section.

4.1.2 Specification Error

Given that my choice of variables did not lead to misspecification, the sampling technique used made may well have. That is, the sample of the population of the student body of the university was not random. In order to recruit participants for the experiment, presentations were made to several undergraduate economics classes to have them sign up at the University of Calgary's Behavioral and Experimental Economics Laboratory website. As such, only those students who signed up at the website and were available at the times the experiment was run were given the option of participating. Of those given the option, there were even fewer that actually showed up for the experiment. One could think of these events as allowing for self-selection into the experiment, leading to the data set including just those students most willing and able to participate. Obviously, if the intention was to get

[2]It would be inappropriate to assume that the unobserved effects here (e.g. preferences) would not be correlated with one or more explanatory variables, like affect, but a Wald likelihood ratio test was run nonetheless. The null hypothesis that there was zero correlation between the unobserved heterogeneity and the X-matrix was rejected.

a random sample of the general population, limiting our participation to university students who were present for a presentation, signed up, had an agreeable schedule and decided to show up for the experiment may have led to sample selection bias, contaminating the results. Technically, the findings are only directly applicable to the subset of the population identified.

If the goal is to generalize the findings to the population as a whole, then the sample selection bias can be shown to be a serious specification error (Heckman, 1979). A possible remedy for selection bias involves incorporating the inverse mills ratio into the regression. However, in a circumstance such as this, the inverse mills ratio is nearly impossible to calculate, as it involves computing the probability of selection. While I cannot use an inverse mills ratio to completely account for selection bias, the fact that I am using panel data techniques (e.g. a fixed effects regression) may be an asset. According to Heckman (1979), selection bias bears a great deal of resemblance to omitted variable bias. The use of panel data techniques diminishes any potential omitted-variable bias, and as such, diminishes the effects of model misspecification due to selection bias (Burndt, 1991).

4.2 Results

4.2.1 Hypothesis 1

1 *The measure of impulsiveness elicited using the Barratt Impulsiveness Scale should be correlated with the traditional economic rate of discounting.*

The frequency of scores on the Barratt Scale are shown in Figure 4.1. A number of statistics could potentially be useful here, however due to scaling issues a correlation measure is most applicable since it is normalized (Pindyck and Rubinfeld, 1998). Using both Spearman rank and Kendall rank correlations on data from the control treatment, the null hypothesis that ARate and the Barratt measure are independent is not rejected ($p = 0.7263$ and $p = 0.8496$, respectively). The results are similar for the same tests looking at the correlation between the Barratt measure and BRate ($p = 0.3371$ and $p = 0.3315$, respectively).

One possible explanation for the lack of overall correlation is that the measured discount rates ARate and BRate were incentive compatible, whereas items on the Barratt Impulsiveness Scale were not. That is, monetary incentives behind choices over discount rates may have compelled participants to put relatively more effort into these choices, while lack of monetary incentives behind the Barratt questions may have led participants to put relatively less effort into these choices. This may have resulted in less reliable answers to the Barratt questions.

However, given that the Barratt measure is a composite of 30 different items, there is a possibility that ARate may be significantly correlated with one or more of these items. In order to measure the direct relationship between the discount rate and each Barratt item, a partial correlation coefficient was calculated between the discount rate (ARate or BRate) and the Barratt item score (controlling for the effect of affect, the significance of which will be seen later). At the .05 significance level, the statements "I act 'on impulse'", "I act on the spur of the moment", "I buy things on impulse", "I am happy-go-lucky", "I change residences", "I change jobs" and "I don't save regularly" were significantly positively correlated with ARate. Interestingly, the statement "I do not plan for job security" was significantly negatively correlated with ARate. The first six items correspond to factors that Patton, Stanford and Barratt

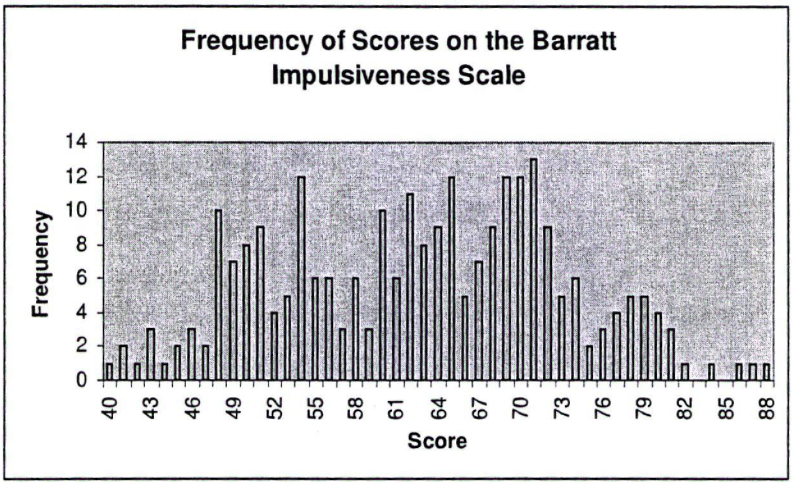

Figure 4.1: Frequency of Scores on the Barratt Impulsiveness Scale.

