Individual Risk Aversion Through the Life Cycle: Incorporation of Observed Measures of Individual Risk Aversion in the Estimation of Dynamic Life Cycle Decision Models*

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Abstract

I develop a dynamic model of individual lifetime behavior and jointly estimate a set of correlated dynamic equations for observed risk aversion, wealth-related decisions (employment, occupation, investment, and savings), and other characteristics that an individual may value independently of wealth (family and health). I consider how to incorporate observed measures of individual risk aversion (calculated from survey responses) into an empirical model of individual behavior and how to reconcile the use of these measures with the economic theory of individual behavior over time. I allow risk preferences to be an endogenous determinant of observed behaviors and find that there is correlation, through unobserved characteristics, between risk aversion and wealth-related behaviors, as well as causal effect of risk preferences on these outcomes. The joint estimation of observed risk aversion and behaviors reduces the bias on the estimated marginal effects of endogenous variables that impact wealth-related decisions and better approximate the distribution of individual unobserved heterogeneity. Risk aversion provides explanatory power, yet require using econometric methods that account for correlated unobservables. Failure to model this correlation may result in biased estimates and overestimation of policy effects.

Keywords: Risk Preferences, Elicited Risk Aversion, Survey Measures
JEL Classification: D91, D81, C39.

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1 Introduction

In this paper, I consider the incorporation of observed measures of individual risk aversion into an estimable empirical model, and how to reconcile the use of these observed measures with the economic theory of behavior over time. Specifically, I compare the estimated marginal effects of policy variables of interest when these measures are excluded or, exogenously or endogenously, included. Since risk aversion is an abstract conceptualization based on the properties of the utility function, economists have developed experimental methods for elicitation of risk preferences. As a result, there are available observed measures of risk aversion from experimental settings and from representative surveys.[1] The use of these measures in the empirical economics literature has been increasing in the last 10 to 15 years; however, there is not a generally accepted way of using them to evaluate the role of risk aversion on individual behavior (Holt and Laury, 2014). Additionally, even when predictions of economic models are well established, there are empirical limitations that challenge applied researchers. Examples are the typically unaddressed endogeneity between risk preferences and observed individual behavior and the infrequently studied evolution of risk aversion through the life cycle (e.g., risk preferences affect individual investment decisions which affect wealth levels, and accumulation of wealth through the life cycle affects future wealth and risk preferences).

I propose a dynamic model of individual life-cycle behavior to be reconciled with observed risk aversion over time. In the model, individual wealth-related decisions depend on risk preferences. Observed risk aversion is obtained from survey responses and is considered a proxy for an individual's risk preferences. I model it as a realization of risk attitudes and as an endogenous determinant of observed individual behaviors. Using the model, I derive a set of estimable correlated dynamic equations representing wealth-related behaviors such as employment, occupation, savings, and financial investment decisions. The resulting set of jointly-estimated equations also includes stochastic health and family characteristics that individuals may value independently of wealth, and that may affect risk preferences and may be affected by wealth-related decisions. Following Bommier and Rochet (2006) dynamic risk aversion model, I expand the classic notion on risk aversion to depend only on wealth uncertainty. I explore the role of risk aversion and life expectancy using information from the Survey of Social Protection (EPS), unique representative survey data available from Chile, which contains elicited individual values obtained four times over seven years for every individual in the sample. By correlating subjective measures with observed behaviors I relate the experimental literature on risk aversion with the revealed preference approach; and I account for several sources of estimation biases.[2]

[1] A review on the conceptualization of risk aversion, empirical methods for elicitation of risk preferences and the use of these measures in the literature is presented in Section 3. Examples of survey with observed measures of risk aversion are: Panel Study of Income Dynamics (wave of 1996), National Longitudinal Survey of Youth (waves of 1993 and 2002), Health and Retirement Survey (waves 1992, 1994, 1998, 2000, and 2002), Italian Survey of Household Income and Wealth (1995), German Socio-economic Panel (waves of 2004 and 2006).

[2] Specifically, the model addresses endogeneity, selection, and measurement error bias. Several theoretically-relevant explanatory variables for the behaviors or outcomes I model are endogenous. For example, investment

According to economic theory, an individual is risk averse (loving) if she, starting from a position of certainty, rejects (accepts) any fair gamble. An individual is said to be risk neutral if she is indifferent between the options (Meyer, 2014). Individuals may be characterized by their degree of risk aversion. The economics of uncertainty literature defines the level of risk aversion by the degree of curvature of the utility function, according to the models of Pratt (1964) and Arrow (1965). An individual's level of risk aversion is not necessarily constant over time and it may change during her life cycle. Three effects explain this evolution: changes in wealth levels over the life cycle, aging, and variation in the length of the planning horizon that individuals consider when making decisions (Bommier and Rochet, 2006).

Since risk aversion is manifested in preferences, it influences many (if not all) behavioral decisions. The classic example of the role of risk aversion is in the insurance market. Risk averse individuals are more likely to buy insurance (e.g., health, car, house, private unemployment insurance, etc.) and to demand more insurance coverage than risk neutral individuals (Mossin, 1968; Rosen et al., 2003). Risk aversion also explains individual employment decisions, job change, and occupation and industry choice (Kihlstrom and Laffont, 1979; Guiso and Paiella, 2008). It also impacts saving decisions and wealth accumulation. Depending on her level of risk aversion, an individual may save more and chose different investment instruments (Gollier, 2004).

Empirical measures of risk aversion have been developed and used to explain observed behaviors (Holt and Laury, 2014).[3] Some authors have used them to understand what drives differences in observed behaviors across individuals and to test theoretical predictions. Empirical measures of risk aversion have also been used to explain financial and savings decisions, to analyze retirement wealth accumulation, and to explain individual behavior and outcomes in the labor market. Risk aversion may play a role in explaining the gender wage gap and asset accumulation gap, financial investment allocation, entrepreneurship and employment status, occupation selection, among others. Some authors that have explored these roles are Johnson and Powell (1994); Schubert et al. (1999); Bernasek and Shwiff (2001); Hartog et al. (2002); Cramer et al. (2002); Eckel and Grossman (2008); Arano et al. (2010); Le et al. (2011); Chakravarty et al. (2011); Nelson (2014). Some authors also suggest observe measures of risk aversion should be used to test whether theoretical assumptions about risk preferences made in several welfare analyses hold (Harrison et al., 2007).

Mainly due to empirical limitations, there are still challenges in the literature. First, even though models of individual economic behavior predict that risk aversion may evolve over an individual's life cycle (see Bommier and Rochet (2006) and the references therein); longitudinal information on observed risk aversion is scarce, it has been hard to verify its evolution empirically. Datasets tend to be cross sections of information and they do not always allow to reconstruct the history of individuals. The EPS is a unique dataset that

vehicles determine wealth accumulation, yet investment amounts and portfolio allocation (i.e., levels of risk) are chosen by the individual. Selection bias results from participation behaviors that may be correlated with other modeled behaviors (e.g., participation in optional savings accounts and earnings). Measurement error might also be present in the survey measures for subjective assessments as well as reported savings.

[3]Measures of risk aversion are discussed in detail in Section 3.

contains observed measures of risk aversion for the representative sample of the population over time. Second, there is no consensus about how observed measures of risk aversion should be incorporated into empirical models when measures of observed risk aversion and behavior are correlated through unobservables (Holt and Laury, 2014). Many papers suffer from selection issues. For instance, researchers are usually only able to observe individuals who participate in financial markets, who are expected to be the least risk averse individuals. Moreover, papers that use elicited measures of risk aversion typically do not account for the endogeneity between risk preferences, wealth accumulation, and other characteristics. Since risk aversion influences many behaviors simultaneously, it is important to empirically account for the correlation across outcomes. By jointly estimating a set of equations, I account for the correlations between risk preferences and individual behaviors. Third, there is a gap in the literature for reconciling observed measures of risk aversion over time with our theoretical models of rational economic behavior. Additionally, there is not an accepted way to relate experimental measures of risk aversion (e.g., observed risk aversion from hypothetical settings coming from survey responses) with observed behaviors (e.g., savings or investment). These limitations have also resulted in weak evidence on how risk aversion varies with demographic characteristics. Except for gender and age differences, there is little conclusive evidence regarding additional sources of individual heterogeneity since most of this heterogeneity comes from behaviors that are a function of risk preferences. Finally, there are theoretically-relevant individual unobserved characteristics and unmodeled factors that likely interact with risk preferences and affect empirical measures of risk aversion that have not been considered (e.g., the length of the planning horizon, which influences individuals' dynamic behaviors).

I contribute to the literature by addressing most of these concerns. First, I model risk aversion through the life cycle by using four waves of the EPS. The EPS includes rich information about individual characteristics and questions to elicit individual risk aversion through the life cycle between the years 2002 and 2009 for every individual. This data feature allows me to account for observed variations in risk aversion over time while modeling life-cycle decisions that impact wealth accumulation. Second, I reconcile the use of observed risk aversion with a model of economic behaviors over time. This is relevant as it justifies the role of observed measures of risk aversion in empirical models and it provides an interpretation to the result. Third, based on this model, I explore how elicited risk aversion should be incorporated into empirical models and I compare the marginal effects of policy variables of interest when observed risk aversion is excluded from the estimation (e.g., when observed measures of risk aversion are not available), or exogenously or endogenously included in an individual's decision-making problem. To the best of my knowledge, this is the first paper to study the consequences of different modeling assumptions when incorporating observed risk aversion. Fourth, I relate the experimental literature on risk aversion with the revealed preference approach. I achieve this by allowing for correlation between elicited risk aversion coming from hypothetical settings and observed real-life behaviors that depend on individual risk preferences (e.g., likelihood of investing in risky assets). Fifth, I also allow for correlation with other outcomes that an individual may value besides wealth and by jointly estimating a set of correlated equations, I reduce several potential sources of estimation bias (e.g., endogeneity, selection, and measurement error). To the best of my knowledge, this is the first paper to include a wide set of correlated behaviors when studying the incorporation of observed measures of risk aversion in empirical models. [4] Following the conceptualization of dynamic risk aversion (see Bommier and Rochet (2006)) I also allow endogenous correlation between risk aversion and the length of the planning horizon.

Consistent with other results in the literature I find that women are less like than men to be in the most risk averse category; and as age increases, individuals are less likely to be in the least risk averse category. Individuals that have higher levels of educations, they are more likely to less risk averse. I find that been in very good health status significantly increases the likelihood of been in the least risk averse category, while been in poor health significantly decreases the likelihood of been in the least risk averse category. I find no significant effect of investments in mandatory financial investments for retirement, to have an effect on risk aversion; however as work experience increases, individuals are less likely to be in the least risk averse category. Consistent with the economic conceptualization of risk aversion, I find that elicited risk aversion and wealth-related behaviors exhibit correlation through unobservable individual characteristics.

For the analysis on the incorporation of observe measures of risk aversion, I focus on the estimated marginal effects of policy variables that affect investment and savings decisions through the life cycle; while accounting for risk preferences. In particular, I compare the estimated marginal effects when risk aversion is not modeled, when observed risk aversion is endogenously modeled with wealth-related decisions, and when risk aversion is assumed to be an exogenous determinant to decisions, and when its evolution through the life-cycle is modeled as a function of previous realizations of risk aversion. Additionally, I also allow different specifications for the individual correlated unobserved heterogeneity. Failure to model this correlation results in biased estimates of parameters of policy interest. For example, the significance of the marginal effects changes when estimating the model with and without correlated unobserved heterogeneity. Additionally, most of the marginal effects between the two models are statistical different. This is relevant for information for doing policy simulation and evaluation, as we can overestimate effects by not modeling correlation across outcomes. By jointly estimating observed risk aversion and behaviors and outcomes, I reduce the bias on the estimated marginal effects of variables of policy interest and better approximate the distribution of the remaining individual unobserved heterogeneity. From an empirical perspective, observed measures of individual risk assessments provide explanatory power, yet require using econometric methods that account for unobserved correlation through non-idiosyncratic avenues. Evidence that the unobserved determinants of observed

[4] To address these biases stemming from unobservables, I use the Discrete Factor Random Effects (DFRE) estimation method to jointly estimate 22 correlated equations that capture wealth-related behaviors and outcomes, subjective assessments, family characteristics, and health characteristics. Estimation is discussed in detail in Section 4.

measures of risk aversion and individual behaviors and outcomes are correlated is consistent with the conceptualization of risk aversion and suggests that empirical models that treat observed risk aversion as an exogenous covariate are incorrectly specified.

The rest of the paper is organized as follows. Section 2 reviews the literature that uses observed measures of individual risk aversion or its proxies. Section 3 discusses the conceptualization of risk aversion and empirical measures. Section 4 presents the empirical model and the estimation method, and Section 5 presents the data and research sample. The estimation results are presented in Section 6 and finally Section 7 concludes.

2 Related Literature

Risk Aversion and Wealth-related Behaviors

Elicited measures of risk aversion have been useful in explaining different wealth-related behaviors in the economic literature. As a starting point, researchers have attempt to study heterogeneity in risk aversion between individuals, focusing on exogenous individual characteristics such as gender or age. Many studies have found that women are more risk averse than men (Grable, 2000; Halek and Eisenhauer, 2001; DeLeire and Levy, 2001; Grazier and Sloane, 2008; Dohmen et al., 2005, 2011; Le et al., 2011). However, some other studies have found mixed results or no gender differences (Harbaugh et al., 2002; Andersen et al., 2006; Harrison et al., 2007; Tanaka et al., 2010). Holt and Laury (2002) find that women are more risk averse than men only in low-payoff conditions. Arano et al. (2010) find significant differences only between married women and their spouses.

With respect to age, there is more consistency among results. Harrison et al. (2007) and Dohmen et al. (2005, 2011) find that willingness to take risks has its maximum among middle-age individuals. Albert and Duffy (2012) find that young individuals are close to risk neutral while older individuals are more risk averse.

An important point of interest has been the relationship between individual risk aversion and labor market outcomes. Some authors have explored the idea that more risk averse individuals are less likely to be self-employed than to be a dependent worker. This hypothesis suggests that starting a business naturally entails more risk and earnings variation. There is evidence that supports this idea (Cramer et al., 2002; Ekelund et al., 2005; Brown et al., 2011). Grazier and Sloane (2008) find that workers seem to have preferences for risky jobs based on family composition and gender, which are assumed to be proxies for risk aversion. In an attempt to explain the gender wage gap, Le et al. (2011) analyze the role of risk aversion in explaining wages received. They find that females are more risk averse than males and that workers with more favorable attitudes towards risk are associated with higher earnings. They suggest that gender differences in risk attitudes can account for a small part of the standardized gender pay gap.

In addition, the financial economics literature has used individual investment decisions, such as observed participation in financial markets and risky asset holdings, as proxies for individual risk aversion to test the correlation between risk aversion and individual wealth levels. Using six waves of the Panel Study of Income Dynamics, Brunnermeier and Nagel (2008) test whether wealth fluctuations generate time-varying risk aversion. They proxy for risk aversion using an individual's risky asset share over total investments in the stock market. They find evidence that changes in liquid wealth have a significant effect on the probability of entering or exiting the stock market but have little effect on asset allocation for households that already participate in the market. A natural limitation of Brunnermeier and Nagel (2008) research is that it focuses on one risky behavior, such as investments in the stock market. There is also a selection issue, since their conclusion is based only on a sample of individuals who have chosen to participate in the financial market.

Guiso and Paiella (2008) use a cross-sectional dataset on household willingness to pay for a hypothetical risky security as an elicited measure of risk aversion and find that absolute risk aversion is decreasing in individual's endowment. They reject the CRRA specification as a framework for explaining lifetime individual risk aversion. Chiappori and Paiella (2011) use longitudinal data on individual's wealth invested in risky and safe assets. Using a first difference approach, they test how changes in wealth affect share of risky assets when time-invariant unobserved heterogeneity is eliminated. They find that investment in risky assets does not change as financial wealth changes. This conclusion does not hold as they expand the wealth measure to include business equities and housing, where investment in risky assets increases as wealth increases. They recover the distribution of risk aversion for households with risky assets, and they find a negative and significant correlation between risk aversion and wealth. There is also evidence that past consumption levels explain current risky asset holdings (Lupton, 2003; Ravina, 2005).

Sahm (2012) is one of the few authors that uses elicited measures of risk aversion from a longitudinal dataset for the U.S. She corrects endogeneity by assuming that unobserved heterogeneity is time-invariant and due to data availability, she focus on individuals over the age of 50. She finds that changes in household income and wealth, as well as other variables that affect income such as a serious health condition or job displacement, have little impact on measured risk tolerance. She also finds that risk tolerance increases with improvement in macroeconomic conditions. These results are consistent with the findings of Malmendier and Nagel (2011), Guiso et al. (2013) Necker and Ziegelmeyer (2016), and Dohmen et al. (2016).

Risk Aversion and Other Individual Behaviors

There is also empirical evidence on the correlation between risk preferences and other characteristics that individuals may value independently of wealth, such as family characteristics, health status, and cultural backgrounds. However, the results are not informative about the direction of causality between these variables and risk aversion. Using a matching approach and a longitudinal dataset for correcting for selection and reverse causality, Decker and Schmitz (2016) find that health shocks significantly increase individual risk aversion, consistent with other results . Eisenhauer and Ventura (2003) find that risk aversion is higher among single individuals and among individuals with poor health. Spivey (2010) hypotheses that, due to the uncertainty in searching for a partner, a more risk averse individual should get married sooner than a less risk averse individual. Her empirical findings support this idea. Despite some data limitations, she runs regressions to test for reverse causality and she suggests that being married does not affect an individual's risk aversion. There is also evidence that more risk averse individuals are less likely to divorce (Light and Ahn, 2010). Doepke and Tertilt (2016) correlate family structure (marital status, divorce risks, number of children) with individuals' and family savings and labor supply decisions over time, which we know are affected and affect risk aversion as it impact wealth. They also recognize the impact that these decisions may have on aggregated savings and labor supply and how macroeconomic variable may also affect individual's decisions. With respect to children, the causality is less clear. Schmidt (2008) finds that more risk averse individuals are more likely to get married sooner and that more risk averse young woman are more likely have children sooner, yet the opposite is true for woman at the end of their fertile age. Spivey (2010) finds that individuals become more risk averse after having children; which is consistent with the findings of Görlitz and Tamm (2015), who find that parenthood leads to changes in individual risk aversion over time. Very importantly, Görlitz and Tamm (2015) suggest that we should be careful in interpreting causal effects of incorporating observed risk aversion as an explanatory variable for economic outcomes.

There is also evidence that individuals with higher cognitive ability are more willing to take risks, and that cultural background, such as religion, nationality and migration status, have an impact on risk taking behavior (Jaeger et al., 2010; Dohmen et al., 2008; Noussair et al., 2013; Weber, 2013).

3 Conceptualization of Risk Aversion

3.1 Economic Modeling of Risk Aversion

The roots of our modern understanding of risk aversion date back to the writing of Bernoulli in 1738. Its subsequent development was formalized by the contributions of Morgenstern and Von Neumann (1953) (Gollier, 2004). Pratt (1964) and Arrow (1965) introduced the absolute and relative measures of risk aversion. These measures rely on the shape of the per-period utility function in a static setting. They define the coefficient of absolute and relative risk aversion as: $A(\omega) = -\frac{u''(\omega)}{u'(\omega)}$ and $R(\omega) = -\omega\frac{u''(\omega)}{u'(\omega)}$ where $u'(\cdot)$ and $u''(\cdot)$ are the first and second derivatives, respectively, of the per-period utility function, and ω denotes wealth.[5]

To make optimization problems tractable, researchers often impose assumptions about the utility function and, hence, about risk aversion. Among all the many classes of utility functions, a functional form that has received special attention is the constant relative risk

[5] It assumes that the utility function captures individual preferences over wealth, and that it is twice continuously differentiable with a positive first derivative.

aversion (CRRA) specification. The general representation of this functional form is:

$$u(\omega) = \begin{cases} \frac{\omega^{1-\rho}}{1-\rho} \text{ if } \rho \neq 1 \\ \ln(\omega) \text{ if } \rho = 1 \end{cases} \tag{1}$$

where ρ is a constant parameter that is commonly refer to as "the (relative) risk aversion parameter" or simply "*rho*." This representation has been widely used in the economics, psychology, and health literatures for modeling risk aversion (Wakker, 2008). Pratt and Arrow's static framework restricts how risk aversion evolves through the life cycle. In this model, risk aversion may change over time only if the argument (e.g., wealth) of the static utility function changes. Such changes are typically assumed to be exogenous.

