

**SAVING BEHAVIOR OF U.S. HOUSEHOLDS:  
A PROSPECT THEORY APPROACH**

**DISSERTATION**

**Presented in Partial Fulfillment of the Requirements for  
the Degree Doctor of Philosophy in the Graduate  
School of the Ohio State University**

**By**

**Patricia Fisher, B.S., M.S.**

**\*\*\*\*\***

**The Ohio State University  
2006**

**Dissertation Committee**

**Dr. Catherine P. Montalto, Adviser**

**Dr. Sharon Seiling**

**Dr. Kathryn Stafford**

**Approved by**

---

**Adviser,  
College of Human Ecology**

UMI Number: 3226479



---

UMI Microform 3226479

Copyright 2006 by ProQuest Information and Learning Company.  
All rights reserved. This microform edition is protected against  
unauthorized copying under Title 17, United States Code.

---

ProQuest Information and Learning Company  
300 North Zeeb Road  
P.O. Box 1346  
Ann Arbor, MI 48106-1346

## **ABSTRACT**

The main purpose of this dissertation is to explore household saving using a prospect theory approach through the use of the loss aversion model and behavioral portfolio theory. The research begins by investigating the effect of having expected per-period income above or below the reference level as well as the effect of uncertainty on the likelihood of saving based on the loss aversion model. The focus then moves to saving motives based on the ideas of behavioral portfolio theory. The direct measure of saving available in the dataset is saving over the previous year. Saving horizon is also investigated since the saving measure is a short-term measure and some regular savers may not have saved during the past year.

The dataset used is the 2004 Survey of Consumer Finances. The sample excludes retired U.S. households for a final number of 3,694 households. Having expected per-period income above the reference level increases the likelihood of saving. Having expected per-period income below the reference level is significantly and negatively related to the likelihood of saving, and has a greater effect on the likelihood of saving than having expected per-period income above the reference. The group of uncertainty variables is significant in explaining the likelihood of saving. In contrast to the theories

reviewed, most of the uncertainty variables are not found to increase the likelihood of saving.

Saving motives and saving horizon are significant in explaining the likelihood of saving. Saving for a foreseeable expense significantly increases the likelihood of saving in both the models with and without interaction terms. Having a motive to save for the education of children or grandchildren significantly decreases the likelihood of saving in the model without interactions, while this variable is not significant when interactions are added. Inclusion of interactions of saving horizon variables with the saving motive variables is found to be significant in explaining the likelihood of saving, indicating that saving motives do differ by saving horizon.

## **ACKNOWLEDGEMENTS**

Thank you to my committee – Catherine Montalto, Sharon Seiling, Kathryn Stafford, and Jonathan Fox, for your support and for your time. I am especially grateful to Dr. Montalto for constant guidance. I would also like to acknowledge Janice Heckroth, who first convinced me to think about graduate school. Thank you to Cameron for making me smile and laugh. To my friends and family, thank you for always being there for me and telling me not to quit. I would also like to thank my mom and Jen for always trying to make my life easier.

## **VITA**

August 1, 1979 .....Born – Johnstown, Pennsylvania

2000.....B.S. Consumer Affairs, Indiana University of  
Pennsylvania

2001-present.....Graduate Teaching Associate,  
Department of Consumer Sciences,  
The Ohio State University

2003.....M.S. Family Resource Management,  
The Ohio State University

2006.....Lecturer, The Ohio State University

## **PUBLICATIONS**

Fisher, P.J., Fox, J., & Bartholomae, S. (2003, April). Measuring the impact of financial education: Challenges and pitfalls. *Consumer Interests Annual*, 49.

Hanna, S.D., Gutter, M.S., & Fisher, P.J. (2003, April). Risk aversion and the elasticity of marginal utility with respect to consumption. *Consumer Interests Annual*, 49.

## **FIELDS OF STUDY**

Major Field: Human Ecology  
Consumer Economics and Personal Finance

## TABLE OF CONTENTS

	Page
Abstract .....	ii
Acknowledgements .....	iv
Vita .....	v
List of Tables .....	ix
List of Figures .....	x
Chapters:	
1. Introduction .....	1
2. Literature Review .....	5
2.1 Theoretical Models .....	5
2.1.1 Life-Cycle/Permanent Income Hypothesis .....	6
2.1.2 Prospect Theory .....	10
2.1.2.1 Certainty, Probability, and Possibility .....	12
2.1.2.2 The Reflection Effect .....	12
2.1.2.3 Probabilistic Insurance .....	13
2.1.2.4 The Isolation Effect .....	14
2.1.2.5 Prospect Theory .....	15
2.1.3 Model of Loss Aversion and Consumption/Saving .....	22
2.1.3.1 Loss Aversion .....	23
2.1.3.2 Two-Period Model of Consumption/Saving .....	26
2.1.4 Behavioral Portfolio Theory .....	29
2.1.5 Summary of Theoretical Models .....	36
2.2 Research Questions .....	38
2.3 Review of Empirical Studies .....	39
2.3.1 Income and Consumption/Saving .....	39
2.3.2 Expected Income .....	42
2.3.3 Loss Aversion .....	43
2.3.4 Income Risk .....	46
2.3.5 Uncertainty .....	47

2.3.6 Marital Status .....	48
2.3.7 Number of Earners .....	48
2.3.8 Unemployment .....	49
2.3.9 Self-Employment .....	49
2.3.10 Health Status .....	50
2.3.11 Saving Motives .....	50
2.3.12 Control Variables .....	57
2.3.12.1 Demographic Variables .....	57
2.4 Hypotheses .....	60
3. Data and Methodology .....	63
3.1 Data and Sample .....	63
3.2 Methods .....	66
3.2.1 Descriptive Statistics .....	66
3.2.2 Logistic Regression Analysis .....	67
3.2.3 Likelihood Ratio Test .....	70
3.3 Empirical Specification .....	71
3.3.1 Empirical Model .....	71
3.3.2 Variables .....	72
3.3.3 Estimating Equations .....	81
3.3.4 Estimation and Empirical Tests .....	83
3.4 Interpretation .....	85
4. Results .....	87
4.1 Overview of the Non-Retired U.S. Household Sample .....	87
4.2 The Likelihood of Saving .....	89
4.2.1 Descriptive Statistics by Saving Horizon .....	89
4.2.1.1 Households with a Short Saving Horizon .....	89
4.2.1.2 Households with a Medium Saving Horizon .....	90
4.2.1.3 Households with a Long Saving Horizon .....	91
4.2.1.4 Comparison of Horizon Groups .....	93
4.2.2 Results of Logistic Regression .....	99
4.2.2.1 Model 1 .....	100
4.2.2.2 Model 2 .....	101
4.3 Results of Likelihood Ratio Tests .....	104
4.3.1 Likelihood Ratio Tests of Model 1 .....	104
4.3.2 Likelihood Ratio Test of Model 2 .....	106
4.4 Predicted Probabilities .....	106
4.4.1 Model 1 .....	106
4.4.2 Model 2 .....	109
4.5 Discussion of Results .....	111
5. Summary, Implications, and Limitations .....	117
5.1 Summary .....	117
5.2 Implications .....	121



5.2.1 Implications for Policymakers .....	122
5.2.2 Implications for Financial Professionals and Educators .....	123
5.3 Limitations and Conclusions.....	124
Bibliography .....	126
Appendix A.....	137
Appendix B .....	141
Appendix C .....	147

## LIST OF TABLES

Table	Page
2.1 Hypothesized effects of variables on the likelihood of saving .....	62
3.1 Empirical measure of expected per-period income .....	74
3.2 Baseline model.....	86
4.1 Descriptive statistics by saving horizon.....	92
4.2 Logistic regression of the likelihood of saving.....	103
4.3 Likelihood ratio tests.....	105
4.4 Likelihood ratio test of interaction and no interaction models .....	106
4.5 Predicted probabilities for model with no interactions .....	109
4.6 Predicted probabilities for model with interactions by horizon.....	111
4.7 Hypothesized effects of variables on the likelihood of saving and empirical results .....	116

## LIST OF FIGURES

Figure	Page
2.1 Prospect theory value function.....	19

## **CHAPTER 1**

### **INTRODUCTION**

Different theories which imply different direction of causalities have been proposed to explain household saving (Attanasio & Banks, 2001). A number of recent developments have brought the debate on the determinants of household saving to the center of the policy arena. There have been large demographic transitions in most developed countries, making many existing pay-as-you-go pension systems such as Social Security unsustainable, at least under the existing parameters. This has stimulated a debate on the adequacy of household savings for financing retirement funds. No agreement exists among economists and/or policy-makers about which is the most relevant model for describing observed household saving behavior.

From a psychological point of view, saving can be considered the result of a decision making process and to save as the act of regularly setting aside resources for a goal (Lewis, Webley, & Furnham, 1995; Wärneryd, 1999). Psychology has treated saving from a variety of points of view (Canova et al., 2005). Some have focused on the influence of personality traits, such as ability to delay gratification, self-control, risk aversion, locus of control, or time preferences (Livingstone & Lunt, 1993; Lunt &

Livingstone, 1991; Roman & Kaplan, 1995; Webley, Burlando, & Viner, 2000). Others have analyzed socio-economic variables such as age, education, and income, along with habits and attitudes (Furnham, 1985, 1999). The decision to save has been shown to involve complex psychological and socio-psychological processes, although influenced by economic factors (Furnham & Argyle, 1998).

The life-cycle model has been at the center of the academic and policy debate for nearly 50 years (Attanasio & Banks, 2001; Siegmman, 2002). At the same time, several economists have started to develop models that go beyond the permanent income and life-cycle models. Several theories have been proposed that relax one or more assumptions generally made within the life-cycle/permanent income framework (Attanasio & Banks, 2001). Prospect theory, the model of loss aversion, and behavioral portfolio theory are examples of theoretical frameworks that move away from these assumptions.

The typical economist would state that people with temporarily high income will tend to save more to compensate for lower future income, while people with temporarily low income will generally save less in anticipation of higher future income (Dynan, Skinner, & Zeldes, 2004). Even if saving rates vary with regard to lifetime income, we would expect people with high current incomes, holding other things constant, to save more than those with low current incomes (Friedman, 1957). According to the life-cycle/permanent income hypothesis, people smooth their consumption over the lifetime, even when income varies, and this consumption is based on lifetime wealth. Similarly, prospect theory and loss aversion indicate that when income is high people will be more likely to save and when income is low will be less likely to save. However, prospect

theory is not based on lifetime or permanent wealth but on a reference level of consumption.

Models based on the life-cycle/permanent income hypothesis generally state that individuals respond to good and bad news symmetrically regarding consumption decisions. According to the loss aversion model, people resist lowering consumption in response to bad news about future income, which is greater than resistance to increasing consumption in response to good news. Behavioral portfolio theory states that there is a hierarchy of need in portfolio construction. The extension to household saving would suggest that saving behavior follows a hierarchy of need.

The purpose of this study is to investigate the saving behavior of households using a loss aversion model augmented with behavioral portfolio theory. The first part of the study investigates reactions to expected income, which is based on the loss aversion model, a component of prospect theory. The effect of uncertainty on the likelihood of saving also follows from prospect theory. Part two of the study investigates saving motives and planning horizons using behavioral portfolio theory, which is based on security, potential, and aspirations from the SP/A framework and prospect theory.

This dissertation begins with a review of the literature in Chapter 2. Two models of behavior related to household saving, life-cycle saving/permanent income hypothesis and prospect theory, are reviewed followed by the loss aversion model and behavioral portfolio theory. The loss aversion model is a part of prospect theory, and behavioral portfolio theory is partly based on prospect theory, so it is important to understand the theory which these build upon. Following the theoretical review is an empirical review and presentation of the hypotheses. The empirical models and methodology are

presented in Chapter 3. Chapter 4 presents the results of the study, followed by a summary, implications, and conclusions in Chapter 5.

## **CHAPTER 2**

### **LITERATURE REVIEW**

This chapter includes three sections. First is a review of theoretical models. This first section includes a review of the life-cycle/permanent income hypothesis, commonly used to study household saving behavior, followed by a review of prospect theory, which provides a framework that moves away from standard economic assumptions and which provides background for both the loss aversion model and behavioral portfolio theory. The loss aversion model and behavioral portfolio theory follow prospect theory, after which the research questions are introduced. In the second section is a review of empirical research. The last section in this chapter includes the hypotheses.

#### **2.1 Theoretical Models**

The life-cycle/permanent income hypothesis and its extensions have taken center stage in looking at household saving behaviors for nearly 50 years (Attanasio & Banks, 2001). Many empirical studies show results that are inconsistent with the life-cycle/permanent income hypothesis (Banks, 1985), which has led to the proposal of theories which relax the assumptions of the life-cycle/permanent income hypothesis



(Attanasio & Banks, 2001). First is a discussion of the life-cycle/permanent income hypothesis, after which is a discussion of prospect theory, which concerns the behavior of decision makers who face a choice between two alternatives (Kahneman & Tversky, 1979). The loss aversion model and behavioral portfolio theory are also presented, followed by the research questions.

### **2.1.1 Life-Cycle/Permanent Income Hypothesis**

From a theoretical viewpoint, the model most frequently used in analyzing consumption and saving issues is the life-cycle/permanent income hypothesis (Guariglia, 2001). The life-cycle model of household savings behavior, grounded in expected utility theory, is generally associated with Modigliani (Modigliani & Brumbreg, 1954; Modigliani & Ando, 1957) and Friedman (1957). Modigliani and Friedman made their contributions by translating the abstract notion of an optimal consumption profile into a model that could be estimated econometrically (King, 1985). This demonstrated the empirical relevance of the separation of the consumption and income profiles, which is the principal implication of the life-cycle model. Modigliani's stress on the role of wealth in the consumption function and Friedman's concept of "permanent income" are based on the idea that current consumption is not determined primarily by current income.

Friedman's (1957) Permanent Income Hypothesis (PIH) is based on the intuition that individuals wish to smooth consumption and maintain a fairly constant standard of living even when income fluctuates over the short-run. Friedman hypothesized that individuals base consumption on a longer-term view of income, such as a notion of

lifetime wealth or wealth over a reasonably long horizon. The basic hypothesis is that individuals consume a fraction of permanent income in each period, and the average propensity to consume equals the marginal propensity to consume.

Modigliani's Life-Cycle Hypothesis is an extension of the Permanent Income Hypothesis, and provides a model of saving over the lifetime (Modigliani and Brumberg, 1954). The most simple textbook version of the life-cycle model is very simple and intuitively attractive (Attanasio & Banks, 2001). Facing a hump-shaped income profile, which rises with experience and tenure until retirement, after which there is a dramatic drop, consumption is kept either flat or slightly increasing or decreasing. The path of consumption is dependent on the relationship between the discount factor and the interest rate. In reality, consumption expenditure is much more complex.

Life-cycle theory aids in thinking about important policy questions, such as how societies should collectively provide for the increasing numbers of elderly, and how government provision interacts with private provision (Deaton, 2005). Households at different life cycle stages, with different economic and demographic characteristics, should be motivated to save or dissave depending on their practical needs and long-term financial plans (Chang, 1994).

In the first phase, pre-retirement, individuals accumulate wealth through saving and in the second phase, post-retirement, dissave (Modigliani & Brumberg, 1954; Deaton, 2005). The model's utility function states that an individual's lifetime utility is dependent on current and future consumption (Ando & Modigliani, 1963). Utility is maximized subject to the budget constraint that the present value of lifetime consumption is equal to the present value of lifetime income. Under certain assumptions, such as

perfect certainty about the future and the absence of a bequest motive, individuals totally exhaust their assets at the end of their lives. The model allows planned consumption for each future period to be written as a function of expected wealth at the time of planning, with the functional parameters being dependent upon age and tastes rather than wealth. Real consumption is a proportion of expected real wealth, which is the addition of initial assets at the planning date, current income and expected future income, which is discounted. Individuals borrow and lend in capital markets to smooth consumption given an income stream that is relatively low early and late in life, and relatively high in middle age.

Over time, the life-cycle model has been amended in many ways, and the restrictive assumptions have been relaxed. The buffer-stock extension of this model, which allows for uncertainty and is led by the precautionary motive for saving, is widely used in studies of the saving behaviors of households. According to models based on precautionary savings, precautionary motives are the only reason for impatient consumers to participate in any saving (Carroll, 2001). Consumers are impatient in the sense of wanting to borrow against future income to finance current consumption (Carroll, 2002). Along with Skinner (1988) and Kimball (1990b), Deaton (1991) assumes that consumers have a precautionary demand for saving. These precautionary motives interact with liquidity constraints because the inability to borrow when times are bad provides an additional motive for building up assets when times are good, even if consumers are impatient. The more prudent are consumers and the more uncertainty regarding income, the greater the demand for precautionary savings.

Many researchers have analyzed intertemporal consumption and saving behaviors assuming that an impatient consumer maximizes a utility function subject to an uncertain, exogenous income (Zeldes, 1989b; Deaton, 1991; Carroll, 1997; Carroll, 2001). The buffer-stock model is generated within the standard life-cycle model with minor modifications (Attanasio & Banks, 2001). With income uncertainty, the consumer wishes to hold a buffer stock of savings to counter the effects of future income shocks, due either to credit constraints (Deaton, 1991) or the convexity of marginal utility (Carroll, 1997). The convexity of marginal utility implies that future uncertainty raises the expected marginal utility of future consumption and therefore the desire to save (Ameriks, Caplin, & Leahy, 2003). Carroll (2002) shows that concavity of the consumption function implies that impatient consumers will engage in “buffer-stock” saving behavior. There will be some target level of the cash-on-hand ratio such that if cash-on-hand is greater than the target, impatience will outweigh prudence and wealth will fall. If cash-on-hand is lower than the target, the precautionary saving motive will outweigh impatience and the consumer will try to build wealth back up toward the target. The “buffering capacity” of a given level of wealth is dependent on how much lower wealth could potentially be driven in the case of a negative shock, so borrowing shifts the consumption function and wealth distribution left, without changing steady-state consumption behavior (Carroll, 2001). This was referred to by Friedman (1957) as households attempting to maximize utility by using savings as a buffer against income fluctuations. According to Gourinchas and Parker (2002), young consumers behave as buffer-stock agents, and the typical consumer switches to the life-cycle savings pattern around age 40.

### 2.1.2 Prospect Theory

Expected utility theory is widely used in looking at decision making under risk (Kahneman & Tversky, 1979). This framework has generally been accepted as a normative model of rational choice, and is widely applied as a descriptive model of economic behavior. Kahneman and Tversky (1979) describe several cases in which preferences systematically violate the axioms of expected utility theory, and argue that utility theory is not an adequate descriptive model. Kahneman and Tversky (1979) and Tversky and Kahneman (1986) argue that people treat expected gains and losses differently, in contrast to expected utility theory. In particular, people overweight prospective losses and underweight equivalent gains (Attanasio & Banks, 2001). The predictive power of prospect theory in explaining saving “puzzles” is now a significant area for empirical investigation.

Decision making under risk can be viewed as a choice between prospects or gambles (Kahneman & Tversky, 1979). A prospect  $(x_1, p_1; \dots; x_n, p_n)$  is a contract that yields outcome  $x$  with probability  $p_i$ , where  $p_1 + p_2 + \dots + p_n = 1$ . In order to simplify notation, null outcomes are omitted and  $(x, p)$  is used to denote the prospect  $(x, p; 0, 1-p)$  that yields  $x$  with probability  $p$  and 0 with probability  $1-p$ . The riskless prospect that yields  $x$  with certainty is denoted by  $x$ . These prospects are restricted with so-called objective or standard probabilities.

The application of expected utility theory to choices between prospects is based on three beliefs (Kahneman & Tversky, 1979):

- (i) Expectation:  $U(x_1, p_1; \dots; x_n, p_n) = p_1 u(x_1) + \dots + p_n u(x_n)$ .

That is, the overall utility of a prospect, denoted by  $U$ , is the expected utility of its outcomes.

- (ii) Asset Integration:  $(x_1, p_1; \dots; x_n, p_n)$  is acceptable at asset position  $w$  if and only if  $U(w + x_1, p_1; \dots; w + x_n, p_n) > u(w)$ .

That is, a prospect is acceptable if the utility resulting from integrating the prospect with an individual's assets exceeds the utility of those assets alone (Kahneman & Tversky, 1979). The domain of the utility function is final states, including one's asset position, rather than gains or losses.

Most economic applications introduce the following additional assumption:

- (iii) Risk Aversion:  $u$  is concave ( $u'' < 0$ ).

A person is risk averse if he prefers the certain prospect ( $x$ ) to any risky prospect with expected value  $x$  (Kahneman & Tversky, 1979). In expected utility theory, risk aversion is equivalent to the concavity of the utility function. Kahneman and Tversky (1979) state that risk aversion may be the best known generalization regarding risky choices. This idea led the early decision theorists of the eighteenth century to propose that utility is a concave function of money (Kahneman & Tversky, 1979), an idea that is included in research on risk aversion by Pratt (1964) and Arrow (1971). Most applications of the theory have been concerned with monetary outcomes, although the domain of the utility function is not limited to any particular set of consequences (Kahneman & Tversky, 1979).

Kahneman and Tversky (1979) demonstrate several phenomena which violate the basic tenets of expected utility theory using the responses of students and university faculty to hypothetical choice problems. The problems described are selected

illustrations of a series of effects, each of which has been observed in several problems with different outcomes and probabilities. The reliance on hypothetical choices raises questions regarding the validity of the method and generalizability of the results. However, all other methods that have been used to test utility theory also suffer from critical disadvantages.

#### **2.1.2.1 Certainty, Probability, and Possibility**

In expected utility theory, the utilities of outcomes are weighted by their probabilities. The preferences of individuals systematically violate this principle. People overweight outcomes that are considered certain relative to outcomes which are merely probable. This “certainty effect” violates the substitution axiom of expected utility theory, which asserts that if B is preferred to A, then any (probability) mixture (B, p) must be preferred to the mixture (A, p). Kahneman and Tversky (1979) provide problems demonstrating common attitudes toward risk or chance that cannot be captured by the expected utility model. The authors provide an empirical generalization concerning the manner in which the substitution axiom is violated: if (y, pq) is equivalent to (x, p) then (y, pqr) is preferred to (x, pr),  $0 < p, q, r < 1$ .

#### **2.1.2.2 The Reflection Effect**

The problems related to certainty, probability, and possibility involve preferences only between positive prospects, or prospects that involve no losses (Kahneman & Tversky, 1979). When the signs of the outcomes are reversed so that gains are replaced by losses, the preference between negative prospects is the mirror image of the preference

between positive prospects. Therefore, the reflection of prospects around 0 reverses the preference order, which is called the “reflection effect.” The reflection effect implies that risk *aversion* in the positive domain is accompanied by risk *seeking* in the negative domain. This trend was reported by Williams (1966) whose subjects were indifferent between (100, 0.65; -100, 0.35) and (0), indicating risk aversion. These subjects were also indifferent between (-200, 0.80) and (-100), indicating risk seeking. Preferences between positive prospects are inconsistent with expected utility theory. The preferences between the corresponding negative prospects violate the expectation principle in the same way. Outcomes which are obtained with certainty are overweighted relative to uncertain outcomes. The certainty effect contributes to a risk averse preference in the positive domain for a sure gain over a large gain that is merely probable. The same effect leads to a risk seeking preference for a loss that is merely probable over a smaller loss that is certain in the negative domain. The overweighting of certainty favors risk aversion in the domain of gains and risk seeking in the domain of losses. The reflection effect eliminates aversion for uncertainty or variability as an explanation of the certainty effect. It appears that certainty increases the aversiveness of losses as well as the desirability of gains.

### **2.1.2.3 Probabilistic Insurance**

The prevalence of the purchase of insurance against large and small losses has been regarded as strong evidence for the concavity of the utility function for money (Kahneman & Tversky, 1979). An examination of the relative attractiveness of various forms of insurance is not supportive of the notion that the utility function for money is



concave at all points. People often prefer insurance programs offering limited coverage with low or zero deductible over comparable policies offering higher maximal coverage with higher deductibles, which is contrary to risk aversion. Another type of insurance problem in which individual's responses are inconsistent with the concavity hypothesis may be called probabilistic insurance. Probabilistic insurance represents many forms of protective action where one pays a certain cost to reduce the probability of an undesirable event, without eliminating the event altogether. Examples of probabilistic insurance are the installation of a burglar alarm, replacement of old tires, or the decision to stop smoking. Kahneman and Tversky (1979) find evidence that individuals find probabilistic insurance to be unattractive relative to regular insurance, in contrast to expected utility theory (with a concave  $u$ ) which implies that probabilistic insurance is superior to regular insurance. The authors speculate that contingent insurance will be generally more attractive than probabilistic insurance when the probabilities of unprotected loss are equated. Therefore, two prospects equivalent in probabilities and outcomes could have different values depending on their formulation. This general phenomenon is titled by Kahneman and Tversky (1979) as "the isolation effect."

#### **2.1.2.4 The Isolation Effect**

Individuals often disregard the common components of two alternatives in order to simplify the choice (Kahneman & Tversky, 1979). This approach to problems regarding choice may produce inconsistent preferences, because a pair of prospects can be decomposed into common and distinctive components in more than one way, and different decompositions sometimes lead to different preferences. The authors

investigate two types of decision trees to demonstrate this phenomenon: standard and sequential. In the standard decision tree, the decision maker faces a choice between two risky prospects, while in the sequential form the choice is between a risky and a riskless prospect. This is accomplished by introducing a dependency between the prospects without changing either probabilities or outcomes. For example, in the sequential formulation, the event “not winning 3,000” is included in the event “not winning 4,000” while in the standard formulation the two events are independent. Thus, in the sequential formulation the outcome of winning 3,000 has a certainty advantage, while it does not in the standard formulation. This reversal of preferences due to the dependency among events violates the basic supposition of a decision-theoretical analysis that choices between prospects are determined solely by the probabilities of final states. While preferences may be altered by different representations of probabilities, choices may be altered by varying the representation of outcomes. This phenomenon suggests that the carriers of value or utility are changes of wealth, rather than final asset positions that include current wealth. This conclusion is the cornerstone of an alternative theory of risky choice, called prospect theory.

#### **2.1.2.5 Prospect Theory**

Prospect theory was developed for simple prospects with monetary outcomes and stated probabilities, but can be extended to more involved choices (Kahneman & Tversky, 1979). The theory has two phases in the choice process: an early phase of editing and a subsequent phase of evaluation. The editing phase includes a preliminary analysis of the offered prospects, which often yields a simpler representation of these

prospects. In the second phase, the edited prospects are evaluated and the prospect with the highest value is chosen. The function of the editing phase is to organize and reformulate the options in order to simplify subsequent evaluation and choice. Editing consists of the application of several operations that transform the outcomes and probabilities associated with the offered prospects. The major operations of the editing phase are: coding, combination, cancellation, simplification, and the detection of dominance.

Many anomalies of preference result from the editing of prospects, such as inconsistencies associated with the isolation effect resulting from the cancellation of common components. The preference order between prospects need not be invariant across contexts, because the same offered prospect could be edited in different ways depending on the context in which it appears. Following the editing phase, the decision maker is assumed to evaluate each edited prospect, and to choose the one of highest value. The overall value of an edited prospect,  $V$ , is expressed in terms of two scales,  $\pi$  and  $v$ .

The first scale,  $\pi$ , associates a decision weight  $\pi(p)$  with each probability, reflecting the impact of  $p$  on the overall value of the prospect. However,  $\pi$  is not a probability measure. The second scale,  $v$ , assigns each outcome  $x$  a number  $v(x)$  which reflects the subjective value of that outcome. Outcomes are defined relative to a reference point, which serves as the zero point of the value scale. Thus,  $v$  measures the value of deviations, or gains and losses, from the reference point.

The basic formulation concerns two simple prospects of the form  $(x, p; y, q)$ , which have at most two non-zero outcomes (Kahneman & Tversky, 1979). One receives

x with probability p, y with probability q, and nothing with probability  $1 - p - q$ , where  $p + q \leq 1$ . An offered prospect is strictly positive if its outcomes are all positive, and is strictly negative if its outcomes are all negative. If the outcome is neither strictly positive nor strictly negative, a prospect is regular. The basic equation of prospect theory describes the way in which  $\pi$  and  $v$  are combined to determine the overall value of regular prospects. If  $(x, p; y, q)$  is a regular prospect, then

$$(1) V(x, p; y, q) = \pi(p)v(x) + \pi(q)v(y)$$

Where  $v(0)=0$ ;  $\pi(0)=0$ , and  $\pi(1)=1$ . As in utility theory,  $V$  is defined on prospects, while  $v$  is defined on outcomes. The two scales coincide for sure prospects, where  $V(x, 1.0) = V(x) = v(x)$ . This equation (1) generalizes expected utility theory by relaxing the expectation principle.

The evaluation of strictly positive and strictly negative prospects follows a different rule (Kahneman & Tversky, 1979). In the editing phase such prospects are separated into two components: (i) the riskless component, or the minimum gain or loss which is certain to be obtained or paid, and (ii) the risky component, or the additional gain or loss at stake. The evaluation of such prospects is described in the following equation. If  $p + q=1$  and either  $x > y > 0$  or  $x < y < 0$ , then

$$(2) V(x, p; y, q) = v(y) + \pi(p)[v(x) - v(y)].$$

The value of a strictly positive or strictly negative prospect equals the value of the riskless component plus the value-difference between the outcomes, multiplied by the weight associated with the more extreme of the outcomes. A decision weight is applied to the value-difference  $v(x) - v(y)$ , which represents the risky component of the prospect, but not to  $v(y)$ , which represents the riskless component. The right-hand side of equation

(2) equals  $\pi(p)v(x) + [1 - \pi(p)]v(y)$ , which means that equation (2) reduces to equation (1) if  $\pi(p) + \pi(1-p) = 1$ , a condition that is not generally satisfied.