(1995) label "Motor Impulsiveness", referring to acting on the spur of the moment. The latter two refer to factors labelled "Non-Planning Impulsiveness".

The statements that were significantly positively correlated with BRate at the .05 level correspond to the statements "I act on the spur of the moment", "I spend or charge more than I earn", "I am happy-go-lucky", "I change jobs" and "I get easily bored when solving thought problems". In contrast, the statements "I do not plan for job security" and "I do not plan trips well ahead of time" were significantly negatively correlated with BRate. Similar to the results of ARate, the first four of the above items correspond to Motor Impulsiveness and the other three to Non-planning Impulsiveness.[3] The higher proportion of statements corresponding to Non-Planning Impulsiveness makes intuitive sense: The nature of BRate would lend itself to be more associated with planning than ARate, due to the longer-term nature of the questions.

In short, I find that the composite measure of the Barratt Impulsiveness Scale is not significantly correlated with either of the two discount rates collected in this experiment. However, several individual items from the Barratt Scale are significantly correlated with one of more of the discount rates.

4.2.2 Hypotheses 2 through 5

2 *Females will have a lower discount rate than males.*

3 *Younger people will have higher discount rates.*

4 *Negative affect will induce a higher discount rate, while positive affect will in-*

[3]No statements attributed to Attentional Impulsiveness were significantly correlated with either ARate or BRate.

duce a lower discount rate.

5 *There will be an affect-sensitivity difference between genders.*

The use of dummy variables is invaluable to modeling the effect of gender, age and affect on ARate. That is, there are a number of variables in our results that would otherwise not be quantifiable (e.g. gender, negative affect, etc.), and through the use of dummy variables on their own and in interaction terms, we are able to capture both the linear and non-linear effects of these variables (Berndt, 1991). Whether we are interested in modeling differences in averages or differences in marginal effects (e.g. the marginal effect of affect on females may be different from the marginal effect of affect on males) dictates whether we use interaction or standard dummy variables.

The model is of the following form:

$$ARate = \beta_0 + \beta_1 age + \beta_2 gender + \beta_3 poor + \beta_4 good + \beta_5 gender * poor + \beta_6 gender * good + \beta_7 session2 + \beta_8 session3 + \beta_9 session4 \quad (4.1)$$

where *age* is the age (in years) of the individual, *gender* is a dummy variable specified as 1 if the individual is female, *poor* is a dummy variable which takes the value of 1 if the individual had a poor outcome in the initial game (e.g. their income was < \$5), *good* is a dummy variable which takes the value of 1 if the individual had a good outcome in the initial game (e.g. their income was > \$6), and *gender* * *poor* and *gender* * *good* are cross-effect terms to measure the affect-sensitivity difference

	Coefficient	Standard Error	$P > \|t\|$
age	-.8667572	1.006563	0.390
gender	-6.122794	2.169556	0.005
poor	-.3540028	.6159092	0.565
good	-.9875381	.5256856	0.060
$gender * good$	1.358997	.7193472	0.059
$gender * poor$	2.556289	.9619869	0.008
Session2	-.1446991	.434928	0.739
Session3	.5222398	.4007373	0.193
Session4	-.4524853	.4382249	0.302
constant	26.16775	18.14418	0.149

Table 4.1: Regression 1 – Age, Gender and Affect in Intertemporal Choice (Pseudo R-Squared = .2236)

between genders for both positive and negative affect. The dummy variables *session2* through *session4* control for which session the observation came from in order to control for the effect of repeated experience. Data points with values $good = poor = 0$ consist of those in the control treatment as well as those in the affect treatment with payoffs ≥ 5 and ≤ 6. The marginal effects (as evaluated at the means) that result from the initial regression are reported in Table 4.1.[4] Marginal effects are reported as estimated coefficients resulting from any maximum likelihood estimator have no simple interpretation.

