NBER WORKING PAPER SERIES

DIMINISHING MARGINAL UTILITY REVISITED

Miles S. Kimball
Daniel Reck
Fudong Zhang
Fumio Ohtake
Yoshiro Tsutsui

Working Paper 32077
http://www.nber.org/papers/w32077

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
January 2024

We acknowledge support from the United States National Institute on Aging (R01AG040787, R01AG020717) and from Center of Excellence funding to the University of Osaka from the Japanese government. The views expressed herein are those of the authors and do not necessarily reflect the views of the National Bureau of Economic Research.

Diminishing Marginal Utility Revisited
Miles S. Kimball, Daniel Reck, Fudong Zhang, Fumio Ohtake, and Yoshiro Tsutsui
NBER Working Paper No. 32077
January 2024
JEL No. D01,D03,D15,D19

ABSTRACT

How quickly does marginal utility fall with increasing consumption? It depends on the dimension along which we consider concavity of the utility function. This paper estimates the distribution of heterogeneous curvature parameters in individuals' utility functions from hypothetical choice data, while accounting for survey response error. Types of curvature examined include relative risk aversion, intertemporal substitution, the reciprocal of the altruism elasticity, and a new measure of inequality aversion, which queries how much more a dollar means to a poor family than to a rich family.

Median values of curvature parameters ranging from 0.6 to 13.2. Utility functions are most concave for situations involving altruism, followed by risk aversion, inequality aversion, and intertemporal substitution. Heterogeneity of curvature in the population also varies: altruism is the most heterogeneous, followed by risk aversion, the elasticity of intertemporal substitution, and inequality aversion. Nonetheless, curvature parameters are highly correlated (ρ > .8) over different elicitations within parameter type, and modestly correlated across dimensions in some cases, including inequality aversion and risk aversion (ρ ≈ 0.3), altruism and risk aversion (ρ ≈ 0.3), and altruism and inequality aversion (ρ ≈ 0.14).4).

Miles S. Kimball
Economics Building
University of Colorado Boulder
261 UCB
#212
Boulder, CO 80302
and NBER
miles.kimball@colorado.edu

Daniel Reck
University of Maryland
Department of Economics
Tydings Hall
7343 Preinkert Dr
College Park, MD 20742
and NBER
dreck@umd.edu

Fudong Zhang
Tsinghua University
PBC School of Finance
zhangfd@pbcsf.tsinghua.edu.cn

Fumio Ohtake
Institute of Social and Economic Research,
Osaka University.
6-1 Mihogaoka,
Ibaraki City, Osaka 567
JAPAN
fumio.ohtake@gmail.com

Yoshiro Tsutsui
Kyoto Bunkyo University
Senzoku-80 Makishimacho
Uji, Kyoto 611-0041
JAPAN
tsutsuiyoshiro@gmail.com

1 Introduction

Beginning with Barsky et al. (1997), the elicitation of preferences by hypothetical choices has been increasingly accepted as a source of useful evidence about preferences, though the method is not without controversy. Most hypothetical choice measurement of preferences to date has focused on either risk aversion (Barsky et al., 1997; Kimball, Sahm and Shapiro, 2009) or the income elasticity of labor supply Kimball and Shapiro (2008).[1] Work on hypothetical choice data, especially the work on risk aversion, has proven useful in a variety of settings, including studies on gender and risk-taking (Jianakoplos and Bernasek, 1998; Schubert et al., 1999; Barber and Odean, 2001), the psychology of risk aversion and investment (Shefrin, 2000; Hong, Kubik and Stein, 2004; Kumar, 2009; Borghans et al., 2008), the tendency to engage in other risky behaviors (Dohmen et al., 2011), and experimental analysis of risk-taking (Harrison, Lau and Rutström, 2007; Andersen et al., 2008), to name a few. Emboldened by the success of the measurement of these specific preferences by hypothetical choices, this paper examines new, experimental survey questions attempting to measure preferences over several different domains with one common theme: diminishing marginal utility.

Diminishing marginal utility is a ubiquitous feature of modern economic theory. Many economic phenomena are modeled using additively separable concave components of utility. These include the diminishing value of wealth as income increases in relation to inequality, relative risk aversion, resistance to intertemporal substitution, and the price elasticity of charitable giving. Among these phenomena, is the curvature needed to explain each one consistent with the curvature needed to explain others? Or are preferences more complex than that? We give a provisional answer to these questions, based on direct elicitation of preferences by posing hypothetical choices. Our overall finding is that preferences are too complex to represent any and all curvature in the utility function by a single parameter, but also that there are intriguing relationships between curvature in different dimensions, which warrant further attention.

[1] Barsky et al. (1997) also contained a small section on time preference, a topic we study more comprehensively here.

We choose to study diminishing marginal utility along these dimensions because of their importance for the proper specification of preferences in structural economic models. Macroeconomists have used the curvature γ of the isoelastic utility function

$$U(C) = \frac{C^{1-\gamma}}{1-\gamma}$$

to represent both risk aversion and resistance to intertemporal substitution (the reciprocal of the elasticity of intertemporal substitution). The literature has already recognized that these two may be different: Epstein and Zin (1989) and Weil (1990) specify "generalized isoelastic preferences," separating intertemporal substitution and relative risk aversion within the Kreps-Porteus class of preferences (Kreps and Porteus, 1978). Separating these two concepts has led to a wealth of important advances in macroeconomics and finance. Two oft-cited examples are Bansal and Yaron (2004), who use these preferences to propose an explanation for the equity premium puzzle and other puzzles in asset pricing, and Campbell and Viceira (2002), who use them to study the behavior of long-run investors. Many other examples exist, as the preferences proposed by these authors are now part of the foundational theory of asset pricing (Duffie, 2010). By examining empirically whether and how other distinctions between different uses of curvature are important, we hope to inspire efforts to model more flexible preferences along the lines of Epstein and Zin (1989) and Weil (1990).

We readily acknowledge that the elicitation of preferences by hypothetical choices is imperfect. As even some of our results will show, answers to questions can be sensitive to the framing of the question in a manner that makes underlying preferences difficult to recover from hypothetical choice data. However, even when the precise value of preference parameters implied by answers to hypothetical choice data is suspect, variation in hypothetical choice data across individuals is a useful source of information about true preferences. For example, Barsky et al. (1997) show that individuals measured to be more risk averse on the Health and Retirement Study based on hypothetical choices were also more likely to engage in risky behaviors such as smoking or holding risky assets. Risk preference has also been shown to covary within families (Kimball, Sahm and Shapiro, 2009) and to be relatively stable across time, though not perfectly so because of the effects of changes in age and macroeconomic conditions on risk preference (Sahm, 2012). This evidence, along with much of the evidence described in the first paragraph, suggests that variation between individuals in hypothetical choice data does correlate with choices in the manner predicted by economic theory, at least for the case of relative risk aversion. Hypothetical choice data are also valuable when there is no practical alternative for measuring preference parameters, or, relatedly, when the conventional econometric approach does not lead to a consensus on the values of different preference parameters. Our primary aim in this paper is to give the reader an unvarnished report of what the hypothetical choice approach yields in our context, without taking a strong stand on what should be done with that information. Even with the feasibility limitations we faced over how large a sample we could obtain for all of these different curvature measures using our survey module, which is a limiting factor for our analysis, our results raise some interesting possibilities that merit further analysis. At a minimum, our method puts the intuitions of a representative sample of Americans into the discussion alongside the intuitions of economists about the values of preference parameters. It is also important to note that the questions we pose are cognitively difficult. Beyond trying to design questions that are as easy to understand as possible given the concept to be measured, our response, following Kimball, Sahm and Shapiro (2008), is to model survey response error carefully, and to consider survey response bias whenever possible. (There are also some types of hypothetical situations we did not pursue to avoid excessive cognitive difficulty.)

We use hypothetical choice data to estimate by maximum likelihood the distribution of preferences parameters governing the concavity of the utility function in each particular dimension. We discuss each dimension in turn. First, one set of questions implicitly asks respondents to compare the benefit of a small transfer to a higher-income family with a larger transfer to a similar but lower-income family. We call concavity in this direction "Inequality Aversion," because it reflects the degree to which a dollar means more to a poor family than a rich one—an oft-mentioned intuitive reason for caring about inequality.[2]

Second, we measure conventional Relative Risk Aversion in two different ways. These measures, identical to those used on recent waves of the Health and Retirement Study, involve choosing between a safe job—one where income is certain—and a risky job—one where income could be higher or lower than the safe job. They differ in the stakes of the risky job.

The third dimension of concavity we study is resistance to intertemporal substitution. We ask two sets of hypothetical choice questions involving the decision to make a necessary purchase either now or one year in the future. The growth rate of consumption is varied exogenously between the two sets of questions—by assuming income will be the same or doubled one year in the future—to elicit information on time preference and the elasticity of intertemporal substitution (EIS).