The prospect theory equations retain the general bilinear form underlying expected utility theory (Kahneman & Tversky, 1979). In order to accommodate the effects described above, it is assumed that values are attached to changes rather than to final states, and that decision weights do not coincide with stated probabilities. These departures from expected utility theory lead to normatively unacceptable consequences, such as inconsistencies, intransitivities, and violations of dominance. These anomalies of preference are normally corrected by the decision maker after that individual realizes the preferences are inconsistent, intransitive, or inadmissible. However, in many situations, the decision maker does not have the opportunity to discover that his preferences could violate decision rules that he wishes to obey, and in these circumstances the anomalies implied by prospect theory are expected to occur.

The value function in prospect theory is (i) defined on deviations from the reference point, (ii) generally concave for gains and convex for losses, and (iii) steeper for losses than for gains (Kahneman & Tversky, 1979). A value function satisfying these properties is displayed below. The proposed S-shaped value function is steepest at the reference point.

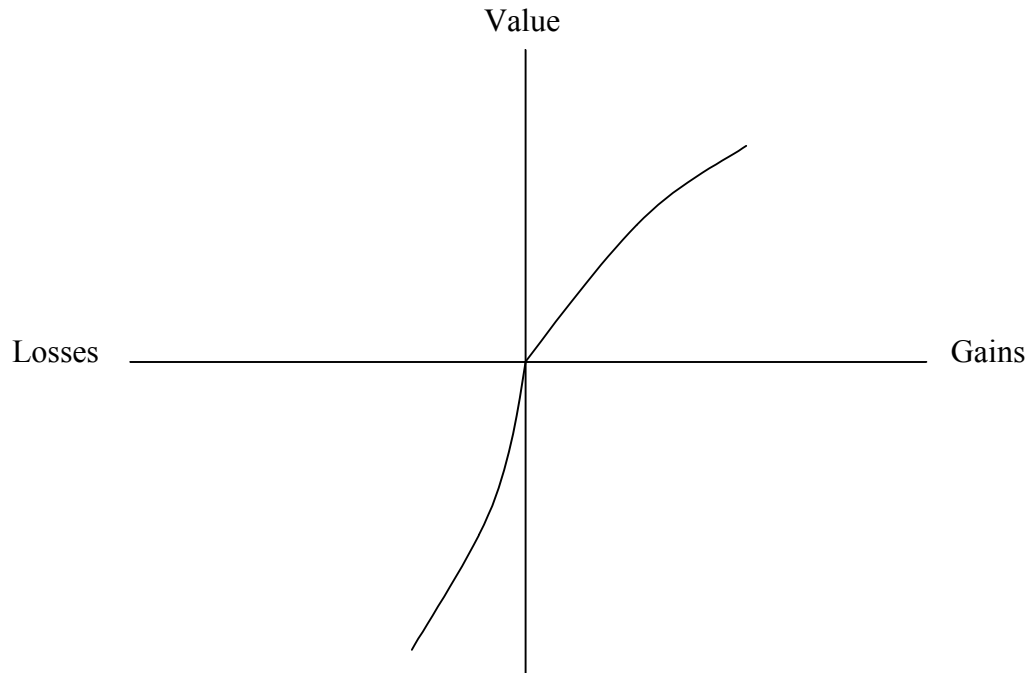


Figure 2.1. Prospect Theory Value Function.

The phenomenon of loss aversion is part of the value function within prospect theory. Another large part of prospect theory is the weighting function. A short summary of the weighting function follows. The value of each outcome is multiplied by a decision weight in prospect theory (Kahneman & Tversky, 1979). Decision weights are inferred from choices between prospects, but they are not probabilities. They do not obey the probability axioms and should not be interpreted as measures of degree or belief. The weighting function,  $\pi$ , relates decision weights to stated probabilities, and is an increasing function of  $p$ , with  $\pi(0)=0$  and  $\pi(1)=1$ . Outcomes contingent on an impossible event are ignored, and the scale is normalized so that  $\pi(p)$  is the ratio of the weight associated with the probability  $p$  to the weight associated with the certain event.

Tversky and Kahneman (1991) extend their treatment of choice under uncertainty, where the outcomes of risky prospects are evaluated by a value function that has the following three essential characteristics: reference dependence, loss aversion, and diminishing sensitivity. Reference dependence means that the carriers of value are gains and losses that are defined relative to a reference point. Loss aversion implies that the function is steeper in the negative than in the positive domain, meaning that losses loom larger than corresponding gains. Diminishing sensitivity means that the marginal value of gains and losses decreases with their size. These three properties lead to an asymmetric S-shaped value function, discussed above, that is concave above the reference point and convex below it. Loss aversion implies that the impact of a difference on a dimension is generally greater when the difference is viewed as a loss than when the same difference is evaluated as a gain.

Another feature of prospect theory is mental accounting, which refers to a set of cognitive operations used by individuals and households to organize, evaluate, and keep track of financial activities (Thaler, 1999). One component of mental accounting involves the assignment of activities to specific accounts. Both the source of funds and their uses are categorized or labeled in mental accounting systems. Money is commonly labeled at three levels: expenditures, wealth, and income. Expenditures are grouped into budgets such as food or housing. Wealth is allocated into accounts. Some examples of these accounts are checking, pension, or “rainy day” funds. Income is divided into categories such as regular or windfall.

Dividing spending into budget categories serves two purposes (Thaler, 1999). First, this budgeting process can assist with making rational trade-offs between

competing uses for funds. Next, this system can act as a self-control device. The mental accounting system is the household's method to keep spending within the budget (Thaler & Shefrin, 1981). Within households there is considerable variation on how explicit the budgeting process is. Generally, the tighter the budget, the more explicit the budgeting rules will be. Households living near the poverty level will use strict, explicit budgets while wealthy families have budgets that are less binding and less well defined. The budgets of poorer families tend to be defined over shorter periods, while wealthier families may use annual budgets.

One way to deal with self-control problems is to place funds in accounts that are "off-limits" (Thaler, 1999). Shefrin and Thaler (1988) propose that there is a hierarchy of money locations arranged by how tempting it is for a household to spend the money in each. The "current assets" category, which includes, for example, cash on hand and money market or checking accounts, is the most tempting and is routinely spent each period. Less tempting to spend is funds held in a "current wealth" category, which includes a variety of liquid asset accounts such as savings accounts, stocks and bonds, or mutual funds. Funds in the current wealth category are generally designated for saving. After this current wealth category, the next hierarchy is home equity. Home equity loans have made this category of funds more accessible, but most households aim to pay off their mortgage prior to retirement. The least tempting category of funds is held in the "future income" account. This account includes money that will be earned later in life along with retirement accounts such as IRAs and 401(k)s. According to the analysis of Shefrin and Thaler (1988), the marginal propensity to spend a dollar of wealth in the



current income account is close to 1.0, while the propensity to spend a dollar of future income is close to zero.

### **2.1.3 Model of Loss Aversion and Consumption/Saving**

Bowman, Minehart & Rabin (1999) have extended Kahneman and Tversky's (1979) Prospect Theory to examine how loss aversion affects consumption. A two-period consumption/saving model is developed where loss-averse consumers face uncertainty over their second-period income. In each period, the agent's utility is assumed to depend upon both level of consumption and a comparison of this level to a reference point that depends on past consumption. A fundamental asymmetry is found in the response of consumption to anticipated changes in income. When there is sufficient income uncertainty, a person resists consuming below his reference point in the first period even when the expected average per-period income is below his reference point, while upward revisions are more likely to immediately affect consumption. The model conforms with the idea that people resist decreasing their standard of living in response to bad news about income.

Bowman et al. (1999) assume that a person's per-period utility function can be represented by a function  $U(r,c)$ , where  $c$  is the individual's consumption level and  $r$  is the individual's reference level of consumption. It is assumed that the gain-loss utility function, measuring how people are affected by movements in consumption about a fixed reference point, is independent of the reference point itself, depending only on the difference between consumption and the reference point,  $c - r$ . The consumer's overall utility can be written as:

$$U(r, c) \equiv w(r) + v(c - r),$$

where  $v(\cdot)$  is the gain-loss utility function, and  $w(\cdot)$  is the “reference utility.” The function  $w(\cdot)$  represents any residual way in which the consumer’s utility depends on movements in the reference point, holding the difference between consumption and the reference point,  $c - r$ , fixed. It is assumed that  $U(\cdot, \cdot)$  is defined for all non-negative values of  $r$  and  $c$ . Bowman et al. (1999) normalize  $v(\cdot)$  to be equal to zero if  $c = r$ , so that  $v(0) = 0$  and  $U(r, r) = w(r)$ . Both components of the utility function are assumed to be continuous, have a bounded slope, and, except when  $c = r$ , are twice differentiable.

### **2.1.3.1 Loss Aversion**

The loss aversion theory begins with the assumptions on the utility function incorporated into Kahneman and Tversky’s prospect theory.

A1:  $v(x)$  is strictly increasing in  $x$ .

A2: If  $y > x > 0$ , then  $v(y) + v(-y) < v(x) + v(-x)$ .

A3:  $v(x)$  is strictly concave for  $x > 0$  and strictly convex for  $x < 0$ .

The first assumption implies that  $U(r, c)$  is increasing in  $c$ , which means that “more is better.” The second assumption assumes that the marginal utility of a loss is strictly greater than the marginal utility of a comparable gain, which is a property shared with standard models of concave utility. The third assumption represents an assumption of diminishing marginal sensitivity to changes in consumption: the marginal utility of a further gain in consumption decreases as the gain grows larger, while the marginal disutility of a further loss in consumption decreases as the loss grows larger. An

implication of this assumption is that people are risk-averse in situations which involve a sure gain, but are risk-loving in situations involving a sure loss.

Psychological evidence indicates that people have a relative aversion to losses even when comparing very small losses to very small gains. This idea has been formalized by Bowman et al. (1999) in a fourth assumption:

$$A4: \text{ If } x > 0, \text{ then } \lim_{x \rightarrow 0} \frac{v'(-x)}{v'(x)} \equiv L > 1.$$

Due to Assumption 4, loss aversion predicts the rejection of any “slightly-better-than-fair” bet if it is small enough, contrary to the prediction of standard utility theory that people are close to risk-neutral for small bets (Bowman et al., 1999). Bowman et al. (1999) also impose further conditions on the gain-loss utility function. Experimental evidence from Kahneman and Tversky indicate that the ratio of loss aversion, or the marginal utility of losses divided by the marginal utility of gains, is generally between 2 and 2.5. A loss of one unit is more than twice as unpleasant as a gain of one unit is pleasant. The following assumption, B1, makes this property global:

$$B1: \text{ For all } x \geq 0, y < 0, v'(y) > 2v'(x).$$

Individuals may incorporate reference point effects into their consumption decisions due to the fact that future reference points may be affected by current choices in an intertemporal setting. Bowman et al. (1999) assert that assumptions must, therefore, be made about how a person’s welfare depends on his or her reference point. The authors make an assumption that an equal increase in both level of consumption and reference level of consumption does not decrease utility, and may increase it. It is also assumed

that the marginal utility of an equal increase in consumption and the reference level is non-increasing. These conditions are represented in assumption A5:

$$A5: U_r(r,c) + U_c(r,c) \geq 0. U_{rr}(r,c) + 2U_{rc}(r,c) + U_{cc}(r,c) \leq 0.$$

This implies that  $w(\cdot)$  is non-decreasing and weakly concave everywhere (Bowman et al., 1999). Since it is equivalent to  $U(r,r)$ ,  $w(r)$  can be interpreted as a type of “reference-adjusted” utility function, representing a consumer’s utility from consuming at level  $r$  when he is accustomed to that level. Another assumption, B2, states that a person derives more satisfaction from a fixed consumption level the lower his reference point:

$$B2: U(r, c) \text{ is decreasing in } r.$$

It is equivalent to the condition that  $w'(x) < v'(y)$  for all  $y$  and all  $x \geq 0$ . Assumption B2 is not the only assumption that could realistically be made in this context, and is at odds with models such as Boyer (1983) that assume consumption to be a type of durable good, where higher past consumption raises the pleasure of current consumption. The following alternative to B2, C, represents the fact that someone who is currently deprived of a given level of consumption is likely to feel a greater sense of loss if he has been accustomed to it:

$$C: U(r,c) \text{ is decreasing in } r \text{ when } r > c, \text{ and increasing in } r \text{ when } r < c.$$

This assumption states that the nearer  $r$  is to  $c$ , fixing a consumption level,  $c$ , the greater the utility from consuming  $c$  will be. This assumption is called acclimation and is equivalent to the conditions that  $w'(x) < v'(y)$  for all  $x \geq 0, y \geq 0$  and that  $w'(x) < v'(y)$  for all  $x \geq 0, y \leq 0$ . Bowman et al. (1999) do not have experimental evidence describing how utility changes as the reference point changes, so it is assumed that Assumptions 1-5 hold and that, in addition, either B1-B2 or C holds. Assumptions such as B1-B2 or C are

necessary to guarantee some basic regularity of intertemporal behavior. In conjunction with Assumptions 1-5, either B1-B2 or C guarantees that a person will not exhibit “starve-binge” behavior – purposely consuming below the reference point in the present period solely to consume above the reference point in the future.

### **2.1.3.2 Two-Period Model of Consumption/Saving**

Bowman et al. (1999) consider a simple model of consumption and saving decisions based on assumptions from Tversky and Kahneman’s Prospect Theory (1979) along with some additional assumptions. It is assumed that two periods remain in a consumer’s life, and that any income uncertainty is resolved in the second period. No liquidity constraints prevent consuming guaranteed second-period income in the first period, but consumption is not allowed to be negative in either period, so the consumer cannot borrow against an uncertain future income. It is assumed that there is no discounting and that savings earn no interest. Let  $r_t$  be the reference level in period  $t$ ,  $Y_t$  be income in period  $t$ , and  $c_t$  be consumption in period  $t$ . The consumer’s problem is to maximize expected lifetime utility, given by

$$U(r_1, c_1; r_2, c_2) \equiv 2(r_1) + v(c_1 - r_1) + E\{w(r_2) + v(c_2 - r_2)\},$$

subject to the constraint that

$$c_1 + c_2 = Y_1 + Y_2.$$

This maximization problem is influenced by the way the reference points are formed. Bowman et al. (1999) model reference-point formation in a method consistent with recent literature on habit formation in consumption. The first-period reference

point,  $r_1$ , is taken as exogenously determined and the second-period reference point,  $r_2$ , is determined in part by  $r_1$  and in part by first-period consumption,  $c_1$ :

$$r_2 \equiv (1 - \alpha)r_1 + \alpha c_1,$$

where  $\alpha$  is within  $[0,1]$  and represents the speed at which the reference point changes in response to recent consumption. If  $\alpha=0$ , then first-period consumption has no effect on the consumer's second-period reference level, so that utility is time-separable; if  $\alpha=1$ , then the second-period reference level adjusts fully to first-period consumption.

When income is certain, the idea that a person with high consumption is happier when acclimated to that standard of living than when accustomed to being poor is necessary to insure that consumption choices strictly increase in lifetime income (Bowman et al., 1999). The consumer prefers to spread his income increase across both periods. When income is uncertain, there is a wider range of possible behavior. When there is enough uncertainty, people resist lowering consumption in response to news that they will probably not be able to maintain the current standard of living. This conforms to the intuition, dating at least back to Duesenberry (1952), that in response to bad news about income people resist decreasing their standard of living.

Theorem 2 in Bowman et al. (1999) states that as long as future per-period income exceeds the current reference level with at least probability  $\alpha/(1 + \alpha)$  under Condition C or  $2\alpha/(1 + \alpha)$  under Conditions B1-B2, a person will consume at or above his reference level in the first period no matter how low expected lifetime income is:

*Theorem 2: If assumptions A and C hold and  $P[Y \geq r_1] \geq \alpha/(1 + \alpha)$ , or if Assumptions A and B hold and  $P[Y \geq r_1] \geq 2\alpha/(1 + \alpha)$ , then  $c_1 \geq r_1$  whenever  $P[Y \geq 0.5r_1] = 1$ .*

This result is dependent on two aspects of loss aversion that are non-standard to economists: dependence on reference points and risk-loving preferences in losses (Bowman et al., 1999). In the analysis of consumption under certainty, risk-loving behavior leads a person to concentrate losses. While habit formation leads the consumer to concentrate losses in the first period when income is certain, there is a strong incentive to postpone these losses under uncertainty, since there is some chance that future income will be high enough to avoid taking any loss. When there is enough uncertainty, people resist lowering consumption in response to news that they will probably be unable to maintain their standard of living. With uncertainty there is a strong incentive to postpone losses since there is a chance that no loss will occur.

Theorem 2 implies an asymmetry in consumer behavior under loss aversion (Bowman et al., 1999). Although first-period consumption never lies below the reference level when the probability of gain exceeds the bounds shown in Theorem 2, consumption may lie above the reference level even when the probability fails to meet these bounds.

*Proposition 4: The converse of Theorem 2 does not hold. Neither Conditions A, C, and  $P[Y \geq r_1] < \alpha/(1 + \alpha)$  nor Conditions A, B, and  $P[Y \geq r_1] < 2\alpha/(1 + \alpha)$  imply that  $c_1 \leq r_1$ .*

A certain decline in expected income growth leads to an equivalent decline in expected consumption growth, but a certain increase in expected income growth leads to a lesser increase in expected consumption growth, since the agent reacts to sufficiently good news by raising first-period consumption.

In the model by Bowman et al. (1999), an increase in uncertainty can either increase or decrease consumption, as shown in Proposition 5.

*Proposition 5: Let  $c_1(Y,k)$  be the consumer's first-period consumption when faced with probabilistic total income  $((1-k)Y, (1+k)Y)$ , where  $k \in [0,1]$ . (i) If A holds and  $\alpha > 0$ , then there exists  $Y^* < r_1$  such that for all  $Y$  ( $Y^*, r_1$ ) and  $k$  satisfying  $(1-k)Y > 0.5r_1$ ,  $c_1(Y,k) > c_1(Y,0)$ . (ii) If A and C hold, then there exists  $k^* > 0$  and  $Y^* > r_1$  such that for all  $Y$  ( $r_1, Y^*$ ) and all  $k < k^*$ ,  $c_1(Y,0) > c_1(Y,k)$ .*

According to Part (i) of this proposition, when expected per-period income is slightly below the reference level an increase in the probability that a consumer will be able to consume above his reference level in each period will lead him to decrease savings (Bowman et al., 1999). However, part (ii) suggests that if expected per-period income is slightly above the reference level, an increase in uncertainty is likely to increase savings. Part (i) of Proposition 5 generalizes to any symmetric distribution, while part (ii) does not. The intuition behind the proof of part (ii) is that when expected average per-period income exceeds the reference point, an increase in uncertainty that raises the odds that the consumer will not be able to maintain current consumption will increase savings.

#### **2.1.4 Behavioral Portfolio Theory**

Behavioral portfolio theory (BPT) is a positive portfolio theory based on two theories of choice under uncertainty (Shefrin & Statman, 2000): SP/A theory (Lopes, 1987) and prospect theory (Kahneman & Tversky, 1979). These two theories emerged from the literature addressing the observation that people who buy insurance policies often purchase lottery tickets as well (Shefrin & Statman, 2000). BPT has been presented in two versions: a single mental account version (BPT-SA) and a multiple mental account



version (BPT-MA). BPT-SA investors integrate their portfolios into a single mental account by considering covariance. BPT-MA investors segregate their portfolios into mental accounts, overlooking covariance among these mental accounts. These investors might place foreign stocks in one mental account and domestic stocks in another.

Shefrin and Statman (2000) review the safety-first portfolio framework from Roy (1952), Telser (1955), and Arzac and Bawa (1977) as well as Lopes' (1987) SP/A theory. Safety-first portfolio theory states that investors aim to minimize the probability of ruin (Roy, 1952). An investor is "ruined" when terminal wealth falls short of a subsistence level. Elton and Gruber (1995) discuss two generalizations of safety-first. The first, by Kataoka, found in Elton and Gruber (1995) follows the objective to maximize the subsistence level subject to the constraint that the probability that wealth falls below subsistence does not exceed a predetermined level. The second model, developed by Telser (1955), features both a subsistence level and a ruin probability. A portfolio is considered safe if the probability of ruin does not exceed a specified level, and the investor is suggested to choose a portfolio to maximize expected wealth subject to that constraint.

SP/A theory, a psychological theory of choice under uncertainty, was developed by Lopes (1987). SP/A theory focuses on the twin desires for security (S) and potential (P) along with aspiration levels (A) associated with security and potential. The notion of security is a general concern about avoiding low levels of wealth. Potential relates to a general desire to reach high levels of wealth, and aspirations are referred to as goals. Danger refers to the possibility that wealth might fall below a particular minimum level  $s$  (Shefrin & Statman, 2000).

The probability of safety can be modeled as  $\text{Prob}(W \geq s)$ . This is a decumulative probability, meaning that it has the form  $D(x) = \text{Prob}(W \geq x)$ , where  $D$  is called a *decumulative distribution function*. Lopes (1987) uses a discrete-state formulation, similar to that in Arzac's (1974) safety-first framework. Consider a two-date framework, where the dates are labeled zero and one. Let there be  $n$  states associated with date one, where  $p = \text{Prob}(W)$ ,  $i = 1, 2, \dots, n$ , and wealth levels are ranked  $W_1 \leq W_2 \leq \dots \leq W_n$ . Expected wealth,  $E(W) = \sum p_i W_i$ , can be expressed as  $\sum D_i(W_i - W_{i-1})$ , where the summation is from  $i=1$  to  $n$  and  $W$  is zero. In this expression for  $E(W)$ , the individual receives  $W_1$  with certainty ( $D_1 = 1$ ), receives the increment  $W_2 - W_1$  (an amount over  $W_1$ ) with probability  $D_2$ , receives the further increment  $W_3 - W_2$  with probability  $D_3$ , and so on.

In this framework, two emotions operate on the willingness to take risk: fear and hope (Lopes, 1987). Fear leads individuals to overweight the probabilities attached to the worst outcomes relative to the best outcomes. Lopes (1987) postulates that fear leads individuals to act as if they computed  $E(W)$  using a value for  $p_1$  that is excessively high, and a value for  $p_n$  that is excessively low. In other words, people act as if they are unduly pessimistic when computing  $E(W)$ . Hope leads individuals to underweight the probabilities attached to the best outcomes relative to the worst outcomes. In this case, individuals act as if they are unduly optimistic when computing  $E(W)$ , using a value for  $p_1$  that is excessively low, and a value for  $p_n$  that is excessively high.

Fear underlies the concern for security, and hope underlies the concern for potential (Lopes, 1987). Formally, fear affects attitude toward a risky outcome through a weighting of the decumulative probabilities. Lopes (1987) computes  $E(W)$  using the

decumulative function  $h_s(d) = D_s^{1+q_s}$  where the subscript  $s$  stands for security. For  $q_s > 0$ , this function attaches disproportionate weight to higher values of  $D$ . As a result,  $D$  stochastically dominates  $h_s(D)$ , since it effectively shifts probability weight from the right of the distribution's support to the left.

Hope operates like fear, but induces higher weighting of lower values of  $D$ , the ones that attach to higher outcomes (Lopes, 1987). The counterpart to  $h_s(D)$  is  $h_p(D)$ , where the  $p$  stands for potential:  $h_p(D)$  has the form  $1 - (1 - D)^{1+q_p}$ . Lopes (1987) argues that the emotions of fear and hope are present in all individuals, and that each emotion serves to modify the decumulative weighting function. Lopes' (1987) suggestion is that the final shape of the decumulative transformation function is a convex combination of  $h_s$  and  $h_p$ , reflecting the relative strength of each. Specifically, the transformation function  $h(D)$  has the form,

$$h(D) = \delta h_s(D) + (1 - \delta) h_p(D).$$

In SP/A theory, the investor substitutes  $E(W)$  with  $E_h(W)$ , replacing the probability  $p_i$  attached to the  $i$ th event with the difference  $r_i = h(D_{i+1}) - h(D_i)$ . SP/A departs from the expected utility framework using a rank dependent formulation, replacing  $D$  with  $h(D)$ . The rank ordering of states is typically the inverse of the rank associated with the price per unit probability ratio,  $v_i/p_i$ , which is the pricing kernel. Consistency requires that the ranking of states by  $v_i/r_i$  be the same as the original ranking by  $v_i/p_i$ .

Lopes (1987) suggests that risky outcomes are evaluated in terms of two variables. The first variable is  $E_h(W)$ , the expected value of  $W$  under the transformed decumulative function  $h(D)$ . The second variable is  $D(A)$ , the probability that the payoff

will be  $A$  or higher.  $E_h(W)$  will be lower than  $E(W)$  for individuals who are strongly driven by fear. The greater the fear, the lower the value of  $E_h(W)$ . Similarly, hope operates by increasing  $E_h(W)$  relative to  $E(W)$ . Lopes (1987) illustrates the SP/A framework using the choice of crops by farmers. Subsistence farmers often choose between food crops and cash crops. The prices of food crops are low but generally stable, while the prices of cash crops are volatile but offer the potential for higher wealth. Lopes (1987) notes that these farmers tend to plant food crops to the point where their subsistence needs are met and allocate the remainder of their land to cash crops. This suggests, according to Lopes (1987), that farmers gamble on cash crops because they aspire to escape poverty.

In this illustration, there are two implicit aspiration levels: subsistence and some level above subsistence (Shefrin & Statman, 2000). The *fear* of falling below subsistence motivates the allocation to food crops, which is the safety-first approach. The *aspiration* of escaping poverty motivates allocating the remainder to cash crops. This example is similar to Friedman and Savage's (1948) observation that people simultaneously purchase insurance and lottery tickets. This simultaneity is the "hallmark" of efficient BPT-SA portfolios (Shefrin & Statman, 2000). In SP/A theory, risk is multidimensional, and is described with five parameters: strength of fear, strength of hope, aspiration level, strength of fear relative to hope, and strength of the desire to reach the aspiration level relative to fear and hope. Altering these parameters alters the single account behavioral portfolio theory investor's choice of portfolio.

Some investors have low aspirations and others have high aspirations, while most investors combine the two (Shefrin & Statman, 2000). People want to avoid poverty, but

also want a chance at riches. Portfolios combining low and high aspirations are often described as layered pyramids where investors divide current wealth between a bottom layer which is designed to avoid poverty and a top layer designed for a shot at riches. In BPT-SA, investors act as if they consider covariances, integrating portfolios into a whole. In BPT-MA, investors act as if they overlook covariances by segregating their portfolios into distinct mental accounts.

Tversky & Kahneman (1986) provide evidence of the difficulty that covariance and other properties of joint probability distributions impose on mental processes. People simplify choices by dividing joint probability distributions into mental accounts and in a layered pyramid structure of portfolios. Shefrin and Statman (2000) present BPT-MA for the case of two mental accounts. To explain the mental accounting structure of portfolios in BPT-MA, they use an investor who contains three entities: a principle called the “planner” and two agents called “doers.” This follows the self-control framework discussed by Thaler and Shefrin (1981) and applied by Shefrin and Statman (1984) in the context of dividends. The first doer has a low aspiration level while the second doer has a high aspiration level. Each doer is associated with one mental account, and the planner balances the two doers to maximize overall utility, dividing current wealth  $W_0$  between the two. Imagine that the low aspiration doer’s utility possess a Cobb-Douglas function,

$$U_s = P_s^{1-\gamma} E_h(W_s)^\gamma,$$

where  $P$  is the probability of falling short of the aspiration level  $A$  (\$0.20),  $W$  is the terminal wealth of the low aspiration doer, and is a non-negative weighting parameter (0.1). Similarly, the utility of the high aspiration doer is

$$U_r = P_r^{1-\beta} E_h(W_s)^\beta,$$

where  $P$  is the probability of falling short of the high aspiration level  $A$  (\$1.20),  $W$  is the terminal wealth of the high aspiration doer, and is 0.1.

The utility function of the planner combines the utilities of the low and high aspiration doers,  $U_s$  and  $U_r$ , where the weight attached to the high aspiration doer is  $K = 10,000$ , much higher than the weight attached to the low aspiration doer,  $K = 1$ . We assume that the planner's utility takes the form,

$$U = [1 + K_{dr}(P_r^{1-\beta} E_h(W_r)^\beta)]K_{ds} [P_s^{1-\gamma} E_h(W_s)^\gamma].$$

The planner divides initial wealth  $W_0$  into two portions,  $W_{s,0}$  for the low aspiration account and  $W_{r,0}$  for the high aspiration account (Shefrin & Statman, 2000). The utility of the planner is zero when the utility of the low aspiration is zero, but it is not necessarily zero when the utility of the high aspiration doer is zero, which implies that the *first* dollar of wealth  $W_0$  will be allocated to the low aspiration account. In other words, safety, or achieving low aspiration, comes *first*.

BPT-MA investors match mental accounts with goals, and the mental accounts are not integrated (Shefrin & Statman, 2000). Portfolios in BPT-MA resemble layered pyramids where each layer, or mental account, is associated with a particular aspiration level. Shefrin and Statman (2000) describe the two-layer model with a low aspiration layer designed to avoid poverty and a high aspiration layer designed for a shot at riches. A multiple accounts behavioral portfolio theory framework is also briefly discussed where there are three mental accounts in the hands of three “doers” whose aspiration levels range from low to medium to high.

### **2.1.5 Summary of Theoretical Models**

Economics can be distinguished from other social sciences by the belief that individuals have stable preferences that are well-defined, acting on markets that eventually clear (Goette von Wildhaus, 2001). Prospect theory departs from the standard economic assumptions in two essential ways. First, Kahneman and Tversky (1979) have found that people care much more about losses relative to their reference point than about gains, and are risk-averse in gains while they are risk-loving in losses. Second, prospect theory emphasizes the importance of an editing stage before actions are chosen. Editing refers to how individuals view particular situations. According to economic theory, individuals are forward-looking and consider the full consequences of a decision (Goette von Wildhaus, 2001). This differs from prospect theory, and Kahneman and Tversky (1979; Tversky & Kahneman, 1991) have shown several examples where individuals do not consider the full consequences of current actions on utility.