Bommier and Rochet (2006) expand the analysis by defining an individual intertemporal risk aversion measure. This measure incorporates the horizon length, or the remaining number of periods, to study how risk aversion varies during the life cycle.[6] In Bommier and Rochet (2006), the maximal value of the discounted lifetime utility at age n is $V_n(\omega_n) = \max_{C_n,...,C_N} U(C_1^*, ..., C_{n-1}^*, C_n, ..., C_N)$ subject to $\omega_n = \sum_{t=n}^{N} p_t C_t$, where ω_n denotes wealth and p_t is the price of a composite good consumed in period t. Present and future consumption is denoted by $(C_n, ..., C_N)$, the optimal past consumption path by $(C_1^*, ..., C_{n-1}^*)$, and N is the horizon length. The dynamic absolute and relative measures of risk aversion are: $A_n^D(\omega_n) = -\left[\frac{V_n''(\omega_n)}{V_n'(\omega_n)}\right]$ and $R_n^D(\omega_n) = -\omega_n \left[\frac{V_n''(\omega_n)}{V_n'(\omega_n)}\right]$ where $V_n'(\omega_n)$ and $V_n''(\omega_n)$ are the first and second derivatives of the value function. The dynamic versions of the absolute and relative measures of risk aversion depend on the shape of the value function, as well as values of wealth and the number of remaining periods at age n, both of which vary over the life cycle.

The authors discuss three mechanisms that may impact risk aversion through the life cycle: wealth, age, and the horizon length. Time t values of wealth not only define risk aversion at the current period but also determine subsequent values of wealth and hence investment and savings behaviors. The marginal utility of wealth may change with age, and with the number of remaining years in one's decisionmaking problem. They show that relative risk aversion decreases as age increases. They also show that relative risk aversion increases as the horizon length increases. Importantly, if other variables in addition to wealth or consumption, such as leisure or lifestyle variables, impact utility; then risk aversion also depends on the chosen values of those inputs. Moreover, since these optimally chosen behaviors are endogenous (i.e., as they are determined by the optimization of one's lifetime utility) they also depend on preferences, including risk preferences.

The conceptualization of risk aversion in this paper is based on the extended dynamic model of Bommier and Rochet (2006). In Section 4 I extend the classic notion of risk aversion to be dependent only on wealth and consumption and allows interaction with other characteristics that an individual may value independently of wealth such as family or health.

[6]They assume that individuals are rational, time consistent, forward-looking, and have preferences over consumption, that each period an individual behaves in a way that maximizes her lifetime utility subject to her budget constraint, and that there is no uncertainty.

The empirical model allows for correlation in the unobservables that affect risk aversion, horizon length, wealth, and lifestyle characteristics.

3.2 Empirical Measures of Risk Aversion

Since Pratt (1964) and Arrow (1965) introduced their measures of risk aversion, several empirical papers have attempted to estimate or to elicit these values. Empirical methodologies, contexts, types of data, and results have been quite varied (Eisenhauer and Ventura, 2003).

Researchers have used a variety of ways to elicit direct measures of risk attitude. There are generally three approaches for measuring risk attitude: the investment portfolio approach, the lottery choice menu approach, and the pricing task approach (Holt and Laury, 2014). The investment portfolio approach asks respondents to choose between alternative financial gambles. One alternative is always less risky than the rest. The lottery choice menu builds the individual's risk attitude based on a structured list of binary choices between safe and risky gambles. The pricing task approach asks respondents to name a certainty equivalent money amount for a gamble. Risk attitude is inferred using this value and the expected value of the gamble. The three approaches are similar since binary choices in a menu list can be thought of as pairs of alternative portfolios and one can be asked to elicit a certainty equivalent instead of a price or a choice (Holt and Laury, 2014). Observed measures of risk aversion from these approaches are available from both, experimental settings and in surveys where individuals are asked to chose between alternative gambles or scenarios.

The experimental measure of Holt and Laury (2002) is widely used, while the use of survey measures have increased in the past decade as questions of hypothetical gambles derived from Holt and Laury (2002) have been included in surveys. These survey measures have been validated as controls of risk preferences for many different behaviors (see Anderson and Mellor (2009) and references therein). Survey measures on risk aversion first appeared in the Health and Retirement Survey (HRS), representative of the American population over the age of 50. It was also introduced for the National Longitudinal Survey of Youth (NLSY) and in the Panel Study of Income Dynamics (PSID) but not with the same periodicity for constructing longitudinal information. Outside the U.S., the German Socio-economic Panel allows 2 waves of information for risk aversion, while the Italian Survey of Household Income and Wealth allows a cross-section. This research uses the lottery choice menu using 2 questions from the Chilean Survey of Social Protection. This a unique dataset as it allows to construct a 3-category elicited measure of risk aversion observed 4 times for the same individuals, between the years 2002 and 2009, for a representative sample of the adult population. A critique on elicitation methods is that it may be noisy capturing risk preferences. Anderson and Mellor (2009) studies the correlation between these two popular approaches for eliciting risk aversion and find no significant correlation between experimental measures and survey measures. Importantly, they find that effort or ability may partially explain correlation across different types of measures. For partially solving these issues, Sahm (2012) accounts for measurement error in the HRS measure. This paper allows correlation across equation to also capture, among other factors, measurement error in individual's risk preferences.

A different approach is to recover primitive parameters governing an individual's decision making process. Barsky et al. (1995) compute the relative risk aversion parameter of a CRRA static utility function by directly using survey measures of elicited risk aversion. They calculate bounds on the relative risk aversion parameter by solving an equation so that the individual is indifferent between the two options of a hypothetical gamble. This is a different way of calculating an observed risk aversion measure, based on survey questions. Other authors estimate the relative risk aversion parameter from a CRRA specification without using observed measures of risk aversion. Rather than directly computing bounds, they parametrized the contemporaneous utility function, model decisions through the life cycle, and estimate the risk aversion parameter *rho*. This is computationally a more demanding approach. It has the advantage that authors can study how risk aversion varies as exogenous characteristics change. Some examples of the latter approach can be found in Keane and Wolpin (2001); Todd and Wolpin (2006); Blau and Gilleskie (2006, 2008); Van der Klaauw and Wolpin (2008).

There is a connection between measures of risk aversion coming from lottery choice menus with the conceptualization of risk aversion. These survey answers are viewed as resulting from an expected utility calculation (Barsky et al., 1995; Spivey, 2010). Typically a respondent will be asked: *What do you prefer, a job with a certain lifetime-stable salary or a job where you have* p *chances of earning* λ_1 *of your lifetime income or* $(1-p)$ *changes of earning* λ_2 *of your lifetime income?* where $\lambda_1 \geq 1$ and $0 < \lambda_2 < 1$. Assuming U be the utility function and c the permanent consumption (equal to lifetime stable salary), then the indifference point between options solves: $p \times U(\lambda_1 c) + (1-p) \times U(\lambda_2 c) = U(c)$. Some authors assume a static framework using a CRRA form for U and directly compute the relative risk aversion parameter by normalizing wealth, replacing the survey information, and solving for the indifference *rho* (Barsky et al., 1995). This is a simplified analysis as it uses a static model to solve for risk preferences over lifetime consumption and one can only solve for *rho* between bounds (i.e., with two questions about preferences toward hypothetical gambles, we end up with only one computation of *rho*). To avoid making assumptions about the functional form of the utility function and about the evolution of risk aversion over time, rather than following that approach, this paper categorizes risk aversion based on individual's answers.

4 Empirical Model and Estimation

This section presents a dynamic model of life-cycle decisions that directly impact wealth accumulation. In particular, individuals make decisions with respect to employment, occupation, investment portfolio for retirement, and savings. The model includes other characteristics that an individual may value independently of wealth, such as family and health characteristics. The objective is to provide a framework to study the incorporation of observed measures of risk aversion through the life cycle. Two subjective assessments that are determined simultaneously with the decisions are incorporated: an individual's reported level of risk aversion and expected duration of life. This section also derives a set of correlated equations to be estimated and presents the estimation strategy.

4.1 The Modeling of Risk Aversion

The theoretical and estimable model in this paper is build up upon the evidence find in empirical papers of risk aversion and consistently with the models of individual economic behavior (see Section 3). I consider risk aversion through the life cycle to be determined by an individual's wealth level, and I allow interaction with other characteristics that may affect decisions independently of wealth (family and health characteristics).

Rather than focusing in one behavior or outcome, the estimable model in this paper allows for correlation between an observed measure of risk aversion with real life observed behaviors that partially could capture individual's risk preferences (e.g., financial investments). It also allows for correlation with other behaviors and outcomes that the literature has used as proxies for risk aversion, such as health and family structure. I explore the role of permanent and time varying individual unobserved heterogeneity in wealth-related decisions, survey measures of risk aversion, and other outcomes related with individual's health and family characteristics. Importantly, I also allow for unobserved components to be correlated between all these observed variables.

4.2 Timing and Notation

An individual enters each period t with information about her history of past choices and relevant knowledge about current individual and market characteristics, denoted by the vector Ω_t. The choice history includes accumulated value of assets for retirement (A_t^r), chosen financial investments for retirement last period (i_{t-1}), optional savings last period (s_{t-1}), and work experience up to period t (E_t). Her current characteristics are summarized by marital state (M_t), number of children (N_t), health status (H_t), individual exogenous characteristics (X_t) (e.g., gender and age), and other exogenous market-level characteristics (Z_t) (e.g., prices). I denote $\tilde{\Omega}_t$ as the set of endogenous variables influencing the individual's decision (i.e., Ω_t includes $\tilde{\Omega}_t$, X_t, and Z_t).

The retirement system in Chile is based on individual savings and capitalization. It is mandatory that every dependent worker save ten percent of her employment income. Through this paper I refer to dependent workers as employed workers, as opposed to self-employed (or independent) workers. I define w_t to be the hourly wage rate and h_t hours worked per month. This mandatory saving is credited to a retirement account that can be liquidated only when the individual retires. Each period the worker chooses one of five possible investment funds, or a combination of two of those funds, in which to invest that money. The funds differ by the level of financial risk and are offered by private firms whose objective is to manage workers' investments for retirement. The individual makes

5 investment decisions, $i_t = (i_t^A, i_t^B, i_t^C, i_t^D, i_t^E)$, that consist of whether or not to invest in each of the accounts.[7] If an individual is not employed in t but was in the past, she does not contribute to the account ($w_t = 0$), but she still makes the investment decisions.[8]

In addition to mandatory savings, individuals may choose to hold voluntary savings (s_t). These savings can be cashed at any time, before or after retirement. Therefore an individual's wealth entering the period has two components. The first component is the value of accumulated assets for retirement, $A_t^r = A_{t-1}^r \cdot R_{t-1}^r(i_{t-1}) + a_t^r$, which depends on the return of required investments for retirement on previous assets, $R_{t-1}^r(i_{t-1})$, and the worker's contribution in $t-1$, denoted by a_t^r. R_{t-1}^r is a function of the chosen investments last period, i_{t-1}. The second component is the value of accumulated optional savings, $s_{t-1} \cdot R_{t-1}^o$ where the return for optional savings is denoted by R_{t-1}^o. When an individual is making the investments and savings decisions, she does not know the rates of return as they depend on the performance of the financial market. I assume that she observes the rates of return from the previous period when entering period t.[9]

At the beginning of each period the individual receives, for each occupation, a wage offer, w_t^*, which is unobserved by the econometrician and drawn from an occupation-specific wage distribution. She also receives a draw, denoted k_t from the medical care consumption distribution which represents stochastic necessary consumption within the current period. The individual realizes her level of risk aversion (r_t) and forms her expected duration of life (T_t^e) which are important for solving the expected utility maximization problem. Simultaneously, the individual decides her employment state (e_t), occupation category (o_t), investment fund (i_t), and optional savings (s_t). Elicited risk aversion and expected duration of life are realized at the time the individual faces wealth uncertainty and makes the decisions. The per-period alternatives are $e_t = \{0, 1, 2\}$ indicating non-employed, working part-time, and working full-time, respectively; $o_t = \{1, 2, ..., 6\}$ indicating occupation categories (elementary occupations; legislators, senior officials and managers, professionals, technicians and associate professionals; clerical support workers; service and sales workers; skilled agricultural, forestry and fishery workers, craft and related trade workers; and plant and machine operators and assemblers); $i_t^A = \{0, 1\}$, $i_t^B = \{0, 1\}$, $i_t^C = \{0, 1\}$, $i_t^D = \{0, 1\}$, $i_t^E = \{0, 1\}$, indicating no investment or investment in that fund, and $s_t = \{0, 1\}$ indicating no optional savings or some optional savings. According to the survey answers that the individual provides for the hypothetical lotteries, r_t takes one of three values, $r_t = \{1, 2, 3\}$ where 1 is the most risk averse category and 3 is the least risk averse category. Expected duration of life, T_t^e, is reported in years.

The period t marital status (m_t), changes in family size (n_t), and health status (H_t) are observed entering period t. In order to focus on the role of wealth-related decisions, I assume that their future values are stochastic outcomes that are realized at the end of

[7] Account A invest between 40 and 80 percent in equities; account B 25 and 60 percent; account C 15 and 40 percent; account D 5 and 20 percent; and account E less than 5 percent.

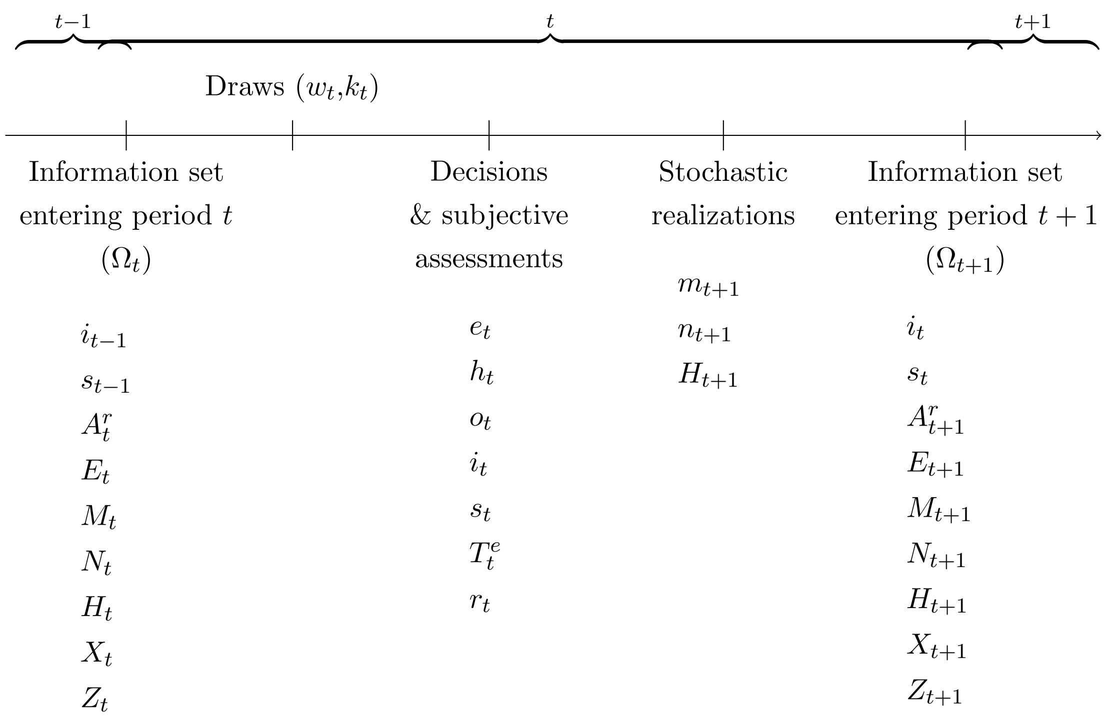
[8] For a complete description of the system, see Berstein (2010).

[9] These rate of returns are public information and individuals do indeed receive this information.

each period, prior to entering the next period. These transitions may depend on the current period decisions, as well as previous behaviors and outcomes, but are not explicitly modeled as choice variables. For example, health status entering next period may be a function of current period employment status and health consumption. Past marriage realizations are summarized by the marital history vector M_t. This vector includes the marriage state entering the period, m_t, number of years married if married, number of marriages, and interaction terms with gender. Past child realizations are summarized by the child history vector N_t which include the number of children up to period t, and interaction terms with gender.

After making the period t decisions and subjective assessments, and realizing the period $t+1$ stochastic values, the individual updates her information set to Ω_{t+1}. Figure 1 depicts the timing of endogenous decisions, stochastic realizations and subjective assessments.

Figure 1: Timing of Decisions, Subjective Assessments and Stochastic Realizations



4.3 Utility Function and Constraints

Each period t the individual receives utility (U_t) from consumption (c_t), leisure (l_t), marital status (m_t), number of children (N_t), and health status (H_t). The per-period utility function is:

$$U_t = U\left(c_t, l_t; X_t, m_t, N_t, H_t, \epsilon_t, r_t^*\right) \tag{2}$$

where ϵ_t is an alternative-specific preference error and r_t^* defines the curvature of the per-period utility function. Note that consumption and leisure (c_t, l_t) are endogenous arguments of the utility function. The marginal utility of these inputs depends on exogenous individual characteristics, marital status, number of children, and health status.

The individual faces a time constraint and a budget constraint given in equations 3 and 4. Total time, Γ_t, is distributed between leisure, working hours, and family time $f(m_t, N_t)$.

An employed individual receives earned income (Y_t) equal to $w_t h_t$, where w_t is the hourly wage and h_t denotes hours worked per period. She receives non-earned income from her spouse, if married (m_t). She also receives interest income on previous savings, with rates of returns R^o_{t-1} for optional savings, and $R^r_{t-1}(i_{t-1})$ for required savings which is a function of the chosen investment funds. The individual allocates her earnings and wealth between consumption, savings, medical care consumption expenditures $K(k_t)$, and family expenditures $g(m_t, N_t)$ each period. More specifically,

$$\Gamma_t = l_t + e_t h_t + f(m_t, N_t) \tag{3}$$

$$c_t + a^r_t + s_t + K(k_t) + g(m_t, N_t) = w_t h_t + A^r_{t-1} R^r_{t-1}(i_{t-1}) + a^r_{t-1} + s_{t-1} R^o_{t-1} + m_t Y_t \tag{4}$$

where s_t is optional savings, and a^r_t defines the required savings each period if a person is employed. That is

$$a^r_t = \alpha w_t h_t \tag{5}$$

where α represent the fraction of required savings for retirement. Each period, an individual chooses e_t, h_t, o_t, i_t, and s_t to maximize remaining lifetime utility given information (Ω_t) entering period t and her current beliefs about future stochastic outcomes. The individual's lifetime utility is

$$\sum_{t=1}^{T} \beta^{t-1} U\left(c_t, l_t; X_t, m_t, N_t, H_t, \epsilon_t, r^*_t\right) \tag{6}$$

where β is an exogenous discount factor and T represents length of the planning horizon. In the empirical specification there are four decisions (e_t, o_t, i_t, s_t) since hours of work are included in the categorization for employment e_t which takes values {0,1,2} for non-employed, working part-time, and working full-time.

Risk Aversion

In a static framework, risk aversion would be measured using Pratt (1964) and Arrow (1965). Risk aversion would depend only on the curvature of the per-period utility function (r^*_t) and wealth level. In a dynamic setting, an individual's level of risk aversion may vary over the life-cycle due to the different mechanisms discussed in Section 3.1. Risk aversion depends on the curvature of the current period utility as well as the curvature of the discounted future utility. In the empirical framework, I denote r_t to be elicited risk aversion and it is modeled as a realization of risk preferences in a dynamic framework. Elicited risk aversion (r_t) is affected by the curvature of the per-period utility function (r^*_t) and by the curvature of future utility (r^*_t for $t \geq t+1, t+2, ..., T$). Note that since I am not estimating the primitives of the utility function I am assuming a general form for the utility function. This is an important element of this research as I am not imposing any assumption on the structure of risk preferences. The approach taken by this paper consist on developing a framework for the incorporation of observed measures of risk aversion in the estimation of a set of correlated equations derived from a structural problem. Appendix A presents Pratt (1964)'s and Arrow (1965)'s measures of risk aversion for a static problem and Bommier and Rochet (2006)'s dynamic measure of risk aversion for a simplified version of this model with two periods.

4.4 Optimization Problem

Each period t the individual maximizes the present discounted value of her expected lifetime utility, given her information and beliefs and state variables, and subject to her time and budget constraints.