The fourth kind of concavity we study is the reciprocal of the altruism elasticity, which governs the price sensitivity of giving. We ask two types of hypothetical choice questions involving a transfer of income from the respondent—a parent—to their adult offspring. The curvature parameter is solicited by varying the price of giving between questions types, via the introduction of a 50 percent tax subsidy toward giving.

The distribution of curvature parameters varies greatly among different types of curvature. We estimate that the median value of the curvature parameter is highest for altruism and risk aversion over small stakes, followed by risk aversion over large stakes, inequality aversion, and intertemporal substitution. The estimated median value of the curvature parameter ranges from 0.6 to 13.2 depending on the dimension.

In addition to analyzing concavity in each dimension for the population as a whole, we examine differences in the estimated mean and median of the preference parameters' distribution between different demographic subgroups: for example, we ask whether women tend to be more inequality

[2] Many other questions could also be said to measure inequality aversion. We view "inequality aversion questions" as the name for a class of survey questions that could inform the inequality aversion parameter in the construction of a social welfare measure. Which set of inequality aversion questions can best inform the inequality aversion parameter in a social welfare function is in part an empirical question, in part an economic theory question, and in part a philosophical question.

averse than men (they do).[3] We then compare the mean and variance of the estimated distributions across different preference parameters, and between different ways of measuring more or less the same parameter. For example, we use a single set of questions to estimate a distribution of inequality aversion parameters, and then compare the mean inequality aversion with mean relative risk aversion, as well as mean inequality aversion for a second measure of inequality aversion. Since variation in the measure across individuals is also of interest, we then estimate the *correlation* between preference parameters across individuals by incorporating answers to two sets of questions into the same maximum likelihood estimation.

The amount of heterogeneity of curvature parameters in the sample also varies: curvature for altruism is most heterogeneous, followed by risk aversion, intertemporal substitution and finally inequality aversion. That inequality aversion is least heterogeneous according to our estimates might be surprising given the contentiousness of the debate over income inequality.

Despite stark differences in the distributions of different curvature parameters, they are correlated across individuals in interesting ways. When we measure inequality aversion in two different ways, the overall distributions are different but the curvature parameters are very highly correlated ($\hat{\rho} = 0.84$). The same is true when we ask about risk aversion in two different ways ($\hat{\rho} = 0.87$). Inequality aversion and risk aversion are modestly correlated ($\hat{\rho} \approx 0.3$, depending on which measure we use). However, the resistance to intertemporal substitution is virtually uncorrelated with other preference parameters. Altruism is modestly correlated with both inequality aversion ($\rho \approx 0.14$) and risk aversion ($\rho \approx 0.29$), though these estimates are imprecise.

These results suggest that we should on one hand reject the idea that a single value for γ in a model will accurately capture all types of diminishing marginal utility, and on the other hand, the idea that different types of curvature–especially risk aversion, inequality aversion, and altruism–are entirely unrelated. We leave to future research the question of how curvature should be modeled, especially in calibrated macroeconomic models, in light of our results and future research on similar topics.

[3]We do not provide a demographic breakdown for the altruism section because its questions were asked only to a subset, approximately one-third, of the total respondents (see explanation in Section 2).

2 Data

Our data come from a 2005 Survey of Consumers short panel, in a module that we designed. The first wave of surveys is administered to a nationally representative sample of 278 individuals, who were contacted by telephone in February of 2005. In August, 207 of these individuals were re-contacted and asked the same questions. Table 1 provides sample characteristics for both waves of the sample.

For budgetary reasons and to simplify the hypothetical situations posed to respondents, some of our survey questions are asked of only part of the sample. For the results we report here, this restriction only applies to questions on altruism, which were only asked of respondents who have children age 30 or over. There were 97 such individuals in the first wave and 71 in the second wave.

2.1 Design of Hypothetical Choice Questions

The questions we use are designed specifically to solicit information on the curvature of the respondent's utility function along some dimension. This section describes the questions we use and how we map survey responses to values for curvature parameters. We assume an isoelastic utility function of the form

$$U(C) = \frac{C^{1-\gamma}}{1-\gamma}.$$

The curvature of U is governed by $\gamma = -\frac{CU''}{U'}$. Respondent i's answers to a set of questions will indicate that their curvature parameter, denoted γ_i, falls in a certain range.[4]

A particular question tests whether $\theta_i = \log(\gamma_i) \gtrless x$, where x is a constant whose value is implied by the hypothetical scenario. We then directly incorporate survey response error by adding an error component, which may cause a respondent to mistakenly indicate that their curvature parameter falls into the wrong range. We assume the respondent answers the question based on

[4] An alternative would be to ask questions that solicit a particular value of γ_i. We did not pursue that approach because we feared such questions would be so difficult cognitively that survey response error, along with rounding error, would render them less useful in eliciting their preferences than the discrete choices we gave them.

whether $\theta_i + \varepsilon_{iw} \gtrless x$ where ε_{iw} is the survey response error for individual i in wave w.

The full questionnaire is included in the Appendix D to this paper. Tables 2 and 3 summarize the mapping between survey responses and values of preference parameters. We will describe each type of question briefly in this section.

2.1.1 Inequality Aversion

The first set of questions examines how marginal utility declines by asking the respondent to consider which of two lump-sum gifts would "make a bigger difference" to two families, who differ only in their income level. We view these questions as a way to ask about what a respondent's inequality aversion would be if they were philosophically Utilitarian. That matches our goal of finding out people's views on the appropriate curvature to apply to each individual's consumption in a Utilitarian social welfare function, taking a broadly Utilitarian approach to social choice as given.[5] In that context, inequality aversion is an important parameter for the design of optimal tax and transfer policy. If no form of Utilitarianism or related philosophy would play any role in social choice, one would want to measure inequality aversion in some other way. For example, it is easy to think of other ways of measuring inequality aversion that encourage respondents to incorporate their philosophical/ideological perspectives into their answers. That raises many issues that are beyond the scope of this paper.

The text of the questions is given by questions BC1-BC9. First, we ask whether the respondent believes that $1,000 is "worth more to a poor family than a rich family." Interpreting questions on the value of hypothetical transfers as evidence on inequality aversion requires that the individual engage in interpersonal comparisons of utility, a topic of considerable philosophical debate. This first question tests 1) whether the individual is willing to engage in interpersonal comparisons of utility and 2) whether the individual is at all inequality averse, i.e. whether $\gamma_i > 0$. We will maintain the former, and as such treat individuals who say "no" to this question in one or both

[5] For example, we consider Prioritarianism as a broadly Utilitarian approach that is consistent with our own skepticism that positive facts about Platonic cardinality of the utility function can answer an ethical question such as what inequality aversion parameter to use in a social welfare function.

waves as missing in that wave when we estimate the distribution of inequality aversion parameters.[6]

If the individual answers "yes" to this first question, we ask a series of questions on whether $1,000 to a family with a given income would make a bigger difference than a larger dollar amount to a family with twice the income. To ease the cognitive burden of this comparison, individuals are asked first to do this comparison between "two families like yours," who only differ in their income level. For one set of questions, we ask for the comparison between "a family with the same income as your family," and "a family with twice your family's income." The text of question BC2, the first question in this set of questions, is as follows:

> "Think of two families like yours, one with the same income as your family, the other with twice your family's income. Thinking of how much a given amount of money would mean to these two families, which would make a bigger difference, one thousand dollars to the family with an income like yours or four thousand dollars to the family with twice your family's income?"

For every set of questions we use, the questions unfold differently depending on the respondent's answers, in a manner that does not allow an individual to give inconsistent responses. If the respondent answers that $4,000 to the family with twice the income would make a bigger difference, they are then asked:

> "Which would make a bigger difference, one thousand dollars to the family with an income like yours or two thousand dollars to the family with twice your family's income?"

If the respondent answers instead, in the earlier question, that $1,000 to the family with an income like theirs would make a bigger difference, they are then asked if $8,000 to the family with twice the income would make a bigger difference.

[6]One alternative would be to treat them as if they have exactly zero curvature over incomes ($\gamma = 0$), which would decrease the estimated mean inequality aversion slightly. One reason we do *not* assign these respondents to a zero-curvature special case is that several individuals answer "no" to the question in one wave but not the other, and these individuals do not report low inequality aversion in the wave where they say "yes." See Tables 18 and 19 in the appendix for more detail.

In a second set of questions, we ask the individual to compare "a family with half the income of your family," and a family with "the same income as your family." We ask the question both ways to address concerns about framing effects arising from preferring transfers to a family that has income similar to the respondent's family.

Recall that the marginal utility of one dollar is $C^{-\gamma}$. We map the questions on inequality aversion to the following comparison of marginal utilities:

$$1000C^{-\gamma} \gtrless M(2C)^{-\gamma},$$

where $M \in \{2000, 4000, 8000, 15000\}$ is the transfer to the family with twice the income. Solving for $\theta_i \equiv \log(\gamma_i)$ and adding survey response error in wave w, ε_{iw}, indicates that the individual should answer the question based on whether

$$\theta_i + \varepsilon_{iw} \gtrless \frac{\log(\frac{M}{1000})}{\log(2)}. \tag{1}$$

We know that $\theta_i + \varepsilon_{iw}$ is in a certain range, which given some distributional assumptions, allows us to obtain the individual i's contribution to the log likelihood function.