The theoretical literature based on the life-cycle/permanent income model and the precautionary saving extension suggest different saving behaviors than the literature based on prospect theory and loss aversion. According to the permanent income hypothesis, wealth serves as an “emergency reserve” against uncertainty (Friedman, 1957). The life-cycle/permanent income hypothesis predicts that the relationship between consumption growth and expected income growth is unitary. Positive expected income growth and negative expected income growth have symmetrical effects on consumption and saving. Consumption in each period is based on a fraction of permanent or lifetime wealth. Prospect theory states that consumers care more about losses relative to the reference point than about gains (Kahneman & Tversky, 1979), with

individuals being more sensitive to reductions in their level of well-being than to increases (Benartzi & Thaler, 1995). Therefore, negative expected income growth has a greater effect on consumption and saving than positive expected income growth.

Consumers who are above their reference level of income will be able to save because they can consume at the reference level, but consumers who are below the reference will not save because they do not like to reduce consumption below the reference level.

Loss aversion has been used to look at the consumption behavior of consumers in the presence of uncertainty, and explains asymmetric consumption responses to expected losses or gains in income (Bowman et al., 1999). According to the loss aversion model, households do not like to be below the reference level of income, and will not save if current income is below this reference level (Bowman et al., 1999). Households are more likely to save if current income is above the reference level. Expected income growth also has an effect on saving. The effect of a decrease in saving due to negative expected income growth is expected to be greater than the effect of an increase in saving due to positive expected income growth. Consumers make consumption and saving decisions based on expected per-period income according to the model of loss aversion. Uncertainty that decreases the probability of consuming at the reference level is expected to have a positive effect on saving.

According to behavioral portfolio theory, there is a hierarchy of need that investors follow in developing portfolios. These portfolios resemble a layered pyramid, where each layer is an aspiration. The first dollar of wealth goes to “safety,” with a low aspiration layer designed to avoid poverty and a higher aspiration layer designed to gain riches. According to BPT, households will follow a hierarchy of need in their saving.



The first dollars saved will go to “safe” accounts in order to keep the household out of poverty. After this has been achieved, money saved can go to accounts other than those designed for safety. Achieving security allows an individual to move wealth into accounts with potential. Therefore, households in the stage of saving for security reasons will have different saving motives than households that have moved beyond ensuring safety and are hoping to achieve “riches.” BPT-MA investors match mental accounts with goals, which indicates that saving motives or goals will match the aspiration level of the investor. Households will follow a hierarchy of need in saving behaviors. The first dollars saved will serve to keep the family out of poverty, and after the household achieves this level of safety it can begin to save for higher aspiration goals. The saving behavior of households would thus be expected to be affected by directly indicated saving motives. The saving motives are also expected to differ by the saving horizon of a household, since households focused on safety may have a short saving horizon while those focused on riches may have a longer saving horizon.

## **2.2 Research Questions**

***Research Question 1:*** How does expected per-period income affect the likelihood of saving?

***Research Question 2:*** How is the likelihood of household saving affected by income uncertainty?

***Research Question 3:*** How is the likelihood of household saving affected by household saving motives?

**Research Question 4:** Does the relative importance of saving motives vary by the length of the household's saving horizon?

## **2.3 Review of Empirical Studies**

### **2.3.1 Income and Consumption/Saving**

The life-cycle theory of saving predicts that people save a lot when income is high relative to lifetime average income and dissave when income is low relative to that average, basing consumption on lifetime wealth (Dornbusch & Fisher, 1994; Deaton, 2005). Thurow (1969) was the first to explicitly raise concern that the correlation between income and consumption over the working life may not be consistent with the predictions of a basic life-cycle model. Many empirical studies show findings that are inconsistent with the model, and the empirical application of the life-cycle model has been questioned (King, 1985). Many researchers have found that consumption is too sensitive to current income to be consistent with a lifetime conception of permanent income (Thaler, 1990). The conclusion is the same whether one studies low frequency decisions such as the shape of the life-time consumption profile, or high frequency decisions such as the smoothing of year to year consumption. Over the life-cycle, empirical research shows that the young and old appear to consume too little, and the middle aged consume too much, while consumption appears to be excessively sensitive to income.

Several empirical studies indicate that the level of saving among the elderly may not move downward as expected (Mirer, 1979; Avery & Kennickell, 1991). Banks, Blundell and Tanner (1998) and Bernheim, Skinner and Weinberg (1997) consider the

consumption drop at retirement to be evidence that individuals may not be far-sighted utility maximizers as life-cycle theory suggests. Several tests of the life-cycle/permanent income hypothesis using aggregate data have rejected the theory. Hall (1978) showed that an implication of the permanent income hypothesis is that consumption should follow a random walk. He argued that postwar U.S. data are consistent with this implication, to a first approximation. Campbell and Mankiw (1990) found that a predictable one percent increase in income leads to a statistically significant consumption increase of between 0.3 and 0.7 percent.

Tests of the life-cycle/permanent income hypothesis using household data have shown mixed results. Altonji and Siow (1987) found little evidence against the life-cycle saving/permanent income hypothesis, as did Runkle (1991). Altonji and Siow (1987) found that households expecting income to rise exhibit a higher sensitivity of consumption to predictable income than households expecting income to fall, though neither sensitivity is significantly different from zero. Zeldes (1989a) rejected the life-cycle/permanent income hypothesis in his study, attributing the rejection to liquidity constraints. Flavin (1991) also rejected the theory, attributing the rejection to myopia. Shea (1995) found that consumption is more sensitive to predictable wage declines than to predictable wage increases, which is inconsistent with both myopia and liquidity constraints.

A number of explanations have been suggested for the correlation between income and consumption (Browning & Crossley, 2001). First, it is possible that most households set current consumption to a constant fraction of current income, which is called “rule of thumb” behavior. This is not compatible with the life-cycle framework.

A second explanation, suggested by Thurow (1969), is that households are liquidity constrained, and would like to spend more than their current income when younger but they are unable to borrow. A third explanation, suggested by Nagatani (1972) is that instead of being liquidity constrained, households are prudent. Prudence leads households to treat future uncertain income cautiously and to not spend as much in the current period as they would if future income were certain. Prudence is the precautionary motive for saving. Both the liquidity constraint and prudence explanations offer justification for consumption to track income in early life, but there is difficulty in explaining the downturn in income and consumption in later years (Browning & Crossley, 2001). Browning and Crossley (2001) have pointed out that the performance of the life-cycle/permanent income model depends on the frequency of analysis required. Over short periods of time, there is evidence of consumption smoothing as predicted by the model, but as the periods lengthen, the evidence becomes less convincing.

Carroll and Summers (1991) have provided evidence against the rule of thumb explanation, citing that correlation between income and consumption is too strong unless nearly all households use the rule of thumb. The authors favor liquidity constraints and prudence. Browning and Crossley (2001) stated that there is an emerging consensus that the correlation between income and consumption can be explained by some combination of precautionary savings, or prudence, with demographic changes over the life-cycle. Attanasio et al. (1999) and Gourinchas and Parker (1999) have argued that a precautionary motive must be used in addition to accounting for family size in order to remove some of the “excessive” correlation between consumption and income over the working life. This differs from what Browning and Ejrnaes (2000) found, which is that if

the number and ages of children are taken into account, then there is no need to include prudence.

### **2.3.2 Expected Income**

Chang et al. (1997) found households with a higher probability of experiencing an income decrease to be more likely to hold adequate emergency funds. Carroll and Weil (1994) used three separate household-level data sets to show that higher labor income growth is correlated with a higher saving rate. Similar evidence has been found for Taiwan (Deaton & Paxson, 1994). Shapiro and Slemrod (1995) found that consumers expecting faster income growth were more likely to save a temporary increase in income. Carroll et al. (2000) found that increases in growth precede increases in saving. This evidence suggests that future income growth should be controlled for in a model of saving.

According to the loss aversion model, there is a fundamental asymmetry in the response of consumption to anticipated changes in income (Bowman et al., 1999). Downward revisions in expected future income growth tend to have a greater impact on expected consumption growth than upward revisions. When a person receives good news about future income prospects, current consumption may be immediately adjusted upward, but learning of a negative shock to income in a future state of the world may have no effect on current consumption. When there is enough uncertainty, people resist lowering consumption in response to news that they will probably not be able to maintain their standards of living. There is an incentive to postpone such losses since there is a chance that future income will be high enough to avoid taking any loss at all. The

asymmetry in the response of consumption to anticipated income changes implies that a one percent decline in expected income growth leads to a one percent decline in expected consumption growth. At the same time, a one percent increase in expected income growth leads to less than a one percent increase in expected consumption growth, since the consumer reacts to sufficiently good news by increasing first-period consumption.

Shea (1995) found evidence of asymmetric behavior when investigating expected wage growth for consumers with union contracts. The results indicate that when wages change consumption responds more to predictable declines in wages than to predictable increases. Bowman et al. (1999) found evidence supporting the asymmetric behavior predicted by their loss aversion model using aggregate data from five countries. This asymmetry is at odds with the predictions of the permanent income hypothesis and other alternatives such as liquidity constraints, rule-of-thumb behavior, and habit formation (Bowman et al., 1999).

### **2.3.3 Loss Aversion**

The concept of losses being more painful than equally sized gains are pleasurable is a central part of Kahneman and Tversky's (1979) prospect theory, and is called loss aversion. Loss aversion is the tendency of individuals to be more sensitive to reductions in their level of well-being than to increases (Benartzi & Thaler, 1995). Utility is defined over gains and losses relative to some neutral reference point, such as the status quo. This is inconsistent with economic theory, which assumes that individuals care only about their level of wealth, and that the marginal utility of wealth is declining (Goette von Wildhaus, 2001). Loss aversion, also referred to as disappointment aversion, is one of

the many extensions of expected utility (Aizenman, 1998). A consumer reveals disappointment aversion if he or she attaches extra disutility to circumstances where the realized income is below the point where the consumer is indifferent between the prospect of a safe income and a risky income. The utility function of prospect theory has a kink at the origin, with the slope of the loss function steeper than the gain function. The ratio of these slopes at the origin is a measure of loss aversion.

Shea's (1995) finding that consumption is more sensitive to declines in predictable real wages than to predictable increases in wages is inconsistent with the life-cycle/permanent income hypothesis, but is qualitatively consistent with the theoretical work incorporating loss aversion into intertemporal preferences. The model of loss aversion proposed by Bowman et al. (1999) is possibly consistent with the asymmetry found in Shea (1995). Shea (1995) examined loss aversion at the household level using a sample of households with household heads matched to long-term union contracts. In this model, preferences exhibit loss aversion, where utility is concave when consumption increases above a reference level of consumption but is convex when consumption declines below reference consumption. This idea captures the intuition that households suffer relatively large psychic losses when forced to cut living standards by even a small amount (Shea, 1995), and has been documented by Kahneman, Knetsch, and Thaler (1991).

Loss aversion affects savings because households get used to a particular level of disposable income and tend to view reductions in that level as a loss (Thaler & Benartzi, 2001). Households may be reluctant to increase savings because they don't want to experience a cut in take-home pay, and gains and losses are experienced in nominal

dollars. Bowman et al. (1999) provide evidence of asymmetric reactions in consumption growth to anticipated good and bad news about income growth, using aggregate data. Bowman et al. (1999) show that loss-averse households may optimally refuse to reduce consumption today when faced with expected but uncertain declines in future income. Loss aversion can potentially explain why consumption is more sensitive to predictable income decreases than increases (Shea, 1995). Individuals do not increase consumption when income is increasing in the future, but do cut back on consumption when income is declining in the future (Shea, 1995). Therefore, saving is found to increase with income growth. Bowman et al. (1999) also found that anticipated positive income growth does not affect consumption growth; therefore saving increases with income growth.

Loss aversion has been found to explain a variety of field and experimental data. Abdellaoui and Bleichrodt (2005) used experimental data to investigate evidence of loss aversion at the aggregate and individual level, finding strong evidence at both levels. Schmidt and Traub (2002) provided an experimental test of loss aversion. While other empirical studies conclude that loss aversion is a good descriptor of behavior in general, Schmidt and Traub (2002) have argued that this conclusion should be taken with caution. The existence of loss aversion found to be prominent at the aggregate level could be due to the large extent of loss aversion rather than a general occurrence. Bowman et al. (1999) used aggregate data from several countries and found a larger response of consumption to predictable declines in income than to predictable income growth. Shea (1995) investigated loss aversion among households, but uses only households whose heads were matched to long-term union contracts. Predictable wage movements were



significantly correlated with consumption changes, and were more strongly related to predictable income declines than increases.

#### **2.3.4 Income Risk**

Some researchers have used income variance measures derived from observed income processes to measure income risk (Carroll, 1994; Carroll & Samwick, 1997, 1998; Kazarosian, 1994). These measures are sensitive to assumptions about measurement error (Browning & Lusardi, 1996). Carroll (1994) has found that the degree of uncertainty in future income affects consumption, with consumers facing greater income uncertainty having lower current consumption, holding all else equal. Empirical studies have also shown that households facing higher income risk are more likely to save (Lusardi, 1998). Modigliani and Brumberg's (1954) original life-cycle model recognized that planning over the life-cycle requires people to look into an uncertain future, which is difficult to express theoretically. Modigliani saw the main effect of uncertainty as creating demand for precautionary saving and that, except perhaps among the very young, the accumulated assets of life-cycle savers could serve as a retirement fund as well as a buffer against unexpected emergencies. If income or assets deviate from previously planned expectations, the plans can be revised. Friedman (1957) found that under uncertainty, the average propensity to consume out of permanent income could be lower. Sandmo (1970) has shown that theoretically, increased uncertainty about future income decreases consumption, increasing saving.

Dardanoni (1991) found significantly lower average consumption across occupation and industry groups when income variance, represented by the variability of

earnings in different occupations, is greater. Miles (1997) found that for each cross-section of the Family Expenditure Survey, uncertainty played a statistically significant role in determining consumption. Households whose respondent has experienced unemployment in the past have significantly lower wealth (Lusardi, 1998). Using panel data, Carroll and Samwick (1998) found that income risk has positive effects on wealth accumulation, applying proxies for income risks across education and occupation. Also using panel data, Guariglia (2001) tested the precautionary saving hypothesis and found that in accordance with the hypothesis, various measures of uncertainty based on earnings variability have a statistically significant effect on households' saving decisions. Households are found to save more if they expect their financial situation to deteriorate.

### **2.3.5 Uncertainty**

Researchers have shown that increased uncertainty about future income decreases consumption, increasing saving (Sandmo, 1970; Zeldes, 1989; Deaton, 1991; Carroll, 1994). Sandmo (1970) stated that this relationship exists because increased saving raises the expected value of future consumption, while others contribute the relationship to the presence of precautionary savings motives (Zeldes, 1989; Kimball, 1990a; Deaton, 1991; Carroll, 2001). According to BPT, risk is multidimensional (Shefrin & Statman, 2000).

When there is enough uncertainty, people resist lowering consumption in response to news that they will probably be unable to maintain their reference level of consumption (Bowman et al., 1999). As long as future per-period income exceeds the current reference level with a minimum level of probability, a person will consume at or

above the reference level in the first period no matter how low expected lifetime income is. This results from the existence of reference points and risk-loving preferences in losses. Under uncertainty there is an incentive to postpone losses since there is some chance that future income will be high enough to avoid taking a loss. When expected per-period income is above the reference level, an increase in uncertainty is likely to increase savings. When expected average per-period income is below the reference point, an increase in uncertainty also leads to an increase in saving. Since a household below the reference point resists reducing consumption in response to bad news, this “increase” in saving could result in a decrease of negative saving.

### **2.3.6 Marital Status**

Saving rates are higher for married couples with no children and lower for households with children, with single parents having the lowest saving rate in the population (Browning & Lusardi, 1996). In a study by Smith (1994), continuously married households experienced a large increase in assets each year, while asset growth for households who never remarried was much smaller, and was negative among widowed and separated families. Married couples may behave differently than the non-married due to the income insurance provided by a potential second earner (Bosworth et al., 1991).

### **2.3.7 Number of Earners**

In order to account for the fact that households with only one earner are more exposed to risk, Lusardi (1998) interacts a dummy variable equal to 1 if the household

has more than one earner with the variance of income and finds the interaction term to be significant. Bosworth et al. (1991) state that married couples may behave differently than the non-married due to the income insurance provided by a potential second earner.

Households with two spouses participating in the labor force are exposed to less uncertainty than households with less than two earners. Including the number of earners in a household as a variable allows for the separation of the effects of marital status and a second earner.

### **2.3.8 Unemployment**

When unemployment occurs, two reasons why household expenditures can change are that the costs of working decline and there may be a response to the fact that unemployment represents “news”, leading to consumption changes (Browning & Crossley, 2001). Browning & Crossley (2001) used data drawn from the Canadian Out of Employment Panel and found that households show some smoothing of consumption during unemployment, since expenditure changes are much smaller than income changes. It is also true that job and income loss appear to be associated with some expenditure fall.

### **2.3.9 Self-Employment**

Kennickell & Lusardi (2003) found two groups in the population for which the precautionary saving motive is particularly important: older households and business owners. Self-employed households face different risks, and the results of Kennickell & Lusardi (2002) indicate that desired precautionary saving levels are much larger for business owners than for the main sample. In their analysis, Kennickell & Lusardi found

that business owners account for only 11 percent of the population, but 24 percent of total desired precautionary savings. Self employment is inherently more risky than wage-earning (Hamilton, 1995) and it has been observed that saving behavior is significantly different between wage and salary earners and the self-employed (Sandmo, 1970).

### **2.3.10 Health Status**

Sources of risk other than income risk that have been investigated are longevity risk and health risk (Davies, 1981; Leung, 1994; Starr-McCluer, 1996; Hubbard, Skinner & Zeldes, 1995; Palumbo, 1999). It is important to model health risks as well as other sources of risk such as consumption risk and other emergencies (Kennickell & Lusardi, 2003). Several studies have found that health affects total wealth accumulation (Smith, 1999a; Venti & Wise, 2000; Wu, 2003). Health has been found to be a significant predictor of the share of financial wealth held in each asset category, as well as in the probability of owning different types of financial assets, even after controlling for risk preferences, bequest motives, planning horizons, and health insurance (Rosen & Wu, 2003). Holding other things constant, households in poor health are less likely to hold risky financial assets. Poor health is associated with a smaller share of financial wealth held in risky assets.

### **2.3.11 Saving Motives**

Traditional economic models view family savings held in different household asset categories as interchangeable (Xiao & Anderson, 1997). In reality, this assumption is counterintuitive, and empirical studies have shown it to be invalid (Shefrin & Thaler,

1988). Xiao and Anderson (1997), in contrast, have assumed that a household may consider different categories of assets to be used for different purposes. Households hold varying types and differing levels of assets to meet financial needs. Assets can be separated into financial and nonfinancial, as defined by the Federal Reserve System (Kennickell & Starr-McCluer, 1994). Xiao and Anderson (1997) explored why consumers hold various financial assets and maintain particular levels of these assets using a framework based on the needs hierarchy theory of Maslow (1954), new consumer demand theory (Lancaster, 1966), and prospect theory (Kahneman & Tversky, 1979).

According to Xiao and Noring (1994), few have investigated motivations for saving directly. Keynes (1936) first discusses saving motives, identifying eight different motives. Eight motives for saving are listed by Keynes (1936), and Browning and Lusardi (1996) have provided a title for each motive, provided in italics, along with adding one motive to this list:

- (1) “To build up a reserve against unforeseen contingencies” (*the precautionary motive*)
- (2) “To provide for an anticipated future relationship between the income and needs of the individual...” (*the life-cycle motive*)
- (3) “To enjoy interest and appreciation...” (*the intertemporal substitution motive*)
- (4) “To enjoy a gradually increasing expenditure...” (*the improvement motive*)
- (5) “To enjoy a sense of independence and the power to do things, though without a clear idea or definite intention of specific action” (*the independence motive*)
- (6) “To secure a masse de manoeuvre to carry out speculative or business projects” (*the enterprise motive*)

- (7) “To bequeath a fortune” (*the bequest motive*)
- (8) “To satisfy pure miserliness, i.e., unreasonable but insistent inhibitions against acts of expenditure as such” (*the avarice motive*)
- (9) To accumulate deposits to buy houses, cars, and other durables (*the down payment motive*)

This list shows recognition of considerable heterogeneity in the motives for saving (Browning & Lusardi, 1996). It is unlikely that one motive will be sufficient for all members of a population at a given time or for the same person over a long period of time. Many of the motives are complementary. Households saving for retirement, or the life-cycle motive, may also build up financial reserves that can be used to buffer pre-retirement income or consumption shocks, which is the precautionary motive.

There are two reasons why it is important to analyze household motives for saving (Horioka & Watanabe, 1997). First, it provides a better understanding of the saving behavior of households, differences among household saving rates, factors influencing the level of household saving, trends in the household saving rate, and a variety of other issues related to saving. Second, analyzing the motives for which households save provides information on which economic model is of greater applicability in the “real world.” A number of theoretical and simulation studies have analyzed saving for selected motives such as retirement (Modigliani & Brumberg, 1954), precautionary reasons (Leland, 1968), and saving for the purchase of a house (Artle & Varaiya, 1978; Slemrod, 1982; Hayashi et al., 1988), but empirical studies of saving for specific motives have been few (Horioka & Watanabe, 1997).

Theoretical economic models have suggested several motives for saving including retirement, bequest, and “rainy days.” Retirement as a saving motive was suggested by the life-cycle hypothesis (Ando & Modigliani, 1963; Modigliani & Brumberg, 1954). The bequest motive was inherent in Friedman’s permanent income hypothesis (Friedman, 1957). The third motive proposed by economists is precautionary saving. There are two limitations of these economic models (Xiao & Anderson, 1997). First, each model includes only one motive when examining saving behavior. Second, different components of saving are treated as interchangeable.

Some studies have investigated the importance of motivations to save (Canova et al., 2005). Katona (1975) showed that in the United States in the 1960s, people saved for emergencies, to have funds in reserve for necessities, for retirement or old age, for their children’s needs, to buy a house or durable goods, and for holidays. Xiao and Noring (1994) examined eight motives reported by consumers and found them to be associated with family financial resources. As household resources increased, respondents tended to report different motives for saving, which was interpreted as reflective of hierarchical household financial needs based on Maslow’s (1954) theory. Several studies have investigated the precautionary saving motive (Kotlikoff, 1989). Horioka and Watanabe (1997) found the retirement motive and two precautionary motives, illness and peace of mind, to be of dominant importance in the net saving of Japanese households.

Huston and Chang (1997) found that having saving motives for emergencies increases the likelihood of holding adequate emergency funds. Chen and DeVaney (2001) also found a positive relationship between having saving motives and the adequacy of quick and comprehensive emergency funds. Harris, Loundes, and Webster



(2002) found the most frequently indicated reasons for saving among Australian families were retirement, holidays, and rainy days. The next four motives, in order, were: investing for a house, paying back debts, providing for children's education, and purchasing durable goods. Webley et al. (2000) compared the saving motives of Italians, English, and Israeli respondents. Italians were relatively more inclined to save as much as possible, with important motives being saving for children's education and for medical care. The English respondents indicated saving for future purchases was more important.

Saving motives are not necessarily exclusive – households may save for precautionary reasons but with the reasonable expectation that unspent balances will be passed on to children (Smith, 1999b; Dynan et al., 2002). Wörneryd (1995) distinguished four motives for saving and stressed that individuals can save for one or more motives at the same time. The first motive is labeled as “saving as a continuous habit” which is a well established habit of saving not related to a specific goal. The second is due to uncertainty about the future and is labeled the precautionary motive. The third motive is the bequest motive, which is saving for the well-being of the family after death. The final motive is the “profit motive” and consists of the desire to make an income from money put aside. The multiple regression analysis results indicate that saving as a continuous habit and precautionary savings contribute significantly to explaining the variance of the total sum of money saved.

Canova et al. (2005) analyzed the goals motivating the decision to save and examined the links between the goals. Participants were first asked to give personal reasons for why they hold that particular focal goal, and then why the reasons were important to them. Using network analysis, Canova et al. (2005) developed a structured

network including sequences of reasons explaining why one holds a saving goal. Fifteen salient goals were identified and were found to function hierarchically, with more concrete motivations at the bottom of the hierarchy. These include saving for a better house, a new car, or vacation, saving in order to have a buffer, and retirement saving. The hierarchical structure developed shows that goals of a psychological nature are found at the higher levels: self-gratification and self-esteem. Considering the hierarchy of the motivations as a cognitive schema indicates that the structure of saving motives may not depend entirely on socio-demographic variables. One limitation is that the sample is not representative of the general population and therefore the results cannot be widely generalized.

Others have proposed hierarchical structures of saving motives. Lindqvist (1981) proposed a structure of reasons for saving where at the lowest level is the need to handle cash to deal with short-term financial goals and at the second level the need to have a precautionary reserve of money. The third level includes a large amount of money to buy something expensive and at the top level is the need to manage accumulated wealth. The various levels of reasons for saving correspond to different types of savers. Xiao and Olson (1993) use Maslow's (1954) theory along with other theories and divide household financial assets into three groups: Account 1 (checking and saving accounts, certificates of deposit, and money market accounts), Account 2 (individual retirement accounts, Keogh plans, various saving plans, and other financial assets, and Account 3 (mutual funds, bonds, and stocks, excluding those in Accounts 1 and 2). The marginal propensities to consume from Account 1 were found to be the greatest, while those from

Account 3 were the smallest. This was interpreted as reflecting hierarchical financial needs. Different household assets may have different meanings for each consumer.

Xiao and Noring (1994) explored the nature between consumers' perceived motives for saving and household financial resources. Low-income consumers were found to be more likely to report saving for daily expenses, while the middle-income group was more likely to report saving for emergencies, and the high-income group was more likely to report saving for growth. Controlling for assets and net worth, the same patterns emerged. Xiao and Anderson (1997) used asset shares as a proxy for financial needs to explore associations between financial assets and needs. Shares of twelve household financial assets show three distinctive patterns as the level of total financial assets increases. These patterns can be interpreted as reflecting three family financial needs: survival, security, and growth. The findings imply a hierarchy of household financial needs represented by shares of various financial assets.

Xiao and Anderson (1997) used Maslow's (1954) hierarchy of needs theory, Lancaster's (1966) new consumer demand theory, and prospect theory (Kahneman & Tversky, 1979). Maslow's (1954) theory assumes that human needs are hierarchical and people attempt to fill higher-level needs after lower-level needs have been met. Human needs are categorized as being of two types: a deficit or lower level need and a growth need that is at a higher level. People first pursue deficit needs, where the more they get, the less they want. When these deficit needs are met, people will pursue growth needs, where the more they get, the more they want (Alderfer, 1989; Maslow, 1955). Xiao and Anderson (1997) categorize financial needs as survival, security, and growth. Survival and growth needs have the same characteristics as Maslow's (1954) deficient and growth

needs, respectively. As an individual's financial resources increase, demand for survival needs decrease, but growth needs increase. Security needs combine characteristics of survival and growth needs, which implies that the demand for security needs will increase when resources increase to a certain point, then decrease. Survival and security in the model of Xiao and Anderson (1997) follow the component of security in BPT (Shefrin & Statman, 2000), while growth follows the component of potential. The concept of aspirations, or goals, is unique to BPT.

### **2.3.12 Control Variables**

#### **SP/A Variables**

Chang (1994) found that those with a high level of risk tolerance accumulated more non-housing wealth than those with low risk tolerance. Conversely, a study by Lusardi (1998) indicates that households whose respondent is more risk-averse, or has a lower level of risk tolerance, accumulate more. Saving has been found to be higher among those who hold stocks and bonds (Avery & Kennickell, 1991; Bosworth, Burtless, & Sabelhaus, 1991). The amount of money a household would like to have for emergencies, or the desired emergency fund, and the number of saving motives a household has will be used as proxies for potential and aspirations.

#### **2.3.12.1 Demographic Variables**

In addition to consumption expenditure affecting individual utility, many other variables are also likely to affect utility (Attanasio & Banks, 2001). Therefore, these variables are controlled for in order to more accurately assess the relationships of interest.

One demographic factor found to be related to saving is household composition (Browning & Lusardi, 1996; Attanasio & Banks, 2001). In their logit analysis, Lee, Park, and Montalto (2000) found saving to be related to family life-cycle stages.

### Age

Household saving appears to be related to the household head's age (Chang, 1994; Lee et al., 2000). Chang and Huston (1995) found age to be positively associated with adequacy of intermediate emergency funds, as did Huston and Chang (1997). Holding other variables at their mean values, predicted saving increases with age (Chang, 1994). Age may also serve as a proxy for longevity or mortality risk, which Kennickell and Lusardi (2003) found to be significantly related to precautionary savings. Hubbard, Skinner, and Zeldes (1994; 1995) found age to have little effect on behavior.

### Education

Theoretical models do not predict that low saving should exist among those with lower levels of education (Browning & Lusardi, 1996). However, saving has been shown to be higher among higher education groups (Avery & Kennickell, 1991; Bernheim & Scholz, 1993; Attanasio, 1993; Engen et al., 2000; Lee et al., 2000), and education may be correlated with tastes toward saving (Mayer, 1972). In a study by Solmon (1975), both average and marginal propensities to save tended to rise with educational attainment with all other things being equal. When investigating saving across education groups, Attanasio (1993) examined cohorts and found that the age profile of saving is hump-shaped for each education group, but is especially high among highly educated households. Education has been found to be positively associated with adequacy of intermediate emergency funds (Chang & Huston, 1995; Huston & Chang, 1997). Chen

and DeVaney (2001) found a positive relationship between education and adequacy of quick and comprehensive emergency funds. A factor related to saving is time preference (Deaton, 1991; Carroll, 1992) and education is one way to proxy for this concept.