The individual dynamic problem is specified as follows. Each period an individual evaluates her employment alternatives (which include hours of work), occupation, investments, and saving alternatives. Alternative $eois$ (where $e_t = e$, $o_t = o$, $i_t^A = i^A$, $i_t^B = i^B$, $i_t^C = i^C$, $i_t^D = i^D$, $i_t^E = i^E$, $s_t = s$) is denoted by $d_t^{eois} = 1$. The value of this alternative is the sum of current period utility and the maximum expected lifetime utility at $t+1$ given the alternative chosen at time t. The instant utility of choice d_t is U_t^{eois}. Individuals have expectations over their duration of life. Let T be the final period for an individual. At period $t = T$ the individual cares about her per-period utility and maximizes equation 7.[10] That is,

$$V_T^{eois}(\Omega_T, \epsilon_T, w_T, k_T) = U_T^{eois} \text{ if } t = T \tag{7}$$

For all $t < T$, the individual's value function (equation 8) has two components: the per-period utility and the discounted maximal expected value of utility at time $t+1$. Specifically,

$$\begin{aligned} V_t^{eois}(\Omega_t, \epsilon_t, w_t, k_t, R_t^o, R_t^r) = U_t^{eois} + \\ \beta \int_{R_{t+1}^r} \int_{R_{t+1}^o} \int_{w_{t+1}} \int_{k_{t+1}} \int_{\epsilon_{t+1}} \left[\max_{eois'} V_{t+1}^{eois'}(\Omega_{t+1}, \epsilon_{t+1}, w_{t+1}, k_{t+1}, R_t^o, R_t^r | d_t = eois) \right] \\ dF(\epsilon_{t+1}) dF(k_{t+1}) dF(w_{t+1}) dF(R_{t+1}^o) dF(R_{t+1}^r), \\ \forall t = 1, 2, ..., T-1 \end{aligned} \tag{8}$$

where $dF(\epsilon_{t+1})$, $dF(k_{t+1})$, $dF(w_{t+1})$, $dF(R_{t+1}^o)$, and $dF(R_{t+1}^r)$ are the probability density functions over the alternative-specific preference error, medical consumption, wages, return on optional savings, and returns on required savings, respectively.

[10] I am assuming no bequest motive. Since the individual values family characteristics and she is making decisions that affects wealth, an extension of this model could allow for bequest motives.

4.5 Toward an Empirical Framework

Demand Equations

I assume that individuals behave as if they are solving the optimization problem defined in Section 4.4. Individuals optimize with respect to e_t, o_t, i_t, and s_t. The solution to this optimization problem yields eight equations that are functions of individual observed and unobserved (by the econometrician) information. These demand functions are presented in equations 9 to 12. I refer to these equations as demand functions. By solving the system of equations, one can express each of the demands as a function of the variables contained in Ω_t. In order to derive the estimated set of equations I approximate these demand functions by a Taylor series expansion of its arguments. Because the behaviors are chosen jointly, they are correlated through common observed heterogeneity as well as unobserved heterogeneity. For allowing correlation across decision in the estimation, I decompose the unobserved heterogeneity into three components. These components are defined as follows: 1) permanent individual unobserved heterogeneity (μ), 2) time-varying individual unobserved heterogeneity (ν_t), and 3) idiosyncratic unobserved heterogeneity (ε_t). This procedure allows me to jointly estimate individual decisions and account for estimation biases that are typically present in the literature of empirical risk aversion.

$$\ln\left[\frac{p(e_t=j)}{p(e_t=0)}\right] = e^j(i_{t-1}, s_{t-1}, A_t^r, E_t, M_t, N_t, H_t, X_t, Z_t, \mu, \nu_t) \quad j=\{1,2\} \tag{9}$$

$$\ln\left[\frac{p(o_t=j)}{p(o_t=1)}\right] = o^j(i_{t-1}, s_{t-1}, A_t^r, E_t, M_t, N_t, H_t, X_t, Z_t, \mu, \nu_t) \quad j=\{2,...,6\} \tag{10}$$

$$\ln\left[\frac{p(i_t^j=1)}{p(i_t^j=0)}\right] = i^j(i_{t-1}, s_{t-1}, A_t^r, E_t, M_t, N_t, H_t, X_t, Z_t, \mu, \nu_t) \quad j=\{A,B,C,D,E\} \tag{11}$$

$$\ln\left[\frac{p(s_t=1)}{p(s_t=0)}\right] = s(i_{t-1}, s_{t-1}, A_t^r, E_t, M_t, N_t, H_t, X_t, Z_t, \mu, \nu_t) \tag{12}$$

Subjective Assessments: Risk Aversion and Duration of Life

As derived from the optimization problem, we know that the estimable parameters of the set of correlated equations 9 to 12 are functions of the primitive parameters of the model, including r_t^* as a component of the per-period utility function. The curvature of the utility function is unobserved so in an estimation that does not include measures of risk aversion it is expected to get biased estimates. Adding elicited measures of risk aversion (r_t) into the estimation procedure will result in approaching the bias from the omitted information. Individual risk aversion could be considered one of the components of individual unobserved heterogeneity. When observed measures of risk aversion are not available due to data scarcity, researchers may chose to address this unobserved characteristics by modeling individual unobserved heterogeneity and consider risk aversion to be once of the components of it. In this paper, since I am adding observed measures of individual risk preferences, while modeling individual unobserved heterogeneity, we gain additional information by incorporating r_t into the model as it may help to better approximate the distribution of unobservables. In Section 6 I present the estimates of the model under different structures of individual unobserved heterogeneity and considering scenarios in which observed measures of risk aversion are not available. Observed risk aversion is modeled as a realization of the distribution of elicited risk aversion.

The horizon length has a similar interpretation. An economic model typically assumes that there are individual preferences and a planning horizon length that rationalizes observed behaviors. In many applications, the horizon length of the lifetime optimization problem is assumed to be some fixed number. In this model the individual's horizon length T defines the dynamic optimization problem and affects the primitive parameters of the model. Additionally, from Bommier and Rochet (2006) we know that the horizon length is one of the determinants of the individual's dynamic risk aversion. We may also consider T as the horizon length that affects the individual's valuation of the hypothetical gambles over lifetime income, used to construct r_t. Since T is unobserved we can use the individual reported expected duration of life, T_t^e, as a proxy. The individual may change her expectation of duration of life as she faces different scenarios (for instance, the individual may report a different level of expected duration of life in one wave after facing a health shock). T_t^e is a realization of the value that rationalizes her decisions and it is included into the set of equations as an assessment that is jointly realized with elicited risk aversion. Similarly, its incorporation reduces the bias due to omitted information and it may also help in identifying the distribution of unobservables.

Based on the above discussion, the preferred model treats the two subjective assessments as jointly realized with the observed wealth related decisions (i.e., at the moment the individual faces the uncertainty). This modeling assumption implies that r_t and T_t^e can be expressed as functions of variables contained in Ω_t as well as the permanent and time-variant unobserved components. The two subjective assessments are defined in equations 13 and 14. I also try other modeling assumptions in which current and lagged period subjective assessments are used as explanatory variables of decisions. These specifications are discussed in detail in Section 6.

$$T_t^e = T^e(i_{t-1}, s_{t-1}, A_t^r, E_t, M_t, N_t, H_t, X_t, Z_t, \epsilon_t^T, \mu, \nu_t) \tag{13}$$

$$\begin{aligned} ln\left[\frac{p(r_t=j)}{p(r_t=1)}\right] &= r^j(i_{t-1}, s_{t-1}, A_t^r, E_t, M_t, N_t, H_t, X_t, Z_t, \mu, \nu_t) \\ & j=\{2,3\} \end{aligned} \tag{14}$$

Stochastic Outcomes

At period t there is uncertainty about elements of the next period recursive value function, specifically, about future stochastic outcomes: wage draw, future marital status, number of children, health care consumption and health status. I assume that the individual does not know these future values, but she does know the stochastic process. These outcomes are not modeled as decision as in this model individuals make decisions with respect to variables that affect wealth. I allow the realization of these values to be affected by previous choices as well by decisions at period t. The objective of incorporating family and health characteristics is to extend the classic notion of risk aversion to be a function exclusively of wealth, and allowing interaction with other characteristics that individuals may value independently of their effect on wealth. Additionally, since family and health characteristics are variables that the literature have used as proxies for risk aversion, in this paper I estimate the correlation across risk aversion and these outcomes. These densities and probability functions are presented in equations 15 to 19.

The density of wages is a function of work experience, occupation category, health status, and other individual's exogenous individual characteristics, such as age, gender and education. It also depends on a vector of employment demand side shifters, Z_t^E such as unemployment rates.

$$w_t = w(E_t, o_t, H_t, X_t, Z_t^E, \epsilon_t^w) \tag{15}$$

where ϵ_t^w is an uncorrelated error term. The probability of being not married in period $t+1$ ($m_{t+1} = 0$) relative to being married ($m_{t+1} = 1$) is given in equation 16. The probabilistic dichotomous event depends on endogenous and exogenous individual characteristics. While not modeled explicitly, I assume that there is a marriage market such that supply side factors, Z_t^M, also impact marriage probability. Supply side factors may include the number of marriages in the population of each gender or by other characteristics.

$$\ln\left[\frac{p(m_{t+1} = 1)}{p(m_{t+1} = 0)}\right] = m(d_t, \tilde{\Omega}_t, X_t, Z_t^M) \tag{16}$$

The probability of decreasing or increasing the number of children in period $t+1$ ($n_{t+1} = \{-1, 1\}$) relative to not ($n_{t+1} = 0$) is defined in equation 17 and depends on endogenous and exogenous individual characteristics, and exogenous supply side factors.

$$\ln\left[\frac{p(n_{t+1} = j)}{p(n_{t+1} = 0)}\right] = n^j(d_t, \tilde{\Omega}_t, X_t, Z_t^N), \qquad j = \{-1, 1\} \tag{17}$$

The density function at period $t+1$ of health consumption, measured by the number of medical visits, is a function of endogenous and exogenous individual characteristics, and supply side factors such as medical care prices and insurance coverage, Z_t^K.

$$k_{t+1} = k(d_t, \tilde{\Omega}_t, X_t, Z_t^K, \epsilon_t^k) \tag{18}$$

where ϵ_t^k is an uncorrelated error term. The probability of being in health status j in period $t+1$ ($H_{t+1} = j$ where $j = \{2, 3, 4\}$ represent categories good, regular, and poor respectively) relative to being in a very good health status ($H_{t+1} = 1$) is

$$\ln\left[\frac{p(H_{t+1} = j)}{p(H_{t+1} = 1)}\right] = H^j(H_t, k_t, e_t, o_t, X_t, Z_t^H), \qquad j = \{2, 3, 4\} \tag{19}$$

and depends on current health and medical care consumption which represents medical care inputs. The period t employment and occupation choice, as well as other individual exogenous characteristics, also impact health transitions. Employment behavior may directly affect health or may proxy for omitted non-medical care inputs such as nutrition and exercise.

The stochastic outcomes defined in equations 15 to 19 are jointly estimated with the observed behaviors and subjective assessments in equations 9 to 14. I allow correlation across all fifteen equations through theoretically-relevant observed variables, and permanent and time-varying individual unobserved heterogeneity. Note that many of these decisions and outcomes can be thought as proxies for risk aversion.[11]

Returns on required, R_t^r, and optional, R_t^o, savings are stochastic and exogenous to the individual as they depend on financial markets. These returns vary by investment fund and not by individual (e.g., two individuals investing in account A accumulate wealth at the same rate of return) Retirement wealth evolves according to equation 20.

$$A_{t+1}^r = A_t^r \cdot R_t^r(i_t) + a_t^r \tag{20}$$

4.6 Estimation Strategy

Initial Conditions

Because individuals are aged 25 to 59 years old when they are first observed in 2002, some of the state variables that explain endogenous behavior are non-zero. However, I cannot use a dynamic equation (i.e., all that depends on past values) to estimate this initially-observed variation. Thus, I model the initial conditions as static equations (i.e., initial employment status, initial work experience, initial occupation category, initial savings decision, initial marital status, initial number of children, and initial health status.) All of them are modeled as a function of exogenous individual and market characteristics, and are jointly estimated with the rest of the equations by allowing the initial conditions to be correlated through individual permanent unobserved heterogeneity.

Exogenous individual characteristics for initial employment status, initial work experience, and initial occupation category include age, gender, education, parent's years of schooling, interaction terms between gender and parent's education, self-reported socioeconomic status of household when growing up. Market characteristics include the vector $Z_I = (Z_I^E$, Z_I^M, Z_I^N, Z_I^K, $Z_I^H)$. The same individual characteristics are included for initial health status, which depends also on characteristics of the health market include Z_I^K and Z_I^H. Exogenous individual characteristics for initial marital status and initial number of children include age, gender, education, parent's education, interaction terms between gender and parent's education, socioeconomic status of household and number of children in household when growing up. Characteristics of the marriage market for initial marital status and characteristics of the children market for initial number of children are included (Z_I^M or

[11] The literature has used occupation categories, investment decisions, family characteristics, among others, as indirect measures of an individual's risk aversion.

Z_I^N, respectively).

Estimation method

The set of estimated equations consists of 22 equations: 8 demand behaviors, 2 subjective assessments, 5 stochastic outcomes, and 7 initial conditions. The demand, assessments and outcomes are correlated through permanent and time-varying unobserved heterogeneity while the initial conditions equations are correlated through the permanent component. This heterogeneity represents an individual's characteristics and attitudes that are unobserved by the econometrician and that affect simultaneously an individual's behavior and observed outcomes. As mentioned, the joint estimation of this set of equations is one of the features of this paper since it accounts for different sources of estimation bias that the literature typically does not approach. I also estimate the model under alternative modeling assumptions for the unobserved heterogeneity. The details of these specifications are presented in Section 6.

These equations are estimated using the Discrete Factor Random Effects (DFRE) method. The DFRE method does not impose distributional assumptions over the correlated error terms across equations. Rather, the support of the unobserved heterogeneity distribution is discretized and the mass point locations as well as their probabilities are estimated jointly with parameters on the observed heterogeneity in each equation (Mroz and Guilkey, 1992; Mroz, 1999). The DFRE method perform as well as maximum likelihood estimation assuming normality when the true distribution of the error term is jointly normal. When the distribution is not normal, the DFRE performs better both in precision and bias (Mroz, 1999).

It is assumed that the error in each demand, subjective assessment, and stochastic outcome equation has the form:

$$\epsilon_t^z = \mu^z + \nu_t^z + \varepsilon_t^z, \; z = \{1, ..., 15\} \tag{21}$$

and that the error in each initial condition equations has the form:

$$\epsilon_t^{z_i} = \mu^{z_i} + \varepsilon_t^{z_i}, \; z_i = \{1, ..., 7\} \tag{22}$$

where z represents the per-period equation, z_i the initial conditions equation, μ captures permanent unobserved heterogeneity, ν_t captures time-varying unobserved heterogeneity, and ε_t is an independently and identically distributed component.

The advantage of the DFRE method in this setting is that it allows us to estimate the decisions and observed outcomes derived from the individual's optimization problem without assuming specific functional forms for the utility function, constraints, and expectation processes, and without assuming any specific distributional form for the correlated error terms. Importantly, it does not impose any assumption on the individual's risk preferences. Additionally, it allows for both the permanent and time-varying unobserved components in a flexible way. Moreover, this method allows us to account for, among other unobserved factors, measurement error in endogenous variables as one of the components of the modeled individual unobserved heterogeneity.

Identification

The identification of the set of equations relies on various sources. First, identification comes from the exclusion of certain explanatory variables from each outcome equation. Assumptions regarding the timing of decision-making in the individual's optimization problem allow for the exclusion of particular variables from particular equations. Theory suggests that the pre-determined variables and exogenous price and supply-related variables enter the behavioral equations. Some of these variables are excluded from the outcome equations. For instance, I assume that medical care decisions are made after the main behaviors and their associated prices are realized. Thus, I condition medical care expenditures on the observed period t behaviors, and assume that the supply side variables that determined the behaviors do not have an independent effect of medical care expenditures.

The vector of prices and supply-side variables that serve as the identifying variables in the behavioral equations, $Z_t = (Z_t^E, Z_t^M, Z_t^N, Z_t^K, Z_t^H)$, include theoretically relevant market level supply-side factors that affects individual decisions, such as unemployment rates, health market characteristics, marriage market characteristics, and costs associated to family (e.g., tuition prices). Z_t enters the information set Ω_t at the beginning of period t and affects all individual demands and subjective assessments (equation 9 to equation 14). The coefficients on these included variables are jointly significant at a 1 percent level in equations 9–14 (p-values < 0.0003 for the joint significance Wald tests). For equation 11 (outcome $j = D$) the included variables are jointly significant at a 10 percent level (p-value $= 0.0539$ for the joint significance Wald test). The exception is equation 11 (outcome $j = B$) for which the joint insignificance of the coefficients cannot be rejected (p-value $= 0.1203$ for Wald test). The detail is presented in Table D1.

Additionally, the dynamic specification of wealth-related decisions and subjective assessments include lagged endogenous variables that are functions of market-level exogenous variables (e.g., the vector Z_{t-1} is included in explaining decisions at period $t-1$) such that the history of exogenous variables provides another source of exogenous variation (Arellano and Bond, 1991). I test the significance of lagged exogenous market characteristics in period t behavior and subjective assessment equations by adding them to the equation specification one at a time and re-estimating the model. Most of the coefficients on the lagged Zs are insignificant in explaining period t decisions and assessments, conditional on Z_t. The detail is presented in Table D2.

For the stochastic outcomes (equation 15 to equation 19), conditional on the behavior at period t, only the a subset of Z_t that directly affects the outcome of interest enters into the probability function. For instance, conditional on the observed behavior in t, only characteristics of the marriage market (Z_t^M) affect the probability of being married next period. For each stochastic outcome, I have an equation-specific set of exclusion restrictions denoted by Z_t^E, Z_t^M, Z_t^N, Z_t^K, or Z_t^H. In equation 18 for medical consumption I include a specific vector Z_t^K which exclude 4 variables from the vector Z_t. The variables included in Z_t^K capture medical care market characteristics such as number of medical doctors and hospital beds by geographical region. Z_t^K is excluded from the health status equation at the end of period t as health at t is a function (among other variables) of medical consumption at period t, health status at $t-1$, and its own vector Z_t^H. I run separate regressions by adding the excluded variables one by one in equations 18 and 19. For equation 18, the coefficients on the excluded variables in Z_t^E and Z_t^H are insignificant (p-values of 0.6290 and 0.1510, respectively) supporting the exclusion. The coefficients on the variables in Z_t^M and Z_t^N are significant at a 1 percent level. For equation 19 one variable in Z_t^K is significant at a 1 percent level and the other one is insignificant (p-value $= 0.2157$).

Identification also comes from the functional form assumption on the distribution of the idiosyncratic component of the error term in each equation (ε_i^z and ε_t^z) and from the restriction on the number of factors allowed for approximating the distribution of correlated individual unobserved heterogeneity.

Likelihood Function

The likelihood function conditional and unconditional to the unobserved heterogeneity is given by equations 23 and 24, respectively.

$$L_{ct}(\mu,\nu_t) = f_w(\epsilon_t^W|\mu,\nu_t) f_k(\epsilon_t^K|\mu,\nu_t) \prod_j^J \left\{ Pr\left(I(d_t^j = d^j)|\mu,\nu_t \right) f_j(\epsilon_t^j|\mu,\nu_t) \right\}^{I(d_t^j=d^j)} \tag{23}$$

where d_t^j represents a choice, $j = \{E, O, I^A, I^B, I^C, I^D, I^E, S, T^e, R, M, N, H\}$, $f(\cdot)$ represents the density function of the error term of each equation, $Pr(\cdot)$ is the cumulative distribution function for each choice, and $I(d_t^j = d^j)$ is an indicator of a particular choice.

$$L_t = \sum_{q=1}^{Q} PW_{\mu q} \sum_{r=1}^{R} PW_{\nu r} \prod_{t=1}^{T} L_{ct}(\mu,\nu_t) \tag{24}$$

where $PW_{\mu q}$ is the probability of observing q mass points for the permanent component μ and $PW_{\nu r}$ is the probability of observing r mass points for the time-varying component ν_t. These approximate the true distributions of μ and ν_t.

5 Data and Research Sample

The main source of data are the first 4 waves of the EPS (Encuesta de Protección Social). This survey is an individual longitudinal dataset for the years 2002, 2004, 2006, and 2009. It is administered by the Ministry of Labor and Social Security in Chile jointly with the University of Chile and the Institute for Social Research from the University of Michigan. I complement the EPS with administrative data from the Chilean Superintendence of Pensions (Superintendencia de Pensiones).

The EPS 2002 was designed to obtain a representative sample of individuals who are affiliated with the Chilean retirement system. Beginning in 2004, the EPS is a representative sample of the entire adult population since the sample was extended to include those individuals who are not affiliated with the retirement program (i.e., any individual who has not worked as a dependent worker for at least one month since 1981). Table 1 presents the total sample size for each wave of the survey.