2.1.2 Risk Aversion

We examine two measures of relative risk aversion. These measures, questions BC25-BC26b in the questionnaire, are based on a choice between a "safe" and "risky" job, and are identical to those used on the *[YEARS]* waves Health and Retirement Study.

We ask the respondent to suppose that they will move to a new city because of allergies,[7] and must choose between a safe job that guarantees their current income for life, and a risky job that has a fifty-fifty change of increasing it or decreasing it by different amounts. For example, the text of the first question about risk aversion is as follows:

> Suppose that you are the only income earner in the family. Your doctor recommends

[7]This part of the question is included to avoid status quo bias in favor of the job the respondent has currently.

> that you move because of allergies, and you have to choose between two possible jobs. The first would guarantee your current total family income for life. The Second is possibly better paying, but the income is also less certain. There is a fifty-fifty chance that the second job would increase your total lifetime income by twenty percent and a fifty-fifty chance that it would cut it by ten percent. Which job would you take – the job that would guarantee your current income or the job that might increase or decrease it?

If the individual opts for the risky job, we ask about an otherwise identical choice with worse down-side risk:

> Suppose the chances were fifty-fifty that the second job would increase your total lifetime income by twenty percent, and fifty-fifty that it would cut it by fifteen percent. Would you still take this job or would you take the job that guarantees your family income?

If the individual instead opts for the safe job in the first question we then ask about a choice with a smaller down-side risk. The first set of questions solicits risk preference over smaller stakes than the second set of questions. See Table 2 and the questionnaire for further details.

The hypothetical situation in these questions implies the following comparison of utilities:

$$\frac{C^{1-\gamma}}{1-\gamma} \lesseqgtr \frac{1}{2}\frac{(M_1 C)^{1-\gamma}}{1-\gamma} + \frac{1}{2}\frac{(M_2 C)^{1-\gamma}}{1-\gamma}$$

where M_1 is the downside risk factor and M_2 is the upside risk factor. For example, in question BC26, where income is either reduced by one third or doubled in the risky job, $M_1 = 2/3$ and $M_2 = 2$. Just as with inequality aversion, the inequalities for each question yields a set of cutoffs for $\theta_i + \varepsilon_{iw}$—that is, for log inequality aversion measured with error in wave w.

The survey included two more experimental sets of questions on risk preference. We omit these from the body of the paper for brevity and because we believe in retrospect that these questions had a flawed design. These questions and estimates based on them are discussed in Appendix B.

2.1.3 Elasticity of Intertemporal Substitution

Questions BC13 through BC20 are designed to examine preferences for consumption across time. The first set of questions, BC13-16, asks for a choice between paying a certain amount now and a greater amount one year in the future. For example, BC13 reads:

> First, suppose you are sure that your overall income and spending next year will be exactly the same as this year and that there will be no inflation. When you go to make a necessary purchase, you have the choice between paying two hundred dollars now or a larger amount a year from now. Would you prefer to pay two hundred dollars now or two hundred ten dollars a year from now?

If the respondent would prefer to pay $210 in one year, we ask

> Would you prefer to pay two hundred dollars now or two hundred twenty dollars a year from now?

The statement that "your overall income and spending next year will be exactly the same as this year," with no inflation, is meant to insure that the shadow interest rate in the hypothetical situation is identical to the utility discount. Thus, these questions would identify the classical discount factor, which we denote by β. An important feature of the hypothetical scenario for the first set of questions is that overall income and spending is supposed to be held fixed between the two years; a choice between consuming now and in the future only identifies the true discount rate under this assumption. In the second set of questions, BC17-20, overall income and spending doubles from this year to the next, and we solicit a choice about preferences over spending a certain amount now or spending a larger amount in one year. The first question reads:

> Second, suppose an established business has hired you with a start date a little less than a year from now. This employer values your skills so highly that, as soon as you start the new job, your family income will double, and you plan to double your family spending as well. You cannot increase your total spending now because you cannot do any more borrowing than you now plan.

> It is necessary for you to make a purchase now, before the new job starts. You are given the choice between paying two hundred dollars now, which would require you to reduce other expenditures, or you can pay a larger amount twelve months from now after your income and spending double. Would you prefer to pay two hundred dollars now or two hundred fifty dollars a year from now after your income doubles?

The next questions depend on the respondent's answers similarly to before. Because the first question pins down a discount rate, the two questions together are informative about curvature over intertemporal consumption decisions.

The parameterization of preferences for intertemporal substitution, and for altruism, is a non-trivial issue. We could use the utility function

$$U(C_1, C_2) = \frac{C_1^{1-\gamma}}{1-\gamma} + \beta\frac{C_2^{1-\gamma}}{1-\gamma}$$

where C_1 is consumption now and C_2 is consumption a year from now. Alternatively, we could use the consumption growth rate at a zero interest rate $g \equiv \frac{\log(\beta)}{\gamma}$ as a primitive parameter in place of the discount factor β, in which case we would have

$$U(C_1, C_2) = \frac{C_1^{1-\gamma}}{1-\gamma} + e^{\gamma g}\frac{C_2^{1-\gamma}}{1-\gamma}$$

In any case, we will have two parameters, a curvature parameter γ and a second parameter which (in this paper) holds less interest. Due to computational feasibility issues, we also need to impose an independence assumption on the two parameters. Because of this and ambiguity about what the second primitive parameter should be, we introduce a more general specification of preferences, involving a new parameter ξ. Let the primitive parameters be γ and $\phi \equiv \gamma^{\xi}\log(\beta)$. Preferences are given by

$$U(C_1, C_2) = \frac{C_1^{1-\gamma}}{1-\gamma} + e^{\phi\gamma^{\xi}}\frac{C_2^{1-\gamma}}{1-\gamma} \tag{2}$$

We will then assume ϕ and $\log(\gamma)$ are uncorrelated across individuals, and use our estimate of ξ as information on the correlation between γ and β or g. In other words, we assume that we know the functional form of the relationship between γ and β (or γ and g) down to a single parameter ξ,[8] and we use that assumption to construct a parameter $\phi(\xi)$ that will by construction be independent of γ at the true value of ξ. The two different question types can then be written as straightforward marginal utility comparisons involving γ and ϕ.

One difference from previous sections is that in this case, we add survey response error to ϕ, so the individual's answers are determined by their values of $\phi_i + \varepsilon_{iw}$ and γ_i. We do this because answers to the question depend more directly on ϕ_i; differences between answers to the two questions are what tell us about γ_i. If $\xi = 0$, for example, answers to the first question do not depend on γ_i at all, so we could not allow for any survey response error unless we put the error on ϕ.

2.1.4 Altruism

Questions BC29-BC36 are designed to solicit preferences over altruism. As with the questions about intertemporal substitution, we use two sets of questions to identify the joint distribution of two parameters. The first is the curvature of the subutility function, denoted by γ. Curvature over consumption here will determine the price sensitivity of altruistic giving.[9] As in the previous section, the second primitive parameter could be a discount factor for nonself consumption, a critical consumption ratio or something in between. The first set of questions asks whether the respondent would be willing to provide 5 percent of their income each month to an adult child with less to live on. The different questions of this form vary the child's income. The text of the first question in this set is as follows:

> We would like to find out about situations in which you (and your(husband/wife/partner)) might be willing to give substantial financial help to a grown son or daughter. You should suppose that any help you give will not be repaid and that your child has been

[8] Specifically, the relationship is that $\log(\beta) = \frac{\gamma}{\gamma^{\xi+1}}$.

[9] Specifically, γ will be the inverse of the price elasticity of giving.

> unlucky rather than lazy.
>
> Suppose that one of your grown children had only half as much income per person to live on as you do. Would you be willing to give your child five percent of your own income each month to help out until things change – which might be several years?

If the respondent answers "yes," we ask:

> Suppose now that this child had three-quarters as much income per person as you do. Would you be willing to give your child five percent of your own income each month?

Alone these questions would identify the "critical consumption ratio" g, the ratio of parent to child consumption at which the parent would wish to start giving the child money. The critical consumption ratio is the exact analogue of the consumption growth rate at a zero interest rate from the intertemporal substitution setting. The second question supposes that giving is subsidized by a 50 percent tax credit from the government:

> Now, suppose that the government gave you a fifty percent tax credit for any gifts of money that you give your grown children, so that every hundred dollars you give your child costs you only fifty dollars after you get the tax break.

We then ask questions very similar in their format to the previous set of questions, but reminding the respondent that they would receive a tax credit for their giving. In this case, giving 5 percent of the parent's income would only require that the parent consume 2.5 percent less, because of the tax credit. By varying the price of altruistic giving between the two questions, we obtain information on the curvature over consumption, γ.