### Race

White households are consistently found to save more than black or other ethnic households (Avery & Kennickell, 1991; Lee et al., 2000) even when the households are otherwise similar (Lee et al., 2000). Black householders have been found to be less likely to have adequate intermediate emergency funds (Chang & Huston, 1995; Huston & Chang, 1997). Chen and DeVaney (2001) found a positive relationship between being white and the adequacy of quick and comprehensive emergency funds.

### Children

Households with dependent children have been shown to be more likely to spend more than income (Lee et al., 2000). Mason (1975) found that larger family size was associated with lower levels of saving, holding income and other demographic variables constant, and household size has been found to have a negative effect on the probability of meeting emergency fund guidelines (Chang & Huston, 1995).

### Income

A strong positive relationship has been found between income and saving (Browning & Lusardi, 1996). Hefferan (1982) found that the decision to save is primarily influenced by income and the amount of saving is adjusted for an estimate of consumption needs. A large proportion of aggregate saving is due to families in the top income decile (Avery & Kennickell, 1991). Bosworth, Burtless, and Sabelhaus (1991) found that the level of saving is generally negative for the first and second income

quintile and is the highest in the top quintile. Davis and Schumm (1987) found that beyond a threshold level, savings rise rapidly as income increases.

Some of the correlation that has been observed between income and saving can be attributed to measurement error in income when saving is defined as income minus consumption (Browning & Lusardi, 1996). The idea of consumption smoothing gives a positive correlation between current income and saving because transitory income shocks lead to a higher current income and increased saving. However, the observed positive correlation between income and the level of saving is believed to be due to factors other than these. Households with higher income have more resources to set aside and may be more likely to be successful in investing and managing their money (Chang, 1994).

#### Home Ownership

Saving is typically higher for homeowners (Avery & Kennickell, 1991; Bosworth et al., 1991). Chen and DeVaney (2001) found a positive relationship between homeownership and the adequacy of quick and comprehensive emergency funds.

### **2.4 Hypotheses**

The idea that people do not act optimally when making decisions under uncertainty is captured by Prospect Theory, developed by Kahneman and Tversky (1979), and its concept of loss aversion. The effects of positive and negative expected income growth on saving are expected to be asymmetric, with a greater effect of negative expected income growth. Uncertainty is expected to have a positive effect on saving.

*Hypothesis 1a:* Holding other things constant, having expected per-period income above the reference level is significantly and positively related to the likelihood of saving.

*Hypothesis 1b:* Holding other things constant, having expected per-period income below the reference level is significantly and negatively related to the likelihood of saving.

*Hypothesis 1c:* Holding other things constant, the absolute value of the effect of having expected per-period income below the reference level on the likelihood of saving is greater than the absolute value of the effect of having expected per-period income above the reference level.

*Hypothesis 2:* Holding other things constant, uncertainty will significantly and positively affect the likelihood of saving.

Saving motives are expected to affect the likelihood of saving based on the idea of a hierarchy of need.

*Hypothesis 3:* Holding other things constant, saving motives will significantly affect the likelihood of saving.

The measure of saving used in this study is based on saving over the past year, which is a short-term measure. For this reason, horizon is introduced into the model. The suggestion that there may be a hierarchy of need in saving behaviors is part of behavioral portfolio theory, also based on Prospect Theory. If households have a short saving horizon, it is possible that their saving motives are more focused on immediate needs such as an emergency fund. Households with longer saving horizons may be more likely to focus on longer term goals, or those related to potential, such as a bequest.

*Hypothesis 4:* Holding other things constant, saving horizon has a significant effect on the likelihood of saving.

*Hypothesis 5:* Holding other things constant, the effect of savings motives on the likelihood of saving will differ by saving horizon.



Hypotheses	Variable	Expected Effect
H1a	Per-period income above normal income	+ * <sup>a</sup>
H1b	Per-period income below normal income	- * <sup>b</sup>
H1c	Effect of below relative to effect of above	$b > a$
H2	Income uncertainty	+ **
H3	Saving Motives	+ or - **
H4	Horizon	+ **
H5	Interaction between Saving Motives and Long Horizon	+ or - **

\* indicates significant effect of individual variable

\*\* indicates significant effect of group of variables

Table 2.1 Hypothesized effects of variables on the likelihood of saving

## CHAPTER 3

### DATA AND METHODOLOGY

This chapter presents the dataset and sample that are used in the study. The specification of the empirical model and the statistical approach to the tests of the hypotheses are also presented.

#### **3.1 Data and Sample**

The dataset used will be the 2004 Survey of Consumer Finances. The Survey of Consumer Finances (SCF) is a triennial interview survey of U.S. families sponsored by the Board of Governors of the Federal Reserve System along with the U.S. Department of the Treasury (Aizcorbe, Kennickell, & Moore, 2003). The Survey of Consumer Finances data have been collected since 1983. Data for the SCF have been collected by NORC, a research organization at the University of Chicago, since 1992. The survey is designed to provide information on the financial characteristics of U.S. households. These data include detailed information on American households' assets and liabilities, and use of financial services along with information on pensions, labor force participation, and demographic characteristics as of the time of the interview. The interviews occur

between May and December of each survey year (Aizcorbe et al., 2003). The SCF also collects information on total cash income before taxes for the calendar year preceding the survey.

The survey is expected to provide reliable information on components of wealth that are broadly distributed in the population along with components that are highly concentrated in a relatively small portion of the population (Bucks, Kennickell, & Moore, 2006). This is attained by employing a sample design that consists of two parts. The first is an area-probability sample, a geographically based random sample intended to provide good coverage of assets that are broadly distributed in the population, such as home ownership. The second is called the list sample, a supplemental sample which disproportionately includes wealthy families, who hold a relatively large share of less commonly held assets such as non-corporate businesses and tax-exempt bonds. In the 2004 survey, 4,522 families were interviewed. Of these, 3,007 were from the area-probability sample, and 1,515 were from the list sample.

The SCF sample is not an equal-probability design, so weights play a critical role in interpreting the survey data (Board of Governors of the Federal Reserve System, 2006). The main data set contains the final nonresponse-adjusted sampling weights, which are intended to compensate for unequal probabilities of selection in the original design and for unit nonresponse, or failure to obtain an interview. The weight is a partially design-based weight constructed at the Federal Reserve using original selection probabilities and frame information along with aggregate control totals estimated from the Current Population Survey.

The Federal Reserve Board employs multiple imputation techniques to deal with the problem of missing responses (Kennickell, 1997). Multiple imputation uses stochastic multivariate methods to replace each missing value with two or more values generated to simulate the sampling distribution of the missing values. The purpose of this process is to obtain the best possible estimates of the true but unobserved values of data which are missing. For analysis, the multiply imputed values are averaged to provide the best estimate of what the results would have been if the missing data had been observed, and variance estimates are corrected for uncertainty due to missing values. Most of the SCF variables that originally contained missing values have been imputed five times by drawing repeatedly from an estimate of the conditional distribution of the data. The multiple imputation technique produces five complete data sets which are referred to as “implicates” (Board of Governors of the Federal Reserve System, 1996). Thus, the 2004 SCF consists of five complete implicates, and the number of observations in the full data set is five times the actual number of respondents. All five implicates are used for this study.

When imputation techniques are used to fill in missing data, extra variability will be found in the data due to the missing values (Montalto & Sung, 1996). This variability can be incorporated into empirical estimates through the use of "repeated-imputation inference" techniques which estimate this variability. The coefficients and estimates of variance derived by RII techniques allow for more valid inference and tests of significance. It has been recommended that researchers use RII techniques in order to produce estimates which incorporate variability in the data due to missing values (Rubin, 1987; Montalto & Sung, 1996). RII techniques will be used for the logistic regression

analyses in this study. The pooled data, which does not account for the variability in the data due to missing values, will be used for the likelihood ratio tests, ANOVA, chi-square, and t-tests.

The descriptive analyses in this study are weighted using the SCF final nonresponse-adjusted sampling weights to produce point estimates that are nationally representative. The logistic regression analyses will not be weighted. Kennickell and McManus (1993) and Montalto (1998) have discussed disadvantages of using the weight variable in multivariate analyses since the weights are constructed from variables such as income that are commonly used in such analyses.

The sample will be limited to non-retired respondents due to the fact that retirees would be expected to have different saving behaviors than non-retirees. In their study of precautionary savings and wealth, Kennickell and Lusardi (2003) found that the desired precautionary saving differs between persons under 62 and persons 62 and older. Individuals from the U.S. and Britain have been found to reduce consumption at retirement (Hurd & Rohdwedder, 2003). After removing households in which the respondent or spouse (if present) was retired, the weighted sample size is 88,998,670 respondents, with an unweighted sample of 3,694 respondents.

## **3.2 Methods**

This section presents the statistical techniques that will be used.

### **3.2.1 Descriptive Statistics**

The effect of saving motives on the likelihood of saving is expected to differ among the three saving horizon groups. Descriptive statistics for the variables included

in the model will be presented, and chi-square, ANOVA, and t-tests will be used to test for significant differences in the variables among the short, medium, and long horizon groups. A chi-square test will be used for dichotomous variables, while ANOVA will be used for continuous variables. Significant differences among the saving horizon groups will first be investigated, after which pairwise differences will be tested. Chi-square will be used for dichotomous variables to test whether there is a significant pairwise difference. For the continuous variables, Tukey's test will be used to evaluate whether differences between pairs of means are significantly different, such as whether there is a significant difference in the mean desired emergency fund between the short and medium horizon groups.

### **3.2.2 Logistic Regression Analysis**

The form of the logistic model is similar to that of the traditional linear regression model in that its equation is of the form  $Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_k X_k$  (Jaccard, 2001). The differences between the two can be better understood by describing each as a special case of the generalized linear model (McCullagh & Nelder, 1989). There are three components of the generalized linear model: a random component, a systematic component, and a link component (Agresti, 1996). The random component refers to the outcome variable, and the probability distribution associated with it (Jaccard, 2001).  $Y$  is a continuous variable in traditional regression analysis, while in classic logistic regression,  $Y$  is dichotomous with an underlying binominal probability distribution. The systematic component refers to the predictor variables and how they are combined to build the explanatory model. The systematic component,  $\alpha + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_k X_k$ ,

includes an intercept ( $\alpha$ ), regression coefficients ( $\beta$ ), and predictors, denoted by  $X$ . This systematic component is often called a linear predictor. A given  $X$  can be a combination of other predictors, such as  $X_3 = (X_1)(X_2)$ , to accommodate interactions or curvilinear effects in the model. The link component specifies how the mean of  $Y$ ,  $\mu = E(Y)$  is related to the systematic component or linear predictor. This mean can be modeled directly or a monotonic function of the mean can be modeled. A general expression is  $g(\mu) = \alpha + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_k X_k$ , where the function  $g(\mu)$  represents some function of the mean and is called the link function.

Logistic regression does not model the mean of  $Y$  directly, but models the mean as transformed by a logit link, which is defined as  $\ln(\mu/(1 - \mu))$  (Jaccard, 2001). For a dichotomous variable  $Y$  with values of 1 and 0, the model focuses on how the natural log of the odds that  $Y = 1$  varies as a function of the linear predictor  $\alpha + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_k X_k$ . For a dichotomous variable,  $Y$ , the probability that  $Y = 1$  is denoted as  $\pi$ . The term  $\text{logit}(\pi)$  refers to the logit function of this probability and equals the natural log of  $\pi/(1 - \pi)$ . The model that describes the relationship between  $\text{logit}(\pi)$  and the set of predictors  $X$  is  $\text{logit}(\pi) = \alpha + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_k X_k$ . This equation describes the log odds that  $Y = 1$  as a function of the values of the predictors,  $X$ .

The intercept of the logit model,  $\alpha$ , is the predicted log odds when all predictor variables are equal to zero (Jaccard, 2001). For a dummy variable coded as 0 or 1, the exponent of the logistic coefficient will equal an odds ratio in which the predicted odds for the group scored 1 on the dummy variable is divided by the predicted odds for the reference group, holding all other predictor variables constant. For a continuous variable, the exponent of the logistic coefficient equals a multiplicative factor by which the

predicted odds change given a 1 unit increase in the predictor variable, holding all other predictor variables constant. When the logistic model contains interaction terms, the logistic coefficient for a dummy variable X that is part of a product term XZ is conditioned to the reference group Z. The exponent of the logistic coefficient for X is the odds ratio that divides the predicted odds for the group scored 1 by the predicted odds by the group scored 0 for the case where the dummy variables on Z equal zero. The exponent of the logistic coefficient for a product term XZ, where X is the focal independent variable and Z is the moderator, is a ratio of predicted odds ratios. This ratio focuses on the predicted odds for the group scored 1 on the dummy variable for X divided by the predicted odds for the reference group on X and divides this odds ratio when computed for the group scored 1 on the dummy variable for Z by the corresponding odds ratio for the reference group on Z.

The logit, odds, and probability are three different ways of expressing the same thing, though the probability or the odds is probably most easily understood (Menard, 1995). For a dichotomous variable with scores of 1 and 0, the odds of having a score of 1 is  $\mu/(1 - \mu)$ , where  $\mu$  is the mean and equals the proportion with a score of 1 (Jaccard, 2001). An odds can be converted to a probability, where probability = odds/(1 + odds). A probability can also be converted to an odds, where odds =  $P/(1 - P)$ . A predicted value of  $\text{logit}(\pi)$  can be calculated for any given profile of predictor variables by substituting the values of the predictors into the equation. The exponent of this value provides the predicted value in odds, which can be converted to a predicted probability.



### 3.2.3 Likelihood Ratio Test

To determine whether certain variables or groups of variables in the model are significant, a likelihood ratio test is used to compare the models with and without the variable(s) of interest, based on the log likelihood function (Hosmer & Lemeshow, 2000). This allows for the testing of whether the inclusion of certain variables or a group of variables significantly improves model fit over and above the case where the variables are not included in the model (Jaccard, 2001). The likelihood ratio test also allows for testing of an omnibus effect of a set of variables or a set of interactions, while the logistic coefficients associated with each individual term may be statistically nonsignificant. The most accurate method to evaluate the statistical significance of the contribution of an independent variable to the explanation of a dependent variable is the likelihood ratio test (Menard, 1995). Statistical packages generally use a less computationally intensive alternative to the likelihood test, the Wald statistic, to test for the statistical significance of the individual coefficients. The disadvantage of the Wald statistic is that, for large beta, the estimated standard error is inflated, resulting in failure to reject the null hypothesis when the null hypothesis is actually false.

A likelihood ratio test uses minus twice the log likelihood ratio to obtain a quantity whose distribution is known and can be used for hypothesis testing purposes (Hosmer & Lemeshow, 2000). The comparison using the likelihood function is based on the following:

$$G = -2\ln[(\text{likelihood of the restricted model}/\text{likelihood of the full model})].$$

The quantity inside the brackets is called the “likelihood ratio.”

Under the hypothesis that the omitted variable or group of variables is equal to zero, the statistic  $G$  follows a chi-square distribution with  $n$  degrees of freedom. The degrees of freedom will be equal to the number of variables omitted from the full model to get the restricted model. The likelihood ratio test can be performed using the values for  $-2\log L$  on the SAS output. The value of  $-2\log L$  of the full model is subtracted from the value of  $-2\log L$  of the restricted model, with degrees of freedom equal to the number of variables omitted in the restricted model.

### **3.3 Empirical Specification**

This section presents the empirical models used to investigate the research questions.

#### **3.3.1 Empirical Model**

Logistic regression will be used since the dependent variable is dichotomous. Logistic regression does not assume linearity of the relationship between the independent variables and the dependent variable, does not require normally distributed variables, and does not assume homoscedasticity (Menard, 1995; Hosmer & Lemeshow, 2000). This method requires that observations are independent and that the logit of the independent variables is linearly related to the dependent variable. In addition, coefficients within the model will be compared, for which logistic regression is more appropriate than probit.

Multivariate logistic regression will be used to investigate several factors which the theories state will affect the likelihood of saving. The effect of expected per-period income and uncertainty on the likelihood of saving will be explored. Effects of saving

motives on the likelihood of saving and the variation by saving horizon will also be investigated.

### **3.3.2 Variables**

#### **1) Dependent Variable**

Saving can be defined as the change in wealth over a certain time period or as the difference between income and consumption (Browning & Lusardi, 1996). In the SCF, respondents are asked whether spending exceeded income, was about the same as income, or was less than income over the past year. The response to this question will be used to create a dichotomous dependent variable. The dependent variable is coded as 1 if spending, excluding investments, was less than income over the past year (indicating the household had the potential to save over the past year), and 0 if spending was equal to or more than income over the past year (indicating the household did not have the potential to save).

#### **2) Explanatory Variables**

According to prospect theory/loss aversion, consumers base their consumption and saving on a reference level of consumption, and adjust their consumption in the presence of uncertainty. The concept of loss aversion in a consumption-savings model is based on a consumer who faces uncertainty over future income (Bowman et al., 1999). The review of the theories suggests that saving behavior is affected by uncertainty, including income uncertainty, employment uncertainty, and health uncertainty (Sandmo, 1970; Davies, 1981; Zeldes, 1989; Deaton, 1991; Carroll, 1994; Palumbo, 1999;

Kennickell & Lusardi, 2003). Security, potential, and aspirations from behavioral portfolio theory will be controlled for along with other control variables listed below.

#### *Expected Per-Period Income*

The literature based on prospect theory, particularly the aspect of loss aversion, indicates that individuals do not like to consume below a certain reference level and resist decreasing consumption. If so, consumers will only save when they have income in excess of what is needed to finance the reference level of consumption. When expected per-period income is above the reference level a household is expected to save, while if expected per-period income is below the reference level a household is not likely to save since there is resistance to consuming below the reference level.

The empirical measure of expected per-period income is based on two questions SCF respondents are asked. First, respondents indicated whether their income over the past year was high, low, or about the same compared to normal income. “Normal income” will proxy the reference level of first period income. Respondents were also asked if they think their income will go up more than, less than, or the same as prices in the next year. Responses to this question will be used to proxy second period income relative to the reference level.

Second period income: Expect income in the next year to increase:	First period income: Income over the past year compared to normal income		
	High	About the Same	Low
More than prices	(1) above	(3) above	(9) reference category
About the same	(2) above	(8) reference category	(5) below
Less than prices	(7) reference category	(6) below	(4) below

Table 3.1. Empirical measure of expected per-period income.

Two dichotomous variables will be created to measure expected per-period income relative to the reference level: above and below. As shown in Table 3.1, if (1) first period income is above normal and second period income is expected to increase more than prices, or (2) first period income is above normal and second period income is expected to keep pace with prices, or (3) first period income is normal and second period income is expected to increase more than prices then the indicator for “above” is equal to 1. The indicator for “below” is equal to 1 if (4) first period income is below normal and second period income is expected to increase less than prices, or (5) first period income is below normal and second period income is expected to keep pace with prices, or (6) first period income is normal and second period income is expected to increase less than prices.

The reference group will be households whose expected per-period income is not above or below normal. This includes the following cases: (7) first period income is above normal and second period income is expected to increase less than prices, or (8) first period income is normal and second period income is expected to keep pace with

prices, or (9) first period income is below normal and second period income is expected to increase more than prices.

### Variables Related to Uncertainty

#### *Income Uncertainty*

Respondents are asked whether they have a good idea of income next year. This response will be used to proxy income uncertainty. This will be included as a dichotomous variable, with households indicating they do not have a good idea of income next year coded as a 1, and 0 otherwise.

#### *Unemployment*

An indicator for whether the respondent and/or spouse (if present) is either currently unemployed or has been unemployed over the past 12 months will be used to proxy uncertainty, with a 1 indicating current unemployment or unemployment over the past year, and 0 otherwise.

#### *Self Perceived Health Status*

Respondents are also asked a question regarding their health status, and this question will be used as a proxy for health uncertainty. Two dichotomous variables will be included: fair health and poor health. If the respondent and/or spouse/partner (if present) report their health as fair, the fair health variable will be coded as 1, and 0 otherwise. The poor health variable will be coded as 1 if the respondent and/or spouse/partner (if present) reports to be in poor health, and 0 otherwise. Good to excellent health for the respondent and/or spouse/partner (if present) will be the reference category.

### *Marital Status*

Marital status will be included as five dichotomous variables: married, living with a partner, separated/divorced, widowed, and never married. Each variable will be coded as 1 if the household head falls into that category, and will be 0 otherwise. The reference category will be household heads who are married. Those who are divorced, widowed, or never married may be subject to more risk than those who are married.

### *Less than Two Earners*

A dichotomous variable will be included for having less than two earners in the household, based on the respondent and spouse/partner, if present. The variable will be coded as 1 if there are not two earners in the household, and will be 0 otherwise.

Households with two earners may be exposed to less risk than those with one or less than one earner.

### *Self-Employment*

A dichotomous variable will be included to indicate if the respondent or spouse is self-employed, and will be coded as 1 if either the respondent or spouse is self-employed, and 0 otherwise.

## Variables Related to Saving Motives

In the SCF, respondents are asked their most important reasons for saving, and can provide up to six reasons.

### *Precautionary Saving Motive*

Kennickell and Lusardi (2003) consider four motives given by respondents in the SCF to be related to precautionary saving: (1) “emergencies/other unexpected needs”, (2)

“reserves in case of unemployment”, (3) “in case of illness, medical/dental expenses”, and (4) “to have cash available on hand/liquidity”. If respondents indicated any of these precautionary motives for saving as one of their six reasons for saving, the variable will be coded as 1. Otherwise the variable will be coded as 0.

*Down Payment Saving Motive*

Households indicating they have a motive to save for a down payment for a house, car, boat, other vehicle, or durable household goods will be coded as 1. Otherwise the variable will be coded as 0.

*Education Saving Motive – Self and/or Spouse*

One saving motive discussed by Browning and Lusardi (1996) is the improvement motive. A dichotomous variable will be included to indicate if the household has a directly indicated motive to save for education for self or spouse. A directly indicated saving motive to fund education will serve as a proxy for the improvement motive and will be coded as 1 if the household indicates such a motive as one of up to six reasons given for saving. This variable will be coded as 0 otherwise.

*Life-Cycle Saving Motive*

A dichotomous variable will be included for the life-cycle saving motive. The dichotomous variable will be coded as 1 if the household directly indicates that saving for a retirement is one of up to six reasons for saving, and 0 otherwise.

*Education Saving Motive – Children and/or Grandchildren*

A dichotomous variable will be included to indicate if the household has a directly indicated motive to save for education for children and/or grandchildren. This



will be coded as 1 if the household indicates such a motive as one of up to six reasons given for saving, and 0 otherwise.

#### *Bequest Saving Motive*

A dichotomous variable will be included for the bequest motive. It will be coded as 1 if the household directly indicates that giving to the family or providing an estate is one of up to six reasons for saving, and 0 otherwise.

#### *Saving for Foreseeable Major Expense*

A dichotomous variable will be included to indicate if the household is saving for a foreseeable major expense in the next 5 to 10 years, with a 1 indicating saving for a foreseeable major expense, and 0 otherwise.

### Control Variables Related to SP/A

There are three components within behavioral portfolio theory (BPT) that will be proxied for: security, potential, and aspirations. Risk tolerance serves as a proxy for both security and potential, with low risk tolerance representing the desire or preference for security and above average to high risk tolerance representing potential. The desired emergency fund of a household will also serve as a proxy for potential. To proxy for aspirations, the number of saving motives a household indicates to be important will be used.

#### *Risk Tolerance*

Risk tolerance will be used as a proxy for “security” and “potential” from BPT. The desire to avoid poverty, security, is represented by “low risk tolerance” which indicates that the household is not willing to take any financial risks. The desire to gain

riches, potential, is represented by “above average to high risk tolerance” which indicates that the household takes above average to substantial risks expecting to earn above average to substantial returns.

Three dichotomous variables will be included for the amount of risk the household is willing to take: (1) low risk tolerance, (2) average risk tolerance, and (3) above average to high risk tolerance. Low risk tolerance will be coded as 1 if the household is not willing to take any financial risk, and 0 otherwise. Average risk tolerance, which is the reference category, will be coded as 1 if the household is willing to take average financial risks expecting to earn average returns, and 0 otherwise. High risk tolerance will be coded as 1 if the household is willing to take above average to substantial financial risks expecting to earn above average to substantial returns, and 0 otherwise.

#### *Desired Emergency Fund*

To proxy for potential, the amount a household would like to hold in an emergency fund is used. Generally, financial planners suggest keeping enough funds for three months spending in the case of an emergency. Households with greater spending or aspirations could be expected to indicate a higher level of emergency fund. A continuous variable will be included for the amount of emergency fund savings a household desires to hold. The variable will be measured in \$1,000,000 due to the large size of the desired emergency fund relative to the dichotomous variables. Scaling the variable is necessary to enable convergence of the maximum likelihood model. There must be some overlap in the distribution of the covariates in the model in order to have finite maximum likelihood estimates (Hosmer & Lemeshow, 2000).

### *Number of Saving Motives*

A continuous variable will be included for the number of saving motives a household indicates to be important. Respondents could list up to 6 saving motives. The number of saving motives will be coded from 0 to 6 based on the response.

### Control Variables

#### *Age*

Age of the head is measured with a continuous variable.

#### *Number of Dependent Children*

A continuous variable will be included for the number of dependent children present in the household.

#### *Education*

Education will be measured with a continuous variable. Respondents are asked the highest grade in school or year in college they have completed. The value can range from 0 for no grades completed to 17 for having at least some graduate education.

#### *Race/Ethnicity*

Four dichotomous variables will be included for race/ethnicity: Non-Hispanic White, Non-Hispanic Black, Hispanic, and Non-Hispanic Other. The reference category in the regression analyses will be White. The variable will be coded as 1 if the respondent self-identifies into the category, and will be 0 otherwise.

#### *Income*

Annual household income, measured in 2003 dollars, will be a continuous variable. Household income will be measured in \$100,000 due to the large numbers for

income relative to the dichotomous variables. Scaling the variable is necessary to enable convergence of the maximum likelihood model. In order to have finite maximum likelihood estimates there must be some overlap in the distribution of the covariates in the model (Hosmer & Lemeshow, 2000).

#### *Home Ownership*

A dichotomous variable will be included to indicate if a household owns a home, with a 1 indicating the household owns a home, and 0 otherwise.

#### *Saving Horizon*

Three dichotomous variables will be included to control for a household's saving horizon since the dependent variable, saving, is based on short term saving over the previous year. Respondents are asked what time period is most important to them regarding plans for saving. The five response categories include: next few months, next year, next few years, five to ten years, and more than ten years. Medium will be coded as 1 if the household indicates that the period most important to them for saving and spending decisions is the next few years, and 0 otherwise. Long will be coded as 1 if the household indicates their most important period is five years or longer. Short horizon will be the reference category.

### **3.3.3 Estimating Equations**

The estimating equations follow. The table in Appendix A includes the names used for the variables along with variable definitions. Equation 1 includes two indicator variables for medium and long saving horizon. Equation 2 includes interaction terms between the saving horizon variables and the saving motive variables. According to

Brambor et al. (2005), each of the elements of the interaction term should be included individually as well. The independent saving motive variables will each serve as focal independent variables, while the variables for medium and long horizon will be moderator variables, with short horizon as the reference category.

$$(1) P(\text{Saved}) = A_0 + A_1 \text{ above} + A_2 \text{ below} + A_3 \text{ knowinc} + A_4 \text{ marst2} + A_5 \text{ marst3} + A_6 \text{ marst4} + A_7 \text{ marst5} + A_8 \text{ earners} + A_9 \text{ unemp} + A_{10} \text{ eselfemp} + A_{11} \text{ fairhlth} + A_{12} \text{ poorhlth} + A_{13} \text{ emergmotv} + A_{14} \text{ dwnpmotv} + A_{15} \text{ edumotv} + A_{16} \text{ cedumotv} + A_{17} \text{ retmotv} + A_{18} \text{ beqmotv} + A_{19} \text{ savexp} + A_{20} \text{ risktol1} + A_{21} \text{ risktol3} + A_{22} \text{ emergfund} + A_{23} \text{ numotvs} + A_{24} \text{ age} + A_{25} \text{ educat} + A_{26} \text{ race2} + A_{27} \text{ race3} + A_{28} \text{ race4} + A_{29} \text{ nkids} + A_{30} \text{ income} + A_{31} \text{ own} + B_{32} \text{ medium} + B_{33} \text{ long}$$

$$(2) P(\text{Saved}) = B_0 + B_1 \text{ above} + B_2 \text{ below} + B_3 \text{ knowinc} + B_4 \text{ marst2} + B_5 \text{ marst3} + B_6 \text{ marst4} + B_7 \text{ marst5} + B_8 \text{ earners} + B_9 \text{ unemp} + B_{10} \text{ eselfemp} + B_{11} \text{ fairhlth} + B_{12} \text{ poorhlth} + B_{13} \text{ emergmotv} + B_{14} \text{ dwnpmotv} + B_{15} \text{ edumotv} + B_{16} \text{ cedumotv} + B_{17} \text{ retmotv} + B_{18} \text{ beqmotv} + B_{19} \text{ savexp} + B_{20} \text{ risktol1} + B_{21} \text{ risktol3} + B_{22} \text{ emergfund} + B_{23} \text{ numotvs} + B_{24} \text{ age} + B_{25} \text{ educat} + B_{26} \text{ race2} + B_{27} \text{ race3} + B_{28} \text{ race4} + B_{29} \text{ nkids} + A_{30} \text{ income} + B_{31} \text{ own} + B_{32} \text{ medium} + B_{33} \text{ long} + B_{34} \text{ emergmotv*medium} + B_{35} \text{ emergmotv*long} + B_{36} \text{ dwnpmotv*medium} + B_{37} \text{ dwnpmotv*long} + B_{38} \text{ edumotv*medium} + B_{39} \text{ edumotv*long} + B_{40} \text{ cedumotv*medium} + B_{41} \text{ cedumotv*long} + B_{42} \text{ retmotv*medium} + B_{43} \text{ retmotv*long} + B_{44} \text{ beqmotv*medium} + B_{45} \text{ beqmotv*long} + B_{46} \text{ savexp*medium} + B_{47} \text{ savexp*long}$$

### 3.3.4 Estimation and Empirical Tests

Equation 1 will be estimated on the sample of non-retired households to examine whether a household's income relative to the reference level of income, uncertainty variables, and saving motives are significant in explaining saving behavior. Likelihood ratio tests will be used to test significance of coefficients.