An important feature of the EPS is that it provides information about individual preferences over hypothetical gambles. A measure of risk aversion for every individual aged 15 years-old and above can be created from this information, and it is measured every wave.

Table 1: Sample Size in EPS

	2002	2004	2006	2009
Interviews	17,246	16,994	16,752	14,920
Dead*	937	267	309	457
Observations	16,309	16,727	16,443	14,463

Note: (a) *The sample was designed so that it is representative of all the individuals who were ever affiliated with the private retirement system between the years 1981 and 2001. Therefore dead individuals are included in the reference population for the design of the first wave. Dead individuals are also included in the second, third, and fourth wave if the survey year immediately follows a death. Their corresponding questions where answered by a family member.

5.1 Description of Elicited Measure of Risk Aversion

Elicited risk aversion can be derived from a set of questions in the EPS that require respondents to report preferences toward hypothetical gambles over their lifetime income following the lottery choice menu approach. Appendix B presents the survey questions that allow one to obtain the measures for elicited risk aversion and discusses in detail how the measure is constructed. The questions are slightly different in the first wave, but the same in waves 2, 3, and 4. However, since some hypothetical scenarios are the same for all waves, it is possible to construct a comparable risk attitude measure at each wave.

Respondents are separated into three distinct risk preference categories. Depending on the option that the individual accepts, she is more or less risk averse than another individual. The three categories takes values 1, 2, and 3, and are labeled "most risk averse," "intermediate risk aversion," and "least risk averse."

Table 2 presents the distribution of the index of risk aversion for the whole sample. A majority (78%) of individuals belong to the most risk averse category.

An advantage of this measure is that it is constructed over the individual's willingness to gamble using her lifetime income. It avoids the problem in the existing literature where laboratory experiments with small payouts have little effect on the individual lifetime resources and therefore it should not exhibit a risk premium. Additionally, individuals are asked to gamble assuming that they are the only income earners of their households. This wording eliminates the potential problem that the respondent would be more or less likely to gamble with her spouse's income (Barsky et al., 1995; Spivey, 2010). An specific

Table 2: Distribution of Elicited Risk Aversion for the Whole Sample

Elicited Risk Aversion	2002	2004	2006	2009	Total
Most Risk Averse	14,604	12,099	11,258	9,545	47,506
(category = 1)	(90.25%)	(74.42%)	(74.22%)	(74.02%)	(78.52%)
Intermediate	377	1,142	1,194	1,073	3,786
(category = 2)	(2.33%)	(7.02%)	(7.87%)	(8.32%)	(6.26%)
Least Risk Averse	1,201	3,016	2,716	2,278	9,211
(category = 3)	(7.42%)	(18.55%)	(17.91%)	(17.66%)	(15.22%)
Observations	16,182	16,257	15,168	12,896	60,503

Note: (a) Elicited Risk Aversion goes from 1 to 3, being 1 the highest level of risk aversion. This measure was constructed using two questions about preferences over hypothetical lotteries in the four waves of EPS. (b) The whole sample is used. (c) In this paper, elicited risk aversion from the first wave does not enter the estimation.

strong advantage of EPS is that it contains the same questions to elicit risk aversion for the same individuals over 7 years. This allows to analyze risk aversion through the life-cycle and to approach typically unmodeled factors. This paper additionally allows correlation between this elicited measure of risk aversion constructed based on hypothetical scenarios with real-life decisions that may also reflect an individual's level of risk aversion.

5.2 Description of Research Sample

The research sample used in the estimation consists of all individuals aged between 25 and 59 years old (limits included) in 2002 who are observed in all four waves of EPS (no attrition nor deaths) and who have no missing information for the variables: health status, optional savings, work experience, marital status, and region of residence. The research sample contains 7,168 individuals observed four times (28,672 person-year observations). Table 3 details determination of the research sample. Table 4 presents summary statistics describing the demographics of the reference sample (individuals observed more than one period and in age range) and the research sample. The average age and percent of female are similar across the two samples. There is a higher share of individuals in the lower education category in the research sample than in the reference sample.

Table 5 describes the dependent variables for the 15 equation set. The number of observations differs per equations as individuals may have missing information in some dependent variable(s). I assume that this missing information is random. Table 6 describes the explanatory variable used in estimation, entering period t.

Table 3: Construction of Research Sample

Sample	# Individuals
Reference sample	
Age between 25 and 59 years old in 2002*	13,178
And observed in 3 consecutive periods	
First three waves	8,545
Last three waves	8,869
And no attrition no death	
Observed in all four waves**	7,238
And Information available for key variables	
Research Sample***	7,168

Note: (a) * Individuals who show up more than one period. ** Death rates are small for individuals aged between 25 and 59 years old in 2002. *** No missing information in the following variables: health status, optional savings decisions, work experience, marital status, and region of residence. (b) The variables are defined in detail in Appendix C.

Table 4: Summary Statistics for Demographic Variables Between Reference and Research Sample (2002)

Variable	Reference Sample		Research Sample	
	Mean	Std. Dev.	Mean	Std. Dev.
Age	40.633	9.461	40.715	9.275
Female	0.497	0.500	0.462	0.499
Education category				
Less than High School	0.413	0.492	0.531	0.499
High School	0.259	0.438	0.285	0.452
Technical College	0.104	0.305	0.109	0.311
College or Post College	0.067	0.250	0.065	0.247
Missing	0.158	0.365	0.010	0.098

Table 5: Summary Statistics of Dependent Variables for Research Sample

Variable	Estimator	Mean	Std. Dev.	Min.	Max.	N
Employment (e_t)	mlogit					21,504
Full-time employed		0.690	0.462	0	1	
Part-time employed		0.031	0.174	0	1	
Not working		0.278	0.448	0	1	
Occupation (o_t) (if working)	mlogit					15,327
Elementary occupations		0.219	0.414	0	1	
Legis., Prof., Tech., other		0.185	0.388	0	1	
Clerical support workers		0.107	0.309	0	1	
Service and sales workers		0.147	0.354	0	1	
Agricultural, craft and trade		0.057	0.231	0	1	
Operators and assemblers.		0.286	0.452	0	1	
Investment (i_t)	logit					21,504
Account A (Riskier)		0.104	0.305	0	1	
Account B		0.231	0.422	0	1	
Account C		0.495	0.500	0	1	
Account D		0.215	0.411	0	1	
Account E (Safest)		0.037	0.189	0	1	
Savings outcomes (s_t)	logit					21,490
Any Optional Savings		0.263	0.441	0	1	
Expected Duration of Life (T_t^e)	OLS	75.780	10.091	30	110	17,287
Elicited Risk Aversion (r_t)	mlogit					20,557
Most Risk Averse		0.747	0.435	0	1	
Intermediate Risk Averse		0.076	0.265	0	1	
Least Risk Averse		0.177	0.381	0	1	
Log of wage (w_t)	OLS	0.657	1.440	-10.219	5.255	14,705
Marital status (m_{t+1})	logit					21,504
Married		0.571	0.495	0	1	
Variation in number of children (n_{t+1})	mlogit					21,060
No change		0.788	0.408	0	1	
Decrease		0.184	0.387	0	1	
Increase		0.028	0.165	0	1	
Medical consumption (k_{t+1})	OLS					21,438
Number of Medical Visits		6.697	12.639	0	240	
Health status (H_{t+1})	mlogit					14,336
Very good		0.147	0.354	0	1	
Good		0.519	0.500	0	1	
Regular		0.266	0.442	0	1	
Poor		0.068	0.252	0	1	

Table 6: Summary Statistics of Explanatory Variables Entering Period t for Research Sample

Variable	Mean	Std. Dev.	Min.	Max.
Work experience (years)	15.646	8.111	0	30
Employment Status at period t				
Full-time Worker	0.691	0.462	0	1
Part-time Worker	0.032	0.177	0	1
Not employed	0.277	0.447	0	1
Occupation Category in period t				
Elementary occupations	0.117	0.322	0	1
Legis., Prof., Tech., other	0.099	0.298	0	1
Clerical support workers	0.057	0.232	0	1
Service and sales workers	0.078	0.269	0	1
Agricultural, craft and trade, other	0.030	0.172	0	1
Operators and assemblers	0.153	0.360	0	1
Lagged Investment Decision				
Account A (Riskier)	0.059	0.235	0	1
Account B	0.135	0.341	0	1
Account C	0.495	0.500	0	1
Account D	0.095	0.293	0	1
Account E (Safest)	0.021	0.144	0	1
Value of Assets	5.906	12.487	0	241
Any Optional Savings	0.218	0.413	0	1
Married	0.569	0.495	0	1
Duration of marriage (years)	11.444	12.626	0	56
Number of Children	1.009	1.083	0	8
Number of Medical Visits in period t	5.007	11.31	0	240
Health Status				
Very Good	0.139	0.346	0	1
Good	0.536	0.499	0	1
Fair	0.266	0.442	0	1
Poor	0.059	0.236	0	1
Age	43.965	9.628	25	66
Female	0.462	0.499	0	1
Education Category				
Less than High School	0.536	0.499	0	1
High School	0.334	0.472	0	1
Technical College	0.097	0.296	0	1
College and Post-Graduate	0.025	0.156	0	1
Exclusion Restrictions				
Unemployment rate	9.226	2.261	4.200	15
Hospital Beds (# per 1,000 population)	2.345	0.373	1.300	3.900
Number of doctors (# per 1,000 population)	0.978	0.220	0.580	1.870
Number of marriages (# year per 1,000 population)	3.486	0.437	2.500	5.100
Inches of rainfall (thousand inches per year)	17.501	13.705	0.000	65.450
College tuition (thousand dollars)	3.240	0.641	0.000	4.300
Missing Indicators				
Missing: Number of Children	0.021	0.142	0	1
Missing: Education	0.007	0.082	0	1
Missing: Occupation	0.261	0.439	0	1
Missing: Marriage Duration	0.005	0.069	0	1
Missing: Number of Medical Visits	0.252	0.434	0	1

6 Results

In this section I present the estimation results and model fit for the dynamic model presented in Section 4, which accounts for both permanent and time-varying individual unobserved heterogeneity. I compare these results with a simpler model that does not account for correlation across equations. Finally, in order to analyze how survey measures should be used and the information that they add, I present the results of alternative specifications of the model with different structures of correlated unobserved heterogeneity and different assumptions about the exogeneity of the subjective assessments

6.1 Preferred Model: Empirical Specification and Parameter Estimates

Table 7 presents the empirical specification for the preferred model which joint estimates the 22 equations. A model that does not allow for correlation across equations estimates each of the 22 equation separately. Not matter the correlation structure that is allowed across equations, there is always an independent random error in each equation. I refer to the jointly estimated model as model with correlated unobserved heterogeneity (CUH) and the model that does not allow for correlation across equations as model without correlated unobserved heterogeneity (no CUH). Tables D3-D9 in Appendix D presents the parameter estimates for the per-period equations.[12]

The estimation results for investment decisions equations of required retirement savings show that the estimated coefficients on work experience and its square have a statistically significant effect on some of the investment decisions, especially for safest accounts. For most of the investment decisions the coefficients on the value of accumulated assets at the time of making the decision and the coefficients on investment decisions in the previous period are statistically significant, particularly when the individual invested in that same fund. This suggests that there is a persistence effect. These results are consistent with other results discussed in the retirement literature (Hastings et al., 2013; Luco, 2015). The estimated parameters on health status and family characteristics are also statistically significant.

Table D6 presents the estimation results for the subjective assessments. Consistent with other results in the literature I find that women are less like than men to be in the most risk averse category. I find that as age increases and as work experience increases, individuals are less likely to be in the least risk averse category. Individuals that have higher levels of educations, they are more likely to less risk averse. I find that been in very good health status significantly increases the likelihood of been in the least risk averse category, while been in poor health significantly decreases the likelihood of been in the least risk averse category. I find no significant effect of wealth levels and of previous investment decisions on an individual's level of risk aversion. This result suggests that previous financial conditions

[12] Estimates for the initial conditions equations and the model without CUH are available from the author. The preferred model allows for four permanent and four time-varying mass points for capturing the distribution of CUH.

in mandatory retirement investments do not affect an individual's realization of risk aversion. There is a body of the literature that explores the relation between macroeconomic conditions and risk aversion. In this framework, I find that as unemployment rates increases, individuals are more likely to be less risk averse.

Most of the coefficients for the endogenous predetermined explanatory variables are statistically insignificant, while the coefficients that capture unobserved characteristics are statistically significant. In order to further explore these results I examine the correlation between the unobserved heterogeneity components across subjective assessments and the decisions and outcomes of the model using the estimated mass points and probability weights from the joint distribution of unobservable characteristic. In particular, I compute the correlation between risk aversion and expected duration of life, with employment decision, occupation selection, investment decisions for retirement, savings decisions, earnings, family characteristics, medical care consumption, and health status. There is correlation across both, the permanent and time-variant components of the subjective assessments and decisions and outcomes of the model (see Table D10). This suggests that researchers should account for the correlation across outcomes when measures of elicited risk aversion are included.

For both categories of elicited risk aversion there is correlation with occupational categories, in particular in the component that captures permanent unobserved heterogeneity. The least risk averse individuals are also more likely to be employed as legislators, senior officials, managers, professionals, and technicians, and in service and sales occupations; and less likely to be in skilled agricultural, forestry and fishery, craft and trade occupations, than the intermediate risk averse individuals. There is correlation between employment status and expected duration of life, negative for the permanent component and positive for the time-varying component. Unobservable characteristics for individuals in the least risk averse category are positive correlated with unobservable in investments in accounts A, and B (permanent); and negatively correlated with accounts B (time-variant), C, D, E. There is also correlation with savings, medical care consumption, health, and family characteristics. The correlation matrices are available from the author.

Table 7: Specification of Set of Equations in Preferred Empirical Model: Endogenous Subjective Assessments

Equation	Estimator	Explanatory Variables		
		Predetermined Variables	Exogenous Variables	Unobserved Heterogeneity
Wealth-related decisions at period t				
Employment (e_t)	mlogit	i_{t-1}, s_{t-1} A_t^r, E_t, M_t, N_t, H_t	X_t, $Z_t^E, Z_t^M, Z_t^N, Z_t^K, Z_t^H$	μ^E, ν_t^E, ε_t^E
Occupation (o_t)	mlogit	i_{t-1}, s_{t-1} A_t^r, E_t, M_t, N_t, H_t	X_t, $Z_t^E, Z_t^M, Z_t^N, Z_t^K, Z_t^H$	μ^O, ν_t^O, ε_t^O
Savings (s_t)	logit	i_{t-1}, s_{t-1} A_t^r, E_t, M_t, N_t, H_t	X_t, $Z_t^E, Z_t^M, Z_t^N, Z_t^K, Z_t^H$	μ^S, ν_t^S, ε_t^S
Investment in A (i_t^A)	logit	i_{t-1}, s_{t-1} A_t^r, E_t, M_t, N_t, H_t	X_t, $Z_t^E, Z_t^M, Z_t^N, Z_t^K, Z_t^H$	μ^{I^A}, $\nu_t^{I^A}$, $\varepsilon_t^{I^A}$
Investment in B (i_t^B)	logit	i_{t-1}, s_{t-1} A_t^r, E_t, M_t, N_t, H_t	X_t, $Z_t^E, Z_t^M, Z_t^N, Z_t^K, Z_t^H$	μ^{I^B}, $\nu_t^{I^B}$, $\varepsilon_t^{I^B}$
Investment in C (i_t^C)	logit	i_{t-1}, s_{t-1} A_t^r, E_t, M_t, N_t, H_t	X_t, $Z_t^E, Z_t^M, Z_t^N, Z_t^K, Z_t^H$	μ^{I^C}, $\nu_t^{I^C}$, $\varepsilon_t^{I^C}$
Investment in D (i_t^D)	logit	i_{t-1}, s_{t-1} A_t^r, E_t, M_t, N_t, H_t	X_t, $Z_t^E, Z_t^M, Z_t^N, Z_t^K, Z_t^H$	μ^{I^D}, $\nu_t^{I^D}$, $\varepsilon_t^{I^D}$
Investment in E (i_t^E)	logit	i_{t-1}, s_{t-1} A_t^r, E_t, M_t, N_t, H_t	X_t, $Z_t^E, Z_t^M, Z_t^N, Z_t^K, Z_t^H$	μ^{I^E}, $\nu_t^{I^E}$, $\varepsilon_t^{I^E}$
Subjective assessments at period t				
Duration of Life (T_t^E)	ols	i_{t-1}, s_{t-1} A_t^r, E_t, M_t, N_t, H_t	X_t, $Z_t^E, Z_t^M, Z_t^N, Z_t^K, Z_t^H$	μ^{T^e}, $\nu_t^{T^e}$, $\varepsilon_t^{T^e}$
Elicited Risk Aversion (r_t)	mlogit	i_{t-1}, s_{t-1} A_t^r, E_t, M_t, N_t, H_t	X_t, $Z_t^E, Z_t^M, Z_t^N, Z_t^K, Z_t^H$	μ^R, ν_t^R, ε_t^R
Stochastic outcomes at period t				
Log Wage ($w_t \| e_t, o_t$)	ols	E_t, H_t	X_t, Z_t^E	μ^W, ν_t^W, ε_t^W
Medical consumption (k_t)	ols	H_t	X_t, Z_t^K	μ^K, ν_t^K, ε_t^K
Stochastic outcomes at the end of period t				
Marital status (m_{t+1})	logit	e_t M_t, N_t	X_t, Z_t^M	μ^M, ν_t^M, ε_t^M
Change in # children (n_{t+1})	mlogit	e_t M_t, N_t	X_t, Z_t^N	μ^N, ν_t^N, ε_t^N
Health status (H_{t+1})	mlogit	e_t, o_t, k_t E_t, H_t	X_t, Z_t^H	μ^H, ν_t^H, ε_t^H
Initial conditions (at period $t = 1$)				
Employment (e_1)	mlogit		X_1, $Z_1^E, Z_1^M, Z_1^N, Z_1^K, Z_1^H$	μ^{E_i}, ε^{E_i}
Work experience (E_1)	ols		X_1, $Z_1^E, Z_1^M, Z_1^N, Z_1^K, Z_1^H$	μ^{EX_i}, ε^{EX_i}
Occupation (o_1)	mlogit		X_1, $Z_1^E, Z_1^M, Z_1^N, Z_1^K, Z_1^H$	μ^{O_i}, ε^{O_i}
Savings (s_1)	logit		X_1, $Z_1^E, Z_1^M, Z_1^N, Z_1^K, Z_1^H$	μ^{S_i}, ε^{S_i}
Marital status (m_1)	logit		X_1, Z_1^M	μ^{M_i}, ε^{M_i}
Number of children (n_1)	ols		X_1, Z_1^N	μ^{N_i}, ε^{N_i}
Health status (H_1)	mlogit		X_1, Z_1^K, Z_1^H	μ^{H_i}, ε^{H_i}

6.2 Fit of the Model

Table 8 presents the summary of the observed and simulated behavior. The simulated values are obtained using observed values of explanatory variables, with no updating of current endogenous behaviors in response to past behaviors and outcomes, and with 100 replications for the types probabilities. The standard errors are calculated using predictions based on 100 draws of the estimated coefficients from the estimated variance-covariance matrix.

6.3 Contemporaneous Marginal Effects

In this section I compare the marginal effects for the models with and without correlated unobserver heterogeneity across outcomes. The objective is to compare policy variables estimates results as we incorporate or not, observed measures of individual risk aversion. Table 9 presents the contemporaneous marginal effects (model with no updating of current endogenous behaviors in response to past behaviors and outcomes) computed at the observed values for lagged decisions in holding optional savings and investment in the 5 alternatives of financial accounts, and for increases of one unit in work experience, age, and accumulated assets. Standard errors are calculated using predictions based on 100 draws of the estimated coefficients from the estimated variance-covariance matrix.

We can expect the marginal effects of the model without correlated unobserved heterogeneity to be biased due to missing information. The significance of the marginal effects changes when estimating the model with and without CUH. Additionally, most of the marginal effects between the two models are statistical different. This suggests that accounting for correlation across outcomes adds information for identifying the coefficients of interest. Importantly, the preferred model allows us to recover marginal effects by accounting for unobserved characteristics and by including subjective assessments to better approximate this distribution. For accounts B, C, and D, the estimated coefficients on lagged investment in the accounts have a statistically significant effect in explaining this period investment decision. The same is observed for optional savings.