The variables *gender*, *good*, $gender * good$ and $gender * poor$ are all significant below the 10% significance level. The fact that *gender* is negatively related to ARate indicates that females had much lower discount rates than men. That is, females had average three-week discount rates approximately 15% lower than males (holding

[4] As a test for model misspecification, a Ramsey Reset Test was implemented by augmenting the second regression with $\hat{y}_i^2$ and $\hat{y}_i^3$ (new variables made up of the predicted values of the dependent variable). It was found that neither of these variables were significant, a sign that there was no major model misspecification. Further, an visual inspection of the errors resulting from the estimated model reflects the fact that they follow a censored normal distribution.

	Coefficient	Standard Error	$P > \|t\|$
Females			
poor	2.2022862	0.1369779	0.000
good	0.3714589	0.5853119	0.527
Males			
poor	-.3540028	0.6159092	0.566
good	-.9875381	0.5256856	0.062

Table 4.2: Pseudo-Coefficients – Gender-Specific Effects of Affect in Intertemporal Choice (ARate)

all other variables constant). Notice that this is in contrast to Patton et al. (1995) and Harrison et al. (2001) who found no significant discount rate differences between genders.

Most interesting of all of the findings is the relationship between affect and ARate. In order to understand the effects of positive and negative affect and how these effects differ between genders, pseudo-coefficients are reported in Table 4.2. For instance, for females, the effect of positive affect on ARate is the sum of *good* and *gender***good*, while for males the effect of positive affect on ARate is simply *good*.

Put simply, this says that females' discount rates are significantly negative-affect-sensitive, whereas males are not. That is, a poor result in the initial game contributed to higher discount rates in females but not in males: Given a poor result in the initial game, average female three-week discount rates increased by approximately 5.5% (holding all else constant). Further, males are significantly positive-affect-sensitive, whereas females are not. Specifically, a good result in the initial game prompted males to become less impulsive: Given a good result in the initial game, average male three-week discount rates decreased by approximately 2.5% (holding all else constant). Also of interest is the economic significance of the above pseudo-coefficients. These show that both positive and negative affect increase discount rates in females, but decrease discount rates in males. This effect is illustrated in Figure 4.2. While the trendlines in the figure do not account for censoring or control for any of the other variables in the model, it is a useful illustration of the gender-specific effects of affect on discount rates.

To summarize, significant findings here include males showing higher discount rates overall, females becoming more impulsive when primed with negative affect and males becoming less impulsive when primed with positive affect. Surprisingly, in the above analysis age lacks a significant effect on affect. Also note that the affect effects are significant in the analysis of BRate as well (see Tables 4.3 and 4.4 and Figure 4.4). This is strong evidence that these effects are robust across different discounting environments.

4.2.3 Hypothesis 6

6 *Discounting over identical scenarios should be consistent over time.*

Individuals' consecutive ARate values over the four sessions are shown in Figure 4.3. Information on the consistency of ARate is limited due to the fact that only observations from the control treatment may be used, and only those participants who were randomly selected to the control treatment in more than one section are of interest. The figure suggests that there is no pattern of inconsistency among participants.

For a more formal look at the problem, the analysis in the preceeding section is of interest. Table 4.1 offers insight into the consistency of all ARate selections over the four sessions. That none of the session dummy variables is significant indicates