*H1a:* To test whether having expected per-period income above the reference level is significantly related to the likelihood of saving, a likelihood ratio test will be used. The likelihood of Equation 1, the "full model," will be compared to that of the "restricted model" run without "above" to assess whether this variable is significant in explaining the likelihood of saving. The coefficient on "above" in the logistic regression model is expected to be positive.

*H1b:* Similar to the test for H1a, to test whether having expected per-period income below the reference level is significantly related to the likelihood of saving, a likelihood ratio test will be used. The difference of the likelihood of the full and restricted models, one with the "below" variable and one without, will be used for a likelihood ratio test to assess the significance of the variable. The coefficient on this variable in the logit model is expected to be negative.

*H1c:* To assess the asymmetry of the effect on savings of being above and below the reference level, the sign of the coefficients on  $A_1$  and  $A_2$  and the predicted probabilities when expected per-period income is above or below the reference level will be compared. The decrease in the probability of saving due to having expected per-period income below the reference level is expected to be greater than the increase in the probability of saving due to having expected per-period income above the reference level.

*H2*: A likelihood ratio test will be used to test if the group of uncertainty variables,  $A_3$  to  $A_{12}$ , has a significant effect on the likelihood of saving. The likelihood of the full model will be subtracted from the likelihood of the model excluding the group of uncertainty variables to get the likelihood ratio chi-square. The coefficients on the uncertainty variables are expected to be positive since uncertainty is expected to increase saving.

*H3*: A likelihood ratio test will be used to test if the group of saving motives,  $A_{13}$  to  $A_{19}$ , is significantly related to the likelihood of saving. The likelihood of the full model will be subtracted from the restricted model excluding the saving motive variables to obtain the likelihood ratio test statistic.

*H4*: A likelihood ratio test will be used to test if saving horizon is significantly related to the likelihood of saving. The likelihood of the full model will be subtracted from that of the restricted model excluding the two horizon variables in order to obtain the likelihood ratio chi-square.

*H5*: The saving motives found to be significant are expected to differ among those with short and long saving horizons. In order to compare the effects of saving motives for these groups, formal interaction analysis through product terms in a single equation will be used (Jaccard, 2001). A full model with interactions of each saving motive with the horizon variables (Model 2) will be estimated and compared to Model 1. A likelihood ratio test will be used to assess whether the interaction model is an improvement over the non-interaction model.

### **3.4 Interpretation**

Predicted probabilities will be calculated for cases of interest. These variables of interest are dummy variables, so the predicted probability of saving when turning the particular variable “on” will be compared to the predicted probability of the baseline model, shown in Table 3.2, in order to show how the variables are related to saving. The baseline model is based on the reference categories for each dichotomous variable, while continuous variables are set at the respective mean levels.

Predicted probabilities will be used to show the effect of individual variables and will follow the hypotheses. Hypotheses 1a to 1c investigate the effects of being above or below normal income on the likelihood of saving. Predicted probabilities will be used to investigate the effects of being above or below normal income. Hypothesis 2 is related to the effects of uncertainty on the likelihood of saving. The effects of each uncertainty variable on the predicted probability of saving will be explored. Hypothesis 3 expects that saving motives will affect the likelihood of saving, so predicted probabilities will be calculated to look at the effect of having these saving motives on the likelihood of saving. For example, the predicted probability of saving when having a motive to save for emergencies will be compared to the predicted probability of saving in the baseline model in order to illustrate how having this saving motive affects the probability of saving. Saving horizon, the subject of Hypothesis 4, will be explored by calculating the predicted probability of saving when horizon is medium and long, as compared to the baseline model which includes short horizon. To explore the focus of Hypothesis 5, the effect of saving motives by saving horizon, predicted probabilities will be calculated to



investigate the effect of having a short or long saving horizon and having each specific motive.

***Reference Categories***

Normal Income

Income Certainty

Married

Have 2 earners

No unemployment

Not self-employed

Good or Excellent Health

Saving Motives

No Emergency Fund Motive

No Down Payment Motive

No Education (self/spouse) Motive

No Retirement Motive

No Education (child/grandchild) Motive

No Bequest Motive

Not saving for any future expense

Average Risk Tolerance

Mean Emergency Fund (0.20)\*

Mean Number of Motives (1.57)

Mean Age (46.38 years)

Mean Education (14.06 years)

White

Mean Number of Dependent Children (1.07)

Mean Income (7.99)\*\*

Not a Homeowner

Short Horizon

\* Measured in \$1,000,000    \*\*Measured in \$100,000

Table 3.2. Baseline Model

## CHAPTER 4

### RESULTS

The results of the empirical analysis are presented and discussed in this chapter. The first section provides an overview of the non-retired U.S. household sample. The second section presents descriptive results for those with short, medium, and long saving horizons along with the logistic regression results for the likelihood of saving. In the third section, the likelihood ratio test results for the variables of interest are provided. The fourth section provides the predicted probabilities for the models, followed by a discussion of the results in the fifth section.

#### **4.1 Overview of the Non-Retired U.S. Household Sample**

Table 4.1 includes the weighted descriptive statistics of the variables included in the models for the sample and also shows the characteristics by saving horizon. About 57 percent of non-retired U.S. households reported to have spent less than income in 2003, indicating that these households had the potential to save. The expected per-period income of about 44 percent of the sample was about normal, while per-period income

was expected to be higher than normal for about 23 percent and was expected to be lower than normal for almost 34 percent of the sample.

About 37 percent of sample respondents reported to not have a good idea of income in the next year. Almost half of sample respondents (49.78 percent) were married at the time of the interview, with about 9 percent living with partner, 18.38 percent separated or divorced, about 5 percent widowed, and almost 18 percent never married. Almost 58 percent of households had less than two earners, and almost 21 percent of households had a respondent or spouse (if present) who was unemployed at the time or had been unemployed over the previous 12 months. About 17 percent of the sample had a self-employed respondent and/or spouse (if present). Around 20 percent of the sample had a respondent and/or spouse (if present) in fair health, with about 7 percent having a respondent and/or spouse (if present) in poor health.

The most frequently reported saving motive in the sample was saving for retirement (47.81 percent), and the second most frequently reported motive, with around 33 percent of the sample, was saving for emergencies. Almost 32 percent of the sample stated that they had a foreseeable major expense that they were saving for. About 17 percent of respondents reported to have a motive to save for the education of children and/or grandchildren, with almost 9 percent of respondents reporting a motive to save for education for themselves or their spouse/partner (if present). Around 13 percent reported to have a down payment saving motive, and about 6 percent indicated a bequest saving motive.

## **4.2 The Likelihood of Saving**

### **4.2.1 Descriptive Statistics by Saving Horizon**

#### **4.2.1.1 Households with a Short Saving Horizon**

About 47 percent of households with a short saving horizon reported to have spent less than their income over the past year. About 23 percent of those who reported that their most important period for saving is one year or less had expected per-period income higher than normal, and the expected per-period income was lower than normal for about 38 percent of the sample.

Almost 45 percent of households with a short saving horizon did not have a good idea of income in the next year. Around 39 percent of respondents in this group were married, about 11 percent with living with a partner, and around 21 percent were separated or divorced. About 6 percent of respondents with a short saving horizon were widowed and 21 percent were never married. Around 64 percent had less than two earners in the household, and nearly 27 percent of households had a respondent and/or spouse who was unemployed at the time or had been unemployed over the previous year. About 14 percent of respondents with a short saving horizon were self-employed, around 25 percent of households had a respondent and/or spouse in fair health, and about 9 percent of these households had a respondent and/or spouse in poor health.

About 38 percent of households with a short saving horizon reported to have a motive to save for emergencies. Almost 17 percent had a down payment saving motive, almost 9 percent had a motive to save for education for the respondent or spouse, and about 15 percent reported a motive to save for education for children and/or grandchildren. About 32 percent reported a retirement saving motive, while about 6

percent reported a bequest saving motive. Around 23 percent of households with a short saving horizon reported to be saving for a foreseeable major expense.

#### **4.2.1.2 Households with a Medium Saving Horizon**

About 52 percent of households with a medium saving horizon reported to have spent less than income over the previous year. About 23 of households in this horizon group had expected per-period income above the reference level, while around 34 percent reported expected per-period income to be lower than the reference level.

About 36 percent of households with a medium saving horizon did not have a good idea of income in the next year. Almost 50 percent of these household respondents were married, with about 8 percent living with a partner, about 18 percent separated or divorced, around 6 percent widowed, and about 18 percent never married. Around 59 percent had less than two earners in the household, and around 18 percent of households had a respondent and/or spouse who was unemployed at the time or had been unemployed over the previous 12 months. About 16 percent of households with a medium saving horizon had a respondent or spouse/partner who was self-employed. Around 21 percent of households reported that the respondent or spouse (if present) was in fair health, while about 7 percent had a respondent or spouse in poor health.

Nearly 33 percent of households with a medium saving horizon reported to have a motive to save for emergencies, with about 17 percent indicating a down payment saving motive. Around 8 percent of households reported to have a motive to save for education for the respondent and/or spouse (if present), and almost 19 percent reported a saving motive for the education of children and/or grandchildren. Almost 46 percent of

households indicated a retirement saving motive, and almost 7 percent had a bequest saving motive. Around 38 percent of households with a medium saving horizon reported to be saving for a major foreseeable expense.

#### **4.2.1.3 Households with a Long Saving Horizon**

About 68 percent of households reporting that the period most important to them for saving and spending decisions is five years or longer indicated that they had spent less than income over the past year. About 24 percent of households in this group reported expected per-period income to be higher than the reference level, with about 30 percent reporting that income was lower than the reference level.

Thirty percent of households with a long saving horizon did not have a good idea of income in the next year. Almost 60 percent of respondents in this group were married (58.22 percent), with around 7 percent living with a partner, almost 16 percent separated or divorced, around 4 percent widowed, and nearly 15 percent never married. Almost 52 percent of households with a long saving horizon did not have two earners, and around 17 percent of households reported that the respondent or spouse was unemployed at the time of the interview or had been unemployed over the previous year. About 20 percent of the long saving horizon households had a respondent or spouse who was self-employed. Nearly 16 percent had a respondent or spouse (if present) in fair health, while about 4 percent had a respondent or spouse in poor health.

Almost 30 percent of households with a long saving horizon had a motive to save for emergencies, with about 8 percent reporting to have a down payment saving motive. Around 9 percent had a motive to save for the education of the respondent or spouse,

with about 18 percent reporting to have a motive to save for the education of children or grandchildren. Of the households with a long saving horizon, almost 63 percent had a retirement saving motive and around 6 percent had a bequest motive. Almost 35 percent reported to be saving for a major foreseeable expense.

	Non-Retired Sample			
	Total Sample	Short Horizon	Medium Horizon	Long Horizon
Weighted N	88,998,670	29,583,996	23,554,467	35,860,207
Unweighted N	3694	1047	907	1740
Saved * $\diamond$ $\square$	57.14	47.31%	52.27%	68.47%
Per-period income compared to reference				
Above	23.44%	23.22%	22.63%	24.16%
Below * $\diamond$	33.81%	38.00%	34.34%	30.02%
Do not have good idea of income next yr * $\pm$ $\diamond$	36.57%	44.89%	36.02%	30.06%
Marital status *				
Married $\pm$ $\diamond$ $\square$	49.78%	39.47%	49.88%	58.22%
Living with partner $\diamond$	8.79%	11.33%	8.18%	7.10%
Separated/divorced $\diamond$	18.38%	21.49%	18.15%	15.96%
Widowed	5.33%	6.33%	6.00%	4.06%
Never married $\diamond$	17.72%	21.39%	17.78%	14.66%
Less than 2 earners * $\diamond$ $\square$	57.76%	63.96%	59.11%	51.75%
Unemployment * $\pm$ $\diamond$	20.68%	26.83%	18.02%	17.35%
Self-employed * $\diamond$	17.08%	14.04%	16.4%	20.02%
Health				
Fair health * $\diamond$	20.38%	25.45%	20.87%	15.87%
Poor health * $\diamond$	6.71%	9.57%	7.07%	4.11%
Emergency motive * $\diamond$	33.45%	38.42%	32.87%	29.73%
Down payment motive * $\diamond$ $\square$	13.47%	16.70%	17.19%	8.36%
Education for self/spouse motive	8.91%	8.78%	8.37%	9.38%
Retirement motive * $\pm$ $\diamond$ $\square$	47.81%	31.55%	45.85%	62.51%
Education for child/grandchild motive *	17.11%	14.67%	18.78%	18.03%
Bequest motive	6.38%	6.17%	6.64%	6.39%
Saving for foreseeable expense * $\pm$ $\diamond$	31.79%	23.24%	38.33%	34.55%

Continued

Table 4.1 Descriptive statistics by saving horizon.  
(Mean (standard error) for continuous variables; column percents)

Table 4.1 (continued)

Risk tolerance *				
Low $\pm \diamond \square$	38.79%	50.55%	38.69%	29.15%
Average $\pm \diamond$	39.24%	32.44%	42.25%	42.88%
Above average to high $\diamond \square$	21.97%	17.01%	19.06%	27.97%
Desired emergency fund (mean in \$1,000,000) * $\diamond$	0.0170 (0.0003)	0.0105 (0.0003)	0.0148 (0.0007)	0.0239 (0.0004)
Number of motives (Mean) * $\pm \diamond$	1.57 (0.0023)	1.49 (0.0010)	1.61 (0.0023)	1.62 (0.0047)
Age (Mean) * $\pm \diamond$	43.56 (0.0166)	42.21 (0.0405)	43.75 (0.0597)	44.53 (0.0489)
Education (Mean Years) * $\pm \diamond \square$	13.45 (0.0184)	12.70 (0.0165)	13.45 (0.0115)	14.09 (0.0216)
Race *				
Non-Hispanic White $\pm \diamond \square$	69.04%	58.43%	68.67%	78.03%
Non-Hispanic Black $\diamond$	13.96%	17.68%	13.80%	10.99%
Hispanic $\pm \diamond \square$	12.79%	20.15%	12.76%	6.73%
Other	4.21%	3.73%	4.77%	4.25%
Number of Dependent Children (Mean) * $\pm \diamond$	1.08 (0.0006)	1.15 (0.0030)	1.06 (0.0020)	1.03 (0.0032)
Income (mean in \$100,000) * $\pm \diamond \square$	.7176 (0.0064)	0.4648 (0.0024)	0.6300 (0.0031)	0.9847 (0.0115)
Homeowner * $\pm \diamond \square$	64.87%	51.87%	63.85%	76.27%
Saving Horizon				
Short	33.24%	100%	-	-
Medium	26.47%	-	100%	-
Long	40.29%	-	-	100%

Source: 2004 Survey of Consumer Finances. Statistics on categorical variables derived from weighted analyses of data pooled from all 5 implicates. Statistics on continuous variables derived from RII techniques.

\*indicates statistically significant difference among saving horizon groups at an alpha level of 0.05;  $\pm$  indicates statistically significant difference between short and medium saving horizon groups at an alpha level of 0.001;  $\diamond$  indicates statistically significant difference between short and long saving horizon groups at an alpha level of 0.001;  $\square$  indicates statistically significant difference between medium and long saving horizon groups at an alpha level of 0.001

Note: Chi-square test is used for categorical variables, and ANOVA is used for continuous variables.

#### 4.2.1.4 Comparison of Horizon Groups

##### Saving

As seen in Table 4.1, the descriptive statistics for those with short, medium, and long saving horizons show substantial differences. For example, 57 percent of households in the total sample saved, while only 47.3 percent of households with a short saving horizon reported to have spent less than income in the previous year. About 52



percent of households in the medium saving horizon group saved, and over two-thirds of the long saving horizon group (68.47 percent) saved. There is a statistically significant difference in saving among the three groups at an alpha level of 0.05. There are also statistically significant differences between the medium and long horizon groups and the short and long saving horizon groups in the proportion of households that saved, at an alpha level of 0.001.

#### Per-Period Income Compared to Reference Level Variables

The proportions of the saving horizon groups reporting to be above normal income were similar, while a greater proportion of the short saving horizon group reported to have an income below normal than the medium horizon group, which also had a greater proportion than the long saving horizon group. There is a statistically significant difference among the saving horizon groups for having expected per-period income below the reference level at an alpha level of 0.05. There is a statistically significant difference between the short and long horizon groups for the “below” variable at an alpha level of 0.001.

#### Uncertainty Variables

The difference in income uncertainty, or not having a good idea of income in the next year, is significantly different among the saving horizon groups at an alpha level of 0.05. There is a statistically significant difference between the short and medium horizon groups as well as between the short and long horizon groups for the “do not have a good idea of income in the next year” variable at an alpha level of 0.001. The short horizon group has the highest proportion to not have a good idea of income in the next year, with a smaller proportion in the medium horizon group and the smallest proportion in the long

saving horizon group. A greater proportion of the long saving horizon group is married, with a greater majority in the short horizon group living with partner, separated/divorced, and never married. The difference in marital status distribution is statistically significant among the saving horizon groups at an alpha level of 0.05. The proportion married is significantly different between the short and long horizon groups, short and medium horizon groups, and medium and long horizon groups at an alpha level of 0.001. There are significant differences between the short and long horizon groups in the proportions of respondents who were married, living with partner, separated/divorced and never married at an alpha level of 0.001.

A greater percent of households in the short horizon group have less than two earners. This proportion decreases in the medium horizon group and again in the long horizon group. There is a significant difference in the proportion of households with less than two earners among the horizon groups at an alpha level of 0.05. The difference in the proportions of respondents with less than two earners is statistically significant between the short and long horizon groups as well as between the short and medium horizon groups at an alpha level of 0.001. Unemployment is also significantly different among the three horizon groups at an alpha level at 0.05. There are significant differences between the short and medium horizon groups and the short and long horizon groups at an alpha level of 0.001. There is a significant difference in the proportion of households in fair health among the three horizon groups at an alpha level of 0.05, as well as the proportion of households in poor health. There is a significant difference between the short and long horizon groups in the proportion of respondents and/or spouse (if present) in fair health and poor health at an alpha level 0.001. The proportion that is self-

employed increases from the short horizon group to the medium horizon group, and the long horizon group has the highest proportion of self-employed respondent and/or spouse/partner (if present). This difference is statistically significant among the three horizon groups at an alpha level of 0.05 and there is a statistically significant difference between the short and long horizon groups at an alpha level of 0.001.

#### Saving Motive Variables

A greater percent of the short saving horizon group has an emergency motive as compared to both the medium and long saving horizon groups. The difference in the emergency motive is significantly different among the three horizon groups at an alpha level of 0.05, and the difference between the short and long horizon groups is statistically significant at an alpha level of 0.001. There is a significant difference in the proportion of households with a down payment motive among the three horizon groups. The medium saving horizon group has the highest proportion indicating they have a down payment saving motive, which is close to that of the short saving horizon group, and the long horizon group has a lower percentage of households indicating they have a down payment saving motive. There is a significant difference in the down payment motive between the short and long horizon groups as well as the medium and long horizon groups at an alpha level of 0.001. The percent indicating an education for self or spouse motive is similar across the horizon groups and there is no statistically significant difference. There is a significant difference in the proportion with a retirement saving motive across the three horizon groups, and the proportion with this motive increases as there is a move from short saving horizon to medium to long. The differences between the short and medium horizon groups, the short and long horizon groups, and the medium

and long horizon groups are statistically significant at an alpha level of 0.001. The percent of each group with a bequest motive is similar across the three horizon groups, and there are no statistically significant differences among the horizon groups or between pairs of the horizon groups. The proportion of each group saving for a foreseeable major expense is highest for the medium horizon group, followed by the long horizon group. The difference in the proportion with this motive is significant among the three horizon groups at an alpha level of 0.05. The short saving horizon group has the lowest proportion indicating to be saving for a foreseeable major expense. The difference between the short and medium horizon groups and the short and long horizon groups is statistically significant at an alpha level of 0.001.

#### Control Variables

About half of households in the short horizon group indicate their risk tolerance is low, while only about 30 percent of households in the long horizon group are in this category. The middle saving horizon group falls in between at 38.69 percent. The difference in risk tolerance among the three saving horizon groups is significant at an alpha level of 0.05 and there is a significant difference between the short and medium, short and long, and medium and long horizon groups at an alpha level of 0.001. There is a significant difference in the proportion of households with average risk tolerance among the three horizon groups. The difference between the short and medium horizon groups and short and long horizon groups is statistically significant at an alpha level of 0.001. About 17 percent of the short saving horizon group indicates their risk tolerance is above average to high, which increases to about 19 percent of the medium horizon group and almost 28 percent of the long horizon group. The difference in the proportion with

above average to high risk tolerance among the three horizon groups is statistically significant at an alpha level of 0.05, while there is a statistically significant difference between the short and long horizon groups and the medium and long horizon groups at an alpha level of 0.001.

The mean desired emergency fund increases from the short horizon group to the medium horizon group, and increases again in the long horizon group. There is a significant difference in the mean desired emergency fund among the three horizon groups at an alpha level of 0.05 and between the short and long horizon groups at an alpha level of 0.001. The mean number of saving motives a household holds increases as horizon changes from short to medium to long, and is significantly different among the three saving horizon groups at an alpha level of 0.05. The difference between the short and medium horizon groups and between the short and long horizon groups is significant at an alpha level of 0.001. The long saving horizon group is older than the medium horizon group, and the medium horizon group is older than the short horizon group. There is a significant difference in mean age among the three horizon groups at an alpha level of 0.05. The difference between the short and long saving horizon groups is significant at an alpha level of 0.001. Years of education increase as there is a move from short horizon to medium to long. The difference in mean years of education is significantly different among the three saving horizon groups at an alpha level of 0.05. There is a significant difference in mean years of education between the short and medium horizon groups, short and long horizon groups, and medium and long horizon groups, each at an alpha level of 0.001.

A greater proportion of the long horizon group is white compared to the other horizon groups, with a greater proportion of blacks and Hispanics in the short horizon group. There is a significant difference in the distribution by race among the three horizon groups at an alpha level of 0.05. The difference in proportion is significant between the short and medium horizon groups, the short and long horizon groups, and the medium and long horizon groups at an alpha level of 0.001. The mean number of children decreases from the short horizon group to the medium horizon group, and again in the long horizon group. This difference in the mean number of children is statistically significant among the three saving horizon groups at an alpha level of 0.05. There is a significant difference in the mean number of children between the short and medium horizon groups and the short and long saving horizon groups at an alpha level of 0.001. Income rises as horizon changes from short to medium to long. The difference in mean income is significantly different among the three saving horizon groups at an alpha level of 0.05. The difference in mean income is significant between the short and medium horizon groups, short and long horizon groups, and the medium and long horizon groups at an alpha level of 0.001. Home ownership rises as horizon moves from short to medium to long, and the difference among the three groups is significant at an alpha level of 0.05. The difference in the proportion of households owning a home is significant for the short and long horizon groups and the medium and long horizon groups at an alpha level of 0.001.

#### **4.2.2 Results of Logistic Regression**

The results of the logistic regression are obtained using RII techniques.

#### **4.2.2.1 Model 1**

Table 4.2 presents the logistic regression results of the likelihood of saving for Model 1, the model with no interactions, and Model 2, the model with interactions. After controlling for the three SP/A variables along with socioeconomic and demographic variables in Model 1, the following variables are statistically significant: having per-period expected income below the reference level, not having a good idea of income in the next year, being separated/divorced, widowed, or never married, unemployment, self-employment, poor health, education for children/grandchildren motive, saving for a foreseeable expense, low risk tolerance, years of education, being Black, number of children, income, being a homeowner, and having a long saving horizon.

##### Per-Period Income Compared to Reference Level Variables

As expected, having per-period expected income above the reference level was positively related to the likelihood of saving, though not at a significant level ( $p=0.0594$ ) while being below the reference level was significantly and negatively related.

##### Uncertainty Variables

The individual uncertainty variables were expected to have a positive effect on the likelihood of saving, based on the literature. However, all of the uncertainty variables except not having two earners and self-employment had a negative effect on the likelihood of saving. Being separated/divorced, widowed, or never married all had statistically significant, negative effects on the likelihood of saving, as did unemployment and poor health. Self-employment had a significant positive effect on the likelihood of saving.

### Saving Motive Variables

The individual saving motives were expected to increase the likelihood of saving. This effect was not found except for saving for a foreseeable expense, which had a significantly positive effect on the likelihood of saving. Having a motive to save for the education of children or grandchildren had a significantly negative effect. Other saving motive variables were not statistically significant.

### Control Variables

Among the SP/A control variables and the remaining control variables, having a long saving horizon had a strong positive effect on the likelihood of saving. Having low risk tolerance, being a household with a black respondent, and having a greater number of children had significantly negative effects on the likelihood of saving. Increased years of education, increased income, being a homeowner, and having a long saving horizon were significantly and positively related to the likelihood of saving.

#### **4.2.2.2 Model 2**

The results of Model 2 are shown in Table 4.2. As discussed in Section 3.2.2, a model including interaction effects must be interpreted carefully. A term entered in the model which is also part of an interaction term is conditioned on the reference category for the second term in the interaction. For example, the emergency fund saving motive variable is interacted with the horizon variables, so the emergency fund saving motive variable is conditioned on the reference category for horizon, which is short saving horizon. The interaction of this motive with medium saving horizon and long saving horizon will provide the effects of having this motive when a household has a medium or



long saving horizon. The main effect provides the impact for the short horizon, while the interaction terms provide the impact for the medium and long horizon households. The direction and significance of the variables in Model 1 are the same in Model 2 except for having expected per-period income above the reference level and having a motive to save for the education of children or grandchildren. Having expected per-period income above the reference is significantly and positively related to the likelihood of saving in Model 2. In Model 1, having a motive to save for the education of children or grandchildren is significantly related to the likelihood of saving, while it is not in Model 2. The retirement saving motive has a negative effect on the likelihood of saving, though it is not quite significant in Model 2 at the 0.0596 level. Of the interaction terms, only the interaction of retirement with medium saving horizon is significant, with a positive effect on the likelihood of saving.

Though not significant, other interaction variables show some interesting results. Relative to having a short saving horizon, having an emergency saving motive or a down payment saving motive had a negative effect on the likelihood of saving for the medium and long horizon groups. Having a motive to save for education for self or spouse had a negative effect on the likelihood of saving for the medium horizon group, but the effect for the long horizon group was positive. Retirement and education for children or grandchildren saving motives had positive effects on the likelihood of saving for those with a medium or long horizon group relative to those with a short horizon. The effect of the bequest motive for the medium and long horizon groups relative to the short horizon group was negative, while saving for an expense had a positive effect on the likelihood of saving for the medium horizon group and a negative effect for the long horizon group.

Explanatory Variables	Model 1 <sup>a</sup>		Model 2 <sup>b</sup>	
	Point Estimate	p-value	Point Estimate	p-value
Per-period income compared to reference				
Above	0.1945	0.0594	<b>0.2030</b>	0.0497
Below	<b>-0.3745</b>	<0.0001	<b>-0.3795</b>	<0.0001
Do not have good idea of income next year	<b>-0.2831</b>	0.0008	<b>-0.2808</b>	0.0009
Marital Status				
Living with partner	-0.2141	0.1660	-0.1910	0.2200
Separated/divorced	<b>-0.4916</b>	0.0003	<b>-0.4961</b>	0.0003
Widowed	<b>-0.6713</b>	0.0018	<b>-0.6602</b>	0.0022
Never married	<b>-0.4337</b>	0.0040	<b>-0.4297</b>	0.0046
Did not have 2 earners	0.0342	0.7577	0.0407	0.7147
Unemployment	<b>-0.4226</b>	<0.0001	<b>-0.4297</b>	<0.0001
Self-employment	<b>0.3647</b>	0.0003	<b>0.3713</b>	0.0002
Health				
Fair health	-0.1084	0.2839	-0.1158	0.2543
Poor health	<b>-0.8345</b>	<0.0001	<b>-0.8195</b>	<0.0001
Saving Motives				
Emergencies	0.0535	0.6294	0.1534	0.3449
Down Payment	-0.0943	0.5520	0.2134	0.3203
Education for self/spouse	-0.1541	0.3331	-0.0458	0.8561
Retirement	-0.0156	0.8827	-0.3096	0.0596
Education for child/grandchild	<b>-0.2621</b>	0.0487	-0.3805	0.0732
Bequest	0.1885	0.2720	0.2128	0.4641
Saving for foreseeable expense	<b>0.5392</b>	<0.0001	<b>0.5677</b>	0.0005
Risk Tolerance				
Low	<b>-0.3376</b>	0.0006	<b>-0.3244</b>	0.0010
Above average to high	0.1155	0.2594	0.1191	0.2472
Desired emergency fund (in \$1,000,000)	0.0343	0.5783	0.0345	0.5830
Number of saving motives	0.0467	0.5397	0.0501	0.5122
Age	-0.0011	0.7882	-0.0011	0.7734
Education	<b>0.0545</b>	0.0015	<b>0.0568</b>	0.0010
Race				
Black	<b>-0.3764</b>	0.0028	<b>-0.3848</b>	0.0023
Hispanic	-0.1013	0.4498	-0.1190	0.3791
Other	0.1756	0.3828	0.1707	0.3991
Number of children	<b>-0.1178</b>	0.0010	<b>-0.1187</b>	0.0010
Income (in \$100,000)	<b>0.0210</b>	0.0007	<b>0.0207</b>	0.0009
Homeowner	<b>0.3828</b>	0.0002	<b>0.3947</b>	0.0002
Saving Horizon				
Medium	-0.0496	0.6331	-0.1349	0.5170
Long	<b>0.5254</b>	<0.0001	<b>0.5222</b>	0.0058

Continued

Table 4.2 Logistic regression of the likelihood of saving

Table 4.2 (continued)

## Interactions of Motives with Horizon

Emergency * medium	-	-	-0.0952	0.6847
Emergency * long	-	-	-0.2309	0.2737
Down payment * med	-	-	-0.5573	0.0655
Down payment * long	-	-	-0.4591	0.1569
Education self/spouse * medium	-	-	-0.5347	0.1411
Education self/spouse * long	-	-	0.1078	0.7453
Retirement * medium	-	-	<b>0.4657</b>	0.0374
Retirement * long	-	-	0.3495	0.0877
Education child/grandchild * medium	-	-	0.1913	0.4943
Education child/grandchild * long	-	-	0.1763	0.5075
Bequest * medium	-	-	-0.1138	0.7886
Bequest * long	-	-	-0.0151	0.9681
Saving for expense * medium	-	-	0.1102	0.6295
Saving for expense * long	-	-	-0.1261	0.5625

Note: Bolded coefficients are significant at an alpha level of 0.05.