Table 8: Summary of Fit of the Model

Outcome	Observed		Simulated	
	Mean	St. Error	Mean	St. Error
Employment				
Full-time employed	0.690	0.462	0.695	0.159
Part-time employed	0.031	0.174	0.033	0.191
Not working	0.278	0.448	0.272	0.128
Occupation				
Elementary occupations	0.219	0.414	0.248	0.093
Legis., Prof., Tech., other	0.185	0.388	0.174	0.131
Clerical support workers	0.107	0.309	0.096	0.126
Service and sales workers	0.147	0.354	0.144	0.193
Agricultural, craft and trade	0.057	0.231	0.069	0.128
Operators and assemblers.	0.286	0.452	0.270	0.209
Investments				
Account A (Riskier)	0.104	0.305	0.104	0.070
Account B	0.231	0.422	0.223	0.083
Account C	0.495	0.500	0.512	0.064
Account D	0.215	0.411	0.207	0.065
Account E (Safest)	0.037	0.189	0.038	0.050
Optional Savings	0.263	0.440	0.262	0.121
Expected Duration of Life	75.780	10.091	75.775	2.347
Elicited Risk Aversion				
Most Risk Averse	0.747	0.435	0.747	0.175
Intermediate Risk Averse	0.076	0.265	0.076	0.141
Least Risk Averse	0.177	0.381	0.176	0.155
Log of Wage	0.657	1.440	0.534	0.154
Marital status (married)	0.571	0.495	0.575	0.028
Variation in number of children				
No change	0.788	0.408	0.784	0.052
Decrease	0.184	0.387	0.184	0.043
Increase	0.028	0.165	0.032	0.035
Medical consumption	6.697	12.639	6.681	1.564
Health status				
Very good	0.147	0.354	0.145	0.046
Good	0.519	0.500	0.521	0.157
Regular	0.266	0.442	0.268	0.179
Poor	0.068	0.252	0.066	0.141

Note: (a) Simulated values are obtained using observed values of explanatory variables, with no updating of current endogenous behaviors in response to past behaviors and outcomes, and with 100 replications for the types probabilities. (b) Bootstrapped standard errors are calculated using 100 repetitions.

Table 9: Contemporaneous Marginal Effects on Financial Investment and Savings Outcomes for Preferred Model With and Without Correlation Across Equations (%)

Variable	Current Period Decisions											
	Investment in A		Investment in B		Investment in C		Investment in D		Investment in E		Savings	
	CUH	No CUH	CUH	No CUH	With CUH	No CUH	CUH	No CUH	CUH	No CUH	CUH	No CUH
Lagged												
Investment A	13.821^{a}	19.404*	0.204^{a}	0.029	-3.071^{***a}	-6.848***	-0.385^{a}	-1.032	-1.382^{a}	-1.183	3.787^{**a}	4.221
	(8.577)	(11.008)	(1.785)	(1.835)	(0.208)	(2.230)	(1.506)	(2.062)	(1.589)	(1.442)	(1.645)	(5.082)
Investment B	0.759^{a}	1.508	15.839^{***a}	14.277*	-7.980^{***a}	-4.747**	0.716^{a}	-0.373	0.047^{a}	0.096	2.120^{a}	2.332
	(1.254)	(2.445)	(3.315)	(7.329)	(0.675)	(2.137)	(1.239)	(1.945)	(1.348)	(1.611)	(1.337)	(4.669)
Investment C	1.768^{a}	2.936	3.590^{**a}	2.110	6.623^{***a}	7.366***	-1.127^{a}	-1.945	0.136^{a}	0.181	3.278**	3.281
	(2.437)	(3.490)	(2.170)	(2.860)	(0.804)	(2.793)	(1.685)	(2.557)	(1.491)	(1.203)	(1.582)	(4.417)
Investment D	-0.193^{a}	0.814	3.972^{a}	1.903	-11.844^{***a}	-7.052***	10.057^{***a}	5.749*	-0.339^{a}	-0.539	2.555^{a}	2.506
	(2.117)	(3.025)	(2.499)	(3.848)	(1.297)	(2.620)	(3.328)	(3.271)	(1.492)	(4.779)	(2.106)	(5.543)
Investment E	2.368^{a}	4.419	6.347^{**a}	5.017	-0.800^{a}	1.022	-1.972^{a}	-3.503	7.145^{a}	7.332	2.246^{a}	1.869
	(3.053)	(10.362)	(3.383)	(8.809)	(1.415)	(7.344)	(2.152)	(3.924)	(5.654)	(7.690)	(2.512)	(10.884)
Savings	1.094^{a}	1.442	0.218^{a}	0.360	-0.763^{***a}	-0.478	-0.805^{*a}	-0.857	-0.163^{a}	-0.236	16.237^{***a}	16.793***
	(1.272)	(1.739)	(0.477)	(0.773)	(0.243)	(0.392)	(0.429)	(0.822)	(0.622)	(0.692)	(3.787)	(4.546)
Experience	-0.312^{a}	-0.463	0.099^{a}	0.210	1.436^{***a}	1.315***	-0.862^{***a}	-0.475**	-0.016	-0.014	0.407^{a}	0.441
	(0.373)	(0.827)	(0.152)	(0.337)	(0.119)	(0.268)	(0.172)	(0.223)	(0.137)	(0.261)	(0.375)	(0.321)
Age	-0.096^{a}	-0.294	-1.721^{***a}	-2.048***	-0.484^{***a}	0.066	2.022^{***a}	2.110***	0.030^{a}	0.037	-0.527^{***a}	-0.599***
	(0.084)	(0.333)	(0.195)	(0.671)	(0.099)	(0.094)	(0.144)	(0.286)	(0.026)	(0.372)	(0.127)	(0.167)
Assets	0.045^{a}	0.109	0.136^{***a}	0.141**	0.016^{a}	-0.035	-0.057^{***a}	-0.091**	0.027^{a}	0.021	0.104^{***a}	0.119***
	(0.044)	(0.095)	(0.034)	(0.068)	(0.022)	(0.025)	(0.018)	(0.040)	(0.030)	(0.050)	(0.031)	(0.043)

Note: (a) Marginal effects computed at the observed values. (b) Model with no updating of current endogenous behaviors in response to past behaviors and outcomes. (c) Simulated with 100 repetitions. (d) Bootstrapped standard errors are in parentheses using with 100 draws. (e) CUH refers to correlated individual unobserved heterogeneity.

* Significant at the 10 percent level. ** Significant at the 5 percent level. *** Significant at the 1 percent level.

^{a,b,c} Difference in means test between model with and without unobserved heterogeneity significant at the 1, 5, and 10 percent level, respectively.

6.4 Alternative Specifications of the Model

To explore the additional information that survey measures on subjective assessments add to empirical models and how they should be used, I estimate alternative specifications of the model under different structures of correlated unobserved heterogeneity and different assumptions about the exogeneity of the subjective assessments on individual decisions. I allow correlated unobserved heterogeneity to take three forms: no correlation through unobserved heterogeneity, correlation just through permanent unobserved heterogeneity, and correlation through both permanent and time-variant unobserved heterogeneity. An independent random error is always included. The specifications for the subjective assumptions are: jointly determined, exogenous to decisions and as explanatory variables, and predetermined (lagged subjective assessments) as explanatory variables. The objective is to disentangle the role that the estimation structure and the assumptions that we put on subjective assessments have on the marginal effects of interest. I focus on the effect on the marginal effect of lagged investment decisions on this period investment and savings decisions. The summary of the alternative versions of the model are presented in Table 10.

Table 10: Alternative Specifications of the Model

	Unobserved Heterogeneity (CUH)		Subjective
	Permanent	Time-Variant	Assessments
Model 1	No	No	Included: Not Jointly
Model 2	Yes	No	Not included
Model 3	Yes	Yes	Not included
Model 4	Yes	No	Included: Jointly
Model 5*	Yes	Yes	Included: Jointly
Model 6	No	No	Included: RHS
Model 7	Yes	No	Included: RHS
Model 8	Yes	Yes	Included: RHS
Model 9	Yes	No	Included: Jointly and Lagged RHS
Model 10	Yes	Yes	Included: Jointly and Lagged RHS

Note: (a) CUH refers to correlated individual unobserved heterogeneity. (b) Jointly = subjective assessments at time t are jointly estimated with the decisions and outcomes, allowing correlation across equations according to the structure assumed on permanent and time-variant unobserved heterogeneity. (c) RHS = subjective assessments at time t are assumed to be exogenous and included as explanatory variables for wealth-related decisions at time t. (d) Lagged RHS = subjective assessments at time $t-1$ are included as explanatory variables for wealth-related decisions at time t. (e) * Model 5 corresponds to the preferred model developed in Section 4.

Model 1 is considered as a basic comparison framework of a model for explaining behaviors. The coefficients on this model are expected to be biased as assessments do not play a role on the investment decision equations. Model 2 and 3 allows different specifications for the correlation across equations and do not includes subjective assessments. THe objective is to test, when measures on individual risk aversion are not available, if correcting through individual unobserved heterogeneity will let us account for the estimation bias of omitting risk preferences. Model 5 corresponds to the preferred model developed in Section 4 which reconciles observed subjective assessments with a model of economic behavior over time. Model 4 assumes the same specification for assessments and does not allow for time-varying CUH. The purpose is to test whether the structure on the CUH plays a role after including subjective assessments into the estimation. Models 6-8 assumes that subjective assessments are exogenous to decisions and outcomes and are used as additional explanatory variables. These models are compared with Models 1-5 to analyze the impact of the modeling assumptions on assessments on the coefficients of interest. Models 9-10 assumes that predetermined assessments explain wealth decisions and the results are compared to models 6-8 to test the effect of assuming exogeneity of current period assessments.

Tables E1, E2, and E3 in Appendix E specified the set of equations estimated in each model, the correlation allowed across equations if any, the empirical specification of exogenous and endogenous explanatory variables, and the probability weights for the CUH components. Table E4 presents the complete point contemporaneous marginal effects of lagged investment decisions on this period investment and savings decisions and the test for differences between marginal effects for the 10 models with respect to the preferred. The parameters estimates for all equations and models and the information for the test for differences in means for every model are available from the author.

Incorporation of observed measures of risk aversion: Most of the marginal effects for lagged investment decisions are statistically different when comparing Models 1, 2, and 3. These models are estimated as if measures on elicited risk aversion and expected duration of life are not available. Accounting for permanent and time-variant CUH is important in these simply specifications. As well, most of the marginal effects are statistically different when comparing the preferred Model 5 with Models 1 and 4, which assume different structure for the CUH. This suggests that including subjective assessments and controlling for CUH (preferred model) reduces the estimation bias. This is expected as elicited risk aversion and expected duration of life is correlated with the decisions, affects the primitives of the model, and helps to approximate the distribution of the remaining unobserved heterogeneity. This results suggest that although the incorporation of risk aversion provides explanatory power, it requires using econometric methods that account for unobserved correlation through non-idiosyncratic avenues. The same role is found for the two alternative specifications for the subjective assessments (Model 8 compared with Model 6 and 7, and Model 10 compared with Model 9).

Exogeneity assumption: The assumptions on the exogeneity of subjective assessments should be an important consideration in modeling elicited risk aversion. From the conceptualization of risk aversion we know that it is a strong assumption to use elicited measures of risk aversion as exogenous explanatory variables. Empirically, as shown above, I find that observed risk aversion exhibit correlation with decisions and outcomes. The objective of these alternative specification is to test whether the estimates are different when we do not endogenously incorporate risk aversion into an empirical model. For this matters I compare Model 5, Model 8, and Model 10. (Contrary to the evidence and to the conceptualization of risk aversion), in Model 5 I assume that risk aversion is exogenous to an individual's decisions and I included as an additional right-hand side variable. Model 10 relaxes the exogeneity assumption by using predetermined elicited risk aversion as explanatory variables. I found that the marginal effects of policy variables are substantively different under these alternative specifications. When longitudinal measures of risk aversion are available the modeling assumption on Model 10 could be a solution to avoid the previous assumption (Model 5). Despite the fact that the estimate vary, one needs to be careful about the interpretation as the conceptualization of dynamic risk aversion does not suggest that predetermined (lagged) risk aversion directly affects this period decisions. It rather suggest that lagged risk aversion affected lagged decisions and those decisions affected this period decisions.

7 Conclusion

I this paper I study the incorporation of observed measures of individual risk aversion (calculated from survey responses) into an empirical model of individual behavior over time. In the estimable model, I allow risk preferences to be an endogenous determinant of individuals behaviors. I provide a framework to reconcile the use of these measures with the economic theory of individual behavior over time. I model observed risk aversion as a realization of the distribution of individual dynamic risk aversion.

In this paper relates the experimental literature on risk aversion with the revealed preference approach. Consistent with the economic conceptualization of risk aversion, I find that there is correlation across observed measures of risk aversion and observed individual behaviors such as employment decisions, occupation selection, investment decisions for retirement and savings; and other outcomes such as health and family characteristics. These observed behaviors have been use by the literature as proxies for risk aversion. Avoiding this correlation when incorporating observed risk aversion in empirical models result in biased estimates. In this setting, models should not treat observed risk aversion as an additional - exogenous- right-hand side variable. Additionally, I find that the incorporation of risk aversion provides explanatory power, although correction for correlated individual unobserved heterogeneity is still required.

In terms of the demographics of risk aversion, I find that women are less like than men to be in the most risk averse category; as age increases and as work experience increases, individuals are less likely to be in the least risk averse category. Individuals that have higher levels of educations, they are more likely to less risk averse. I find that been in very good health status significantly increases the likelihood of been in the least risk averse category, while been in poor health significantly decreases the likelihood of been in the least risk averse category. I find no significant effect of wealth levels and of previous investment decisions on an individuals level of risk aversion. This result suggests that previous financial conditions in mandatory retirement investments do not affect an individuals realization of risk aversion.

When working with survey measures on subjective assessments, it is expected that observed variables will have measurement error. Although this paper corrects for different sources of bias, such as endogeneity between risk aversion and behavior, selection into behaviors, and measurement error; it does not decompose each effect. An interesting extension would be to explore the sources that might be introducing measurement error and the sources of heterogeneity in measurement error across individuals.

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Appendix

A Derivation of Bommier and Rochet's Dynamic Measure of Risk Aversion (simplified version of the model)

Let the per-period utility function $U_t = U(c_t, l_t; \epsilon_t, r_t^*)$ depend on consumption (c_t) and leisure (l_t). Assume U_t is twice continuously differentiable. ϵ_t denotes a preference error and r_t^* the curvature of the per-period utility function. Assume there is only one asset which generates a return of R_t in period $t+1$ and unknown at t. A_{t-1} denotes wealth entering period t while a_t is the investment decision in t that takes the form of a fraction α of labor income invested. That is, $a_t = \alpha w_t h_t$ where w_t denotes hourly wage and h_t hours worked. Future wage is unknown for the individual at period t. The monetary value of assets (or wealth) evolve according to: $A_t = (1 + R_{t-1})A_{t-1} + a_t$. The individual faces a time constraint $\Gamma_t = l_t + h_t$ and a budget constraint $c_t + a_t = w_t h_t + A_{t-1}R_{t-1}$. I denote the lifetime utility function as V_t.

Using this simple framework I present the measures of true risk aversion for a one period model and for a two period model with and with no uncertainty. True risk aversion changes as one includes more periods as it depend on the curvature of the per-period utility function and future discounted utility.

A.1 One period model with no uncertainty

The static absolute, $A(A_{t-1})$, and relative, $R(A_{t-1})$, measures of risk aversion are:

$$A(A_{t-1}) = -\left[\frac{\frac{d}{dA_{t-1}}\left(\frac{dU(c_t,l_t;r_t^*)}{dc_t}\frac{dc_t}{dA_{t-1}}\right)}{\frac{dU(c_t,l_t;r_t^*)}{dc_t}\frac{dc_t}{dA_{t-1}}}\right] = -r_t^*$$

$$R(A_{t-1}) = -A_{t-1}\left[\frac{\frac{d}{dA_{t-1}}\left(\frac{dU(c_t,l_t;r_t^*)}{dc_t}\frac{dc_t}{dA_{t-1}}\right)}{\frac{dU(c_t,l_t;r_t^*)}{dc_t}\frac{dc_t}{dA_{t-1}}}\right] = -A_{t-1}\cdot r_t^*$$

If $U(\cdot)$ takes a CRRA representation, then $r_t^* = \rho$.

A.2 Two-period model with no uncertainty

For simplicity assume first that there is no uncertainty about the preference errors, wages, and investment return. The discounted lifetime utility function is:

$$V_t = U(c_t, l_t; r_t^*) + \beta \max_d U(c_{t+1}, l_{t+1}; r_{t+1}^* | c_t, l_t)$$

where β is the discount factor and d represents the consumption and savings decision. Or, alternatively, after replacing constraints,

$$\begin{aligned} V_t = {} & U(w_t h_t + A_{t-1}R_{t-1} - \alpha w_t h_t, l_t; r_t^*) + \\ & \beta \max_d U(w_{t+1}h_{t+1} + ((1+R_{t-1})A_{t-1} + a_t)\,R_t - \alpha w_{t+1}h_{t+1}, l_{t+1}; r_{t+1}^* | c_t, l_t). \end{aligned}$$

The absolute, $A^D(A_{t-1})$, and relative, $R^D(A_{t-1})$, versions of the dynamic measures of risk aversion are:

$$A^D(A_{t-1}) = -\left[\frac{\frac{d}{dA_{t-1}}\left(\frac{dU(c_t,l_t;r_t^*)}{dc_t}\frac{dc_t}{dA_{t-1}}\right) + \beta\frac{d}{dA_{t-1}}\left(\frac{d\max_d U(c_{t+1},l_{t+1};r_{t+1}^*|c_t,l_t)}{dc_t}\frac{dc_t}{dA_{t-1}}\right)}{\frac{dU(c_t,l_t;r_t^*)}{dc_t}\frac{dc_t}{dA_{t-1}} + \beta\left(\frac{d\max_d U(c_{t+1},l_{t+1};r_{t+1}^*|c_t,l_t)}{dc_t}\frac{dc_t}{dA_{t-1}}\right)}\right]$$

$$R^D(A_{t-1}) = -A_{t-1}\left[\frac{\frac{d}{dA_{t-1}}\left(\frac{dU(c_t,l_t;r_t^*)}{dc_t}\frac{dc_t}{dA_{t-1}}\right) + \beta\frac{d}{dA_{t-1}}\left(\frac{d\max_d U(c_{t+1},l_{t+1};r_{t+1}^*|c_t,l_t)}{dc_t}\frac{dc_t}{dA_{t-1}}\right)}{\frac{dU(c_t,l_t;r_t^*)}{dc_t}\frac{dc_t}{dA_{t-1}} + \beta\left(\frac{d\max_d U(c_{t+1},l_{t+1};r_{t+1}^*|c_t,l_t)}{dc_t}\frac{dc_t}{dA_{t-1}}\right)}\right]$$

A.3 Two-period model with uncertainty

When we allow the future preference error, wages, and returns to be stochastic, the discounted lifetime utility function is:

$$V_t = U(c_t, l_t; \epsilon_t, r_t^*) + \beta \int_{R_{t+1}} \int_{w_{t+1}} \int_{\epsilon_{t+1}} \left\{ \max_d U(c_{t+1}, l_{t+1}; \epsilon_{t+1}, r_{t+1}^* | c_t, l_t) \right\} dF(\epsilon_{t+1}) dF(w_{t+1}) dF(R_{t+1})$$

where $df(\epsilon_{t+1})$, $dF(w_{t+1})$ and $dF(R_{t+1})$ are probability density functions over ϵ_{t+1}, w_{t+1} and R_{t+1}, respectively. For simplifying the notation I define the operator $\mathbb{E}_{t+1}$ to represent expectations over ϵ_{t+1}, w_{t+1}, and R_{t+1}. The absolute, $A^D(A_{t-1})$, and relative, $R^D(A_{t-1})$, versions of the dynamic measures of risk aversion are:

$$A^D(A_{t-1}) = -\left[\frac{\frac{d}{dA_{t-1}} \left(\frac{dU(c_t, l_t; r_t^*)}{dc_t} \frac{dc_t}{dA_{t-1}} \right) + \beta \frac{d}{dA_{t-1}} \left(\frac{d\mathbb{E}_{t+1}\left\{ \max_d U(c_{t+1}, l_{t+1}; r_{t+1}^* | c_t, l_t) \right\}}{dc_t} \frac{dc_t}{dA_{t-1}} \right)}{\frac{dU(c_t, l_t; r_t^*)}{dc_t} \frac{dc_t}{dA_{t-1}} + \beta \left(\frac{d\mathbb{E}_{t+1}\left\{ \max_d U(c_{t+1}, l_{t+1}; r_{t+1}^* | c_t, l_t) \right\}}{dc_t} \frac{dc_t}{dA_{t-1}} \right)} \right]$$

$$R^D(A_{t-1}) = -A_{t-1} \left[\frac{\frac{d}{dA_{t-1}} \left(\frac{dU(c_t, l_t; r_t^*)}{dc_t} \frac{dc_t}{dA_{t-1}} \right) + \beta \frac{d}{dA_{t-1}} \left(\frac{d\mathbb{E}_{t+1}\left\{ \max_d U(c_{t+1}, l_{t+1}; r_{t+1}^* | c_t, l_t) \right\}}{dc_t} \frac{dc_t}{dA_{t-1}} \right)}{\frac{dU(c_t, l_t; r_t^*)}{dc_t} \frac{dc_t}{dA_{t-1}} + \beta \left(\frac{d\mathbb{E}_{t+1}\left\{ \max_d U(c_{t+1}, l_{t+1}; r_{t+1}^* | c_t, l_t) \right\}}{dc_t} \frac{dc_t}{dA_{t-1}} \right)} \right]$$

B Construction of Elicited Risk Aversion

Individuals are classified into a category of elicited risk aversion based on their answers to three hypothetical gambles. The questions asked in EPS follow.[13]

The first question asks:

> *Suppose that you are the only income earner in the household. You need to choose between two jobs. Which option do you prefer? (Option A) a job with a lifetime-stable and certain salary or (Option B) a job where you have the same chances of doubling your lifetime income or earning only* 1/4 *of your lifetime income.*

If the answer to the question is "option A", the interviewer continues.