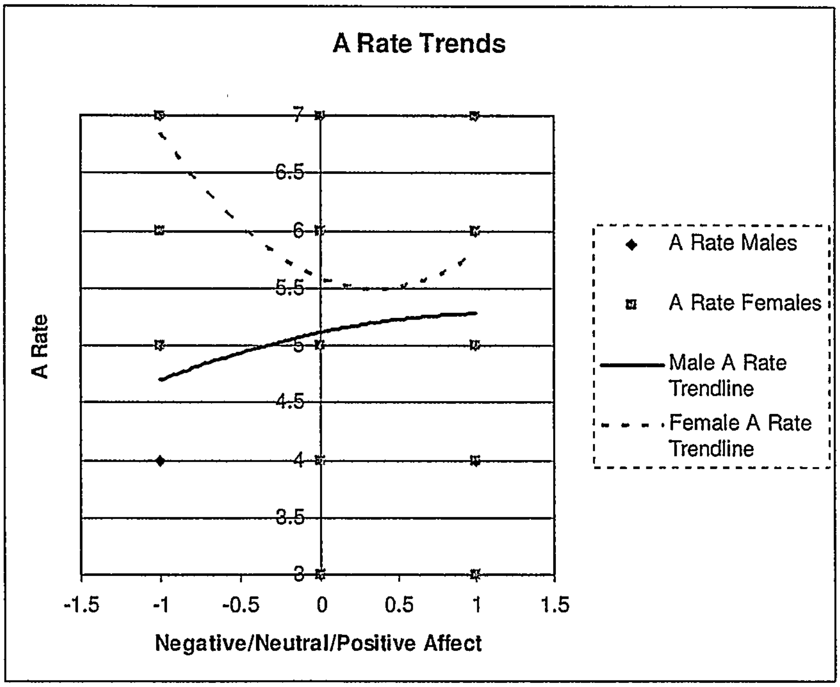

Figure 4.2: The Gender-Specific Effect of Negative Affect(-1) and Positive Affect (1) on ARate.

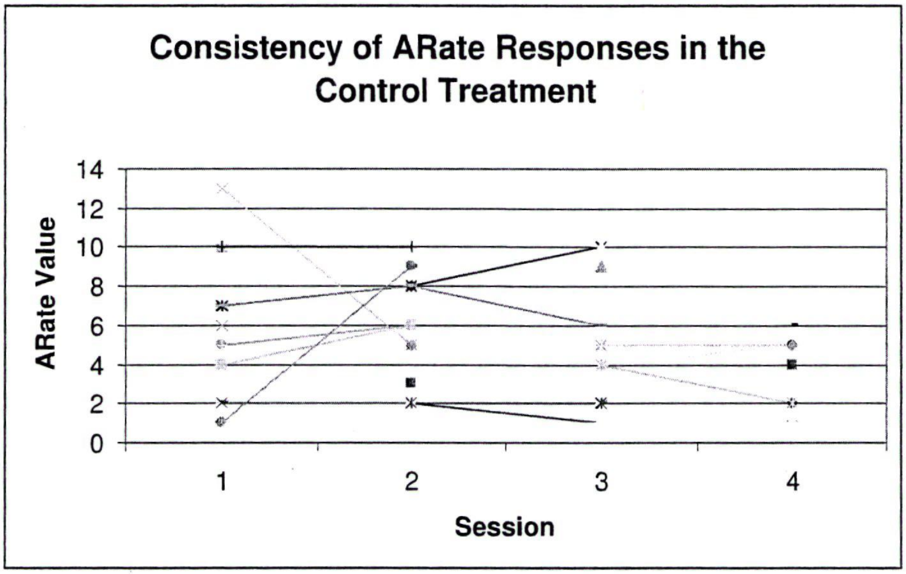

Figure 4.3: Consistency of ARate Responses in the Control Treatment.

that there was no systematic inconsistency among participants. However, note that the absence of systematic inconsistency does not equate to evidence in support of consistency. Participants may have followed some sort of 'random' inconsistency in their choices.

4.2.4 Hypothesis 7

7 *Individuals exhibit dynamically inconsistent preferences.*

Recall that Table B presented a choice between \$100 on the last day of the experiment or $\$100 + x$ five weeks thereafter. Since the time frame of Table B is approaching with the last session, BRate is the perfect variable to use when looking at dynamic inconsistency. As an initial exploration, I calculated the variance of each participant's BRate (from those with more than one observation in the control treatment).

One may expect that if present-biased preferences are prevalent, the measured discount rate of each participant from Table B would increase at some point over the four sessions. Using the same regression method as our initial regression, evidence for present-biased preferences is captured by the coefficients on the dummies for each consecutive session. The marginal effects from this regression are shown in Tables 4.3 and 4.4.

The positive coefficients on all of the session dummy variables suggest that discount rates in Sessions 2 through 4 are larger than those in Session 1. Further, the estimates for both $Session2$ and $Session3$ are significant at or below the 10% significance level. That is, when individuals encountered Table B in Session 2 and Session 3, their three-week discount rates were, on average, approximately 1.5% higher than

	Coefficient	Standard Error	$P > \|t\|$
age	-.0417802	.7985714	0.958
gender	-2.307353	1.664696	0.166
poor	-.0420139	.5093953	0.934
good	-1.215638	.4361052	0.005
$gender * good$	1.409775	.5761148	0.014
$gender * poor$	1.601185	.7771848	0.039
$Session2$	.6657488	.3623838	0.066
$Session3$	.5494181	.3320722	0.098
$Session4$	.4224653	.3498505	0.227
constant	6.026988	14.38818	0.675

Table 4.3: Regression 2 – Dynamic Inconsistency (Pseudo R-Squared = .3214)