<sup>a</sup> Model 1 is the model without interactions.

<sup>b</sup> Model 2 is the model with interactions.

### 4.3 Results of the Likelihood Ratio Tests

#### 4.3.1 Likelihood Ratio Tests of Model 1

Table 4.3 presents the results of the likelihood ratio tests used to test whether the variables of interest are significant in explaining the likelihood of saving. The “full model” for these tests is Model 1, shown in Table 4.2. For each test, the full model is tested against five restricted models, following Hypotheses 1 to 4.

#### Per-Period Income Compared to Reference Level Variables

The full model is first tested against the model excluding the variable for having expected per-period income above the reference. The results of the likelihood ratio test indicate that this variable is significant in explaining the likelihood of saving. According to the results of the logistic regression on this model, this variable has a positive effect but it is not quite significant ( $p=0.0594$ ). The full model is next tested against the model excluding the variable for having expected per-period income below the reference level.

The results indicate that having expected per-period income below the reference level is significant in explaining the likelihood of saving.

#### Uncertainty Variables

To test whether uncertainty is significant in explaining the likelihood of saving, the group of uncertainty variables is excluded from the model, and this restricted model is tested against the full model. The results indicate that the group of uncertainty variables is significant in explaining the likelihood of saving.

#### Saving Motive Variables

The fourth likelihood ratio test examines the group of saving motive variables, which are found to be significant in explaining the likelihood of saving.

#### Saving Horizon Variables

The likelihood ratio test of the two horizon variables in the model indicates that saving horizon is significant in explaining the likelihood of saving.

Model	-2logL	df	LR Test Statistic	df	p-value
Full Model	19578.336	33	-	-	-
Model without "Above"	19596.812	32	18.476	1	<0.001
Model without "Below"	19662.470	32	84.134	1	<0.001
Model without "Uncertainty" variables	20065.803	23	487.467	10	<0.001
Model without "Motive" variables	19792.971	26	214.635	7	<0.001
Model without "Horizon" variables	19797.394	31	219.058	2	<0.001

Table 4.3 Likelihood ratio tests

### 4.3.2 Likelihood Ratio Test of Model 2

Table 4.3 shows the results of the likelihood ratio test of the model with interactions (Model 2) against the model without interactions (Model 1). The results of the likelihood ratio test indicate that there is a significant omnibus interaction effect. The interaction terms significantly improve model fit over the case where no interaction terms are included.

Model	Interaction Model $\chi^2$	df	LR Test Statistic	Df	p-value
Full model with interaction	19488.085	47			
Model without interaction	19578.336	33	90.251	14	<0.001

Table 4.4 Likelihood ratio test of “interaction” and “no interaction” models

## 4.4 Predicted Probabilities

### 4.4.1 Model 1

Table 4.5 presents the predicted probabilities of the baseline model for the model without interactions (Table 3.2). The predicted probabilities are based on the logistic regression output using RII techniques. The baseline model includes households who have expected per-period income that is about normal, do not have uncertainty or any of the six saving motives, have average risk tolerance, are White, do not own a home, have a short saving horizon, and are at the mean for desired emergency fund, number of saving motives, age, education, and income. Based on the model without interactions, the baseline predicted probability of saving is 61.06 percent. Each of the dichotomous variables of interest is “turned on” one at a time in order to illustrate the effect of each variable on the probability of saving.

### Per-Period Income Compared to Reference Level Variables

Having expected per-period income above the reference level increases the predicted probability of saving from 61.06 percent in the baseline model to 65.58 percent, an increase of 4.52 percentage points. The predicted probability of saving when a household's expected per-period income is below the reference level decreases the probability of saving from 61.06 percent in the baseline model to 51.89 percent. This is a decrease of 9.17 percentage points. These results are consistent with Hypothesis 1c, since loss aversion states that having expected per-period income below the reference level will have a greater effect on the likelihood of saving than being above.

### Uncertainty Variables

Not having a good idea of income in the next year decreases the probability of saving for the baseline model of 6.9 percentage points to 54.16 percent. Living with a partner and being separated/divorced, widowed, or never married all decrease the probability of saving, with the lowest predicted probability of saving for a respondent who is widowed, at 44.49 percent, followed by separated/divorced at almost 49 percent. Not being married consistently decreases the predicted probability of saving.

Not having two earners slightly increases the probability of saving from 61.06 percent to 61.87 percent, while unemployment has a negative effect on the probability of saving, decreasing to almost 51 percent. Self-employment of the respondent and/or spouse (if present) increases the predicted probability of saving to about 69 percent. Fair and poor health both show a decrease in the predicted probability of saving, with poor health decreasing the predicted probability of saving almost 21 percent from the baseline model.

### Saving Motive Variables

Of the saving motives, only the emergency and bequest motives increase the predicted probability of saving from the baseline model, as does saving for a foreseeable expense. Being at the baseline model but indicating there is a foreseeable expense the household is saving for has the greatest increase on the probability of saving, with an increase of almost 12 percentage points from the baseline model to almost 73 percent. The down payment, education for self/spouse, education for child/grandchild, and retirement saving motives all decrease the predicted probability of saving compared to the baseline model. Having a medium saving horizon decreases the predicted probability of saving from the baseline model, while having a long saving horizon increases the predicted probability of saving to almost 73 percent.

	Model without interactions Predicted Probability
Baseline Model <sup>a</sup>	61.06%
Variable Changed from 0 to 1:	
Above	65.58%
Below *	51.89%
Do not have good idea of income *	54.16%
Living with partner	55.87%
Separated/divorced *	48.96%
Widowed *	44.49%
Never married *	50.41%
Do not have two earners	61.87%
Unemployment *	50.68%
Self-employment *	69.31%
Fair health	58.56%
Poor health *	40.50%
Emergency saving motive	62.33%
Down payment saving motive	58.80%
Education for self/spouse saving motive *	57.34%
Retirement saving motive	60.69%
Education for child/grandchild saving motive *	54.68%
Bequest saving motive	65.44%
Saving for a foreseeable expense *	72.89%
Medium saving horizon	59.88%
Long saving horizon *	72.62%

<sup>a</sup> Baseline model is described in Table 3.2.

\* Indicates a statistically significant coefficient.

Table 4.5 Predicted probabilities for model with no interactions

#### 4.4.2 Model 2

##### Saving Motives and Saving Horizon

Table 4.6 presents the predicted probabilities of saving based on the baseline model and the results of the interaction model. This table shows the predicted probabilities of saving when having each saving motive for those with short, medium, and long saving horizons. The baseline model is the same as that for the model with no interactions, but the point estimates are different since they are derived from the results of



the model with interaction terms, and this model provides information on the effect of saving motives by saving horizon. The baseline predicted probabilities of saving for those with short, medium, and long horizons are close to those shown in Table 4.5. In the interacted model, those with the characteristics in the baseline model have a predicted probability of saving of 60.59 percent, while this predicted probability in the model with no interactions is slightly over 61 percent. The predicted probability of saving for households with a medium saving horizon and the characteristics in the baseline model is 58.68 percent in the interaction model, while it is 59.88 percent in the model without interactions. The predicted probability of the baseline model with a long saving horizon is almost 73 percent in both models.

Having a motive to save for emergencies has a different effect on the predicted probability of saving among the three horizon groups. For the short horizon group, having this motive increases the predicted probability of saving to almost 65 percent. Having this motive decreases the predicted probability of saving for the medium saving horizon group to about 55 percent, while for the long horizon group, having this motive decreases the predicted probability of saving about 6 percentage points. Having a down payment saving motive increases the predicted probability of saving for the short horizon group while it decreases the probability of saving for the medium and long horizon groups. Having a motive to save for the education of self or spouse (if present) decreases the predicted probability of saving for the short and medium horizon groups while it increases the probability of saving for the long horizon group. There is a decrease in the predicted probability of saving for the short horizon group when a household indicates

saving for the education of children or grandchildren as a motive, but an increase in the predicted probability for the medium and long saving horizon groups.

Having a retirement saving motive decreases the predicted probability of saving for the short saving horizon group, while having this motive and a medium or long saving horizon shows an increase in the predicted probability of saving. The bequest saving motive decreases the predicted probability of saving for the medium and long horizon groups, while for the short horizon group there is an increase in the predicted probability. Saving for a foreseeable expense increases the predicted probability almost 13 percentage points for the short horizon group, 2.4 percentage points for the medium horizon group, and decreases the predicted probability almost 3 percentage points for the long saving horizon group.

	Predicted Probability		
	Short Horizon	Medium Horizon	Long Horizon
Baseline Model	60.59%	58.68%	72.92%
Variable Changed:			
Emergency saving motive	64.98%	54.83%	66.79%
Down payment saving motive	65.41%	44.02%	62.62%
Education for self/spouse saving motive	59.55%	46.62%	75.37%
Retirement saving motive	52.92%	68.47%	80.46%
Education for child/grandchild saving motive	51.90%	62.77%	75.79%
Bequest saving motive	65.20%	56.07%	72.12%
Saving for a foreseeable expense	73.05%	61.08%	70.25%

\* Indicates a statistically significant coefficient.

Table 4.6 Predicted probabilities for interacted model by horizon

## 4.5 Discussion of Results

Table 4.7 summarizes the hypotheses and empirical results. Having expected per-period income above the reference level of income is significantly related to the

likelihood of saving. The results of the logistic regression indicate that it is positively related, though not quite significant in the model with no interactions (0.0594) and significant at a level of 0.0497 in the model with interactions. A household with expected per-period income above the reference level is more likely to save than a household at or below the reference level, holding other variables constant. Being above the reference level increases the baseline predicted probability from 61.06 percent to 65.58 percent. Households may save this extra income for times when income is below normal. Having expected per-period income below the reference level of income is found to be significant in the likelihood ratio test, and is found to be significant and negative in the logistic regression. The relationship of being above and below the reference level of income to the likelihood of saving is found to be asymmetric. Being below the reference level has a greater effect on the likelihood of saving, with a p-value of  $<0.0001$  in the logistic regression. A household with expected per-period income below the reference level is less likely to save than those at or above the reference level, holding other variables constant. The predicted probability of the baseline model is 61.06 percent, and having expected per-period income below the reference level decreases this probability to 51.89 percent. This result is consistent with the loss aversion model, where households do not like to decrease consumption and resist doing so, and with Hypothesis 2c, which states that being below the reference level of expected per-period income will have a greater effect on the likelihood of saving than being above the reference level.

Uncertainty is also found to be significantly related to the likelihood of saving. Uncertainty is expected to have a positive effect, but the results show a negative effect of income uncertainty, marital status other than married, unemployment, and being in fair or

poor health. Married households are more likely save than households where the respondent is not married. Living with a partner is not significantly different from being married, but has a negative effect on the likelihood of saving compared to married households, holding other variables constant. Not having two earners and being self-employed have positive effects, though not having two earners is not significant. These two uncertainty indicators have empirical results that are consistent with Hypothesis 2, which states that uncertainty is expected to increase saving. The self-employed may be more likely to save to invest in their business.

Saving motives are found to be significantly related to the likelihood of saving. The effects of the down payment, education for self/spouse, retirement, and education for children/grandchildren motives are negative, though only a motive to save for the education of children or grandchildren is significant. Households with a motive to save for the education of children or grandchildren may be currently paying for this education, which could explain the decrease in the likelihood of saving. A motive to save for emergencies, a bequest saving motive, and saving for a foreseeable expense are all positively related to the likelihood of saving, but only saving for a foreseeable expense is significant. Emergency saving is often the first type of saving recommended by financial advisers. It could be that households are more aware of this motive to save. Households with a motive to save for a bequest may be beyond saving for immediate needs, and have the ability to do so, which could explain the positive relationship to the likelihood of saving. Saving for a foreseeable expense is not a directly indicated motive but a question that asks directly if the household has a major foreseeable expense, and if so, whether the household is saving for that expense. This question could be getting at behavior more

than a saving motive which is vague, and could be related to future saving goals that a household is not yet saving for. The significance of saving motives supports the idea of mental accounting from prospect theory. Households appear to separate their saving into different “accounts” even when these funds may be kept in one account.

Saving horizon is significantly related to the likelihood of saving. Having a medium horizon shows a small, not significant decrease in the likelihood of saving relative to having a short horizon, holding other variables constant. The p-value of this is 0.6331. Having a long horizon significantly and positively increases the likelihood of saving. Households whose most important period for saving and spending decisions is five years or longer are more likely to save than those with a shorter horizon, holding other variables constant.

The interaction of saving horizon with the saving motive variables is found to be significant in explaining the likelihood of saving. The predicted probability of saving for a household with a short horizon, holding other variables constant, is 60.59 percent, while it is 58.58 percent for the medium horizon group and 72.92 percent for the long horizon group. Holding a particular saving motive has a different effect on the probability of saving among the three horizon groups. Having an emergency saving or down payment motive increases the probability of saving for the short horizon group but decreases the predicted probabilities of saving for the medium and long horizon groups. This could be because households with a short horizon are more focused on saving goals related to immediate need. A motive to save for the education of self or spouse has a negative effect on the probability of saving for households with short and medium horizons but a positive effect for households with a long saving horizon. Having a retirement saving

motive decreases the predicted probability of saving for households with a short saving horizon but has the opposite effect for those with medium and long horizons. A similar effect is found for the saving for education for child or grandchild motive. Having a bequest motive increases the probability of saving for the short horizon group but decreases the probability for the medium and long horizon groups. This is opposite of what was expected, which was that households with longer horizons would have moved past immediate needs saving goals and would be focused on higher level saving goals. Saving for a foreseeable expense increases the probability of saving for the short and medium horizon groups, but decreases the predicted probability of the long horizon group.

Table 4.7 shows the expected effects of variables on the likelihood of saving along with the results of the study. Having expected per-period income above the reference level and having expected per-period income below the reference level have the expected significant effects, and the effect of being below is greater than the effect of being above. The uncertainty variables are found to be significant but did not all have the expected positive effect. The horizon variables are significant and have a positive effect. As expected, the group of saving motives and the group of interactions are found to be significant in explaining the likelihood of saving.

Hypotheses	Variable	Expected Effect	Results
H1a	Per-period income above normal income	+ * <sup>a</sup>	+ * <sup>a</sup>
H1b	Per-period income below normal income	- * <sup>b</sup>	- * <sup>b</sup>
H1c	Effect of below relative to effect of above	b > a	b > a
H2	Income uncertainty	+ **	**
H3	Saving Motives	+ or - **	+ or - **
H4	Horizon	+ **	+ **
H5	Interaction between Saving Motives and Long Horizon	+ or - **	+ or - **

\* indicates significant effect of individual variable

\*\* indicates significant effect of group of variables

Table 4.7 Hypothesized effects of variables on the likelihood of saving and empirical results

## **CHAPTER 5**

### **SUMMARY, IMPLICATIONS AND CONCLUSIONS**

The first section of this chapter summarizes the procedures and major findings of this study, including the two models for the likelihood of household saving. The second section discusses implications and the third section presents limitations and conclusions.

#### **5.1 Summary**

There is no general consensus among economists and policy-makers about the most relevant model for describing observed household saving behavior. The life-cycle/permanent income hypothesis has been widely used in studies of household saving behavior. The development of prospect theory to look at decision making under risk has led to using the component of loss aversion within the theory to look at saving and consumption. Behavioral portfolio theory, based on prospect theory, has been developed and states that there is a hierarchy of need in portfolios, with the first dollars saved going to safe accounts. Investors segregate their portfolios into mental accounts, matching these accounts with goals. These portfolios resemble pyramids with lower layers designed to avoid poverty and higher layers designed to gain riches.



The main purpose of this dissertation was to explore household saving using a prospect theory approach through the use of the loss aversion model and behavioral portfolio theory. The research first focuses on the idea of expected per-period income compared to the reference level and uncertainty based on the loss aversion model. The focus then moves to saving motives which are developed using behavioral portfolio theory. Due to the short-term measure of saving in the data, which is saving over the previous year, saving horizon is also investigated. The purpose of the study was to investigate the effects of expected per-period income relative to the reference level, uncertainty, saving motives, and saving horizon on the likelihood of household saving.

The dataset used was the 2004 Survey of Consumer Finances. The sample excluded retired U.S. households for a total of 3,694 households. The difference in variables by saving horizon was investigated using ANOVA and chi-square analyses. Logistic regression was then used to estimate the likelihood of saving, and likelihood ratio tests were used to investigate the significance of variable(s) of interest. The first model was used to test the significance of having expected per-period income above or below the reference level, and the effect of being below was compared to the effect of being above to assess loss aversion. This was done by first excluding the “expected per-period income above reference level” variable and comparing this to the full model. This was repeated, excluding the “expected per-period income below the reference level” variable. The full model was then compared to a reduced model excluding the group of uncertainty variables using a likelihood ratio test. The likelihood ratio test was also used to test the full model against a reduced model excluding the group of saving motives. To

test for the significance of saving horizon in modeling the likelihood of saving, the full model was compared to a reduced model excluding the saving horizon variables.

The second model included interactions of saving motive variables with saving horizon variables to investigate if the effect of saving motives on the likelihood of saving differs by saving horizon. The model with interactions was compared to the model without interactions using a likelihood ratio test. Predicted probabilities were used to show the effect of individual variables on the probability of saving.

Empirical results suggest that having expected per-period income above the reference level increases the likelihood of saving. The coefficient on the “above” variable was found to be significant when using the likelihood ratio test. This variable was not significant in the logistic regression model without interactions ( $p=0.0594$ ) and was significant in the model with interactions ( $p=0.0497$ ). Having expected per-period income below the reference was found to be significantly related to the likelihood of saving using the likelihood ratio test, and the results of the logistic regression indicate that this significantly decreases the likelihood of saving. The results suggest that being below the reference level has a greater effect on the likelihood of saving than being above the reference level, and hypotheses 1a through 1c were supported.

The group of uncertainty variables was found to be significant in explaining the likelihood of saving. Contrary to Hypothesis 2, most of the uncertainty variables did not increase the likelihood of saving. Not having a good idea of income in the next year, being separated/divorced, widowed, or never married, being unemployed, and being in poor health all had a significant and negative effect on the likelihood of saving, while self-employment had the opposite effect.

The likelihood ratio tests indicate that saving motives and saving horizon are significant in explaining the likelihood of saving, supporting Hypothesis 3 and Hypothesis 4. Saving for a foreseeable expense significantly increased the likelihood of saving in both models. In the model without interactions, having a motive to save for the education of children or grandchildren significantly decreased the likelihood of saving, while this variable was not significant in the model with interactions. The inclusion of interactions between saving horizon variables with the saving motive variables was significant in explaining the likelihood of saving, indicating that saving motives do differ by saving horizon, and supporting Hypothesis 5. Relative to the short saving horizon group, having an emergency fund, down payment, or bequest saving motive decreases the likelihood of saving for the medium and long saving horizon groups. The opposite effect is found for the retirement and education for children or grandchildren saving motives, with having these motives and a medium or long saving horizon increasing the likelihood of saving relative to the short horizon group. Having a motive to save for education for self or spouse and having a medium saving horizon decreases the likelihood of saving relative to the short horizon group, while this motive increases the likelihood of saving for the long horizon group relative to the short horizon group. Saving for a future expense increases the likelihood of saving for the medium saving horizon group relative to the short horizon group, while it decreases the likelihood of saving for the long horizon group relative to the short horizon group.

## 5.2 Implications

The results of this dissertation contribute to the literature in several ways. First, the study explores the concept of loss aversion at the household level. Previous studies have used aggregate data or a subgroup of households, such as households whose head is in a long-term union contract. The results of this study indicate that saving may not react equally to news about income. The results also show the importance of a household's reference level of income and its effect on saving. How the reference level is set and changed is an area that could be further explored. This study is also the first to apply behavioral portfolio theory to household saving rather than to the portfolio of an investor. In addition, the study provides evidence that consumption and saving are affected by the relationship of expected per-period income to the reference level.

This study also provides evidence that uncertainty has a negative effect on the likelihood of saving. According to existing theoretical literature, uncertainty should increase the level of saving, but the results of this study indicate that uncertainty variables such as being in poor health had a strong negative effect on the likelihood of saving. However, this study explored the effect of uncertainty on the likelihood of saving rather than the amount saved and does not allow for examining what happens to household saving after the introduction of uncertainty.

Saving motives were also found to be significant in explaining the likelihood of saving. Having a motive to save for the education of children or grandchildren was found to significantly decrease the likelihood of saving, while saving for a future expense was found to significantly increase the likelihood of saving. The effect of having a specific saving motive on the likelihood of saving was found to differ by saving horizon. Having

an emergency fund, down payment, or bequest saving motive was found to increase the likelihood of saving for those with a short saving horizon, as was saving for a foreseeable expense. For those with a medium saving horizon, having a motive to save for retirement or the education of children or grandchildren increased the likelihood of saving. Saving motives for the education of self or spouse, the education of children or grandchildren, and retirement were found to increase the likelihood of saving for those with a long saving horizon. The results of the study indicate that saving horizon has a significant effect on the likelihood of saving even after controlling for other variables. Having a long saving horizon was found to significantly increase the likelihood of saving relative to having a short or medium saving horizon. Therefore, it is important to include saving horizon in a model of saving.

### **5.2.1 Implications for Policymakers**

Household saving is much more likely among those with a saving horizon of five years or more compared to those with a saving horizon of less than five years.

Policymakers should strive to change the mindset of consumers from the present or immediate future to a longer time period. Programs should be continued and developed to empower consumers who “can’t save” to start saving today. It is also important to make these programs more accessible to consumers. For example, developing saving programs where consumers can have the funds automatically deducted from their income may encourage saving. These programs would ideally be “opt-out” rather than “opt-in” since many studies show that consumers stay with the default, or passive, option.

Consumers do not like to decrease their consumption or feel losses, so having this money

placed in an account for saving before the individual “physically” receives the fund could reduce this feeling of loss. This may also affect the reference level of income, where the reference level is set at the amount of take-home pay rather than gross income. Ideally, policymakers would develop methods to change the focus in America from consumption to saving, and the effectiveness of these methods would be investigated.

### **5.2.2 Implications for Financial Professionals and Educators**

This study provides additional information on how certain factors are related to household saving. Recommendations regarding saving are made by financial professionals and educators, but the determinants of household saving are not yet fully understood. Studying the factors related to saving can enable financial professionals and educators to provide more effective recommendations. One interesting finding in this study is that having a specific saving motive is not necessarily related to an increased probability of saving. Simply getting consumers to establish a certain saving goal does not necessarily mean that savings will occur. Making methods of saving more available to consumers and easier to access could help consumers to save more. For example, offering automatic saving plans where the funds are deducted from the individual’s paycheck before he or she receives the money could increase saving. Making such programs “opt-out” rather than “opt-in” would help many who plan to start saving but fail to do so. Another method financial professionals and educators could use is informing consumers about adjusting their tax withholdings to increase income throughout the year rather than receiving a large lump sum tax refund which is more likely to be spent.

The effect of uncertainty on household saving is also an important issue that financial planners and educators should consider. After controlling for other variables, certain uncertainty variables were found to be negatively related to saving. Understanding why this relationship exists, as well as how to advise individuals facing uncertainty, is important since households facing uncertainty may be more in need of emergency funds or general saving than households not facing uncertainty. Financial professionals should also consider the effect of a household's reference level of income.

### **5.3 Limitations and Conclusions**

One limitation of this study is that the SCF data provides a cross-section of U.S. households. The use of longitudinal data would be desirable, and could provide more information on the effects of expected per-period income relative to the reference level, uncertainty, saving motives, and saving horizon on household saving. Having information on how the saving behaviors of households change as a result of uncertainty or having income higher or lower than the reference level could provide more information on what effects such variables have. Another limitation is that the SCF data are self-reported. Questions are often open to the interpretation of the respondents, and perceptions of what these questions mean may differ among respondents.

The measure of saving in this study was based only on one year and, as an indicator variable, provides information only on whether a household has saved over the previous year. A measure of the magnitude of saving over the previous year could allow for a better model of household saving and a better understanding of the results. Having a measure of dollars saved or a percentage of income saved would allow for estimating

the effect of variables on the amount saved rather than on the likelihood of saving. This would also allow for investigating the effect of saving motives on amount saved in addition to the likelihood of saving.

This study is exploratory in nature and investigates the use of the loss aversion model and behavioral portfolio theory in explaining the likelihood of saving. Expected per-period income compared to the reference level helped to explain the likelihood of saving, as does uncertainty, saving motives, and saving horizon. Saving motives were also found to differ by saving horizon. The results of this study suggest that household saving may be consistent with a prospect theory approach. When investigating household saving behaviors or developing programs to increase saving, it may be important to consider the role of current income, uncertainty, saving motives and saving horizon.



## BIBLIOGRAPHY

- Abdellaoui, M., Bleichrodt, H., & Paraschiv, C. (2005). Loss aversion under prospect theory: A parameter-free measurement. Unpublished manuscript.
- Agresti, A. (1996). *An introduction to categorical data analysis*. New York: Wiley.
- Ai, C., & Norton, E.C. (2003). Interaction terms in logit and probit models. *Economics Letters*, 80, 123-129.
- Aizcorbe, A., Kennickell, A. B., & Moore, K. B. (2003). Recent changes in U.S. family finances: Evidence from the 1998 and 2001 survey of consumer finances. *Federal Reserve Bulletin*, 89.
- Aizenman, J. (1998). Buffer stocks and precautionary savings with loss aversion. *Journal of International Money and Finance*, 17, 931-947.
- Alderfer, C.P. (1989). Theories reflecting my personal experience and life development. *Journal of Applied Behavioral Science*, 25, 351-365.
- Allison, P.D. (1999). *Logistic regression using SAS: Theory and application*. Cary, NC: SAS Institute, Inc.
- Altonji, J.G., & Siow, A. (1987). Testing the response of consumption to income changes with (noisy) panel data. *Quarterly Journal of Economics*, 102(2), 293-328.
- Ameriks, J., Caplin, A., & Leahy, J. (2003). The absentminded consumer. Working Paper. University of California, Berkeley.
- Ando, A. & Modigliani, F. (1963). The “life cycle” hypothesis of saving: Aggregate implications and tests. *American Economic Review*, 53(1), 55-84.
- Arrow, K.J. (1971). *Essays in the theory of risk-bearing*. Chicago: Markham.

- Artle, R., & Varaiya, P. (1978). Life-cycle consumption and homeownership. *Journal of Economic Theory*, 18(1), 38-58.
- Arzac, E. (1974). Utility analysis of chance-constrained portfolio selection. *Journal of Financial and Quantitative Analysis*, 8, 993-1007.
- Attanasio, O.P. (1993). A cohort analysis of life-cycle accumulation of financial assets. *Economic Research*, 47(4), 323-354.
- Attanasio, O.P., & Banks, J. (2001). The assessment: Household saving – issues in theory and policy. *Oxford Review of Economic Policy*, 17, 1-19.
- Attanasio, O.P., Banks, J., Meghir, C., & Weber, G. (1999). Humps and bumps in lifetime consumption. *Journal of Business & Economic Statistics*, 77(1), 22-35.
- Banks, J., Blundell, R., & Tanner, S. (1998). Is there a retirement-savings puzzle? *American Economic Review*, 88, 769-788.
- Banks, M. (1985). The economics of saving: A survey of recent contributions. In *Frontiers of Economics*. K.J. Arrow & S. Honkapohja (Eds.). Basil Blackwell Inc.: New York.
- Benartzi, S. & Thaler, R.H. (1995). Myopic loss aversion and the equity premium puzzle. *Quarterly Journal of Economics*, 110(1), 73-92.
- Bernheim, B.D., & Scholz, J.K. (1993). Private pensions and household saving. Manuscript. Madison: University of Wisconsin.
- Bernheim, B.D., Skinner, J., & Weinberg, S. (1997). *What accounts for the variation in retirement wealth among U.S. households?* NBER Working Paper No. 6227.
- Board of Governors of the Federal Reserve System. (2006). Codebook for 2004 Survey of Consumer Finances. Division of Research and Statistics.
- Bosworth, B.P., Burtless, G., & Sabelhaus, J. (1991). The decline in saving: Evidence from household surveys. *Brookings Papers on Economic Activity*, 1, 183-256.
- Bowman, D., Minehart, D., & Rabin, M. (1999). Loss aversion in a consumption-savings model. *Journal of Economic Behavior & Organization*, 38, 155-178.
- Brambor, T., Clark, W.R., & Golder, M. (2005). Understanding interaction models: Improving empirical analyses. *Political Analysis*, 14(1), 63-82.
- Browning, M., & Crossley, T.F. (2001). The life-cycle model of consumption and saving. The Institute for Fiscal Studies. WP01/15.