> *Now what do you prefer? (Option A) a job with a lifetime-stable and certain salary or (Option B) a job where you have the same chances of doubling your lifetime income or earning only half of your lifetime income.*

The least risk averse categories comes directly from question 1. Elicited risk aversion equals 3 for individuals who selected "option B" in the first question. If the individual chooses "option A" in the first question, the index of risk aversion is constructed using the second question. Individuals who chose "option B" in the second question belong to the second category (elicited risk aversion of 2), and individuals who chose "option A" in

[13] The questions presented in this section where translated from their original wording in Spanish.

the second question belong to the most risk averse category as individuals assigned to this category exhibited that they are not willing to accept any gamble (elicited risk aversion equals 1).

In the first wave, instead of "earning only 1/4 of your lifetime income" for the first question, the survey proposes "decreasing up to 75%." The second question is asked to every individual regardless of the previous answer. For constructing the risk attitude index, this category is created only for those individuals who answered "option A" in the first question

The change in the wording between the first wave and the subsequent ones potentially leads to measurement error bias. Although mathematically the questions in every wave are equivalent and therefore also the elicited measures of risk aversion, some argue that there could be a bias in the answer as individuals could have different aversions to loss (Kahneman and Tversky, 1979). This does not present an issue in this paper since the first wave is only used to set the initial conditions and elicited risk aversion from the first wave does not enter the model. There is one specification of the estimated model in which initial elicited risk aversion (from the first wave) is jointly estimated with the system and it enters as an explanatory variable in the per-period decision in the second wave. This specification accounts among other potential sources of bias, for measurement error.

C Definition of variables

Employment category (e_t): 0 = non-employed, 1 = working part-time, and 2 = working full-time. Full-and part-time categories depend on the reported weekly hours typically worked in period t. More than 20 hours a week is considered full-time.

Occupation category (o_t): $\{1, 2, ..., 6\}$ based on a regrouping of the 1-digit ISCO classification in period t. 1 = Elementary occupations, 2 = Legislators, senior officials and managers, professionals, technicians and associate professionals. 3 = Clerical support workers. 4 = Service and sales workers. 5 = Skilled agricultural, forestry and fishery workers, craft and related trade workers. 6 = Plant and machine operators and assemblers.

Investment category (i_t): This is a set of five variables: $(i_t^A, i_t^B, i_t^C, i_t^D, i_t^E)$. Each of these variables take 1 of 2 values, $\{0, 1\}$, where 0 represents no investment in that account and 1 represents investment in that account. It is based on all the investment options that an individual affiliated with the retirement system in Chile has. Each variable reflects participation in each of the available accounts. Participation in account A is represented by i_t^A and it is the riskier account. participation in account B is represented by i_t^C, in C by i_t^C, in D by i_t^D, and in E, the safest investment, by i_t^E. The retirement system offers five accounts (A, B, C, D, E). An individual may chose to invest in one or in two accounts. The 5 different accounts where introduced in August of 2002. Before that there where 2 accounts (Account C, and Account E). Account E was introduced in May of 2000 and Account C was the only account since December of 1980 until the introduction of the new ones. When the individual did not report a fund, the legal default account, according to the individual's gender and age, was assigned.

Optional savings (s_t): Dichotomous variable that takes the value 1 if an individual reports to have any optional savings in period t and 0 otherwise.

Accumulated required assets (A_t^r): Amount of private savings accumulated in the retirement system. Computed from Administrative data from the Superintendence of Pensions, based on investing 10% of individual's wage every month, in the account of choice reported in EPS from 2002 onwards. When the individual did not report a fund, the legal default account, according to the individual's gender and age, was assigned. Between May of 2000 and August of 2002, when two accounts are available, investments are accumulated using the mean return of the two accounts. In thousand of dollars of 2009.

Work experience (E_t): Years of labor experience since 1980.

Wage (w_t): Hourly wage, measured by the reported after taxes (and legal deductions) monthly wage divided by 4 times the reported weekly hours typically worked. In 2009 dollars.

Marital status (m_t): Takes 1 if the individual reports to be married in period t and 0 otherwise.

Marital history (M_t): May include lagged marital state, number of marriages and cohabitations, and duration of most recent marriage state.

Changes in number of children (n_t): Takes 1 of 3 values which represent changes in the total number of children of 18 years-old or younger in period t (total number refers to children in and outside the household). 0 = no change in the number of children, -1 = decrease in the number of children, 1 = increase in the number of children.

Children history (N_t): May include birth last period, total number of children and ages of each child.

Number of medical visits (k_t): Reported number of medical visits of the individual in period t.

Health status (H_t): Takes 1 of 4 values, $\{1, ..., 4\}$ where 1 = very good, 2 = good, 3 = fair, 4 = poor.

Expected Duration of Life (T_t^e): Reported expected duration of life in years (reported expected age of death) at the beginning of period t.

Elicited Risk Aversion (r_t): Takes 1 of 3 values based on the answers to hypothetical gambles. 1 being the most risk averse category and 3 the least risk averse category. At the beginning of period t.

Other characteristics (X_t):

Age: Age according to administrative records.

Gender: Gender according to administrative records.

Education: Education category. It takes four categories: Less than High School, High School, Technical College, and College and Some Post College.

Region of residence: Set of dummy variables based on the reported region of residence. Using the old Chilean administrative division which labels regions from 1 to 13 for 2002, 2004, and 2006. Using the new Chilean administrative division which labels region from 1 to 15 for 2009. Used for geographical classification for exclusion restrictions. When region of residence is missing, region of place of work if working is used.

Other variables:

Market characteristics (Z_t):

Z_t^E**:** It includes: Unemployment rate by region of residence.

Z_t^M**:** It includes: Number of marriages in a year per 1,000 people by region of residence, Mean college tuition in 2009 dollars by region of residence.

Z_t^N**:** It includes: Number of marriages in a year per 1,000 people by region of residence, Mean college tuition in 2009 dollars by region of residence.

Z_t^K**:** It includes: Number of beds available per 1,000 people of residence, Number of medical doctors available per 1,000 people by region of residence.

Z_t^H**:** It includes: Inches of rainfall in a year by region of residence.

Time trend: 0 in 2002, 2 in 2004, 4 in 2006, and 7 in 2009.

D Estimation Results for Preferred Model: Model with Endogenous Subjective Assessments and Individual Unobserved Heterogeneity

Table D1: Joint Significance Test for Market Level Exogenous Characteristics in Behavioral and Subjective Assessments Equations

Equation	All Market Level Exogenous Characteristics (jointly tested)	
Employment at t	***	p-value= 0.000
Occupation at t	***	p-value= 0.000
Investment in A at t	***	p-value= 0.000
Investment in B at t		p-value= 0.120
Investment in C at t	***	p-value= 0.000
Investment in D at t	*	p-value= 0.054
Investment in E at t	***	p-value= 0.000
Savings at t	***	p-value= 0.000
Duration of Life at t	***	p-value= 0.000
Elicited Risk Aversion at t	***	p-value= 0.000

* Significant at the 10 percent level.
** Significant at the 5 percent level.
*** Significant at the 1 percent level.

Table D2: Significance Test for Lagged Market Level Exogenous Characteristics in Behavioral and Subjective Assessments Equations

Equation	Lagged Market Level Exogenous Characteristics (at $t-1$)					
	Unemployment Rate	Hospital Beds	Number of Doctors	Number of Marriages	Rainfall	College Tuition
Employment at t	**	Not Sig	***	***	*	Not Sig
Occupation at t	***	Not Sig	***	***	***	***
Investment in A at t	Not Sig	Not Sig	**	***	***	Not Sig
Investment in B at t	Not Sig	Not Sig	Not Sig	Not Sig	Not Sig	***
Investment in C at t	Not Sig	Not Sig	**	***	***	Not Sig
Investment in D at t	Not Sig	Not Sig	Not Sig	Not Sig	Not Sig	Not Sig
Investment in E at t	Not Sig	Not Sig	***	Not Sig	Not Sig	Not Sig
Savings at t	**	Not Sig	Not Sig	Not Sig	Not Sig	***
Duration of Life at t	**	Not Sig	Not Sig	Not Sig	Not Sig	Not Sig
Elicited Risk Aversion at t	**	**	***	**	Not Sig	**

* Significant at the 10 percent level.
** Significant at the 5 percent level.
*** Significant at the 1 percent level.

Table D3: Estimation Results: Multinomial Logit on Employment Status (relative to work full-time)

Variable	Part-Time		Not Working	
	Coeff.	St.Er.	Coeff.	St.Er.
Work Experience	-0.065	0.021***	-0.078	0.011***
Experience Squared	0.001	0.001	-0.001	0.000***
Inv in A in $t-1$	-0.164	0.340	-0.077	0.098
Inv in B in $t-1$	-0.089	0.293	-0.100	0.081
Inv in C in $t-1$	-0.093	0.311	-0.100	0.079
Inv in D in $t-1$	-0.043	0.325	0.051	0.094
Inv in E in $t-1$	0.265	0.483	-0.047	0.139
Assets in $t-1$	-0.042	0.006***	-0.002	0.002
Savings in $t-1$	-0.148	0.097	-0.143	0.049***
Marital Status in $t-1$	-0.399	0.138***	-0.249	0.069***
Number of Children	-0.052	0.075	-0.078	0.035**
Female-Married	0.519	0.174***	0.698	0.092***
Female-Children	0.140	0.085*	0.233	0.043***
Health: Very good	-0.007	0.126	0.003	0.066
Health: Fair	0.083	0.099	0.328	0.050***
Health: Poor	0.455	0.172***	1.005	0.088***
Age	0.126	0.064**	0.162	0.029***
Age Squared	-0.044	0.033	-0.072	0.015***
Age Cubic	0.006	0.005	0.014	0.002***
Female	0.619	0.147***	0.602	0.077***
High School	-0.276	0.107***	-0.486	0.052***
Technical College	-0.221	0.168	-1.031	0.093***
College	-0.106	0.849	-1.581	0.347***
Unemployment rate	-0.017	0.025	0.033	0.012***
Hospital Beds	0.201	0.201	-0.087	0.092
Number of doctors	1.174	0.512**	0.191	0.213
Number of marriages	0.166	0.212	0.272	0.082***
Inches of rainfall	0.010	0.004**	0.006	0.002***
College tuition	0.093	0.091	-0.063	0.045
Missing: Children	0.189	0.871	-0.317	0.194
Missing: Education	-0.261	0.785	-0.176	0.317
Time trend	0.086	0.066	0.065	0.019***
Constant	-6.321	0.916***	-2.654	0.406***
Permanent CUH	-0.543	0.258**	-1.229	0.124***
Permanent CUH	0.395	0.154**	0.883	0.091***
Permanent CUH	-0.499	0.176***	-1.399	0.120***
Time-varying CUH	0.297	0.140**	0.028	0.064
Time-varying CUH	0.678	0.310**	1.637	0.409***
Time-varying CUH	0.312	0.177*	-0.146	0.095

* Significant at the 10 percent level.
** Significant at the 5 percent level.
*** Significant at the 1 percent level.

Table D4: Estimation Results: Multinomial Logit on Occupation Category (relative to Elementary occupation)

Variable	Prof and Tech		Clerical Support		Service and Sales		Agricul and Craft		Plant and Machine	
	Coeff.	St.Er.	Coeff.	St.Er.	Coeff.	St.Er.	Coeff.	St.Er.	Coeff.	St.Er.
Work Experience	-0.072	0.029**	-0.013	0.031	-0.058	0.024**	-0.003	0.029	-0.014	0.029
Experience Squared	0.001	0.001	0.000	0.001	0.001	0.001*	0.002	0.001**	0.000	0.001
Inv in A in $t-1$	-0.108	0.205	-0.078	0.200	0.000	0.209	-0.134	0.251	-0.161	0.191
Inv in B in $t-1$	-0.118	0.157	0.174	0.155	0.334	0.156**	-0.001	0.204	-0.083	0.150
Inv in C in $t-1$	-0.401	0.160**	-0.016	0.157	0.063	0.158	-0.347	0.206*	-0.245	0.147*
Inv in D in $t-1$	-0.241	0.220	-0.124	0.218	-0.149	0.215	-0.026	0.232	-0.196	0.196
Inv in E in $t-1$	-0.568	0.373	-0.310	0.386	0.348	0.316	-0.404	0.379	-0.237	0.275
Assets in $t-1$	0.051	0.004***	0.054	0.004***	0.041	0.004***	-0.004	0.006	0.028	0.004***
Savings in $t-1$	0.317	0.085***	0.135	0.089	-0.007	0.089	0.118	0.104	-0.191	0.085**
Marital Status in $t-1$	0.401	0.174**	0.591	0.171***	0.137	0.177	0.068	0.120	0.192	0.133
Number of Children	-0.077	0.063	-0.162	0.068**	0.012	0.065	-0.111	0.053**	0.104	0.049**
Female-Married	0.134	0.259	-0.390	0.245	0.098	0.258	0.471	0.249*	-0.210	0.243
Female-Children	-0.030	0.086	0.083	0.089	-0.133	0.088	0.226	0.102**	-0.239	0.089***
Health: Very good	0.236	0.115**	0.042	0.119	0.121	0.119	0.077	0.135	-0.092	0.111
Health: Fair	-0.265	0.115**	-0.072	0.114	-0.078	0.110	0.079	0.102	-0.067	0.098
Health: Poor	-0.151	0.446	0.042	0.406	0.121	0.372	0.076	0.227	-0.171	0.305
Age	0.010	0.025	-0.080	0.026***	-0.054	0.023**	-0.046	0.026*	0.013	0.025
Age Squared	0.002	0.006	0.010	0.006	0.011	0.005**	0.006	0.006	-0.003	0.006
Female	-0.227	0.180	0.324	0.174*	0.752	0.184***	-1.039	0.202***	-2.275	0.175***
High School	2.656	0.115***	2.778	0.118***	1.558	0.109***	-0.503	0.121***	1.075	0.105***
Technical College	6.471	0.275***	4.494	0.291***	2.771	0.269***	-0.271	0.477	1.523	0.285***
College	8.027	0.602***	5.560	0.710***	3.578	0.732***	1.209	1.048	1.302	0.867

(continuation) Estimation Results: Multinomial Logit on Occupation Category (relative to Elementary occupation)

Variable	Prof and Tech		Clerical Support		Service and Sales		Agricul and Craft		Plant and Machine	
	Coeff.	St.Er.	Coeff.	St.Er.	Coeff.	St.Er.	Coeff.	St.Er.	Coeff.	St.Er.
Unemployment rate	0.027	0.025	0.021	0.027	-0.025	0.024	0.018	0.026	0.061	0.025**
Hospital Beds	-0.136	0.206	-0.199	0.223	-0.275	0.202	-0.217	0.212	-0.058	0.195
Number of doctors	0.743	0.392*	0.446	0.467	1.156	0.412***	-1.558	0.536***	0.418	0.417
Number of marriages	0.063	0.173	0.423	0.183**	0.323	0.164**	-0.620	0.195***	0.253	0.161
Inches of rainfall	0.001	0.005	0.004	0.005	-0.003	0.004	0.027	0.005***	0.005	0.004
College tuition	0.204	0.089**	0.439	0.094***	0.006	0.089	-0.765	0.102***	0.164	0.090*
Missing: Children	-0.084	0.308	-0.235	0.356	-0.586	0.356*	0.081	0.523	0.181	0.332
Missing: Education	4.686	0.538***	3.454	0.633***	2.151	0.613***	-11.427	1.186***	1.692	0.642***
Time trend	0.023	0.038	-0.041	0.038	-0.026	0.037	-0.006	0.048	0.038	0.035
Constant	-2.650	0.696***	-5.162	0.770***	-2.541	0.696***	4.692	0.814***	0.597	0.660
Permanent CUH	-1.440	0.193***	1.370	0.232***	-1.106	0.222***	-1.406	0.339***	-4.461	0.168***
Permanent CUH	-3.777	0.259***	-1.824	0.269***	-0.729	0.209***	0.755	0.248***	-4.240	0.144***
Permanent CUH	1.585	0.228***	1.103	0.307***	3.710	0.217***	-1.595	0.547***	-3.281	0.253***
Time-varying CUH	0.005	0.117	-0.037	0.118	-0.034	0.117	-0.004	0.131	-0.163	0.109
Time-varying CUH	1.171	0.330***	0.358	0.361	0.887	0.344***	0.453	0.501	0.311	0.327
Time-varying CUH	0.709	0.176***	0.477	0.180***	0.211	0.183	-0.294	0.227	-0.068	0.175

* Significant at the 10 percent level.