As with intertemporal substitution, the specification of preferences is a non-trivial issue for these questions. For the reasons listed in the previous section, we assume the same functional form as in (2), but with C_1 representing parent's consumption and C_2 representing child's consumption. We again assume an individual's answers are determined by their values of $\phi_i + \varepsilon_{iw}$ and γ_i (or $\log(\gamma_i)$).

3 Statistical Models

Our statistical model is based on that of Kimball, Sahm and Shapiro (2008), with some modifications to allow us to estimate more complicated models. The following assumptions motivate our statistical model:

1. Preferences do not change across waves, i.e. $\gamma_{iw} = \gamma_{iw'} = \gamma_i$ for two waves w and w'.

2. The logarithm of the curvature γ_i is independently and identically normally distributed with mean μ_θ and variance σ_θ^2 (recall $\theta \equiv \log(\gamma)$).

3. Survey response error ε_{iw} is independent across waves w.

4. Survey response error ε_{iw} is independent of θ_i (and therefore of γ_i).

5. Survey response error is normally distributed for all i and w with mean 0 and variance σ_ε^2.

The first two assumptions allow us to identify the distribution of γ by comparing responses between individuals. The third, fourth, and fifth allow us to identify the distribution of survey response error—and to allow our estimate of the distribution of γ to be robust to survey response error—by comparing responses within a given individual across waves. The mean zero assumption on survey response errors would not be true if there were some systematic bias affecting individuals' question responses. We explore this possibility for inequality aversion and risk aversion over safe and risky jobs, where we have two different measures of what should be the same underlying parameter. We expand this approach somewhat to specify a statistical model to estimate the distribution of two different parameters involved in the same choice problem, and to estimate correlation between different curvature parameters.

The computational burden for some of these problems is intensive. The numerical methods we use are described in Appendix A.

3.1 Distribution of a Single Parameter

We wish to estimate the distribution of a single parameter γ and associated survey response error ε. Under the assumptions listed above, for all i,

$$\begin{bmatrix} \theta_i + \varepsilon_{i1} \\ \theta_i + \varepsilon_{i2} \end{bmatrix} \sim N \left(\begin{bmatrix} \mu_\theta \\ \mu_\theta \end{bmatrix}, \begin{bmatrix} \sigma_\theta^2 + \sigma_\varepsilon^2 & \sigma_\theta^2 \\ \sigma_\theta^2 & \sigma_\theta^2 + \sigma_\varepsilon^2 \end{bmatrix} \right). \tag{3}$$

Given values of μ_θ, σ_θ^2, and σ_ε^2, we integrate the pdf between the cutoffs implied by a respondent's answers to survey questions in waves 1 and 2—which, recall, are determined by $\theta_i + \varepsilon_{i1}$ and $\theta_i + \varepsilon_{i2}$. Denote the lower cutoff by $(\underline{x_{i1}}, \underline{x_{i2}}) \equiv \underline{\mathbf{x_i}}$, and denote the upper cutoff by $(\overline{x_{i1}}, \overline{x_{i2}}) \equiv \overline{\mathbf{x_i}}$.[10] Conditional on a set of population parameters, the probability that respondent i will give answers to the survey questions that imply these cutoffs is

$$p_i(\mu_\theta, \sigma_\theta, \sigma_\varepsilon) = \iint_{\underline{\mathbf{x_i}}}^{\overline{\mathbf{x_i}}} \vec{\phi}(x; \mu_\theta, \sigma_\theta, \sigma_\varepsilon) dx, \tag{4}$$

where $\vec{\phi}$ is the normal probability density function described by equation (3). By the independence of γ_i and ε_{iw} over individuals i, the log-likelihood function will therefore be

$$\mathcal{L}(\mu_\theta, \sigma_\theta, \sigma_\varepsilon) = \sum_{i=1}^{n} \log(p_i(\mu_\theta, \sigma_\theta, \sigma_\varepsilon)).$$

3.2 Correlations between Parameters

We will also estimate the correlation between two parameters, such as two different inequality aversion curvatures, or an inequality aversion parameter and a risk aversion parameter.[11] We introduce subscripts q for question types. We denote covariances by the letter κ, and correlations by

[10] When an individual's answers to a set of questions are missing we assign the individual cutoffs of $-\infty$ and ∞ for that set of questions. Equivalently, we could remove that question's sections of the mean and variance matrices and integrate a modified pdf. These individuals' answers help identify some but not all parameters of the model.

[11] We could, in theory, estimate the distribution of all preference parameters and all correlations between preference parameters in a single, massive maximum likelihood estimation. This procedure would be computationally burdensome due to the curse of dimensionality, so we opt for pairwise maximum likelihood.

the letter ρ. We maintain the same assumptions as before, and add these assumptions for question types q and q':

7. Preference parameters $\theta_i \equiv \log(\gamma_{q,i})$ and $\theta_i' \equiv \log(\gamma_{q',i})$ are correlated within individuals i.

$$Cov(\theta_i, \theta_i') \equiv \kappa_{\theta\theta'} = \rho_{\theta\theta'}\sigma_\theta\sigma_{\theta'}$$

8. Survey response errors $\varepsilon_{iw} \equiv \varepsilon_{qiw}$ and $\varepsilon_{iw}' \equiv \varepsilon_{q'iw}$ are correlated within individuals i in wave w (but still independent across waves).

$$Cov(\varepsilon_{iw}, \varepsilon_{iw}') \equiv \kappa_{\varepsilon\varepsilon'} = \rho_{\varepsilon\varepsilon'}\sigma_\varepsilon\sigma_{\varepsilon'},\ w = 1, 2.$$

Each observation consists of information from four sets of survey questions: two designed to measure θ and two designed to measure θ'. The distribution we use to obtain an individual's contribution to the log likelihood function is therefore:

$$\begin{bmatrix} \theta_i + \varepsilon_{qi1} \\ \theta_i + \varepsilon_{qi2} \\ \theta_i' + \varepsilon_{q'i1} \\ \theta_i' + \varepsilon_{q'i2} \end{bmatrix} \sim N\left(\begin{bmatrix} \mu_\theta \\ \mu_\theta \\ \mu_{\theta'} \\ \mu_{\theta'} \end{bmatrix}, \begin{bmatrix} \sigma_\theta^2 + \sigma_\varepsilon^2 & \sigma_\theta^2 & \kappa_{\varepsilon\varepsilon'} + \kappa_{\theta\theta'} & \kappa_{\theta\theta'} \\ \sigma_\theta^2 & \sigma_\theta^2 + \sigma_\varepsilon^2 & \kappa_{\theta\theta'} & \kappa_{\varepsilon\varepsilon'} + \kappa_{\theta\theta'} \\ \kappa_{\varepsilon\varepsilon'} + \kappa_{\theta\theta'} & \kappa_{\theta\theta'} & \sigma_{\theta'}^2 + \sigma_{\varepsilon'}^2 & \sigma_{\theta'}^2 \\ \kappa_{\theta\theta'} & \kappa_{\varepsilon\varepsilon'} + \kappa_{\theta\theta'} & \sigma_{\theta'}^2 & \sigma_{\theta'}^2 + \sigma_{\varepsilon'}^2 \end{bmatrix} \right)$$

We construct the log-likelihood function by integrating this density function over the hyper-rectangle whose boundaries are implied by a respondent's answers to the four questions, and then adding the logarithm of this integral across respondents as before.

3.3 Adding Systematic Survey Response Error

When two parameters are designed to measure the same underlying preference parameters—as is the case with our measures of inequality aversion and risk aversion over income lotteries—we can model systematic differences in responses between question types as coming from an additional systematic "bias." Doing so generates a more precise estimate of the bias than would be gathered from simply comparing means between two sets of hypothetical questions estimated separately, because we allow the errors within a wave to be correlated. Formally, we use the same model as in the previous section, except that $\varepsilon_{q'iw}$ has mean $\zeta_{q'} \neq 0$ and the true preference parameter θ_i is the same across question types. This implies a distribution of answers of the following form for answers to the two question types in two different waves:

$$\begin{bmatrix} \theta_i + \varepsilon_{qi1} \\ \theta_i + \varepsilon_{qi2} \\ \theta_i + \varepsilon_{q'i1} \\ \theta_i + \varepsilon_{q'i2} \end{bmatrix} \sim N\left(\begin{bmatrix} \mu_\theta \\ \mu_\theta \\ \mu_\theta + \zeta_{q'} \\ \mu_\theta + \zeta_{q'} \end{bmatrix}, \begin{bmatrix} \sigma_\theta^2 + \sigma_{\varepsilon_q}^2 & \sigma_\theta^2 & \kappa_{\varepsilon\varepsilon'} + \sigma_\theta^2 & \sigma_\theta^2 \\ \sigma_\theta^2 & \sigma_\theta^2 + \sigma_\varepsilon^2 & \sigma_\theta^2 & \kappa_{\varepsilon\varepsilon'} + \sigma_\theta^2 \\ \kappa_{\varepsilon\varepsilon'} + \sigma_\theta^2 & \sigma_\theta^2 & \sigma_\theta^2 + \sigma_{\varepsilon'}^2 & \sigma_\theta^2 \\ \sigma_\theta^2 & \kappa_{\varepsilon\varepsilon'} + \sigma_\theta^2 & \sigma_\theta^2 & \sigma_\theta^2 + \sigma_{\varepsilon'}^2 \end{bmatrix} \right) \tag{5}$$

Once again we obtain the log-likelihood function by integrating this density function over the ranges implied by a respondent's answers to the four questions, and then adding the logarithm of this integral across respondents.