- Browning, M., & Ejrnaes, M. (2000). Consumption and children. Working Paper. University of Copenhagen.
- Browning, M. & Lusardi, A. (1996). Household saving: Micro theories and micro facts. *Journal of Economic Literature*, 34(4), 1797-1855.
- Bucks, B.K., Kennickell, A.B., & Moore, K.B. (2006). Recent changes in U.S. family finances: Evidence from the 2001 and 2004 Survey of Consumer Finances. *Federal Reserve Bulletin*, 92, A1-A38.
- Campbell, J.Y., & Mankiw, N.G. (1990). Permanent income, current income, and consumption. *Journal of Business and Economic Statistics*, 8(3), 365-79.
- Canova, L., Rattazzi, A.M., & Webley, P. (2005). The hierarchical structure of saving motives. *Journal of Economic Psychology*, 26, 21-34.
- Carroll, C.D. (1992). How does future income affect current consumption? Working Paper Series: Economic Activity Section 126, Board of Governors of the U.S. Federal Reserve System.
- Carroll, C. (1994). How does future income affect current consumption? *The Quarterly Journal of Economics*, 109(1), 111-148.
- Carroll, C. (1997). Buffer-stock saving and the life cycle/permanent income hypothesis. *Quarterly Journal of Economics*, 112, 1-55.
- Carroll, C. (2001). A theory of the consumption function. *Journal of Economic Perspectives*, 15(3), 23-45.
- Carroll, C. (2002). Theoretical Foundations of Buffer Stock Saving. Working Paper. John Hopkins University.
- Carroll, C.D. & Samwick, A.A., 1997. The nature of precautionary wealth. *Journal of Monetary Economics*, 40(1), 41-71.
- Carroll, C.D. & Samwick, A.A. (1998). How important is precautionary saving? *Review of Economics and Statistics*, 80(3), 410-419.
- Carroll, C., & Summers, L. (1991) Consumption growth parallels income growth: Some new evidence. In B.D. Berrheim and J.B. Shoven (eds.) *National Saving and Economic Performance*. Chicago: University of Chicago Press, 305-43.
- Carroll, C., & Weil, D.N. (1994). Saving and growth: A reinterpretation. *Carnegie-Rochester Conference Series on Public Policy*, 40, 133-192.

- Carroll, C., Overland, J., & Weil, D.N. (2000). Saving and growth with habit formation. *American Economic Review*, 90(3), 341-355.
- Chang, Y.R. (1994). Saving behavior of U.S. households in the 1980s: Results from the 1983 and 1986 Survey of Consumer Finance. *Financial Counseling and Planning*, 3, 3-16.
- Chang, Y. R., Hanna, S. & Fan, J. X. (1997). Emergency fund levels: Is household behavior rational? *Financial Counseling and Planning*, 8(1), 47-55.
- Chang, Y. R. & Huston, S. J. (1995). Patterns of adequate household emergency fund holdings: A comparison of households in 1983 and 1986, *Financial Counseling and Planning*, 6, 119-128.
- Chen, C., & DeVaney, S.A. (2001). The effect of life cycle stages and savings motives on the probability of emergency fund adequacy. *Proceedings of the Association of Financial Counseling and Planning Education*, 176-185.
- Dardanoni, V. (1991) Precautionary savings under income uncertainty: A cross-sectional analysis. *Applied Economics*, 23, 153-60.
- Davies, J. (1981) Uncertain lifetime, consumption, and dissaving in retirement. *Journal of Political Economy*, 89, 561-78.
- Davis, E.P., & Schumm, W.R. (1987). Savings behavior and satisfaction with savings: A comparison of low- and high-income groups. *Home Economics Research Journal*, 15, 247-256.
- Deaton, A. (1991). Saving and liquidity constraints. *Econometrica*, 59(5), 1221-1248.
- Deaton, A.S. (2005). Franco Modigliani and the Life Cycle Theory of consumption. Working Paper. <http://ssrn.com/abstract=686475>.
- Deaton, A.S., & Paxson, C.H. (1994). Saving, growth, and aging in Taiwan. In *Studies in the Economics of Aging*. D.A. Wise (Ed.). University of Chicago Press: Chicago.
- Ding, J., & S.A. DeVaney. (2000). Predictors of emergency funds adequacy. *Proceedings of the Association of Financial Counseling and Planning Education*, 56-65.
- Dornbusch, R. & Fisher, S. (1994). *Macroeconomics*, 6<sup>th</sup> Ed., New York: McGraw-Hill.
- Dynan, K. (1993). How prudent are consumers? *Journal of Political Economy*, 101, 1104-1113.

- Dynan, K.E., Skinner, J., & Zeldes, S.P. (2004). Do the rich save more? *Journal of Political Economy*, 112 (2), 397-444.
- Elton, E., & Gruber, M. (1995). *Modern Portfolio Theory and Investment Analysis*. New York, NY: John Wiley & Sons, Inc.
- Engen, E.M., Gales, W.G., & Uccello, C.E. (2000). The adequacy of household saving. Working Paper CRR WP 2000-01. Center for Retirement Research at Boston College.
- Flavin, M. (1991). The joint consumption/asset demand decision: A case study in robust estimation. National Bureau of Economic Research Working Paper No. 3802, Cambridge, MA.
- Friedman, M. (1957). *A theory of the consumption function*. Princeton: Princeton University Press.
- Friedman, M., & Savage, L.J. (1948). The utility analysis of choices involving risk. *Journal of Political Management*, 24, 9-25.
- Furnham, A. (1985). Why do people save? Attitudes to, habits of, saving money in Britain. *Journal of Applied Social Psychology*, 15, 354-373.
- Furnham, A. (1999). The saving and spending habits of young people. *Journal of Economic Psychology*, 20(6), 677-697.
- Furnham, A., & Argyle, M. (1998). *The psychology of money*. New York: Routledge.
- Götte von Wildhaus (2001). Prospect theory at work. Unpublished dissertation. University of Zurich.
- Gourinchas, P., & Parker, J. (2002). Consumption over the life cycle. *Econometrica*, 70(1), 47-89.
- Guariglia, A. (2001). Saving behaviour and earnings uncertainty: Evidence from the British Household Panel Survey. *Journal of Population Economics*, 14, 619-634.
- Hall (1978) Stochastic implications of the life cycle-permanent income hypothesis: Theory and evidence. *Journal of Political Economy*, 86(6), 971-987.
- Hamilton, G. (1995). The JOBS evaluation: Monthly participation rates in three sites and factors affecting participation levels in welfare-to-work programs. Washington, DC: U.S. Department of Health and Human Services and U.S. Department of Education.

- Harris, M.N., Loundes, J., & Webster, E. (2002). Determinants of household saving in Australia. *Economic Record*, 78(241), 207-223.
- Hayashi, F., Ito, T., & Slemrod, J. (1988). Housing finance imperfections, taxation, and private saving: A comparative simulation analysis of the United States and Japan. *Journal of the Japanese and International Economics*, 2(3), 215-238.
- Hefferan, C. (1982). Determinants and patterns of family saving. *Home Economics Research Journal*, 11(1), 47-55.
- Hoetker, G. (2003). Confounded coefficients: Extending recent advances in the accurate comparison of logit and probit coefficients across groups. Working Paper. University of Illinois, Urbana-Champaign.
- Horioka, C.Y., & Watanabe, W. (1997). Why do people save? A micro-analysis of motives for household saving in Japan. *Economic Journal*, 107(442), 537-552.
- Hubbard, R.G., Skinner, J., & Zeldes, S.P. (1994). Expanding the life-cycle model: Precautionary saving and public policy. *American Economic Review*, 84(2), 174-79.
- Hubbard, R.G., Skinner, J., & Zeldes, S.P. (1995). *Journal of Political Economy*, 103(2), 360-99.
- Hurd, M., & Rohdwedder, S. (2003). The retirement-consumption puzzle: anticipated and actual declines in spending at retirement. Labor and Population Program Working Paper Series 03-12, DRU-3009.
- Huston, S. J. & Chang, Y. R. (1997). Adequate emergency fund holdings and household type. *Financial Counseling and Planning*, 8(1), 37-46.
- Jaccard, J. (2001). *Interaction Effects in Logistic Regression*. Thousand Oaks, CA: Sage Publications.
- Kahneman, D. & Tversky, A. (1979). Prospect theory. *Econometrica*, 47(2), 263-292.
- Kahneman, D., Knetsch, J.L., & Thaler, R.H. (1991). Anomalies: The endowment effect, loss aversion, and status quo bias. *Journal of Economic Perspectives*, 5(1), 193-206.
- Katona, G. (1975). *Psychological economics*. New York: Elsevier.
- Kazarosian, M. (1997). Precautionary saving: A panel study. *Review of Economics and Statistics*, 79, 241-247.

- Kennickell, A. (1997). Multiple imputation and disclosure protection: The case of the 1995 Survey of Consumer Finances. Board of Governors of the Federal Reserve System, Washington, D.C.
- Kennickell, A. & Lusardi, A. (2003). Wealth accumulation and the importance of precautionary savings. Working Paper.
- Keynes, J.M. (1936). The general theory of employment, interest and money. London: MacMillan.
- Kimball, M.S. (1990a). Precautionary saving and the marginal propensity to consume. NBER Working Paper No. W3403. <http://ssrn.com/abstract=420287>.
- Kimball, M.S. (1990b). Precautionary saving in the small and in the large. *Econometrica*, 38, 53-73.
- King, M. (1985) The economics of saving: A survey of recent contributions. In K.J. Arrow & S. Honkapohja (Eds.), *Frontiers in Economics* (pp. 227-327). Oxford: Basil Blackwell.
- Kotlikoff, L.J. (1989). *What determines savings?* Cambridge, MA: The MIT Press.
- Kuehlwein, M. (1993). Life-cycle and altruistic theories of saving with lifetime uncertainty. *Review of Economics and Statistics*, 75(1), 38-47.
- Lancaster, K.J. (1966). A new approach to consumer theory. *Journal of Political Economy*, 74, 132-157.
- Lee, S., Park, M. H., & Montalto, C. P. (2000). The effect of family life cycle and financial management practices on household saving patterns. *Journal of Korean Home Economics Association*, 1(1), 79-93.
- Leland, H. (1968). Saving and uncertainty: The precautionary demand for saving. *Quarterly Journal of Economics*, 82(3), 465-473.
- Leung, S.F. (1994). Uncertain lifetime, the theory of the consumer, and the life cycle hypothesis, *Econometrica*, 62, 1233-1239.
- Lewis, A., Webley, P. & Furnham, A. (1995). *The new economic mind. The social psychology of economic behaviour*. Hemel Hempstead: Harvester Wheatsheaf.
- Lindqvist, A. (1981). *The saving behavior of households*. Doctoral Dissertation, The Stockholm School of Economics, Stockholm.

- Livingstone, S., & Lunt, P. (1993). Savers and borrowers: Strategies of personal financial management. *Human Relations*, 46, 943-985.
- Lopes, L. (1987). Between hope and fear: The psychology of risk. *Advances in Experimental Social Psychology*, 20, 255-295.
- Lunt, P., & Livingstone, S. (1991). Psychological, social and economic determinants of saving: Comparing recurrent and total savings. *Journal of Economic Psychology*, 12, 621-641.
- Lusardi, A. (1998). On the importance of the precautionary saving motive. *American Economic Review Papers and Proceedings*, 88(2), 449-453.
- Malchow-Moeller, N. & Thorsen, B.J. (2005). The buffer-stock consumption model with endogenous income shifts. *Contributions to Macroeconomics*, 5(1), 1-25.
- Maslow, A. (1954). *Motivation and personality*. New York: Harper.
- Mason, A. (1975). An empirical analysis of life-cycle saving, income, and household size. Ph.D. Dissertation, University of Michigan.
- Mayer, T. (1972). *Permanent income, wealth, and consumption: A critique of the permanent income theory, the life-cycle hypothesis, and related theories*. Berkeley: University of California Press.
- McCullagh, P., & Nelder, J. A. (1989). *Generalized linear models*. London: Chapman and Hall.
- Miles, D. (1997). A household level study of the determinants of incomes and consumption. *The Economic Journal*, 107(440). 1-25.
- Mirer, T. W. (1979). The wealth-age relation among the aged. *American Economic Review*, 69, 435-443.
- Modigliani, F. & Brumberg, R. (1954). Utility analysis and the consumption function: An interpretation of cross-section data. In K. Kurihara (ed.), *Post Keynesian Economics*, New Brunswick: Rutgers University Press.
- Modigliani, F. & Ando, A.K. (1957). Tests of the life cycle hypothesis of saving. *Bulletin of the Oxford Institute of Statistics*, 19, 99-124.
- Montalto, C. P. & Sung, J. (1996). Multiple imputation in the 1992 Survey of Consumer Finances. *Financial Counseling and Planning*, 7, 133-146



- Murata, K. (2003). Precautionary savings and income uncertainty: Evidence from Japanese micro data. *Monetary and Economic Studies*, 21-52.
- Nagatani, K. (1972). Life cycle saving: Theory and fact. *American Economic Review*, 62(3), 344-353.
- Palumbo, M.G. (1999). Uncertain medical expenses and precautionary saving near the end of the life cycle. *The Review of Economic Studies*, 66(2), 395-421.
- Pratt, J.W. (1964). Risk aversion in the small and the large. *Econometrica*, 32, 122-136.
- Roman, J.B., & Kaplan, B.J. (1995). Difference in self-control among spenders and savers. *Psychology: A Journal of Human Behavior*, 32, 8-17.
- Rosen, H.S., & Wu, S. (2004). Portfolio choice and health status. *Journal of Financial Economics*, 72(3), 457-484.
- Roy, A.D. (1952). Safety-first and the holding of assets. *Econometrica*, 20, 431-449.
- Runkle, D.E. (1991). Liquidity constraints and the permanent-income hypothesis: Evidence from panel data. *Journal of Monetary Economics*, 27(1), 73-98.
- Sandmo, A. (1970). The effect of uncertainty on saving decisions. *Review of Economic Studies*, 37(3), 353-360.
- Schmidt, U., & Traub, S. (2002). An experimental test of loss aversion. *Journal of Risk and Uncertainty*, 25(3), 233-249.
- Shapiro, M.D., & Slemrod, J.B. (1995). Consumer response to the timing of income: Evidence from a change in tax withholding. *American Economic Review*, 85(1), 274-283.
- Shea, J. (1995). Union contracts and the life-cycle/permanent-income hypothesis. *The American Economic Review*, 85(1), 186-200.
- Shefrin, H.M., & Statman, M. (1984). Explaining investor preference for cash dividends. *Journal of Financial Economics*, 13, 253-282.
- Shefrin, H.M., & Statman, M. (2000). Behavioral portfolio theory. *Journal of Financial and Quantitative Analysis*, 35(2), 127-151.
- Shefrin, H.M., & Thaler, R.H. (1988). The behavioral life-cycle hypothesis. *Economic Inquiry*, 26(4) 609-643.

- Skinner, J. (1988). Risky income, life-cycle consumption, and precautionary savings. *Journal of Monetary Economics*, 22, 237-255.
- Slemrod, J. (1982). Down-payment constraints: Tax policy effects in a growing economy with rental and owner-occupied housing. *Public Finance Quarterly*, 10(2), 193-217.
- Smith, J.P. (1994). Marriage, assets, and saving. Working Paper. RAND.
- Smith, J.P. (1999a). Healthy bodies and thick wallets: The dual relation between health and economic status. *Journal of Economic Perspectives*, 13(2), 145-166.
- Smith, J.P. (1999b). Inheritances and bequests. In J.P. Smith & Robert J. Willis (Ed.). *Wealth, Work, and Health: Innovations in Measurement in the Social Sciences: Essays in Honor of F. Thomas Juster*. Ann Arbor: University of Michigan.
- Solmon, L. C. (1975). The relation between schooling and savings behavior: An example of the indirect effects of education. In F. T. Juster (Ed.), *Education, Income and Human Behavior* (pp. 253-293). New York: McGraw-Hill.
- Starr-McCluer (1996). Health insurance and precautionary savings. *The American Economic Review*, 86(1), 285-295.
- Telser, L. (1955). Safety first and hedging. *Review of Economic Studies*, 23, 1-16.
- Thaler, R.H. (1990). Anomalies: Saving, fungibility, and mental accounts. *Journal of Economic Perspectives*, 4(1), 193-205.
- Thaler, R.H., & Benartzi, S. (2001). Save more tomorrow: Using behavioral economics to increase employee savings. Working Paper. Chicago Graduate School of Business.
- Thaler, R.H., & Shefrin, H.M. (1981). An economic theory of self-control. *Journal of Political Economy*, 89(2): 392-406.
- Thurow, L.C. (1969). The optimum lifetime distribution of consumption expenditures. *American Economic Review*, 59(3), 324-330.
- Tversky, A., & Kahneman, D. (1986). Rational choice and the framing of decisions. *Journal of Business*, 59, S251-S278.
- Tversky, A., & Kahneman, D. (1991). Loss aversion in riskless choice: A reference-dependent model. *Quarterly Journal of Economics*, 106(4), 1039-61.

- Venti, S.F., & Wise, D.A. (2000). Choice, chance, and wealth dispersion at retirement. NBER Working Papers 7521, National Bureau of Economic Research.
- Wärneryd, K.-E. (1995). *A study of saving behaviour toward the end of the life cycle*. CentER for Economic Research, Tilburg University, Progress Report No. 28.
- Wärneryd, K.-E. (1999). *The psychology of saving. A study of economic psychology*. Cheltenham: Edward Elgar Publishing.
- Webley, P., Burlando, R.P., & Viner, A. (2000). Individual differences, saving motives and saving behaviour: A cross-national study. In E. Holzl (Ed.), *Fairness and cooperation*. IAREP/SABE 2000. 25<sup>th</sup> Colloquium, Baden, Vienna, Austria, pp. 497-501.
- Williams, A.C. (1966). Attitudes toward speculative risks as an indicator of attitudes toward pure risks. *Journal of Risk and Insurance*, 33, 577-586.
- Wu, S. (2003). The effects of health events on the economic status of married couples.
- Xiao, J.J., & Anderson, J.G. (1997). Hierarchical financial needs reflected by household financial asset shares. *Journal of Family and Economic Issues*, 18(4), 333-355.
- Xiao, J.J., & Noring, F.E. (1994). Perceived saving motives and hierarchical financial needs. *Financial Counseling and Planning*, 5, 25-44.
- Xiao, J.J., & Olson, G.I. (1993). Mental accounting and saving behavior. *Home Economics Research*, 22(1), 92-109.
- Zeldes, S.P. (1989). Consumption and liquidity constraints: An empirical investigation. *Journal of Political Economy*, 97(2), 305-46.
- Zeldes, S.P. (1989). Optimal consumption with stochastic income: Deviations from certainty equivalence. *Quarterly Journal of Economics*, 104, 275-298.

APPENDIX A  
TABLE OF VARIABLES

<b>Dependent Variable</b>	<b>Definition</b>
Saved	=1 if spending exceeded income in the previous year (excluding investments) =0 if spending was less than or equal to income in the previous year
<b>Explanatory Variables</b>	
Expected Per-Period Income Compared to Reference	X7650 X7364
above	=1 if expected per-period income is above reference income =0 otherwise
normal	=1 if expected per-period income is at reference level =0 otherwise
below	=1 if expected per-period income is below reference income =0 otherwise
<i>Variables Related to Income Uncertainty</i>	
Income Risk	X7366 X7586
knowinc	=1 if the household does not have a good idea of income in the next year =0 otherwise
Marital Status	X8023
marst1 (reference category)	=1 if household head is married =0 otherwise
marst2	=1 if household head is living with partner =0 otherwise
marst3	=1 if household head is separated/divorced =0 otherwise
marst4	=1 if household head is widowed =0 otherwise
marst5	=1 if household head has never been married =0 otherwise
Earners	X4100 X6678
earners	=1 if there are <i>not</i> 2 earners in the household =0 otherwise
Unemployment	X6670 X6678 X6780 X6784
unemp	=1 if respondent and/or spouse (if present) is currently unemployed or has been unemployed over the past 12 months =0 otherwise
Self Employment	X4106 X4706
eselfemp	=1 if respondent and/or spouse (if present) is self-employed =0 otherwise
Self Perceived Health Status	X6030 X6124

fairhlth (reference category)	=1 if respondent and/or spouse (if present) indicates he/she is in fair health =0 otherwise
poorhlth	=1 if respondent and/or spouse (if present) indicates he/she in poor health =0 otherwise
<i>Saving Motive Variables</i>	
Emergency Fund Saving Motive emermotv	X3006 3007 X7513 X7514 X7515 X6848  =1 if household indicates a motive to save for emergencies, unexpected needs, reserves in the case of unemployment, in case of illness, medical/dental expenses, or to have cash available on hand =0 otherwise
Down Payment Saving Motive dwnpmotv	X3006 3007 X7513 X7514 X7515 X6848 =1 if household indicates a motive to save to purchase a home, car, boat, or other vehicle =0 otherwise
Education Saving Motive edumotv	X3006 3007 X7513 X7514 X7515 X6848 =1 if household indicates a motive to save for education for self or spouse =0 otherwise
Retirement Saving Motive retmotv	X3006 3007 X7513 X7514 X7515 X6848 =1 if household indicates saving for retirement is a motive for saving =0 otherwise
Education for Children or Grandchildren Saving Motive cedumotv	X3006 3007 X7513 X7514 X7515 X6848 =1 if household indicates a motive to save for education for children or grandchildren =0 otherwise
Bequest Saving Motive beqmotv	X3006 3007 X7513 X7514 X7515 X6848 =1 if household indicates giving to family/estate is a motive for saving =0 otherwise
Saving for Foreseeable Major Expense savexp	X3010 X7186  =1 if household indicates they are saving for a foreseeable major expense =0 otherwise
<i>Security, Potential, and Aspiration Variables</i>	
Risk Tolerance risktol	X3014 =1 if household indicates they are willing to take below average risk expecting to earn below average returns =0 otherwise

risktol2 (reference category)	=1 if household indicates they are willing to take average risk expecting to earn average returns =0 otherwise
risktol3	=1 if household indicates they are willing to take above average to substantial risk expecting to earn above average to substantial returns =0 otherwise
Desired Emergency Fund emerfund	=X7187/1,000,000
Number of Saving Motives numotvs	X3006 X3007 X7513 X7514 X7515 X6848 Continuous variable ranging from 0 to 6
<i>Control Variables</i>	
Age	X14
Respondent Education educat	X5901 =highest grade of school or year of college completed (0 to 17)
Respondent Race race1 (reference category)	X6809 X6810 X7004 =1 if respondent is non-Hispanic White =0 otherwise
race2	=1 if respondent is non-Hispanic Black =0 otherwise
race3	=1 if respondent is Hispanic =0 otherwise
race4	=1 if respondent is some other race/ethnicity =0 otherwise
Number of Dependent Children nkids	X108 X110 X114 X116 X120 X122 X126 X128 X132 X134 X202 X204 X208 X210 X214 X216 X220 X222 = number of dependent children in the household
Income	Income =household income in previous year/100,000
Home Ownership own	X723 =1 if household owns a home =0 otherwise
Saving Horizon short (reference group)	X3008 =1 if the period most important for spending and saving is the next few months or next year =0 otherwise
medium	=1 if the period most important for spending and saving is the next few years =0 otherwise
long	=1 if the period most important for spending and saving is the next 5 to 10 years or longer than 10 years =0 otherwise

APPENDIX B  
POOLED SAS CODE



```

data one; set data.scf2004;

implic=y1-(10*yy1);
wgt=x42001/5;
nwgt=x42001/23974.74/5;
*Retired;
if x6670=7 then retire=1; *respondent retired;
    else if x6670 ne 7 then retire=0; *respondent not retired;
if x6678=7 then sretire=1; *spouse retired;
    else sretire=0; *spouse not retired;
if (retire=1 or sretire=1) then eretire=1; *respondent or spouse
retired;
    else eretire=0; *respondent or spouse not retired;
if eretire=1 then delete; *removes if retired respondent or spouse;
*****;
* INCOME VARIABLES;
* HH income in previous calendar year;
INCOME=MAX(0,X5729);
* for 2004 and beyond, add in the amount of withdrawals from IRAs
and tax-deferred pension accounts (already included in earlier
years);
INCOME=INCOME+X6558+X6566+X6574+MAX(0,X6464)+MAX(0,X6469)+
    MAX(0,X6474)+MAX(0,X6479)+MAX(0,X6484)+MAX(0,X6489)+
    MAX(0,X6965)+MAX(0,X6971)+MAX(0,X6977)+MAX(0,X6983)+
    MAX(0,X6989)+MAX(0,X6995);
*****;
*Saving over past year;
*wsaved=1 when spending greater than income;
*wsaved=2 when spending equal to income;
*wsaved=3 when spending less than income;
if (x7508>0) then wsaved=x7508;
    else if (x7510=2 & x7509=1) then wsaved=3;
    else wsaved=x7510;
    saved=(wsaved=3);
*SCF Code for Question leading to Income Target;
*1=high 2=low 3=normal;
*Income Compared to Reference - Normal/current income;
if x7650=1 then incref1=1; *income higher than reference;
    else incref1=0;
if x7650=3 then incref2=1; *income about normal;
    else incref2=0;
if x7650=2 then incref3=1; *income lower than reference;
    else incref3=0;
*Income Growth;
if x7364=1 then incgrow1=1; *up more;
    else incgrow1=0;
if x7364=3 then incgrow2=1; *about the same;
    else incgrow2=0;
if x7364=2 then incgrow3=1; *up less;
    else incgrow3=0;
if (incref1=1 and incgrow1=1) then incAA=1;
    else incAA=0;
if (incref1=1 and incgrow2=1) then incAN=1;
    else incAN=0;
if (incref2=1 and incgrow1=1) then incNA=1;

```

```

    else incNA=0;
if (incref3=1 and incgrow3=1) then incBB=1;
    else incBB=0;
if (incref3=1 and incgrow2=1) then incBN=1;
    else incBN=0;
if (incref2=1 and incgrow3=1) then incNB=1;
    else incNB=0;
if (incAA=1|incAN=1|incNA=1) then above=1; *per-period income above;
    else above=0;
if (incNB=1|incBN=1|incBB=1) then below=1; *per-period income below;
    else below=0;
*Income uncertainty;
    if x7586=5 then knowinc=1; *do not have good idea of income next year;
    else knowinc=0;
*Marital status, sex and living arrangement of respondent;
    if x8023=1 then marstat=1;          *married;
    else if x8023=2 then marstat=2;    *living with partner;
    else if x8023=3 or x8023=4 then marstat=3; *separated or divorced;
    else if x8023=5 then marstat=4;    *widowed;
    else marstat=5;                    *never married;
    if marstat=1 then marst1=1; *married;
    else marst1=0;
    if marstat=2 then marst2=1; *living with partner;
    else marst2=0;
    if marstat=3 then marst3=1; *separated/div;
    else marst3=0;
    if marstat=4 then marst4=1; *widowed;
    else marst4=0;
    if marstat=5 then marst5=1; *never married;
    else marst5=0;
*Do not have two earners;
    if ((X4100 >=50 & X4100 <= 90)| X4100=97) then LF=0;
    else LF=1;
    if ((x4700 >=50 & X4700 <= 90)| X4700=97) then SLF=0;
    else SLF=1;
    if ((marstat=1 or marstat=2) and lf=1 and slf=1) then earners=0;
    else earners=1;
*Respondent or Spouse self-employed;
    if x4106=2 then rselfemp=1; *respondent self-employed;
    else if x4106 ne 2 then selfemp=0;
    if x4706=2 then sselfemp=1; *spouse self-employed;
    else if x4706 ne 2 then sselfemp=0;
    if (rselfemp=1 or sselfemp=1) then eselfemp=1;
    else eselfemp=0;
*Respondent or Spouse Unemployed in last 12 mo. or currently;
    if x6670=3 or x6678=3 then curunemp=1; *respondent/spouse unemployed;
    else curunemp=0;
    if x6780=1 or x6784=1 then yrunemp=1; *unemployed last 12 mo;
    else yrunemp=0;
    if curunemp=1 or yrunemp=1 then unemp=1;
    else unemp=0;
*Self-Perceived Health Status;
    if x6030=3|x6124=3 then fairhlth=1; *Respondent/spouse in fair health;
    else fairhlth=0;
    if x6030=4|x6124=4 then poorhlth=1; *Respondent/spouse in poor health;

```

```

    else poorhlth=0;
*Risk Tolerance;
    if x3014=4 then risktol1=1; *no financial risk;
    else risktol1=0;
    if x3014=3 then risktol2=1; *average financial risk;
    else risktol2=0;
    if x3014=1 or 2 then risktol3=1; *above average to high fin risk;
    else risktol3=0;
*Count of Saving Motives;
    array motives{1:6} x3006 x3007 x7513 x7514 x7515 x6848;
    numotvs=0;
    do i=1 to 6;
        if motives{i} gt 0 then numotvs=numotvs+1;
    end;
*Desired Emergency Fund;
    emerfund=x7187/1000000;
*Precautionary motive;
    if (x3006=23|x3007=23|x7513=23|x7514=23|x7515=23|x6848=23|x3006=24|x3007
=24|x7513=24|x7514=24|x7515=24|x3006=25|x3007=25|x7513=25|x7514=25|x751
5=25|x6848=25|x3006=92|x3007=92|x7513=92|x7514=92|x7515|x6848=92)
        then emergmotv=1;
    else emergmotv=0;
*Retirement Saving Motive;
    if (x3006=22|x3007=22|x7513=22|x7514=22|x7515=22|x6848=22)
        then retmotv=1;
    else retmotv=0;
*Education for self/spouse saving motive;
    if (x3006=2|x3007=2|x7513=2|x7514=2|x7515=2|x6848=2) then edumotv=1;
    else edumotv=0;
*Education for children/grandchildren saving motive;
    if (x3006=1|x3007=1|x7513=1|x7514=1|x7515=1|x6848=1)then cedumotv=1;
    else cedumotv=0;
*Downpayment Saving Motive;
    if (x3006=11|x3007=11|x7513=11|x7514=11|x7515=11|x6848=11|x3006=12|x3007
=12|x7513=12|x7514=12|x7515=12|x6848=12|x3006=13|x3007=13|x7513=13|x751
4=13|x7515=13|x6848=13)
        then dwnpmotv=1;
    else dwnpmotv=0;
*Bequest motive;
    if (x3006=3|x3007=3|x7513=3|x7514=3|x7515=3|x6848=3)
        then beqmotv=1;
    else beqmotv=0;
*Saving for Major Future Expense;
    if x7186=1 then savexp=1; *saving for a future expense;
    else savexp=0; *not saving for future expense (even if have one);
*Spending/Saving horizon;
    if x3008=1 then horiz1=1; *next few months;
    else horiz1=0;
    if x3008=2 then horiz2=1; *next year;
    else horiz2=0;
    if x3008=3 then horiz3=1; *next few years;
    else horiz3=0;
    if x3008=4 then horiz4=1; *5-10 years;
    else horiz4=0;
    if x3008=5 then horiz5=1; *longer than 10 years;