** Significant at the 5 percent level.

*** Significant at the 1 percent level.

Table D5: Estimation Results: Logit on Investment and Savings Decisions (relative to not invest in that account or relative to not hold optional savings)

Variable	Logit 1 Account A		Logit 2 Account B		Logit 3 Account C		Logit 5 Account D		Logit 5 Account E		Logit 6 Savings	
	Coeff.	St.Er.	Coeff.	St.Er.	Coeff.	St.Er.	Coeff.	St.Er.	Coeff.	St.Er.	Coeff.	St.Er.
Work Experience	0.053	0.024**	0.001	0.012	-0.115	0.017***	0.068	0.014***	0.033	0.020*	-0.007	0.009
Experience Squared	-0.002	0.001***	0.000	0.000	0.004	0.001***	-0.003	0.000***	-0.001	0.001	0.000	0.000
Inv in A in $t-1$	2.507	0.177***	0.020	0.104	-0.424	0.230**	-0.058	0.141	-0.465	0.202**	0.203	0.068***
Inv in B in $t-1$	0.246	0.176	1.325	0.088***	-1.123	0.190***	0.103	0.117	0.013	0.150	0.116	0.056**
Inv in C in $t-1$	0.559	0.194***	0.344	0.088***	0.889	0.175***	-0.168	0.111	0.039	0.137	0.180	0.055***
Inv in D in $t-1$	-0.067	0.342	0.369	0.114***	-1.739	0.264***	1.210	0.130***	-0.100	0.162	0.138	0.071*
Inv in E in $t-1$	0.672	0.481	0.570	0.158***	-0.110	0.354	-0.305	0.201	1.255	0.179***	0.121	0.103
Assets in $t-1$	0.015	0.003***	0.013	0.002***	0.002	0.002	-0.009	0.002***	0.007	0.003***	0.006	0.001***
Savings in $t-1$	0.365	0.112***	0.021	0.053	-0.106	0.092	-0.119	0.069*	-0.047	0.087	0.825	0.034***
Marital Status in $t-1$	0.338	0.189*	0.068	0.074	-0.173	0.122	0.016	0.097	0.226	0.120*	0.074	0.050
Number of Children	-0.049	0.067	0.013	0.034	-0.275	0.054***	0.210	0.046***	-0.102	0.058*	0.001	0.023
Female-Married	-0.289	0.288	-0.139	0.102	0.165	0.174	0.040	0.130	-0.146	0.164	-0.061	0.070
Female-Children	0.048	0.103	-0.002	0.046	0.655	0.078***	-0.426	0.063***	0.134	0.075*	-0.042	0.032
Health: Very good	0.146	0.138	-0.168	0.066**	0.228	0.115*	-0.022	0.092	0.121	0.109	0.001	0.046
Health: Fair	-0.116	0.155	-0.074	0.062	-0.004	0.101	0.046	0.073	0.060	0.093	-0.077	0.041*
Health: Poor	0.239	0.312	-0.394	0.131***	-0.030	0.184	0.221	0.125*	-0.106	0.171	-0.201	0.081**
Age	0.311	0.033***	-0.347	0.013***	1.207	0.041***	-0.208	0.018	0.035	0.021*	-0.061	0.009***
Age Squared	-0.095	0.007***	0.053	0.003***	-0.318	0.010***	0.104	0.004	-0.006	0.005	0.008	0.002***
Female	-0.314	0.238	0.062	0.084	-1.257	0.152***	1.085	0.110	0.167	0.139	0.131	0.057**
High School	0.705	0.155***	0.261	0.057***	-0.239	0.096**	-0.104	0.072	0.139	0.094	0.294	0.038***
Technical College	1.391	0.199***	0.562	0.086***	-0.798	0.170***	-0.402	0.116	-0.032	0.149	0.529	0.057***
College	1.911	0.427***	0.717	0.210***	-1.079	0.642*	-0.647	0.362	-0.076	0.719	0.893	0.135***

(continuation) Estimation Results: Logit on Investment and Savings Decisions (relative to not invest in that account or relative to not hold optional savings)

Variable	Logit 1 Account A		Logit 2 Account B		Logit 3 Account C		Logit 5 Account D		Logit 5 Account E		Logit 6 Savings	
	Coeff.	St.Er.	Coeff.	St.Er.	Coeff.	St.Er.	Coeff.	St.Er.	Coeff.	St.Er.	Coeff.	St.Er.
Unemployment rate	0.079	0.027***	0.015	0.014	0.023	0.023	0.013	0.017	0.006	0.022	-0.016	0.010*
Hospital Beds	-0.135	0.233	-0.004	0.110	0.278	0.197	-0.001	0.137	0.380	0.166**	0.049	0.069
Number of doctors	-0.052	0.496	-0.442	0.326	0.223	0.510	-0.562	0.347	-1.065	0.382***	0.152	0.150
Number of marriages	0.433	0.196**	-0.108	0.134	-0.427	0.162***	-0.111	0.133	-0.107	0.151	0.037	0.062
Inches of rainfall	0.015	0.004***	0.005	0.003*	-0.009	0.004***	-0.005	0.003	-0.002	0.004	0.005	0.002***
College tuition	-0.517	0.107***	-0.107	0.054**	0.257	0.081***	-0.121	0.064	-0.421	0.078***	0.043	0.034
Missing: Children	0.424	0.357	-0.132	0.155	-0.490	0.378	-0.053	0.261	-0.278	0.385	-0.071	0.112
Missing: Education	0.892	0.815	-0.369	0.650	0.018	0.715	-0.872	0.538	0.354	0.711	0.665	0.197***
Time trend	-0.268	0.041***	-0.217	0.023***	-0.024	0.038	-0.056	0.026	-0.116	0.034***	0.008	0.014
Constant	-7.674	0.924***	1.951	0.769**	-2.374	0.724***	-4.353	0.690	-4.342	0.703***	-1.297	0.283***
Permanent CUH	0.176	0.191	0.195	0.086**	-0.425	0.163***	-0.027	0.117	0.048	0.150	-0.057	0.059
Permanent CUH	-0.500	0.198**	-0.258	0.081***	0.096	0.143	0.157	0.103	0.399	0.124***	-0.356	0.052***
Permanent CUH	0.111	0.181	-0.146	0.090	-0.198	0.162	0.126	0.114	0.068	0.151	-0.091	0.056
Time-varying CUH	2.051	0.210***	2.987	0.087***	-7.760	0.290***	3.405	0.124	2.794	0.267***	0.042	0.047
Time-varying CUH	2.438	0.308***	1.872	0.175***	-5.302	0.357***	2.142	0.213	1.399	0.521***	-0.142	0.113
Time-varying CUH	9.663	0.337***	1.132	0.198***	-21.710	27.740	-4.549	0.462	2.718	0.310***	0.172	0.066***

* Significant at the 10 percent level.
** Significant at the 5 percent level.
*** Significant at the 1 percent level.

Table D6: Estimation Results: Subjective Assessments

Variable	Elicited Risk Aversion (relative to Most)				Expected Duration of Life	
	Intermediate		Least			
	Coeff.	St.Er.	Coeff.	St.Er.	Coeff.	St.Er.
Work Experience	0.024	0.015*	-0.019	0.011*	0.018	0.013
Experience Squared	-0.001	0.001	0.001	0.000		
Inv in A in $t-1$	0.098	0.117	0.123	0.084	-0.158	0.503
Inv in B in $t-1$	-0.021	0.098	0.002	0.071	0.402	0.357
Inv in C in $t-1$	0.072	0.094	-0.028	0.072	0.338	0.361
Inv in D in $t-1$	0.052	0.117	-0.044	0.089	0.435	0.539
Inv in E in $t-1$	-0.390	0.200*	-0.026	0.124	0.284	0.685
Assets in $t-1$	0.001	0.002	-0.001	0.002	0.005	0.006
Savings in $t-1$	0.029	0.060	-0.002	0.042	0.526	0.172***
Marital Status in $t-1$	0.058	0.080	-0.006	0.055	0.785	0.310**
Number of Children	0.001	0.038	0.016	0.026	0.145	0.108
Female-Married	0.046	0.114	0.062	0.081	-0.766	0.467
Female-Children	-0.036	0.054	-0.032	0.037	-0.195	0.151
Health: Very good	0.115	0.076	0.186	0.052***	1.253	0.220***
Health: Fair	0.024	0.067	0.046	0.048	-2.485	0.192***
Health: Poor	-0.176	0.129	-0.075	0.091	-5.987	0.402***
Age	-0.006	0.005	-0.010	0.003***	-0.120	0.042***
Age Squared					0.055	0.010***
Female	-0.090	0.096	-0.370	0.067***	-0.657	0.350*
High School	0.011	0.068	0.109	0.045**	0.513	0.191***
Technical College	0.175	0.102*	0.283	0.067***	1.662	0.353***
College	-0.111	0.613	0.267	0.185	1.735	0.693**
Unemployment rate	-0.022	0.016	-0.020	0.011*	-0.182	0.047***
Hospital Beds	0.346	0.118***	0.202	0.091**	0.164	0.431
Number of doctors	0.519	0.295*	0.078	0.302	0.942	0.677
Number of marriages	-0.281	0.123**	-0.212	0.126*	-0.867	0.335***
Inches of rainfall	-0.015	0.003***	-0.007	0.002***	-0.030	0.009***
College tuition	0.077	0.057	0.104	0.045**	0.328	0.157**
Missing: Children	-0.295	0.214	0.106	0.125	0.968	0.556*
Missing: Education	0.720	0.595	0.423	0.334	0.102	1.000
Time trend	0.045	0.024*	0.012	0.020	0.084	0.082
Constant	-2.805	0.626***	-0.895	0.741	52.038	1.014***
Permanent CUH	-0.152	0.100	-0.200	0.070***	1.337	0.437***
Permanent CUH	-0.059	0.085	-0.275	0.062***	0.060	0.367
Permanent CUH	0.081	0.096	0.154	0.064**	0.222	0.421
Time-varying CUH	0.135	0.079*	-0.049	0.054	0.135	0.223
Time-varying CUH	0.000	0.170	0.065	0.115	1.281	0.788
Time-varying CUH	0.321	0.108***	0.169	0.074**	0.276	0.474

* Significant at the 10 percent level.
** Significant at the 5 percent level.
*** Significant at the 1 percent level.

Table D7: Estimation Results: Wage equation

Variable	Wage (log)	
	Coeff.	St.Er.
Work Experience	0.006	0.003*
Experience Squared	0.000	0.000
Legislators	0.561	0.022***
Clerical	0.339	0.022***
Service and Sales	0.118	0.023***
Agricultural	-0.079	0.023***
Plant Operators	-0.042	0.021**
Health: Very good	0.060	0.013***
Health: Fair	-0.107	0.013***
Health: Poor	-0.196	0.026***
Number of Children	0.003	0.007
Marital Status in $t-1$	0.092	0.011***
Age	0.001	0.001
Female	-0.196	0.013***
High School	0.257	0.012***
Technical College	0.686	0.021***
College	0.875	0.040***
Missing: Occupation	0.139	0.044***
Unemployment rate	-0.003	0.003
Missing: Education	0.365	0.059***
Missing: Children	0.000	0.031
Constant	0.572	0.039***
Permanent CUH	-0.263	0.028***
Permanent CUH	-0.411	0.024***
Permanent CUH	-0.314	0.029***
Time-varying CUH	0.039	0.014***
Time-varying CUH	-10.294	0.039***
Time-varying CUH	0.180	0.019***

* Significant at the 10 percent level.
** Significant at the 5 percent level.
*** Significant at the 1 percent level.

Table D8: Estimation Results: Marital Status, and Variation in Number of Children

Variable	Marital Status (relative to married)		Children variation (relative to no change)			
			Decrease		Increase	
	Coeff.	St.Er.	Coeff.	St.Er.	Coeff.	St.Er.
Duration of marriage	-0.025	0.004***	0.066	0.004***	-0.098	0.014***
Marital Status in $t-1$	-4.382	0.106***	-1.133	0.115***	0.798	0.195***
Number of Children	-0.258	0.035***	1.161	0.032***	0.691	0.065***
Female-Married	-0.097	0.106	-0.316	0.095***	-0.076	0.213
Female-Children	0.100	0.048**	0.177	0.041***	-0.035	0.098
Full-Time employed	-0.047	0.071	0.297	0.060***	0.554	0.194***
Part-Time employed	-0.029	0.153	0.254	0.127**	0.148	0.463
Age	0.063	0.028**	0.515	0.017***	-0.153	0.025***
Age Squared	-0.037	0.017**	-0.113	0.004***	0.006	0.009
Age Cubic	0.006	0.003**				
Female	0.357	0.090***	0.263	0.098***	0.005	0.211
High School	0.016	0.060	-0.078	0.049	0.202	0.118*
Technical College	-0.079	0.092	-0.131	0.080*	0.068	0.187
College	-0.452	0.159***	-0.075	0.127	0.037	0.583
Number of marriages	-0.317	0.085***				
College tuition			-0.001	0.039	-0.217	0.087***
Missing: Marriage Duration	-0.082	0.441	1.595	0.443***	-0.026	0.988
Missing: Children	-0.641	0.158***				
Missing: Education	-0.374	0.553	0.114	0.426	0.941	0.893
Constant	3.257	0.388***	-8.618	0.261***	-2.371	0.463***
Permanent CUH	0.184	0.093**	-0.107	0.079	-0.053	0.200
Permanent CUH	0.016	0.078	0.041	0.064	-0.112	0.206
Permanent CUH	0.045	0.093	-0.099	0.076	-0.183	0.198
Time-varying CUH	0.015	0.089	-0.011	0.079	-0.199	0.212
Time-varying CUH	-1.795	0.352***	0.866	0.319***	3.972	0.439***
Time-varying CUH	-0.043	0.130	0.254	0.105**	-0.072	0.271

* Significant at the 10 percent level.
** Significant at the 5 percent level.
*** Significant at the 1 percent level.

Table D9: Estimation Results: Health status and Medical Care Consumption

Variable	Health Status (relative to very good)						Medical Consumption	
	Good		Regular		Poor			
	Coeff.	St.Er.	Coeff.	St.Er.	Coeff.	St.Er.	Coeff.	St.Er.
Health: Very good	-0.528	0.060***	-0.789	0.084***	-0.889	0.203***	-1.047	0.246***
Health: Fair	0.289	0.081***	1.526	0.084***	1.845	0.122***	4.887	0.207***
Health: Poor	0.678	0.329**	2.353	0.322***	4.108	0.333***	15.679	0.424***
Number of Medical Visits	0.010	0.003***	0.022	0.004***	0.027	0.004***		
Work Experience	0.003	0.005	-0.004	0.006	-0.005	0.008		
Legislators	-0.296	0.142**	-0.442	0.175**	-0.288	0.330		
Clerical	-0.025	0.143	0.007	0.172	0.282	0.352		
Service and Sales	0.011	0.156	-0.090	0.187	0.084	0.322		
Agricultural	-0.165	0.178	-0.244	0.204	-0.191	0.342		
Plant Operators	0.062	0.141	-0.018	0.163	0.208	0.264		
Age	0.034	0.014**	0.084	0.017***	0.163	0.032***	-0.048	0.040
Age Squared	-0.004	0.003	-0.009	0.004**	-0.021	0.007***	0.019	0.009**
Female	0.170	0.064***	0.379	0.075***	0.618	0.115***	4.149	0.177***
High School	-0.098	0.066	-0.537	0.077***	-0.693	0.121***	1.370	0.198***
Technical College	-0.214	0.105**	-0.924	0.139***	-1.301	0.274***	2.881	0.378***
College	-0.489	0.253*	-1.445	0.520***	-1.873	0.826**	3.974	0.943***
Inches of rainfall	0.001	0.002	0.006	0.002**	0.003	0.004		
Hospital Beds							-0.038	0.299
Number of doctors							0.550	0.671
Missing: Occupation	-0.096	0.327	-0.341	0.438	-0.405	0.691		
Missing: Education	-0.201	0.492	-0.657	0.712	-0.766	0.922	2.248	1.000**
Not employed	0.123	0.333	0.254	0.448	0.713	0.686		
Constant	0.869	0.200***	-0.946	0.244***	-4.435	0.508***	1.537	0.882*
Permanent CUH	-0.079	0.139	-0.130	0.168	-0.220	0.294	-0.302	0.413
Permanent CUH	0.072	0.118	0.409	0.136***	0.749	0.206***	-0.201	0.480
Permanent CUH	0.075	0.137	0.093	0.169	0.296	0.288	-0.657	0.434
Time-varying CUH	-0.068	0.075	-0.055	0.090	0.009	0.150	0.215	0.340
Time-varying CUH	1.084	1.442	1.105	1.442	1.624	1.670	-1.633	0.699**
Time-varying CUH	-0.095	0.103	-0.273	0.126**	-0.325	0.210	0.947	0.598

* Significant at the 10 percent level.
** Significant at the 5 percent level.
*** Significant at the 1 percent level.

Table D10: Pearson's Correlation Coefficient of Unobserved Heterogeneity Between Subjective Assessments and Outcomes

Outcome	Risk Aversion				Expected Duration of Life	
	Intermediate		Least			
	Perm.	Time-Var.	Perm.	Time-Var.	Perm.	Time-Var.
Employment (relative to full-time worker)						
Part-Time Worker	-0.021	0.681	-0.558	-0.014	-0.689	0.765
Not Working	-0.092	-0.236	-0.597	0.027	-0.643	0.867
Occupation (relative to elementary occupation)						
Legis., Prof., Tech., other	0.626	0.435	0.967	0.794	0.022	0.815
Clerical support workers	0.058	0.527	0.623	0.948	0.626	0.543
Service and sales workers	0.842	0.081	0.829	0.587	-0.244	0.903
Agricultural, craft and trade	-0.069	-0.638	-0.558	-0.505	-0.664	0.425
Operators and assemblers	0.506	-0.589	0.612	0.479	-0.474	0.339
Investment Decision						
Account A (Riskier)	0.114	0.917	0.682	0.680	0.526	0.407
Account B	-0.389	0.610	0.225	-0.465	0.728	0.321
Account C	0.343	-0.984	-0.210	-0.465	-0.909	-0.399
Account D	0.269	-0.067	-0.285	-0.912	-0.492	0.069
Account E (Safest)	-0.238	0.838	-0.749	-0.169	-0.279	0.351
Saving Outcomes						
Optional Savings	0.222	0.884	0.726	0.432	0.255	-0.151
Elicited Risk Aversion (relative to most risk averse)						
Intermediate Risk Averse	1.000	1.000	0.804	0.342	-0.699	0.268
Least Risk Averse	0.804	0.342	1.000	1.000	-0.213	0.300
Marital status						
Married	-0.675	0.134	-0.209	-0.254	0.997	-0.915
Variation in Number of Children (relative to no change)						
Decrease	0.038	0.177	-0.467	0.609	-0.740	0.920
Increase	-0.263	-0.240	0.012	0.268	0.041	0.859
Health Status (relative to very good)						
Good	0.587	-0.336	0.013	0.188	-0.762	0.812
Regular	0.071	-0.478	-0.529	-0.064	-0.564	0.713
Poor	0.139	-0.369	-0.459	-0.111	-0.561	0.776
Expected Duration of Life	-0.699	0.268	-0.213	0.300	1.000	1.000
Log Wage	0.270	0.179	0.573	-0.181	-0.146	-0.899
Medical Consumption	-0.236	0.729	-0.277	0.278	-0.314	-0.440

Note: (a) Permanent unobserved heterogeneity also enters the initial condition equations.

E Alternative Specifications of the Model

Table E1: System of Equations Estimated for each Model and Unobserved Heterogeneity Allowed

Equation	Model									
	1	2	3	4	5*	6	7	8	9	10
Employment (e_t)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Occupation (o_t)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Savings (s_t)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Investment in A (i_t^A)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Investment in B (i_t^B)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Investment in C (i_t^C)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Investment in D (i_t^D)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Investment in E (i_t^E)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Expected Duration (T_t^E)	✓	x	x	✓	✓	x	x	x	✓	✓
Elicited Risk Aversion (r_t)	✓	x	x	✓	✓	x	x	x	✓	✓
Log Wage (w_t)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Marital status (m_{t+1})	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Change in # children (n_{t+1})	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Medical consumption (k_t)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Health status (H_{t+1})	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Initial conditions										
Employment	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Work experience	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Occupation	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Savings	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Marital status	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Number of children	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Health status	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Elicited risk aversion	x	x	x	x	x	x	x	x	✓	✓
Expected duration	x	x	x	x	x	x	x	x	✓	✓
Correlated Unobserved Heterogeneity										
Permanent	NO	YES	YES	YES	YES	NO	YES	YES	YES	YES
(mass points)	–	(5)	(3)	(6)	(4)	–	(6)	(2)	(3)	(4)
Time-Varying	NO	NO	YES	NO	YES	NO	NO	YES	NO	YES
(mass points)	–	–	(3)	–	(4)	–	–	(3)	–	(3)

Note: (a) Model 5* corresponds to the preferred model developed in Section 4. (b) A check-mark (✓) means that the equation is included in the system estimated, a cross (x) that it does not. (c) When neither components of unobserved heterogeneity are allowed, each equation is estimated independently of the rest (no correlation). (d) Initial conditions equations are correlated solely through permanent unobserved heterogeneity, when corresponds. (e) The number of mass points are selected according to the sufficient number of points for capturing the distribution of permanent and time-varying individual heterogeneity.