	Coefficient	Standard Error	$P > \|t\|$
Females			
poor	1.5591711	0.6738694	0.022
good	0.194137	0.7860662	0.805
Males			
poor	-.0420139	0.5093953	0.934
good	-1.215638	0.4361052	0.006

Table 4.4: Pseudo-Coefficients – Gender-Specific Effects of Affect in Intertemporal Choice (BRate)

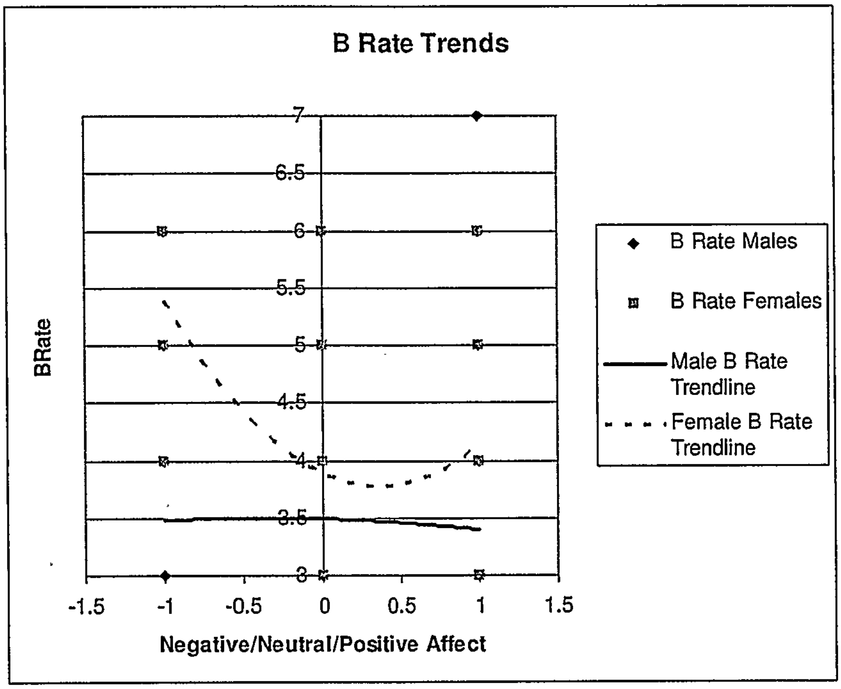

Figure 4.4: The Gender-Specific Effect of Negative Affect(-1) and Positive Affect (1) on BRate.

in Session 1 (holding all else constant). Therefore, the data shows evidence in support of the existence of present-biased or dynamically inconsistent preferences.

This result relates to what was covered in equations 2.12 and 2.13. As the individual weights the present more heavily than the future, the factor used to discount the five-week span given in Table 2 changes from σ^5 to $\beta\sigma^5$, where β implies an increase in the discount rate.

4.2.5 Hypotheses 8 and 9

8 *When predicting the discount rates of other people only identified by age and gender, individuals will use age and gender stereotypes associated with time preference to make their predictions.*

9 *When predicting the discount rates of other people only identified by age and gender, individuals will use their own discount rate as a reference point.*

Using the data from the final stage of each session, where the participants were asked to infer others' discount rates primed only with the third party's age and gender, we may be able to identify any stereotypes that exist regarding discounting. The model being estimated here is:

$$IRate = \beta_0 + \beta_1 age_j + \beta_2 gender_j + \beta_3 ARate_i \tag{4.2}$$

where IRate is the discount rate of the third party (as inferred by participant i), age_j is the age of the third party, $gender_j$ is the dummy for the gender of the third party (1 if female, 0 if male) and $ARate_i$ is the ARate of participant i in that session.[5]

[5]Note that dummy variables for all but one time period were included in the regression to

	Coefficient	Standard Error	$P > \|t\|$
age_j	-.048884	.0123445	0.000
$gender_j$	.4489225	.2844907	0.115
$ARate_i$	.3065346	.0820378	0.000
constant	7.336448	1.705216	0.000

Table 4.5: Regression 3 – Stereotypes in Intertemporal Choice (Male Participants)

	Coefficient	Standard Error	$P > \|t\|$
age_j	-.0760335	.0196707	0.000
$gender_j$	-1.000418	.4479185	0.026
$ARate_i$	.569921	.1051569	0.000
constant	4.5959	2.279965	0.044

Table 4.6: Regression 3 – Stereotypes in Intertemporal Choice (Female Participants)