```

```

    else horiz5=0;
if (horiz1=1 or horiz2=1) then horiz=1;
    else if (horiz3=1) then horiz=2;
    else if (horiz4=1 or horiz5=1) then horiz=3;
if (horiz4=1 or horiz5=1) then long=1;
    else long=0;
if horiz3=1 then medium=1;
    else medium=0;
if (horiz1=1 or horiz2=1) then short=1;
    else short=0;
*Interaction Terms;
if (medium=1 and emergotv=1) then emerxmed=1;
    else emerxmed=0;
if (long=1 and emergotv=1) then emerxlng=1;
    else emerxlng=0;
if (medium=1 and downpmotv=1) then downpxmed=1;
    else downpxmed=0;
if (long=1 and downpmotv=1) then downpxlng=1;
    else downpxlng=0;
if (medium=1 and edumotv=1) then eduxmed=1;
    else eduxmed=0;
if (long=1 and edumotv=1) then eduxlng=1;
    else eduxlng=0;
if (medium=1 and cedumotv=1) then ceduxmed=1;
    else ceduxmed=0;
if (long=1 and cedumotv=1) then ceduxlng=1;
    else ceduxlng=0;
if (medium=1 and retmotv=1) then retxmed=1;
    else retxmed=0;
if (long=1 and retmotv=1) then retxlng=1;
    else retxlng=0;
if (medium=1 and beqmotv=1) then beqxmmed=1;
    else beqxmmed=0;
if (long=1 and beqmotv=1) then beqxlng=1;
    else beqxlng=0;
if (medium=1 and savexp=1) then savxmmed=1;
    else savxmmed=0;
if (long=1 and savexp=1) then savxlng=1;
    else savxlng=0;
*Respondent Education;
if x5901=-1 then x5901=0;
educat=x5901;
*Race/ethnicity of the respondent;
* 1=white non-Hispanic, 2=nonwhite or Hispanic;
    RACECL=1+(X6809 ^= 1 | X6810 NOT IN (1 0));
    H_RACECL=1+(X6809 ^= 1 | X6810 NOT IN (1 0));
*1=white non-Hispanic, 2=black/African-American, 3=Hispanic, 4=other;
if X6809=1 then RACE=1;
    else if X6809=2 then RACE=2;
    else if X6809=3 then RACE=3;
    else RACE=4;

if X6809=1 & X7004^=1 then H_RACE=1;
    else if X6809=2 & X7004^=1 then H_RACE=2;
    else if X6809=3 | X7004=1 then H_RACE=3;

```

```

    else H_RACE=4;
  if h_race=1 then race1=1; *nonhispanic white;
    else race1=0;
  if h_race=2 then race2=1; *nonhispanic black;
    else race2=0;
  if h_race=3 then race3=1; *hispanic;
    else race3=0;
  if h_race=4 then race4=1; *other;
    else race4=0;
*Home ownership;
  if 1<=x723<=5 then own=1; *own;
    else if x723=0 then own=0; *do not own;
*Total household income in 2003;
  inc=income/100000;
*Age of household head & categorical variable;
  *1:<35, 2:35-44, 3:45-54, 4:55-64, 5:65-74, 6:>=75;
  AGE=X14;
  agegroup=1+(AGE GE 35)+(AGE GE 45)+(AGE GE 55)+(AGE GE 65);
*Dependent children in household;
  array one{1:9} x110 x116 x122 x128 x134 x204 x210 x216 x222;
  array two{1:9} x108 x114 x120 x126 x132 x202 x208 x214 x220;
  nkids=0;
  do i=1 to 9;
    if one{i}<18 and (4<=two{i}<=5 or 9<=two{i}<=29 or two{i}=36)
      then nkids=nkids+1;
    end;
  if nkids>0 then children=1; else children=0;

*Code to keep households only if they are in all 5 implicates;
  IMPLIC=Y1-10*YY1;
  PROC SORT; BY YY1 IMPLIC;
  PROC MEANS NOPRINT; VAR IMPLIC; BY YY1;
  OUTPUT OUT=FIVE N=NOIMP;
  DATA FINAL; MERGE ONE FIVE; BY YY1;
  IF NOIMP=5;

```

APPENDIX C  
RII SAS CODE

```

data one; set data.scf2004;
implic=y1-(10*yy1);
wgt=x42001/5;
nwgt=x42001/23974.74/5;
*Respondent or Spouse Retired;
  if x6670=7 then retire=1; *respondent retired;
    else if x6670 ne 7 then retire=0; *not retired;
  if x6678=7 then sretire=1; *spouse retired;
    else sretire=0; *spouse not retired;
  if (retire=1 or sretire=1) then eretire=1;
*****;
  * INCOME VARIABLES;
  * HH income in previous calendar year;
  INCOME=MAX(0,X5729);
  * for 2004 and beyond, add in the amount of withdrawals from IRAs
  and tax-deferred pension accounts (already included in earlier
  years);
  INCOME=INCOME+X6558+X6566+X6574+MAX(0,X6464)+MAX(0,X6469)+
    MAX(0,X6474)+MAX(0,X6479)+MAX(0,X6484)+MAX(0,X6489)+
    MAX(0,X6965)+MAX(0,X6971)+MAX(0,X6977)+MAX(0,X6983)+
    MAX(0,X6989)+MAX(0,X6995);
*****;
*Saving over past year;
*wsaved=1 when spending greater than income;
*wsaved=2 when spending equal to income;
*wsaved=3 when spending less than income;
if (x7508>0) then wsaved=x7508;
  else if (x7510=2 & x7509=1) then wsaved=3;
  else wsaved=x7510;
  saved=(wsaved=3);
*SCF Code for Question leading to Income Target;
  *1=high 2=low 3=normal;
*Income Compared to Reference - Normal/current income;
  if x7650=1 then incref1=1; *income higher than reference;
    else incref1=0;
  if x7650=3 then incref2=1; *income about normal;
    else incref2=0;
  if x7650=2 then incref3=1; *income lower than reference;
    else incref3=0;
*Income Growth;
  if x7364=1 then incgrow1=1; *up more;
    else incgrow1=0;
  if x7364=3 then incgrow2=1; *about the same;
    else incgrow2=0;
  if x7364=2 then incgrow3=1; *up less;
    else incgrow3=0;
*Expected per-period income;
  if (incref1=1 and incgrow1=1) then incAA=1;
    else incAA=0;
  if (incref1=1 and incgrow2=1) then incAN=1;
    else incAN=0;
  if (incref2=1 and incgrow1=1) then incNA=1;
    else incNA=0;
  if (incref3=1 and incgrow3=1) then incBB=1;
    else incBB=0;

```

```

    if (incref3=1 and incgrow2=1) then incBN=1;
    else incBN=0;
    if (incref2=1 and incgrow3=1) then incNB=1;
    else incNB=0;
    if (incAA=1|incAN=1|incNA=1) then above=1; *per-period income above
reference;
    else above=0;
    if (incNB=1|incBN=1|incBB=1) then below=1; *per-period income below
reference;
    else below=0;
*Income uncertainty;
    if x7586=5 then knowinc=1; *do not have good idea of income next year;
    else knowinc=0;
*Marital status, sex and living arrangement of respondent;
    if x8023=1 then marstat=1; *married;
    else if x8023=2 then marstat=2; *living with partner;
    else if x8023=3 or x8023=4 then marstat=3; *separated or divorced;
    else if x8023=5 then marstat=4; *widowed;
    else marstat=5; *never married;
    if marstat=1 then marst1=1; *married;
    else marst1=0;
    if marstat=2 then marst2=1; *living with partner;
    else marst2=0;
    if marstat=3 then marst3=1; *separated/div;
    else marst3=0;
    if marstat=4 then marst4=1; *widowed;
    else marst4=0;
    if marstat=5 then marst5=1; *never married;
    else marst5=0;
*Dual earners;
    IF ((X4100 >=50 & X4100 <= 90)| X4100=97) THEN LF=0;
    ELSE LF=1;
    IF ((X4700 >=50 & X4700 <= 90)| X4700=97) then SLF=0;
    ELSE SLF=1;
    if ((marstat=1 or marstat=2) and lf=1 and slf=1) then earners=0;
    else earners=1;
*Respondent and/or Spouse/Partner Self-employed;
    if x4106=2 then rselfemp=1; *respondent self-employed;
    else if x4106 ne 2 then selfemp=0;
    if x4706=2 then sselfemp=1; *spouse/partner self-employed;
    else if x4706 ne 2 then sselfemp=0;
    if (rselfemp=1 or sselfemp=1) then eselfemp=1;
    else eselfemp=0;
*Unemployment of Respondent/Spouse/Partner last yr or current;
    if x6670=3 or x6678=3 then curunemp=1; *respondent/spouse unemployed;
    else curunemp=0;
    if x6780=1 or x6784=1 then yrunemp=1; *unemployed in last 12 months;
    else yrunemp=0;
    if curunemp=1 or yrunemp=1 then unemp=1;
    else unemp=0;
*Self-Perceived Health Status;
    if x6030=3|x6124=3 then fairhlth=1; *Spouse or Respondent Fair health;
    else fairhlth=0;
    if x6030=4|x6124=4 then poorhlth=1; *Spouse or Respondent Poor health;
    else poorhlth=0;

```



```

*INTERACTION TERMS;
  if (above=1 and knowinc=1) then knowinA=1;
  else knowinA=0;
  if (below=1 and knowinc=1) then knowinB=1;
  else knowinB=0;
*Risk Tolerance;
  if x3014=4 then risktol1=1; *no financial risk;
  else risktol1=0;
  if x3014=3 then risktol2=1; *average financial risk;
  else risktol2=0;
  if x3014=1 or x3014=2 then risktol3=1; *above average to substantial;
  else risktol3=0;
*Count of Saving Motives;
  array motives{1:6} x3006 x3007 x7513 x7514 x7515 x6848;
  numotvs=0;
  do i=1 to 6;
    if motives{i} gt 0 then numotvs=numotvs+1;
  end;
*Desired Emergency Fund;
  emerfund=x7187/1000000;
*Precautionary motive;
  if (x3006=23|x3007=23|x7513=23|x7514=23|x7515=23|x6848=23|x3006=24|x3007=24|x7513=24|x7514=24|x7515=24|x3006=25|x3007=25|x7513=25|x7514=25|x7515=25|x6848=25|x3006=92|x3007=92|x7513=92|x7514=92|x7515=92|x6848=92)
  then emergmotv=1;
  else emergmotv=0;
*Retirement Saving Motive;
  if (x3006=22|x3007=22|x7513=22|x7514=22|x7515=22|x6848=22)
  then retmotv=1;
  else retmotv=0;
*Education for self/spouse saving motive;
  if (x3006=2|x3007=2|x7513=2|x7514=2|x7515=2|x6848=2) then edumotv=1;
  else edumotv=0;
*Education for children/grandchildren saving motive;
  if (x3006=1|x3007=1|x7513=1|x7514=1|x7515=1|x6848=1) then cedumotv=1;
  else cedumotv=0;
*Downpayment Saving Motive;
  if (x3006=11|x3007=11|x7513=11|x7514=11|x7515=11|x6848=11|x3006=12|x3007=12|x7513=12|x7514=12|x7515=12|x6848=12|x3006=13|x3007=13|x7513=13|x7514=13|x7515=13|x6848=13)
  then dwnpmotv=1;
  else dwnpmotv=0;
*Bequest motive;
  if (x3006=3|x3007=3|x7513=3|x7514=3|x7515=3|x6848=3)
  then beqmotv=1;
  else beqmotv=0;
*Saving for Major Future Expense;
  if x7186=1 then savexp=1; *saving for a future expense;
  else savexp=0; *not saving for future expense (even if have one);
*Spending/Saving horizon;
  if x3008=1 then horiz1=1; *next few months;
  else horiz1=0;
  if x3008=2 then horiz2=1; *next year;
  else horiz2=0;
  if x3008=3 then horiz3=1; *next few years;

```

```

    else horiz3=0;
if x3008=4 then horiz4=1; *5-10 years;
    else horiz4=0;
if x3008=5 then horiz5=1; *longer than 10 years;
    else horiz5=0;
if (horiz1=1 or horiz2=1) then horiz=1;
    else if (horiz3=1) then horiz=2;
    else if (horiz4=1 or horiz5=1) then horiz=3;
if (horiz4=1 or horiz5=1) then long=1;
    else long=0;
if horiz3=1 then medium=1;
    else medium=0;
if (horiz1=1 or horiz2=1) then short=1;
    else short=0;
*Interaction Terms;
if (medium=1 and emergmotv=1) then emerxmed=1;
    else emerxmed=0;
if (long=1 and emergmotv=1) then emerxlng=1;
    else emerxlng=0;
if (medium=1 and dwnpmotv=1) then dwnpxmed=1;
    else dwnpxmed=0;
if (long=1 and dwnpmotv=1) then dwnpxlng=1;
    else dwnpxlng=0;
if (medium=1 and edumotv=1) then eduxmed=1;
    else eduxmed=0;
if (long=1 and edumotv=1) then eduxlng=1;
    else eduxlng=0;
if (medium=1 and cedumotv=1) then ceduxmed=1;
    else ceduxmed=0;
if (long=1 and cedumotv=1) then ceduxlng=1;
    else ceduxlng=0;
if (medium=1 and retmotv=1) then retxmed=1;
    else retxmed=0;
if (long=1 and retmotv=1) then retxlng=1;
    else retxlng=0;
if (medium=1 and beqmotv=1) then beqxmmed=1;
    else beqxmmed=0;
if (long=1 and beqmotv=1) then beqxlng=1;
    else beqxlng=0;
if (medium=1 and savexp=1) then savxmed=1;
    else savxmed=0;
if (long=1 and savexp=1) then savxlng=1;
    else savxlng=0;
*Respondent Education;
if x5901=-1 then x5901=0;
educat=x5901;
*Race/ethnicity of the respondent;
    * 1=white non-Hispanic, 2=nonwhite or Hispanic;
        RACECL=1+(X6809 ^= 1 | X6810 NOT IN (1 0));
        H_RACECL=1+(X6809 ^= 1 | X6810 NOT IN (1 0));
    *1=white non-Hispanic, 2=black/African-American, 3=Hispanic, 4=other;
        IF X6809=1 THEN RACE=1;
        ELSE IF X6809=2 THEN RACE=2;
        ELSE IF X6809=3 THEN RACE=3;
        ELSE RACE=4;

```

```

IF X6809=1 & X7004^=1 THEN H_RACE=1;
ELSE IF X6809=2 & X7004^=1 THEN H_RACE=2;
ELSE IF X6809=3 | X7004=1 THEN H_RACE=3;
ELSE H_RACE=4;
if h_race=1 then race1=1; *nonhispanic white;
else race1=0;
if h_race=2 then race2=1; *nonhispanic black;
else race2=0;
if h_race=3 then race3=1; *hispanic;
else race3=0;
if h_race=4 then race4=1; *other;
else race4=0;
*Home ownership;
if 1<=x723<=5 then own=1; *own;
else if x723=0 then own=0; *do not own;
*Total household income in 2003;
inc=income/100000;
*Age of household head & categorical variable;
*1:<35, 2:35-44, 3:45-54, 4:55-64, 5:65-74, 6:>=75;
AGE=X14;
agegroup=1+(AGE GE 35)+(AGE GE 45)+(AGE GE 55)+(AGE GE 65);
*Dependent children in household;
array one{1:9} x110 x116 x122 x128 x134 x204 x210 x216 x222;
array two{1:9} x108 x114 x120 x126 x132 x202 x208 x214 x220;
nkids=0;
do i=1 to 9;
if one{i}<18 and (4<=two{i}<=5 or 9<=two{i}<=29 or two{i}=36)
then nkids=nkids+1;
end;
if nkids>0 then children=1; else children=0;

*****;
IMPLIC=Y1-(10*YY1);
DEP=saved;
X1=above; X2=below; X3=knowinc; X4=marst2; X5=marst3; X6=marst4;
X7=marst5; X8=earners; X9=unemp; X10=eselfemp; X11=fairhlth;
X12=poorhlth; X13=emermotv; X14=dwnpmotv; X15=edumotv; X16=retmotv;
X17=cedumotv; X18=beqmotv; X19=savexp; X20=risktol1; X21=risktol3;
X22=emurfund; X23=numotvs; X24=age; X25=educat; X26=race2; X27=race3;
X28=race4; X29=nkids; X30=inc; X31=own; X32=medium; X33=long;
KEEP IMPLIC DEP X1 X2 X3 X4 X5 X6 X7 X8 X9 X10 X11 X12 X13 X14 X15 X16
X17 X18 X19 X20 X21 X22 X23 X24 X25 X26 X27 X28 X29 X30 X31 X32 X33;
*RUN REGRESSION SEPARATELY ON EACH IMPLICATE AND SAVE COEFFICIENTS AND
VARIANCE COVARIANCE MATRIX;
DATA A; SET one;
IF IMPLIC=1;
PROC LOGISTIC DESCENDING OUTEST=BETAA COVOUT ;
MODEL DEP=X1 X2 X3 X4 X5 X6 X7 X8 X9 X10 X11 X12 X13 X14 X15 X16 X17
X18 X19 X20 X21 X22 X23 X24 X25 X26 X27 X28 X29 X30 X31 X32 X33;
DATA B; SET one;
IF IMPLIC=2;
PROC LOGISTIC DESCENDING OUTEST=BETAB COVOUT ;
MODEL DEP=X1 X2 X3 X4 X5 X6 X7 X8 X9 X10 X11 X12 X13 X14 X15 X16 X17
X18 X19 X20 X21 X22 X23 X24 X25 X26 X27 X28 X29 X30 X31 X32 X33;

```

```

DATA C; SET one;
IF IMPLIC=3;
    PROC LOGISTIC DESCENDING OUTEST=BETAC COVOUT ;
    MODEL DEP=X1 X2 X3 X4 X5 X6 X7 X8 X9 X10 X11 X12 X13 X14 X15 X16 X17
X18 X19 X20 X21 X22 X23 X24 X25 X26 X27 X28 X29 X30 X31 X32 X33;
DATA D; SET one;
IF IMPLIC=4;
    PROC LOGISTIC DESCENDING OUTEST=BETAD COVOUT ;
    MODEL DEP=X1 X2 X3 X4 X5 X6 X7 X8 X9 X10 X11 X12 X13 X14 X15 X16 X17
X18 X19 X20 X21 X22 X23 X24 X25 X26 X27 X28 X29 X30 X31 X32 X33;
DATA E; SET one;
IF IMPLIC=5;
    PROC LOGISTIC DESCENDING OUTEST=BETAE COVOUT ;
    MODEL DEP=X1 X2 X3 X4 X5 X6 X7 X8 X9 X10 X11 X12 X13 X14 X15 X16 X17
X18 X19 X20 X21 X22 X23 X24 X25 X26 X27 X28 X29 X30 X31 X32 X33;

*GENERATE COEFFICIENT VECTOR FROM EACH IMPLICATE;
DATA BETAl; SET BETAA; J+1;
IF J=1;
KEEP INTERCEPT X1 X2 X3 X4 X5 X6 X7 X8 X9 X10 X11 X12 X13 X14 X15 X16
X17 X18 X19 X20 X21 X22 X23 X24 X25 X26 X27 X28 X29 X30 X31 X32 X33;
DATA BETA2; SET BETAB; J+1;
IF J=1;
KEEP INTERCEPT X1 X2 X3 X4 X5 X6 X7 X8 X9 X10 X11 X12 X13 X14 X15 X16
X17 X18 X19 X20 X21 X22 X23 X24 X25 X26 X27 X28 X29 X30 X31 X32 X33;
DATA BETA3; SET BETAC; J+1;
IF J=1;
KEEP INTERCEPT X1 X2 X3 X4 X5 X6 X7 X8 X9 X10 X11 X12 X13 X14 X15 X16
X17 X18 X19 X20 X21 X22 X23 X24 X25 X26 X27 X28 X29 X30 X31 X32 X33;
DATA BETA4; SET BETAD; J+1;
IF J=1;
KEEP INTERCEPT X1 X2 X3 X4 X5 X6 X7 X8 X9 X10 X11 X12 X13 X14 X15 X16
X17 X18 X19 X20 X21 X22 X23 X24 X25 X26 X27 X28 X29 X30 X31 X32 X33;
DATA BETA5; SET BETAE; J+1;
IF J=1;
KEEP INTERCEPT X1 X2 X3 X4 X5 X6 X7 X8 X9 X10 X11 X12 X13 X14 X15 X16
X17 X18 X19 X20 X21 X22 X23 X24 X25 X26 X27 X28 X29 X30 X31 X32 X33;

*GENERATE VARIANCE COVARIANCE MATRIX FROM EACH IMPLICATE;
DATA COV1; SET BETAA; J+1;
IF NOT (J=1);
KEEP INTERCEPT X1 X2 X3 X4 X5 X6 X7 X8 X9 X10 X11 X12 X13 X14 X15 X16
X17 X18 X19 X20 X21 X22 X23 X24 X25 X26 X27 X28 X29 X30 X31 X32 X33;
DATA COV2; SET BETAB; J+1;
IF NOT (J=1);
KEEP INTERCEPT X1 X2 X3 X4 X5 X6 X7 X8 X9 X10 X11 X12 X13 X14 X15 X16
X17 X18 X19 X20 X21 X22 X23 X24 X25 X26 X27 X28 X29 X30 X31 X32 X33;
DATA COV3; SET BETAC; J+1;
IF NOT (J=1);
KEEP INTERCEPT X1 X2 X3 X4 X5 X6 X7 X8 X9 X10 X11 X12 X13 X14 X15 X16
X17 X18 X19 X20 X21 X22 X23 X24 X25 X26 X27 X28 X29 X30 X31 X32 X33;
DATA COV4; SET BETAD; J+1;
IF NOT (J=1);
KEEP INTERCEPT X1 X2 X3 X4 X5 X6 X7 X8 X9 X10 X11 X12 X13 X14 X15 X16
X17 X18 X19 X20 X21 X22 X23 X24 X25 X26 X27 X28 X29 X30 X31 X32 X33;

```

```

DATA COV5; SET BETAE; J+1;
IF NOT (J=1);
KEEP INTERCEPT X1 X2 X3 X4 X5 X6 X7 X8 X9 X10 X11 X12 X13 X14 X15 X16
X17 X18 X19 X20 X21 X22 X23 X24 X25 X26 X27 X28 X29 X30 X31 X32 X33;

***RII PROCEDURE FOR OLS REGRESSION***;

PROC IML;
*READ COEFFICIENTS AND VARIANCE COVARIANCE MATRICES FROM BETA# AND COV#
FILES AND GENERATE VECTORS AND MATRICES;
USE BETA1 VAR{INTERCEPT X1 X2 X3 X4 X5 X6 X7 X8 X9 X10 X11 X12 X13 X14
X15 X16 X17 X18 X19 X20 X21 X22 X23 X24 X25 X26 X27 X28 X29 X30 X31 X32
X33};
    READ ALL INTO Q1;
USE BETA2 VAR{INTERCEPT X1 X2 X3 X4 X5 X6 X7 X8 X9 X10 X11 X12 X13 X14
X15 X16 X17 X18 X19 X20 X21 X22 X23 X24 X25 X26 X27 X28 X29 X30 X31 X32
X33};
    READ ALL INTO Q2;
USE BETA3 VAR{INTERCEPT X1 X2 X3 X4 X5 X6 X7 X8 X9 X10 X11 X12 X13 X14
X15 X16 X17 X18 X19 X20 X21 X22 X23 X24 X25 X26 X27 X28 X29 X30 X31 X32
X33};
    READ ALL INTO Q3;
USE BETA4 VAR{INTERCEPT X1 X2 X3 X4 X5 X6 X7 X8 X9 X10 X11 X12 X13 X14
X15 X16 X17 X18 X19 X20 X21 X22 X23 X24 X25 X26 X27 X28 X29 X30 X31 X32
X33};
    READ ALL INTO Q4;
USE BETA5 VAR{INTERCEPT X1 X2 X3 X4 X5 X6 X7 X8 X9 X10 X11 X12 X13 X14
X15 X16 X17 X18 X19 X20 X21 X22 X23 X24 X25 X26 X27 X28 X29 X30 X31 X32
X33};
    READ ALL INTO Q5;
USE COV1 VAR{INTERCEPT X1 X2 X3 X4 X5 X6 X7 X8 X9 X10 X11 X12 X13 X14
X15 X16 X17 X18 X19 X20 X21 X22 X23 X24 X25 X26 X27 X28 X29 X30 X31 X32
X33};
    READ ALL INTO U1;
USE COV2 VAR{INTERCEPT X1 X2 X3 X4 X5 X6 X7 X8 X9 X10 X11 X12 X13 X14
X15 X16 X17 X18 X19 X20 X21 X22 X23 X24 X25 X26 X27 X28 X29 X30 X31 X32
X33};
    READ ALL INTO U2;
USE COV3 VAR{INTERCEPT X1 X2 X3 X4 X5 X6 X7 X8 X9 X10 X11 X12 X13 X14
X15 X16 X17 X18 X19 X20 X21 X22 X23 X24 X25 X26 X27 X28 X29 X30 X31 X32
X33};
    READ ALL INTO U3;
USE COV4 VAR{INTERCEPT X1 X2 X3 X4 X5 X6 X7 X8 X9 X10 X11 X12 X13 X14
X15 X16 X17 X18 X19 X20 X21 X22 X23 X24 X25 X26 X27 X28 X29 X30 X31 X32
X33};
    READ ALL INTO U4;
USE COV5 VAR{INTERCEPT X1 X2 X3 X4 X5 X6 X7 X8 X9 X10 X11 X12 X13 X14
X15 X16 X17 X18 X19 X20 X21 X22 X23 X24 X25 X26 X27 X28 X29 X30 X31 X32
X33};
    READ ALL INTO U5;

*DEFINE M EQUAL TO THE NUMBER OF IMPUTATIONS;
M=5;
*AVERAGE OF THE FIVE POINT ESTIMATES OF THE COEFFICIENTS (Eq. 1);
QBAR=(Q1+Q2+Q3+Q4+Q5)/M;

```

```

*AVERAGE WITHIN IMPUTATION VARIANCE (Eq. 2);
  UBAR=(U1+U2+U3+U4+U5)/M;
*BETWEEN IMPUTATION VARIANCE (Eq. 3);
  BM=((Q1-QBAR)^(Q1-QBAR)+(Q2-QBAR)^(Q2-QBAR)+(Q3-QBAR)^(Q3-QBAR)
  +(Q4-QBAR)^(Q4-QBAR)+(Q5-QBAR)^(Q5-QBAR))/(M-1);
*RII TOTAL VARIANCE OF THE COEFFICIENTS (Eq. 4);
  TM=UBAR+(1+1/M)*BM;
  TMDIAG=DIAG(TM);
*RII STANDARD ERROR OF THE COEFFICIENTS (Eq. 5);
  TSTD=SQRT(TMDIAG);
*RELATIVE INCREASE IN VARIANCE DUE TO NONRESPONSE (Eq. 8);
  RM=((1+1/M)*BM)/UBAR;
*DEGREES OF FREEDOM (Eq. 7);
  V=(M-1)*(1+INV(DIAG(RM)))##2;
  DFV=(VECDIAG(V));
*FRACTION OF INFORMATION ABOUT COEFFICIENTS WHICH IS MISSING (Eq. 9);
  GAMMA=(RM+(2/(V+3)))/(RM+1);
*CHI-SQUARE TEST STATISTIC FOR THE COEFFICIENTS;
  CHISQ=((QBAR)##2)*INV(TMDIAG);
  PVALUE=1-PROBCHI(CHISQ, 1);

***STEPS TO DERIVE INFORMATION NEEDED FOR THE MODEL TEST STATISTIC***;
*DEFINE K EQUAL TO THE NUMBER OF INDEPENDENT VARIABLES
  EXCLUDING THE INTERCEPT;
  K=33;
*BETWEEN IMPUTATION VARIANCE MATRIX EXCLUDING INTERCEPT;
  BMINDP=BM(| 2:K+1, 2:K+1|);
*WITHIN IMPUTATION VARIANCE MATRIX EXCLUDING INTERCEPT;
  UBARINDP=UBAR(| 2:K+1, 2:K+1|);
*RELATIVE INCREASE IN VARIANCE USED IN CALCULATING MODEL TEST
STATISTIC (Eq. 14);
  RM14=(1+1/M)*TRACE(BMINDP*INV(UBARINDP))/K;
*DENOMINATOR DEGREES OF FREEDOM FOR THE MODEL TEST STATISTIC;
  VDM=(M-1)*(1+INV(RM14))##2;
  DMDF=(K+1)*VDM/2;

```