Table E2: Endogenous and Predetermined Explanatory Variables in each estimated model

Equation	Model 1-3		Model 4-5		Model 6-8		Model 9-10	
	Predetermined	Exogenous	Predetermined	Exogenous	Predetermined	Exogenous	Predetermined	Exogenous
Wealth-related decisions								
at period t								
Employment (e_t)	$\tilde{\Omega}_t$	$X_t,\ Z_t$	$\tilde{\Omega}_t$	$X_t,\ Z_t$	$\tilde{\Omega}_t$	$X_t,\ Z_t,\ r_t,\ T_t^e$	$\tilde{\Omega}_t,\ r_{t-1},\ T_{t-1}^e$	$X_t,\ Z_t$
Occupation (o_t)	$\tilde{\Omega}_t$	$X_t,\ Z_t$	$\tilde{\Omega}_t$	$X_t,\ Z_t$	$\tilde{\Omega}_t$	$X_t,\ Z_t,\ r_t,\ T_t^e$	$\tilde{\Omega}_t,\ r_{t-1},\ T_{t-1}^e$	$X_t,\ Z_t$
Savings (s_t)	$\tilde{\Omega}_t$	$X_t,\ Z_t$	$\tilde{\Omega}_t$	$X_t,\ Z_t$	$\tilde{\Omega}_t$	$X_t,\ Z_t,\ r_t,\ T_t^e$	$\tilde{\Omega}_t,\ r_{t-1},\ T_{t-1}^e$	$X_t,\ Z_t$
Investment in A (i_t^A)	$\tilde{\Omega}_t$	$X_t,\ Z_t$	$\tilde{\Omega}_t$	$X_t,\ Z_t$	$\tilde{\Omega}_t$	$X_t,\ Z_t,\ r_t,\ T_t^e$	$\tilde{\Omega}_t,\ r_{t-1},\ T_{t-1}^e$	$X_t,\ Z_t$
Investment in B (i_t^B)	$\tilde{\Omega}_t$	$X_t,\ Z_t$	$\tilde{\Omega}_t$	$X_t,\ Z_t$	$\tilde{\Omega}_t$	$X_t,\ Z_t,\ r_t,\ T_t^e$	$\tilde{\Omega}_t,\ r_{t-1},\ T_{t-1}^e$	$X_t,\ Z_t$
Investment in C (i_t^C)	$\tilde{\Omega}_t$	$X_t,\ Z_t$	$\tilde{\Omega}_t$	$X_t,\ Z_t$	$\tilde{\Omega}_t$	$X_t,\ Z_t,\ r_t,\ T_t^e$	$\tilde{\Omega}_t,\ r_{t-1},\ T_{t-1}^e$	$X_t,\ Z_t$
Investment in D (i_t^D)	$\tilde{\Omega}_t$	$X_t,\ Z_t$	$\tilde{\Omega}_t$	$X_t,\ Z_t$	$\tilde{\Omega}_t$	$X_t,\ Z_t,\ r_t,\ T_t^e$	$\tilde{\Omega}_t,\ r_{t-1},\ T_{t-1}^e$	$X_t,\ Z_t$
Investment in E (i_t^E)	$\tilde{\Omega}_t$	$X_t,\ Z_t$	$\tilde{\Omega}_t$	$X_t,\ Z_t$	$\tilde{\Omega}_t$	$X_t,\ Z_t,\ r_t,\ T_t^e$	$\tilde{\Omega}_t,\ r_{t-1},\ T_{t-1}^e$	$X_t,\ Z_t$
Subjective assessments								
at period t								
Expected Duration (T_t^E)	–	–	$\tilde{\Omega}_t$	$X_t,\ Z_t$	–	–	$\tilde{\Omega}_t,\ r_{t-1},\ T_{t-1}^e$	$X_t,\ Z_t$
Elicited Risk Aversion (r_t)	–	–	$\tilde{\Omega}_t$	$X_t,\ Z_t$	–	–	$\tilde{\Omega}_t,\ r_{t-1},\ T_{t-1}^e$	$X_t,\ Z_t$
Stochastic outcomes								
at period t								
Log Wage ($w_t \vert o_t, e_t$)	$E_t,\ H_t$	$X_t,\ Z_t^E$	$E_t,\ ot,\ H_t$	$X_t,\ Z_t^E$	$E_t,\ ot,\ H_t$	$X_t,\ Z_t^E$	$E_t,\ ot,\ H_t$	$X_t,\ Z_t^E$
Medical consumption (k_t)	H_t	$X_t,\ Z_t^K$	H_t	$X_t,\ Z_t^K$	H_t	$X_t,\ Z_t^K,\ r_t,\ T_t^e$	$H_t,\ r_{t-1},\ T_{t-1}^e$	$X_t,\ Z_t^K$
Stochastic outcomes								
at the end of period t								
Marital status (m_{t+1})	$e_t,\ M_t,\ N_t$	$X_t,\ Z_t^M$	$e_t,\ M_t,\ N_t$	$X_t,\ Z_t^M$	$e_t,\ M_t,\ N_t$	$X_t,\ Z_t^M,\ r_t,\ T_t^e$	$e_t,\ M_t,\ N_t$	$X_t,\ Z_t^M$
Change in # children (n_{t+1})	$e_t,\ M_t,\ N_t$	$X_t,\ Z_t^N$	$e_t,\ M_t,\ N_t$	$X_t,\ Z_t^N$	$e_t,\ M_t,\ N_t$	$X_t,\ Z_t^N,\ r_t,\ T_t^e$	$e_t,\ M_t,\ N_t$	$X_t,\ Z_t^N$
Health status (H_{t+1})	$e_t,\ o_t,\ k_t,\ E_t,\ H_t$	$X_t,\ Z_t^H$	$e_t,\ o_t,\ k_t,\ E_t,\ H_t$	$X_t,\ Z_t^H$	$e_t,\ o_t,\ k_t,\ E_t,\ H_t$	$X_t,\ Z_t^H,\ r_t,\ T_t^e$	$e_t,\ o_t,\ k_t,\ E_t,\ H_t$	$X_t,\ Z_t^H$
Initial conditions								
(at period $t = 1$)								
Employment	–	$X_1,\ Z_1$	–	$X_1,\ Z_1$	–	$X_1,\ Z_1$	–	$X_1,\ Z_1$
Work experience	–	$X_1,\ Z_1$	–	$X_1,\ Z_1$	–	$X_1,\ Z_1$	–	$X_1,\ Z_1$
Occupation	–	$X_1,\ Z_1$	–	$X_1,\ Z_1$	–	$X_1,\ Z_1$	–	$X_1,\ Z_1$
Savings	–	$X_1,\ Z_1$	–	$X_1,\ Z_1$	–	$X_1,\ Z_1$	–	$X_1,\ Z_1$
Marital status	–	$X_1,\ Z_1^M$	–	$X_1,\ Z_1^M$	–	$X_1,\ Z_1^M$	–	$X_1,\ Z_1^M$
Number of children	–	$X_1,\ Z_1^N$	–	$X_1,\ Z_1^N$	–	$X_1,\ Z_1^N$	–	$X_1,\ Z_1^N$
Health status	–	$X_1,\ Z_1^K,\ Z_1^H$	–	$X_1,\ Z_1^K,\ Z_1^H$	–	$X_1,\ Z_1^K,\ Z_1^H$	–	$X_1,\ Z_1^K,\ Z_1^H$
Elicited risk aversion	–	–	–	–	–	–	–	$X_1,\ Z_1$
Expected duration	–	–	–	–	–	–	–	$X_1,\ Z_1$

Note: (a) Model 5 corresponds to the preferred model developed in Section 4. (b) Unobserved heterogeneity is not specified in this table. (c) Models 9 and 10 include the measure of elicited risk aversion from the first wave of EPS (2002) for modeling the initial condition equation and as explanatory variables for the first-period behaviors. (d) The vector $\tilde{\Omega}_t = (i_{t-1},\ s_{t-1},\ A_t^r,\ E_t,\ M_t,\ N_t,\ H_t)$. (e) The vector $Z_t = (Z_t^E, Z_t^M, Z_t^N, Z_t^K, Z_t^H)$.

Table E3: Unobserved Heterogeneity Support Points and Probability Weights

Model	Permanent CUH		Time-Variant CUH	
	Points of Support	Probability Weights	Points of Support	Probability Weights
Model 1	–	–	–	–
Model 2	1	0.1280	–	–
	2	0.2077	–	–
	3	0.1883	–	–
	4	0.2791	–	–
	5	0.1970	–	–
Model 3	1	0.4854	1	0.0239
	2	0.4392	2	0.4738
	3	0.0754	3	0.5023
Model 4	1	0.0686	–	–
	2	0.4253	–	–
	3	0.0000	–	–
	4	0.3026	–	–
	5	0.1707	–	–
	6	0.0328	–	–
Model 5	1	0.3210	1	0.4218
	2	0.1809	2	0.4741
	3	0.3472	3	0.0249
	4	0.1509	4	0.0793
Model 6	–	–	–	–
Model 7	1	0.1453	–	–
	2	0.3081	–	–
	3	0.0297	–	–
	4	0.1491	–	–
	5	0.0320	–	–
	6	0.3358	–	–
Model 8	1	0.5158	1	0.4819
	2	0.4842	2	0.4440
	–	–	3	0.0742
Model 9	1	0.4735	–	–
	2	0.4899	–	–
	3	0.0366	–	–
Model 10	1	0.4474	1	0.0173
	2	0.1811	2	0.4055
	3	0.3360	3	0.5772
	4	0.0355	–	–

Note: (a) Model 5 corresponds to the preferred model.

Table E4: Comparison of Contemporaneous Marginal Effects of Lagged Investment decisions under Different Models (%) (continues)

	Model 1	Model 2	Model 3	Model 4	Model 5*	Model 6	Model 7	Model 8	Model 9	Model 10
Lagged Investments in Account A										
Investment in A	19.40^{*a}	16.20^{***a}	17.05^{***a}	17.35^{***a}	13.82	19.46^{*a}	19.72^{**a}	14.02^{**a}	18.63^{***a}	18.66^{*a}
Investment in B	0.03^{a}	-1.32^{a}	-0.99^{a}	-0.32^{a}	0.20	0.04^{a}	0.12^{a}	-0.12^{a}	-0.04^{a}	0.02^{a}
Investment in C	-6.85^{***a}	-3.14^{**a}	-4.03^{***a}	-5.94^{***a}	-3.07***	-6.85^{a}	-6.72^{***a}	-3.02^{***a}	-6.41^{***a}	-6.42^{***a}
Investment in D	-1.03^{a}	-1.93^{a}	-1.72^{a}	-0.98^{a}	-0.38	-1.02^{a}	-1.03^{a}	-0.83^{a}	-1.00^{a}	-0.96^{a}
Investment in E	-1.18^{a}	-1.38	-1.51^{a}	-1.15^{a}	-1.38	-1.15^{a}	-1.10^{a}	-1.35	-1.20^{a}	-1.19^{a}
Savings	4.22^{a}	4.00^{**a}	4.10^{***a}	4.10^{***a}	3.79**	4.30^{a}	4.32^{**a}	4.08^{***a}	4.03^{***a}	3.94^{***a}
Lagged Investments in Account B										
Investment in A	1.51^{a}	0.58^{a}	1.55^{a}	1.28^{a}	0.76	1.56^{a}	1.65^{a}	-0.01^{a}	1.35^{a}	1.42^{a}
Investment in B	14.28^{*a}	12.15^{***a}	14.89^{***a}	14.09^{***a}	15.84***	14.32^{**a}	14.06^{**a}	15.58^{***a}	14.23^{***a}	14.24^{***a}
Investment in C	-4.75^{**a}	-0.67^{a}	-7.06^{***a}	-4.46^{***a}	-7.98***	-4.78^{a}	-4.75^{***a}	-6.53^{***a}	-4.50^{***a}	-4.52^{***a}
Investment in D	-0.37^{a}	-1.40^{a}	-0.46^{a}	-0.34^{a}	0.72	-0.40^{a}	-0.37^{a}	0.06^{a}	-0.32 ^{a}	-0.32^{a}
Investment in E	0.10^{a}	-0.30^{a}	-0.24^{a}	0.09^{a}	0.05	0.09	0.05	-0.13^{a}	0.05	0.04
Savings	2.33^{a}	2.36^{*a}	2.27^{*a}	2.36^{a}	2.12	2.36^{a}	2.49^{**a}	2.29^{*a}	2.22^{*a}	2.29^{a}
Lagged Investments in Account C										
Investment in A	2.94^{a}	4.70^{*a}	3.22^{a}	3.10^{*a}	1.77	3.06^{a}	3.23^{a}	1.61^{a}	2.89^{a}	2.86^{a}
Investment in B	2.11^{a}	4.63^{**a}	2.95^{a}	2.16^{a}	3.59*	2.16^{a}	2.21^{a}	3.56^{**c}	2.09^{a}	2.07^{a}
Investment in C	7.37^{***a}	1.81^{a}	10.06^{***a}	7.20^{***a}	6.62***	7.27^{a}	7.15^{**a}	9.13^{***a}	7.50^{***a}	7.59^{***a}
Investment in D	-1.94^{a}	-0.24^{a}	-2.29^{*a}	-1.99^{a}	-1.13	-2.00^{a}	-2.02^{a}	-1.67^{*a}	-1.95^{a}	-1.92^{a}
Investment in E	0.18^{a}	0.74^{a}	0.01^{a}	0.18^{a}	0.14	0.22^{a}	0.21^{a}	0.18^{b}	0.13	0.11
Savings	3.28	3.41^{*a}	3.36^{*a}	3.34^{*a}	3.28**	3.49^{a}	3.57^{**a}	3.49^{**a}	3.22^{*a}	3.29
Lagged Investments in Account D										
Investment in A	0.81^{a}	0.02^{a}	1.62^{a}	0.83^{a}	-0.19	0.99^{a}	1.06^{a}	-4.09^{a}	0.81^{a}	0.80^{a}
Investment in B	1.90^{a}	0.60^{a}	3.00^{a}	1.90^{a}	3.97	1.97 ^{a}	2.13 ^{a}	4.75^{**a}	1.85^{a}	1.85^{a}
Investment in C	-7.05^{***a}	-3.12^{a}	-9.40^{***a}	-6.98^{***a}	-11.84***	-7.20^{a}	-7.26^{**a}	-11.33^{***a}	-6.90^{***a}	-6.90^{***a}
Investment in D	5.75^{*a}	4.06^{a}	7.83^{***a}	5.71^{**a}	10.06***	5.69^{a}	5.63^{a}	11.18^{***a}	5.73^{**a}	5.72^{**a}
Investment in E	-0.54^{a}	-0.85^{a}	-0.41^{a}	-0.54^{a}	-0.34	-0.49^{a}	-0.45^{a}	-0.14^{a}	-0.59^{a}	-0.58^{a}
Savings	2.51	2.59^{c}	2.58	2.56	2.55	2.75^{a}	2.81^{*a}	2.74^{a}	2.46^{a}	2.49^{a}
Lagged Investments in Account E										
Investment in A	4.42^{a}	3.45^{a}	4.90^{*a}	4.59^{*a}	2.37	4.57^{a}	4.73^{a}	2.45^{a}	4.24^{a}	4.38^{a}
Investment in B	5.02^{a}	3.49^{a}	5.46^{*a}	5.07^{a}	6.35*	5.10^{a}	5.01^{**a}	6.11^{**a}	4.96^{**a}	4.92^{a}
Investment in C	1.02^{a}	3.65^{*a}	0.61^{a}	0.88^{a}	-0.80	0.91^{a}	0.93^{a}	0.03^{a}	1.21^{a}	1.15^{a}
Investment in D	-3.50^{a}	-4.30^{*a}	-4.16^{**a}	-3.53^{*a}	-1.97	-3.54^{a}	-3.55^{a}	-2.65^{*a}	-3.49^{*a}	-3.44^{a}
Investment in E	7.33^{a}	6.24^{a}	6.97^{a}	7.23	7.14	7.46^{a}	6.97^{b}	7.54^{a}	7.28^{c}	7.21
Savings	1.87^{a}	2.09^{a}	2.01^{a}	2.01^{a}	2.25	2.04^{a}	2.23**	2.00^{a}	1.75^{a}	1.95^{a}

(continuation) Comparison of Contemporaneous Marginal Effects of Lagged Investment decisions under Different Models (%)

	Model 1	Model 2	Model 3	Model 4	Model 5*	Model 6	Model 7	Model 8	Model 9	Model 10
Lagged Savings										
Investment in A	1.44^{a}	1.26^{*a}	1.20^{a}	1.18^{a}	1.09	1.35^{a}	1.29^{a}	0.98^{a}	1.36^{**a}	1.23^{a}
Investment in B	0.36^{a}	0.47^{a}	0.10^{a}	0.31^{a}	0.22	0.35^{a}	0.32^{a}	0.53^{a}	0.32^{a}	0.35^{a}
Investment in C	-0.48^{a}	-0.73^{a}	-0.01^{a}	-0.29^{a}	-0.76***	-0.41^{a}	-0.33^{a}	-0.56^{a}	-0.44^{a}	-0.33^{a}
Investment in D	-0.86^{a}	-0.52^{a}	-0.90^{*a}	-0.86^{a}	-0.80*	-0.87^{a}	-0.87^{a}	-0.92^{**a}	-0.86^{a}	-0.82^{b}
Investment in E	-0.24^{a}	-0.15	-0.32^{a}	-0.22^{a}	-0.16	-0.26^{a}	-0.23^{a}	-0.31^{a}	-0.23^{a}	-0.21^{a}
Savings	16.79^{***a}	16.50^{***a}	16.68^{***a}	16.61^{***a}	16.24***	16.65^{***a}	16.76^{***a}	16.63^{***a}	16.65^{***a}	16.55^{***a}
Work Experience										
Investment in A	-0.46^{a}	-0.56^{**a}	-0.35^{**a}	-0.43^{a}	-0.31	-0.47^{a}	-0.49^{a}	-0.43^{a}	-0.46^{**a}	-0.44^{a}
Investment in B	0.21^{a}	0.11^{a}	0.34^{a}	0.20^{a}	0.10	0.21^{a}	0.19^{a}	0.22^{a}	0.20^{a}	0.20^{*a}
Investment in C	1.31^{***a}	1.59^{***a}	1.46^{***a}	1.34^{***a}	1.44***	1.32^{**a}	1.34^{***a}	1.47^{***a}	1.32^{***a}	1.32^{***a}
Investment in D	-0.47^{**a}	-0.61^{**a}	-0.67^{***a}	-0.48^{***a}	-0.86***	-0.49^{aa}	-0.50^{**a}	-0.79^{***a}	-0.49^{**a}	-0.48^{***a}
Investment in E	-0.01	-0.05^{a}	-0.02	-0.01	-0.02	-0.01^{b}	-0.01^{a}	-0.02^{a}	-0.02	-0.01
Savings	0.44^{a}	0.42^{b}	0.44^{*a}	0.45^{***a}	0.41	0.45^{a}	0.46^{**a}	0.45^{*a}	0.45^{a}	0.45^{a}
Age										
Investment in A	-0.29^{a}	-0.27^{**a}	-0.17^{a}	-0.24^{a}	-0.10	-0.29^{a}	-0.28^{a}	0.01^{a}	-0.26^{**a}	-0.27^{a}
Investment in B	-2.05^{***a}	-2.07^{***a}	-1.82^{***a}	-2.04^{***a}	-1.72***	-2.04^{***a}	-1.93^{***a}	-1.81^{***a}	-2.06^{***a}	-2.04^{***a}
Investment in C	0.07^{a}	0.07^{a}	-0.19^{a}	0.04^{a}	-0.48***	0.05^{a}	0.02^{a}	-0.39^{***a}	0.05^{a}	0.05^{a}
Investment in D	2.11^{***a}	2.15^{***a}	2.03^{***a}	2.11^{***a}	2.02***	2.10^{***a}	2.10^{***a}	1.97^{***a}	2.11^{***a}	2.11^{***a}
Investment in E	0.04^{a}	0.03^{a}	0.03^{a}	0.04^{a}	0.03	0.04^{a}	0.05^{a}	0.04^{a}	0.03^{a}	0.04^{a}
Savings	-0.60^{***a}	-0.58^{***a}	-0.56^{***a}	-0.60^{***a}	-0.53***	-0.59^{***a}	-0.62^{***a}	-0.57^{***a}	-0.60^{***a}	-0.61^{***a}
Accumulated Assets										
Investment in A	0.11^{a}	0.11^{**a}	0.09^{**a}	0.10^{*a}	0.04	0.10^{a}	0.11^{a}	0.04^{a}	0.11^{***a}	0.10^{a}
Investment in B	0.14^{**a}	0.15^{***a}	0.11^{***a}	0.14^{***a}	0.14***	0.14^{**a}	0.14^{**a}	0.13^{***a}	0.14^{***a}	0.14^{***a}
Investment in C	-0.04^{a}	-0.07^{***a}	0.04^{**a}	-0.03^{a}	0.02	-0.03^{***a}	-0.03^{a}	0.03^{a}	-0.04^{a}	-0.03^{**a}
Investment in D	-0.09^{**a}	-0.07^{**a}	-0.09^{***a}	-0.10^{***a}	-0.06***	-0.09^{a}	-0.09^{**a}	-0.07^{***a}	-0.10^{***a}	-0.09^{***a}
Investment in E	0.02^{a}	0.03	0.02^{a}	0.02^{a}	0.03	0.02^{a}	0.02^{a}	0.02^{a}	0.02^{a}	0.02^{a}
Savings	0.12^{***a}	0.13^{***a}	0.11^{***a}	0.12^{***a}	0.10***	0.12^{***a}	0.12^{**a}	0.12^{***a}	0.12^{***a}	0.11^{***a}

Note: (a) Marginal effects computed at the observed values. (b) Model with no updating of current endogenous behaviors in response to past behaviors and outcomes. (c) Simulated with 100 repetitions. (d) Bootstrapped standard errors are in parentheses using with 100 draws. (e) Model 5 corresponds to the preferred model.

* Significant at the 10 percent level. ** Significant at the 5 percent level. *** Significant at the 1 percent level.

^{a,b,c} Difference in means test with respect to model 5, significant at the 1, 5, and 10 percent level, respectively.