We use this method to estimate the distribution of inequality aversion and risk aversion questions. For inequality aversion, we put systematic survey response error on the measure of inequality that compares a family with the same income as the respondent's family and a family with half that income. One can think of $\zeta_{q'}$ in this case as the bias that results from disproportionately valuing the utility of families like ones own family, and we should expect $\zeta_{q'} < 0$. For risk aversion over risky and safe jobs, we add systematic survey response error on the measure of risk aversion with small stakes, to reflect the well-known problem that under the assumption of CRRA, choices over smaller stakes risks yield higher estimates of risk aversion than choices over large stakes risks. One can think of $\zeta_{q'}$ in this case as a measure of how much this difficulty affects the responses to the survey questions we use.

3.4 Distribution of Two Parameters for the Same Choice Problem

For questions on Intertemporal Substitution and Altruism, our statistical model must take into account that answers to different sets of questions are governed by different parameters. As noted in Sections 2.1.3 and 2.1.4, we take as our primitive parameters ϕ, ξ, and γ, where γ is curvature over consumption as before, ϕ is the parameter that replaces the traditional discount factor, and ξ relates γ, ϕ, and the traditional discount factor (denoted β) or consumption growth rate at a zero interest rate (denoted g). We construct the problem in this way to allow the following statistical assumption:

- ϕ_i and $\theta_i \equiv \log(\gamma_i)$ are statistically independent.

We assume individuals answer question type q based on their value of $\theta_i = \log(\gamma_i)$, and on their value of ϕ measured with error, i.e. the value of $\phi_i + \varepsilon_{qiw}$.

Conditional on θ_i and ξ, the distribution of answers to the two question types will be given by

$$\begin{bmatrix} \phi_i + \varepsilon_{qi1} \\ \phi_i + \varepsilon_{qi2} \\ \phi_i + \varepsilon_{q'i1} \\ \phi_i + \varepsilon_{q'i2} \end{bmatrix} \sim \mathcal{N}\left(\begin{bmatrix} \mu_\phi \\ \mu_\phi \\ \mu_\phi \\ \mu_\phi \end{bmatrix}, \begin{bmatrix} \sigma_\phi^2 + \sigma_\varepsilon^2 & \sigma_\phi^2 & \kappa_{\varepsilon\varepsilon'} + \sigma_\phi^2 & \sigma_\phi^2 \\ \sigma_\phi^2 & \sigma_\phi^2 + \sigma_\varepsilon^2 & \sigma_\phi^2 & \kappa_{\varepsilon\varepsilon'} + \sigma_\phi^2 \\ \kappa_{\varepsilon\varepsilon'} + \sigma_\phi^2 & \sigma_\phi^2 & \sigma_\phi^2 + \sigma_{\varepsilon'}^2 & \sigma_\phi^2 \\ \sigma_\phi^2 & \kappa_{\varepsilon\varepsilon'} + \sigma_\phi^2 & \sigma_\phi^2 & \sigma_\phi^2 + \sigma_{\varepsilon'}^2 \end{bmatrix} \right) \tag{6}$$

Conditional on θ_i and ξ, the probability that an individual will give a set of answers that implies a given set of cutoffs is

$$p(.|\theta_i, \xi) = \iiiint_{\underline{\mathbf{x}(\theta,\xi)}}^{\overline{\mathbf{x}(\theta,\xi)}} \vec{\phi}(x; \mu_\phi, \sigma_\phi, \sigma_\varepsilon, \sigma_{\varepsilon'}, \rho_\epsilon) dx \tag{7}$$

where $\vec{\phi}$ is the normal pdf from (6). We obtain the probability of the answers given by the respondent, making use of the independence assumption we just made, by integrating $p_i|\theta_i$ over possible values of θ, weighted by their likelihood:

$$p_i = \int_{-\infty}^{\infty} \phi(y; \mu_\theta, \sigma_\theta) p(.|y, \xi) dy \tag{8}$$

Finally, as before, we add $\log(p_i)$ across respondents to obtain a log-likelihood function. Intuitively, θ parameters are identified by variation between answers in the two question types for the same individuals, ϕ parameters are identified by variation in answers across individuals, and ξ will be identified by variation indicating whether people with large discount factors also have large curvature, and error parameters are identified by the degree to which individuals' responses are stable across waves.

3.5 Correlating Curvature Parameters when Secondary Preference Parameters are Present

The approach outlined in Section 3.2 must be modified to estimate the correlation between $\theta = \log(\gamma_i)$ from the Intertemporal Elasticity of Substitution or Altruism and $\theta' = \log(\gamma_i')$ from other measures. We maintain our routine assumptions about the distribution of parameters and response errors, described in sections 3.2 and 3.4, and add that ϕ is independent of θ'. In words, the parameter that governs discounting of utility for EIS or altruism is independent of other curvature parameters such as risk aversion. We do allow, however, that in the same wave of the survey, response errors from any two sets of questions can be correlated with one another.

Like in section 3.2, we assume that θ and θ' are jointly normally distributed. The correlation between the two, denoted by ρ, is the primary parameter of interest for us. For clarity, denote the error on θ' by η.[12] Conditional on θ_i, we can derive the conditional distribution of $\theta_i' + \eta_{iw}$ for

[12] We have previously been denoting the error on θ' by ε' but doing so here would lead to ambiguity because there are three question types. We denote the two errors on θ for the two different question types by ε and ε', and we denote the error on θ' by η

waves $w = 1, 2$:

$$\begin{bmatrix} \theta_i' + \eta_{i1} \\ \theta_i' + \eta_{i2} \end{bmatrix} \overset{\theta_i}{\sim} N\left(\begin{bmatrix} \mu_{\theta'} + \rho(\theta_i - \mu_\theta)\frac{\sigma_{\theta'}}{\sigma_\theta} \\ \mu_{\theta'} + \rho(\theta_i - \mu_\theta)\frac{\sigma_{\theta'}}{\sigma_\theta} \end{bmatrix}, \begin{bmatrix} (1-\rho^2)\sigma_{\theta'}^2 + \sigma_\eta^2 & (1-\rho^2)\sigma_{\theta'}^2 \\ (1-\rho^2)\sigma_{\theta'}^2 & (1-\rho^2)\sigma_{\theta'}^2 + \sigma_\eta^2 \end{bmatrix} \right) \tag{9}$$

The distribution for ϕ is exactly same as in equation (6), since nothing about how we model response error for the EIS or altruism parameter has changed. Finally, we need to account for potential correlation in survey response error within waves. Denote the variance from equation (6) by Ω, and denote the variance of equation (9) by Σ. Then let

$$\Lambda = \begin{bmatrix} \kappa_{\varepsilon\eta} & 0 & \kappa_{\varepsilon'\eta} & 0 \\ 0 & \kappa_{\varepsilon\eta} & 0 & \kappa_{\varepsilon'\eta} \end{bmatrix}$$

Using equations (9) and (6) and allowing survey response errors to be correlated within wave, the four reads on ϕ_i with errors and the two reads on θ' with errors (and conditional on θ_i are jointly normally distributed with the same means as in equations (9) and (6) and the following covariance matrix

$$V = \begin{bmatrix} \Omega & \Lambda^{\mathrm{T}} \\ \Lambda & \Sigma \end{bmatrix}$$

To estimate the parameters of the model, we then proceed in a way similar to section 3.4. Conditional on θ and ξ, the probability of observing a response corresponding to a vector of cutoffs for ϕ and θ is

$$p(.|\theta_i, \xi) = \int \ldots \int_{\underline{\mathbf{x}(\theta,\xi)}}^{\overline{\mathbf{x}(\theta,\xi)}} \vec{\phi}(x; \mu_\phi, \mu_{\theta'}, \sigma_\phi, \sigma_{\theta'}, \sigma_\varepsilon, \sigma_{\varepsilon'}, \sigma_\eta, \rho, \rho_{\varepsilon\varepsilon'}, \rho_{\varepsilon\eta}, \rho_{\varepsilon'\eta})dx \tag{10}$$

We can then integrate over values of θ to obtain the likelihood of an observation:

$$p_i = \int_{-\infty}^{\infty} \phi(y; \mu_\theta, \sigma_\theta) p(.|y, \xi) dy \tag{11}$$

We finally add the logarithm of p_i across all respondents, just as in previous sections, to obtain the likelihood function, which depends on the 14 parameters of the model.