The model was estimated using the same techniques as in the initial regression, however, separate regressions were run for participants of each gender. This was done to allow stereotypes across-groups to differ from stereotypes within-group. The marginal effects from the regressions are reported in Table 4.5 and Table 4.6.[6]

The estimated coefficients are, for the most part, highly significant. Similar to the stereotypes mentioned in the hypotheses, is seems that popular expectations are that younger people are more impulsive. The coefficients on gender show a large difference in the expectations of each gender regarding the difference between discount rates across genders.[7] Females expected females to have lower discount rates than males, while males expected females to have higher discount rates than males. As well, the expectation that each participant's discount rate served as a reference point from

account for the unbalanced panel set, yet remain unreported due to the fact that they lack economic significance.

[6]In order to test for model misspecification, a Ramsey Reset Test was implemented in each regression, augmenting the regression with $\hat{y}_i^2$ and $\hat{y}_i^3$. It was found that these variables were not significant, a sign that the models are correctly specified.

[7]While the coefficient on $gender_j$ in the male-specific regression is not significant at conventional levels, it is suggestive of an underlying stereotype.

which to estimate that of others is well founded: The coefficient on ARate is positive and significant in both regressions.

Chapter 5

Conclusion

In this paper, an experiment was presented that offered insight into how intertemporal choice is related to demographic characteristics, affect and stereotypes. Males were found to have higher discount rates, holding all other variables constant. This was parallel to the finding that females predicted discount rates to be higher in males, but in contrast to the finding that males predicted discount rates to be higher in females. Further, while participants predicted the young to be more impulsive, no significant result regarding age was found when looking at elicited discount rates. Of most interest were the significant gender-specific effects of affect on discounting, showing that females primed with negative affect were significantly more impulsive and males primed with positive affect were significantly less impulsive. As well, the data suggests that any sort of affect has a positive influence on females' discount rates and a negative effect on males' discount rates. Further, strong evidence is found showing dynamic inconsistency in participants' choices over time: Discount rates were shown to increase as events moved closer in time.

These results are strengthened by the fact that care has been taken to account for the statistical challenges inherent in the data. The results mentioned above are significant at conventional levels and problems regarding sample selection bias are thought to be minimized through the use of panel data techniques. It should be clear that the results are at least suggestive of the types of age, affect and gender effects at work in intertemporal decision making.

In addition to existing literature on choice over time, the insights provided by the present study may be useful for informing policy in areas such as retirement planning, education and health care. Specifically, the results here may identify those who may be most at risk for sub-optimal decision making.

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Appendix A

Barratt Scale: BIS-11

Below are the 30 personal statements of the Barratt Impulsiveness Scale as listed in Patton et al. (1995). Each is rated on a 1 (rarely/never) to 4 (always/almost always) scale. The scoring on items 4, 5, 13, 14, 15, 16, 17, 19, 20, 21, and 26 is the reverse (4 (rarely/never) to 1 (always/almost always)).

1. I "squirm" at plays or lectures.
2. I am restless at the theatre or lectures.
3. I don't "pay attention".
4. I concentrate easily.
5. I am a steady thinker.
6. I act "on impulse".
7. I act on the spur of the moment.
8. I buy things on impulse.
9. I make up my mind quickly.
10. I do things without thinking.
11. I spend or charge more than I earn.

12. I am happy-go-lucky.

13. I am a careful thinker.

14. I plan tasks carefully.

15. I am self-controlled.

16. I plan trips well ahead of time.

17. I plan for job security.

18. I say things without thinking.

19. I like to think about complex problems.

20. I like puzzles.

21. I save regularly.

22. I am more interested in the present than the future.

23. I get easily bored when solving thought problems.

24. I change residences.

25. I change jobs.

26. I am future oriented.

27. I can only think about one problem at a time.

28. I often have extraneous thoughts when thinking.

29. I have “racing” thoughts.

30. I change hobbies.

Appendix B

Description of Games

1. Week One: Dictator Game

   Participants were randomly matched into anonymous groups of two. Each participant was given the choice between three payoff options: (a) \$9 for self, \$0 for other person (b) \$5 for self, \$5 for other person (c) \$6 for self, \$2 for other person. The computer then randomly chose and implemented one of the partners' choices for each pairing.

2. Week Two: Public Goods Game

   Participants were randomly matched into anonymous groups of four. Each participant was allocated \$10, and had the option of contributing to a public fund which would pay each person in the group 0.25*the sum of all contributions within the group. That is, their payoff was \$10−their contribution + 0.25*the sum of all contributions within the group. Each participant's choice was made without knowledge of others' choices.

3. Week Three: Dictator Game

   Participants were randomly matched into anonymous groups of two. Each participant was given the choice between three payoff options: (a) \$10 for self, \$0 for other person (b) \$5 for self, \$5 for other person (c) \$6 for self, \$2 for other person. The computer then randomly chose and implemented one of the partners' choices for each pairing.

4. Week Four: Stylized Ultimatum Game

   Participants were randomly matched into anonymous groups of two. In each group there was a sender and a receiver. The sender was given $10 and chose how much of this endowment he was to share with the receiver. At the same time, the receiver indicated the minimum offer he would accept from the receiver. Both decisions were made in secret. If the actual offer was greater than or equal to the minimum acceptable offer, each player received the amount agreed upon. However, if the actual offer was less than the minimum acceptable offer, both players received nothing.

Appendix C

Participant Instructions

The following is a copy of the instructions used in public good game of week four.

Instructions for Week Two

This is an experiment in the economics of decision making. During this session you will make a number of decisions. These decisions will result in a payoff which will be paid in cash. Your payment for each session is both compensation for your time as will as for the effort you put into making your decisions.

Remember that in order to maximize your payments from the sessions, you will be required to show up for each of the four sessions. That is, only if you show up for the following session will you have a chance to collect the random payments from stages 3 and 4.

Detailed Instructions

Each session will consist of a number of stages. The stages will proceed as follows:

1. At the beginning of the session, you will be asked to complete a list of personal qualities. Please describe yourself using this list by indicating to what extent the qualities apply to you (the button on the far left corresponds with rarely/never, while the button on the far right corresponds with always/almost

always). All responses are anonymous. Please indicate, without worrying, what you really think of yourself. There is nobody on whom you need to make a good impression. Only if you answer honestly can the results be used.

2. Next, you will be randomly matched to a group of 4. Each of you will be given an endowment of 100 lab dollars (each lab dollar is equivalent to $0.05 Canadian dollars). Of this endowment, you may choose to make a contribution to a public fund (your choice of contribution must be an integer). Each person in your group will receive the same payoff from the public fund. The payoffs will be calculated as follows:

   Group Payoff = 1/4*(sum of all contributions by members of your group)

   Private Payoff = $100 - your contribution

   That is, your total payoff from this stage will consist of your private payoff (your endowment minus your contribution) as well as your group payoff (1/4*(sum of all contributions by members of your group): Total Payoff = Group Payoff + Private Payoff

   The rest of the session will be completed on an individual basis.

3. A number of choices will be presented to you where you are to indicate your preference over a sum of money in two weeks or a different sum of money in five weeks. For each choice, indicate which payment option you prefer. Several people in this session will be randomly chosen to receive one of their choices on the date specified.

4. A second set of choices will be presented to you where you are to indicate your

preference over sums of money. The choices will be between a sum of money on March 23 or a different sum of money on April 27. For each choice, indicate which option you would prefer. Several people in this session will be randomly chosen to receive one of their choices on the date specified.

5. In the next stage you will receive demographic information on four other anonymous participants. You will then be asked to forecast what you believe each of their choices were when they answered questions identical to those in stage 3. When you finish, the computer will match your forecasts with the actual answers. For each correct forecast, you will earn $2.

6. The final stage asks you to provide us with some demographic and address information. This information is confidential.

Your payment for each session will consist of the outcome of the game in stage 2 as well as your earnings from stage 5. Several people will be randomly chosen in stages 3 and 4 and notified in the next session.

Once everyone has had an opportunity to ask any final questions we will begin the session.

Appendix D

Consent Form

A copy of the consent form used is on following page.

Consent Form for Economic Experiments

This experiment studies how individuals make decisions in economic environments. This consent form, a copy of which has been given to you, is only part of the process of informed consent. It should give you the basic idea of what the research is about and what your participation will involve. If you would like more detail about something mentioned here, or information not included here, you should feel free to ask. Please take the time to read this carefully and to understand any accompanying information.

1. This research is being conducted under the supervision of Robert Oxoby, Department of Economics, University of Calgary; phone: (403) 220-2586; e-mail: oxoby@ucalgary.ca.

2. The session will last approximately 90 minutes.

3. The experimenters are not attempting to deceive me in any way.

4. During the experiment I will be asked to make a number of decisions. I will receive a cash payment based on my decisions and the decisions of those with whom I interact. I will sign a receipt for the money. The money will be paid to me in private and I can keep my earnings secret if I wish.