3.6 Computational Issues for Correlating Altruism and Intertemporal Substitution Curvature

When correlating curvature parameters for altruism and intertemporal substitution jointly, we reach the limits of our computational resources. Evaluating the likelihood function in this setting, without any simplification, would require integrating the normal density along non-rectangular domains in four dimensions and rectangular domains in four more dimensions, and then maximizing the likelihood function itself over 16 parameters. Both the curse of dimensionality and the well-known problems with optimization algorithms with numeric integration make this problem computationally too heroic. Therefore, we perform a slightly different analysis to examine this correlation. Noting that many of the parameters in the likelihood function were estimated previously when we estimate the distribution of Altruism and EIS parameters, we fix all previously estimated parameters at their estimated value from the estimations examining EIS alone and Altruism alone. For example, we take the mean and variance of $\log(\gamma)$ for EIS and Altruism from previous estimation. This restriction allows us to bypass the curse of dimensionality, at the cost of a slight loss in precision. Note that we could have used this restriction for many previous estimations; we have verified that if we do so, the results change very little. In addition, estimates of distribution parameters such as the mean and variance of $\log(\gamma)$ are highly consistent across estimations for all estimations in this paper. The second restriction we use to simplify the computational problem is to use only half of the data in two different estimations. One estimation correlates Altruism in wave 1 with EIS in wave 2, the other correlates Altruism in wave 2 with EIS in wave 1. This restriction also simplifies the problem computationally at the cost of a loss of precision. Both estimations lead to similar estimates of the correlation of interest. With these two simplifications, the likelihood function only depends on one parameter, the correlation of interest.[13] Finally, we compute the value of this likelihood function at only a few values, and provide a graph of the likelihood function with its approximate maximum in lieu of point estimates.

4 Results

4.1 Inequality Aversion

Tables 4 and 5 present the estimates of the distribution of inequality aversion for the two measures of inequality aversion, according to selected demographic characteristics.[14] The estimation procedure estimates the mean of log(γ), but it is easier to think in terms of the mean of γ, reported in the second to last column of these tables. The mean inequality aversion in the full sample is 2.99 according to the first measure and 2.28 according to the second. The difference between the means—which is statistically significant at the 5 percent level—can be interpreted as the result of a bias in favor of families similar to the respondent's family in income. In other words, the respondent always grants greater weight to transfers to the family which is presented in the survey as having "income like yours." When considering a family with income "like yours" and family with twice the income, the respondent appears more inequality averse because they are more likely to favor the transfer to the lower-income family, while the opposite is true when comparing a family with income "like yours" to a family with half the income.[15]

Because this bias should push in different directions between the two question types, it is reasonable to think that the true mean inequality aversion in the population is between 2.3 and 3. For reference, inequality aversion of 2 means that the individual should be indifferent between providing $1,000 to a family with a given amount of income or $4,000 to a family with twice that income, while inequality aversion of 3 means that the individual is indifferent between $1,000 to

[13] Without the second restriction, correlations between error terms for EIS and altruism would also need to be estimated.

[14] See the appendix Tables 18 through 20 for detailed cross-tabulation between question types and across waves

[15] The other possibility is that γ is declining in income, but as we note a few paragraphs down, cutting the sample by income shows no indication of a dependence on income in this direction.

the poorer family and $8,000 to the family with twice the income.

We have limited statistical power to distinguish differences between groups, but several interesting patterns emerge when we estimate the distribution separately selecting on demographics. Women are, on average, more inequality averse than men. Inequality aversion appears to be increasing in age and decreasing in educational attainment. There is not much difference by income. Individuals who have never married are less inequality averse than individuals who are married, divorced, or separated (possibly due to age effects). In contrast with what one might expect given political trends, there is no difference between regions[16] or between whites and non-whites.[17] The differences are intriguing, but many are marginally significant or insignificant at conventional statistical levels. Future work could examine these differences with a larger sample and a richer set of demographic covariates—including political beliefs—to more fully understand differences in the population.

4.2 Relative Risk Aversion

Tables 6 and 7 present estimates for risk aversion over income lotteries by selected characteristics. Table 6 presents estimates of relative risk aversion over large stakes. We estimate a mean relative risk aversion of 6.6 and a mean log risk aversion of 1.6. Our estimate of log risk aversion is slightly lower than the estimate of log risk aversion of 1.84 from Kimball, Sahm and Shapiro (2008) but our estimate of mean risk aversion is slightly higher than these authors' estimate of 8.2.[18] Our estimate of mean risk aversion is somewhat lower than the estimate of approximately 12 from Barsky et al. (1997). We attribute this difference in part to framing effects: the estimates in Barsky et al. (1997) were based on an earlier, slightly different framing of the question that may have led the individual to favor the job that guarantees their current income, since it is the status quo job, thereby making an individual appear more risk averse. This issue is discussed in detail in

[16] Individuals from the West appear less inequality averse according to one measure but not the other.

[17] We do not have a large enough sample to split non-whites into more distinct racial groups.

[18] This reversal occurs because we obtain a different variance estimate for log risk aversion in our study, and Jensen's inequality causes the estimate of the mean of γ to be larger when the variance of $\log(\gamma)$ is larger.

Kimball, Sahm and Shapiro (2008), who provide the justification for the question wording we use. In addition, our sample is younger than that in Barsky et al. (1997); it is more similar in age to the sample in Kimball, Sahm and Shapiro (2008). Beyond the dependence of risk aversion on age, several other differences in means by demographic group also match previous results. For example, women are slightly more risk averse than men, and risk aversion is increasing and then decreasing in education.

Table 7 demonstrates that when the stakes are smaller, individuals are estimated as being much more risk averse under the assumption of constant relative risk aversion. The mean value of γ in the population is estimated to be 24.4, far higher than is typically assumed in macroeconomic models. This in the direction of loss aversion, but it is important to recognize that our "small stakes" here are actually very large compared to the stakes in incentivized experiments that have provided the main evidence for loss aversion. Rabin (2000) has shown that the assumption of constant relative risk aversion leads to unrealistic predictions when the stakes are small; something like loss aversion is needed to explain behavior toward stakes measured in a few dollars. We are providing important evidence for the untenability of anything close to expected utility with constant relative risk aversion in the context of quite large risks even for gambles of 20 percent up and x percent down. That is, even at sizes of risk which are clearly big enough to be important to macroeconomists, the stakes can be too small for constant relative risk aversion expected utility to be a good assumption. Despite the higher levels of our "small-stakes" (20 percent up, x percent down) risk aversion compared to our (very-) large-stakes risk aversion (100 percent up, x percent down), however, the heterogeneity in risk aversion with respect to demographic characteristics follows very similar patterns for the two measures. This foreshadows the result that the two measures are highly correlated, despite the differences in their means.

4.3 Elasticity of Intertemporal Substitution

Table 8 reports results for the elasticity of intertemporal substitution by selected characteristics. We estimate a mean value of $\log(\gamma)$ of -0.53 in the population, significantly less curvature than in earlier results. Recall that the elasticity of intertemporal substitution is $1/\gamma$. We would estimate that the median value of the elasticity of intertemporal substitution is $\frac{1}{e^{-0.53}} \approx 1.7$. This number is slightly larger than typical estimates based on macroeconomic data such as Lucas (1990), and much larger than estimates based on household consumption estimates as in Hall (1988). It is not out of the rage of possibility for the widely-varying estimates of this parameter; Gruber (2013), for example, estimates a value of 2. The results suggest that the EIS is increasing in age and eduction, though they are imprecise. Married individuals have a higher EIS than individual who were never married and a lower one than divorced or separated individuals. Individuals who own large amounts of stock have a higher EIS than others, consistent with the findings of Vissing-Jørgensen (2002) and others. White respondents have a slightly higher EIS than non-whites.

4.4 Comparing the Distributions of Curvature Parameters

Having examined each parameter separately, we now turn to contrasting the distributions of different preference parameters. Tables 9 and 10 provide estimates of the distribution of all preference parameters for the full sample, along with confidence intervals for the distribution parameters obtained by inverting the likelihood ratio test. The mean value of log(γ)—the exponential of which is the median value of γ—in the full sample varies significantly according to the dimension of the curvature and the hypothetical situation: $\mu_{\log(\gamma)}$ is highest for altruism and small-stakes risk aversion, followed by large-stakes risk aversion, same-versus-half-income inequality aversion, same-versus-double-income inequality aversion, and finally intertemporal substitution.

Differences in the estimated standard deviation of $\log(\gamma)$, $\sigma_{\log(\gamma)}$, can be interpreted as differences in the heterogeneity, or dispersion, of curvature parameters in each direction away from the median value of γ.[19] By this logic, our estimates indicate that the altruism elasticity is the most heterogeneous curvature parameter, followed by small-stakes risk aversion, large-stakes risk aversion, intertemporal substitution, and either measure of inequality aversion. That people are more in

[19]Because we estimate the mean and variance of $\log(\gamma)$, we can compare the estimated variance of $\log(\gamma)$ in this way. If instead we estimated the mean and variance of γ itself, higher means should be associated with higher variance even holding the relative dispersion of the parameter constant.

agreement about the value of a dollar to a rich person versus a poor person than any other measure of curvature is somewhat surprising given the highly contentious public debate on redistributing income from the rich to the poor. One could rationalize the finding, speculatively, by thinking that the contentiousness of public debate on redistributive taxation results from differences in opinion on the efficiency cost of taxation or the true extent of inequality, rather than the desirability of equity.

Differences in the estimated standard deviation of survey response error, σ_ε, summarize the amount of instability in answers to the hypothetical questions across different waves of the sample. We interpret differences in σ_ε as informative about the difficulty of a question. More difficult questions should generate less stable answers across waves, captured by higher estimates of σ_ε. For example, in Appendix B, we document a very high estimate of σ_ε for a set of questions on decision-making with both uncertainty and temporal variation which was, in hindsight, too difficult to provide useful information on curvature. We estimate higher error variance from risk aversion questions than inequality aversion questions in both cases, so we conclude that risk aversion questions are more cognitively difficult than inequality aversion questions. Recall that we assume different error terms on different question types for EIS and Altruism questions. The error variance on EIS questions where the individual consumes the same this year and next year is lower than the one where consumption doubles, presumably because figuring out the marginal value of a dollar in the second case requires more mental assessment and computation. For altruism, the standard error for survey response error is higher in the case where giving is unsubsidized, which is somewhat puzzling, but could arise from the fact that many individuals indicate that they would give the maximum amount allowed by our questions when giving is subsidized.

When we combine two question types into a single estimation for inequality aversion and risk aversion (see Section 3.3), we estimate a remarkably low correlation between survey response errors between the two different question types in the same wave ($\hat{\rho}_\varepsilon = .33$ for inequality aversion and .16 for risk aversion). We interpret this to mean that respondents were exerting effort to answer these hypothetical questions accurately: a lazy respondent would answer a second, similar set of questions just as they answered the first set, causing the error for one set of questions to be correlated with the error in the other.

From the estimates of the auxiliary parameter ξ, we note that in the case of intertemporal substitution, ξ is close to 1. When $\xi = 1$, the consumption growth rate at a zero interest rate, g and curvature over consumption γ are independent. Finding that ξ is close to one can be interpreted as finding that the correlation between γ and g is small. (This finding does not hold for the estimates for altruism).

4.5 Correlations Between Curvature Parameters

The numbers below the main diagonal of Table 11 are our estimates of correlations between preference parameters. The numbers on and above the main diagonal are estimated variances and covariances.

First, note that when two types of questions attempt to measure the same parameter different ways, the estimated correlation of the resulting curvature parameters is quite high. The correlation between values of $\log(\gamma_i)$ for the two takes on inequality aversion is 0.84, while for two types of risk aversion it is 0.87. In both cases, we cannot reject the hypothesis that the two types of curvature are perfectly correlated.

Other than these two, most of the estimated correlations between curvature parameters are significantly smaller and positive, and many are near zero. Risk aversion and inequality aversion have a correlation of around 0.3. If it were the only hypothesis, the p-value for this correlation being different from zero is significant at the traditional 5 % level as a one-tailed test (which would be appropriate if one were willing to say *a priori* that a negative correlation should not be taken seriously), but in fact, we were looking at many different correlations; multiple-hypothesis-testing correction makes our results only suggestive.[20] Curvature governing intertemporal substitution is slightly positively correlated with inequality aversion (ρ equals 0.03 or 0.18) and risk aversion

[20]Also, it depends on which pairs are compared. Large stakes risk aversion and inequality aversion for the family with double the income are estimated to be nearly uncorrelated. We are not sure why this correlation is estimated to be smaller than the others, but we note that these estimates are imprecise.

over large stakes ($\rho = 0.02$), and very slightly negatively correlated with small stakes risk aversion ($\rho = -0.07$). Curvature governing altruism is positively correlated with inequality aversion (ρ equals 0.10 or 0.17) and risk aversion (ρ equals 0.33 or 0.24). These estimates are imprecise enough that the smaller estimated correlations are not significantly different from zero. Overall, we can universally reject the hypothesis that all types of curvature are perfectly correlated. Curvature governing intertemporal substitution seems particularly unrelated to other kinds of curvature, while risk aversion tends to be correlated with types of curvature other than intertemporal curvature. Some positive correlations between curvature types, such as the one between inequality aversion and risk aversion, or altruism curvature and risk aversion, merit further attention. Perhaps a more primitive concept about preferences, relating uncertainty and equality, could be developed to explain why these parameters are correlated, imperfectly.

Due to computational issues, we must estimate the correlation between altruism curvature and the intertemporal elasticity of substitution—for which the statistical model is more complicated than any other employed in this paper—slightly differently. We use the fact that measurement error is uncorrelated across waves to devise two cross-sectional estimates: the first uses altruism data in wave 1 and EIS data in wave 2 and disregards other data on EIS and altruism questions. The second only uses altruism data from wave 2 and EIS data from wave 1 of the survey. We report these results in Table 12; note that both methods provide similar estimates.[21] The point estimate for the correlation between the altruism elasticity and the elasticity of intertemporal substitution is negative. When we estimate the correlation separately based on whether the individual had more than a high school education in Table 13, the correlation is more strongly negative for less educated individuals though these correlations are not precisely estimated. In addition to this hint that the cognitive difficulty of the questions might play a role in the negative correlation between the altruism elasticity and the elasticity of intertemporal substitution, another clue to a possible explanation is the opposite structures of the altruism elasticity questions and the elasticity of intertemporal substitution questions: the altruism question varies prices and solicits information

[21] With this approach estimates of parameters other than the correlation, such as the mean of $log(\gamma)$ for EIS, are very similar to earlier results from simpler statistical models.

about quantity choices, while the EIS question varies quantities (growth rates of consumption levels) and solicits reservation prices.

5 Conclusion

Our interpretation of the findings from our data is that preferences are far too complex to represent any and all phenomena that have been attributed to diminishing marginal utility by a single curvature parameter. Our hope is that hypothetical choice measures of curvature parameters like those here can provide useful information for modeling preferences in a way that reflects that complexity. In addition to at most modest correlations among the different parameters, different parameters have strikingly different means. To single out a few notable results, risk aversion looks much higher for 20 percent up, x percent down risks than for 100 percent up, x percent down risks; inequality aversion has a median between 2 and 3,[22] and has the least variance across respondents of any of our parameters; inequality aversion had the highest correlations with the risk aversion measures.

Of these parameters, the comparative advantage of hypothetical choice measurement is particularly strong for inequality aversion: market transactions and voting decisions that might reveal something about inequality aversion are all very complex, with many confounding factors if one's aim is to estimate the underlying value of inequality aversion. Within the hypothetical choice approach, inequality aversion should be studied using a wide range of variant sets of questions to understand how different ways of framing questions about inequality aversion affect people's judgements. Future research should also examine the correlation between heterogeneous inequality aversion and behaviors and heterogeneous political beliefs. Attempting to measure inequality aversion requires confronting difficult normative and philosophical questions. But almost all real-world tax systems have some element of redistribution to them. Some parametrization of inequality aversion measures is necessary—in combination with an estimates of the efficiency cost of differ-

[22]One of us (Miles Kimball) has used this as a starting point for undergraduate problem sets based on a social welfare function separably adding up $\frac{-1}{C_i}$ over individuals i, which has inequality aversion of 2.

ent modes of taxation—in order to assess the merits of any existing or proposed tax regime. One could argue that the appropriate level of inequality aversion for policy application should be determined philosophically, as in John Rawls's argument in *A Theory of Justice* for what amounts to an infinite inequality aversion parameter, but in a democracy it is natural to pay attention to the views of the citizenry on inequality aversion, and to empirically separate this from beliefs about other aspects of redistributive policy. [23]

References

Andersen, Steffen, Glenn W Harrison, Morten I Lau, and E Elisabet Rutström. 2008. "Eliciting risk and time preferences." *Econometrica*, 76(3): 583–618.

Bansal, Ravi, and Amir Yaron. 2004. "Risks for the long run: A potential resolution of asset pricing puzzles." *Journal of Finance*, 59(4): 1481–1509.

Barber, Brad M, and Terrance Odean. 2001. "Boys will be boys: Gender, overconfidence, and common stock investment." *Quarterly Journal of Economics*, 261–292.

Barsky, Robert B, F Thomas Juster, Miles S Kimball, and Matthew D Shapiro. 1997. "Preference parameters and behavioral heterogeneity: An experimental approach in the health and retirement study." *Quarterly Journal of Economics*, 112(2): 537–579.

Borghans, Lex, Angela Lee Duckworth, James J Heckman, and Bas Ter Weel. 2008. "The economics and psychology of personality traits." *Journal of Human Resources*, 43(4): 972–1059.

Campbell, John Y, and Luis M Viceira. 2002. *Strategic asset allocation: portfolio choice for long-term investors.* Oxford University Press.