5. I have the right to withdraw from the experiment at any time; however, if I withdraw I will not receive payment for having participated in the experiment.

6. There are no physical or psychological risks involved in the experiment.

7. The data from this experiment will not identify me nor will information directly link me to the data.

8. The research findings will be available on request after the series of experiments has been completed and the results prepared. The data will be analyzed using standard econometric techniques and kept for at least seven years.

9. My participation in this experiment will not affect my academic standing at the University of Calgary.

Your signature on this form indicates that you have understood to your satisfaction the information regarding participation in the research project and agree to participate as a subject. In no way does this waive your legal rights nor release the investigators, sponsors, or involved institutions from their legal and professional responsibilities. You are free to withdraw from the study at any time. Your continued participation should be as informed as your initial consent, so you should feel free to ask for clarification or new information throughout your participation. If you have further questions concerning matters related to this research, please contact Robert J. Oxoby, Department of Economics, University of Calgary, phone (403) 220-2586, email oxoby@ucalgary.ca. If you have any questions or issues concerning this project that are not related to the specifics of the research, you may also contact the Research Services Office at 220-3782 and ask for Mrs. Patricia Evans.

____

Participant's Signature Date

____

Investigator and/or Delegate's Signature Date

A copy of this consent form has been given to you to keep for your records and reference.

Appendix E

Ethics Approval

A copy of the ethics approval notice is on following page.

UNIVERSITY OF CALGARY

MEMO

CONJOINT FACULTIES RESEARCH ETHICS BOARD
c/o Research Services
Room 602 Earth Science
Telephone: (403) 220-3782
Fax: (403) 289 0693
Email: plevans@ucalgary.ca
Monday, February 09, 2004

To: R.J. Oxoby
Economics

From: Dr. Janice P. Dickin, Chair
Conjoint Faculties Research Ethics Board (CFREB)

Re: **Certification of Institutional Ethics Review:** Experiments in Intertemporal Decision-Making

The above named research protocol has been granted ethical approval by the Conjoint Faculties Research Ethics Board for the University of Calgary. Enclosed are the original, and one copy, of a signed **Certification of Institutional Ethics Review**. Please note the terms and conditions that apply to your Certification. If the research is funded, the sponsor should be notified, and the original certificate sent to them for their files. The copy is for your records. The Conjoint Faculties Research Ethics Board will retain a copy of the Certification on your file.

Please note, an annual/progress/final report must be filed with the CFREB twelve months from the date on your ethics clearance. A form for this purpose has been created, and may be found on the "Ethics" website, http://www.ucalgary.ca/UofC/research/html/ethics/reports.html

In closing let me take this opportunity to wish you the best of luck in your research endeavor.

Sincerely,

Patricia Evans

Patricia Evans
Executive Secretary for:
Janice Dickin, Ph.D., LLB., Faculty of Communication and Culture and
Chair, Conjoint Faculties Research Ethics Board

Enclosures(2)
cc: Ms. K. McLeish, co-investigator

UNIVERSITY OF CALGARY

CERTIFICATION OF INSTITUTIONAL ETHICS REVIEW

This is to certify that the Conjoint Faculties Research Ethics Board at the University of Calgary has examined the following research proposal and found the proposed research involving human subjects to be in accordance with University of Calgary Guidelines and the Tri-Council Policy Statement on *"Ethical Conduct in Research Using Human Subjects"*. This form and accompanying letter constitute the Certification of Institutional Ethics Review.

File no:	**CE101-3821**
Applicant(s):	**R.J. Oxoby** Kendra McLeish
Department:	**Economics**
Project Title:	**Experiments in Intertemporal Decision-Making**
Sponsor (if applicable):	

Restrictions:

This Certification is subject to the following conditions:

1. Approval is granted only for the project and purposes described in the application.
2. Any modifications to the authorized protocol must be submitted to the Chair, Conjoint Faculties Research Ethics Board for approval.
3. A progress report must be submitted 12 months from the date of this Certification, and should provide the expected completion date for the project.
4. Written notification must be sent to the Board when the project is complete or terminated.

Janice Dickin

Janice Dickin, Ph.D, LLB,
Chair
Conjoint Faculties Research Ethics Board

6 February 2004
Date:

Distribution: (1) Applicant, (2) Supervisor (if applicable), (3) Chair, Department/Faculty Research Ethics Committee, (4) Sponsor, (5) Conjoint Faculties Research Ethics Board (6) Research Services.