[23] It should be noted that in the range of policies being actively discussed by politicians still in office—within the "Overton Window"—an inequality aversion of 2 almost always points to the same policy as an inequality aversion of ∞.

Chetty, Raj. 2006. "A new method of estimating risk aversion." *The American Economic Review*, 96(5): 1821–1834.

Dohmen, Thomas, Armin Falk, David Huffman, Uwe Sunde, Jürgen Schupp, and Gert G Wagner. 2011. "Individual risk attitudes: Measurement, determinants, and behavioral consequences." *Journal of the European Economic Association*, 9(3): 522–550.

Duffie, Darrell. 2010. *Dynamic asset pricing theory.* Princeton University Press.

Epstein, Larry G, and Stanley E Zin. 1989. "Substitution, risk aversion, and the temporal behavior of consumption and asset returns: A theoretical framework." *Econometrica*, 937–969.

Genz, Alan. 1992. "Numerical computation of multivariate normal probabilities." *Journal of Computational and Graphical Statistics*, 1(2): 141–149.

Genz, Alan. 2004. "Numerical computation of rectangular bivariate and trivariate normal and t probabilities." *Statistics and Computing*, 14(3): 251–260.

Genz, Alan, and Frank Bretz. 1999. "Numerical computation of multivariate t-probabilities with application to power calculation of multiple contrasts." *Journal of Statistical Computation and Simulation*, 63(4): 103–117.

Genz, Alan, and Frank Bretz. 2002. "Comparison of methods for the computation of multivariate t probabilities." *Journal of Computational and Graphical Statistics*, 11(4): 950–971.

Gruber, Jonathan. 2013. "A tax-based estimate of the elasticity of intertemporal substitution." *Quarterly Journal of Finance*, 3(1).

Hall, Robert E. 1988. "Intertemporal Substitution in Consumption." *Journal of Political Economy*, 96(2): 339–57.

Harrison, Glenn W, Morten I Lau, and E Elisabet Rutström. 2007. "Estimating risk attitudes in Denmark: A field experiment." *Scandinavian Journal of Economics*, 109(2): 341–368.

Hong, Harrison, Jeffrey D Kubik, and Jeremy C Stein. 2004. "Social interaction and stock-market participation." *Journal of finance*, 59(1): 137–163.

Hurd, Michael D, and Susann Rohwedder. 2006. "Some answers to the retirement-consumption puzzle." National Bureau of Economic Research Working Paper 12057.

Jianakoplos, Nancy Ammon, and Alexandra Bernasek. 1998. "Are women more risk averse?" *Economic Inquiry*, 36(4): 620–630.

Kimball, Miles S, and Matthew D Shapiro. 2008. "Labor Supply: Are the Income and Substitution Effects Both Large or Both Small?" National Bureau of Economic Research Working Paper 14208.

Kimball, Miles S, Claudia R Sahm, and Matthew D Shapiro. 2008. "Imputing risk tolerance from survey responses." *Journal of the American Statistical Association*, 103(483): 1028–1038.

Kimball, Miles S, Claudia R Sahm, and Matthew D Shapiro. 2009. "Risk Preferences in the PSID: Individual Imputations and Family Covariation." *The American Economic Review: Papers and Proceedings*, 99(2): 363–368.

Kreps, David M, and Evan L Porteus. 1978. "Temporal resolution of uncertainty and dynamic choice theory." *Econometrica*, 185–200.

Kumar, Alok. 2009. "Who gambles in the stock market?" *Journal of Finance*, 64(4): 1889–1933.

Lucas, Robert E. 1990. "Supply-Side Economics: An Analytical Review." *Oxford Economic Papers*, 42(2): 293–316.

Rabin, Matthew. 2000. "Risk aversion and expected-utility theory: A calibration theorem." *Econometrica*, 68(5): 1281–1292.

Sahm, Claudia R. 2012. "How much does risk tolerance change?" *Quarterly Journal of Finance*, 2(04).

Schubert, Renate, Martin Brown, Matthias Gysler, and Hans Wolfgang Brachinger. 1999. "Financial decision-making: are women really more risk-averse?" *American Economic Review*, 381–385.

Shefrin, Hersh. 2000. *Beyond greed and fear: Understanding behavioral finance and the psychology of investing.* Oxford University Press.

Vissing-Jørgensen, Annette. 2002. "Limited Asset Market Participation and the Elasticity of Intertemporal Substitution." *Journal of Political Economy*, 110(4).

Weil, Philippe. 1990. "Nonexpected utility in macroeconomics." *Quarterly Journal of Economics*, 105(1): 29–42.

Table 1: Sample Characteristics

Characteristic	Wave 1 Number (Freq.)	Wave 2 Number (Freq.)
All	278 (1.00)	207 (1.00)
Male	125 (0.45)	96 (0.46)
White	218 (0.78)	170 (0.82)
Non-white	60 (0.22)	37 (0.18)
Ages 18-34	53 (0.19)	30 (0.14)
Ages 35-54	170 (0.61)	126 (0.61)
Ages 54+	55 (0.20)	51 (0.24)
< 12 years educ.	27 (0.10)	20 (0.10)
12 years educ.	75 (0.27)	52 (0.25)
12-16 years	64 (0.23)	49 (0.24)
16 years educ	73 (0.26)	49 (0.24)
>16 years educ	38 (0.13)	37 (0.18)
Children in Household	117 (0.42)	83 (0.40)
Married	162 (0.58)	131 (0.63)
Divorced/Separated	51 (18.41)	31 (0.15)
Widowed	23 (0.08)	18 (0.09)
Never Married	41 (0.14)	27 (0.13)
West	62 (0.22)	48 (0.23)
Midwest	68 (0.24)	55 (0.27)
Northeast	44 (0.16)	28 (0.14)
South	104 (0.37)	76 (0.37)
Median income	$66,250	$62,000
Median stock value (if own stocks)	$60,000	$62,500

Notes: The first number in each entry is the actual number of respondents. The second number is the percentage of respondents in that wave which meet the specified criterion.

Table 2: Survey Design: Inequality Aversion and Risk Aversion

		Index Number of Categorical Response					
		0	1	2	3	4	5
Inequality Aversion (double)	Hypothetical Transfer	Reject that $1000 means more to a poor family	Prefer $1000 to double income family always	Prefer $2000 to your family but not $4000	Prefer $4,000 to your family but not $8,000	Prefer $8,000 to your family but not $15,000	Prefer $15,000 to your family to $1000 to 2x inc.
	Values of γ	none	$[0, 1]$	$[1, 2]$	$[2, 3]$	$[3, 3.91]$	$[3.91, \infty)$
Inequality Aversion (half)	Hypothetical Transfer	Reject that $1000 means more to a poor family	Prefer $1000 to your family always	Prefer $2,000 to half-inc. family but not $4,000	Prefer $4,000 to half-inc. family but not $8,000	Prefer $8,000 to half-inc. family but not $15,000	Prefer $15,000 to half-inc. family to $1,000 to yours
	Values of γ	none	$[0, 1]$	$[1, 2]$	$[2, 3]$	$[3, 3.91]$	$[3.91, \infty)$
Risk Aversion (small)	Gamble		Accept 15 percent downside risk	Accept 10 percent but not 15 percent	Accept 5 percent but not 10 percent	Reject 5 percent	
	Values of γ		$[0, 1.67]$	$[1.67, 4.91]$	$[4.91, 13.49]$	$[13.49, \infty)$	
Risk Aversion (large)	Gamble		Accept one third	Accept one half but not one third	Accept 20 percent but not one half	Reject 20 percent	
	Values of γ		$[0, 1]$	$[1, 2]$	$[2, 3.76]$	$[3.76, \infty)$	

Notes: See Section 2.1 for more detail on survey design, along with the questionairre provided at the end of the paper.

Table 3: Survey Design: Elasticity of Intertemporal Substitution and Altruism

		Index Numer of Categorical Response				
		1	2	3	4	5
Elasticity of Intertemporal Substitution 1 (Income Same)	Hypothetical Payments	Prefer $300 in one year	Prefer $250 in one year but not $300	Prefer $220 in one year but not $250	Prefer $210 in one year but not $220	Prefer $200 now to $210 in one year
	Values for β [a]	$[0,\ \frac{2}{3}]$	$[\frac{2}{3},\ \frac{4}{5}]$	$[\frac{4}{5}, \frac{10}{11}]$	$[\frac{10}{11},\ \frac{20}{21}]$	$[\frac{20}{21},\ \infty]$
Elasticity of Intertemporal Substitution 2 (Income Doubles)	Hypothetical Payments	Prefer $800 in one year	Prefer $400 in one year but not $800	Prefer $300 in one year but not $400	Prefer $250 in one year but not $300	Prefer $200 now to $250 in one year
	Values for $2^{-\gamma}\beta$ [b]	$[0,\ \frac{2}{3}]$	$[\frac{2}{3},\ \frac{4}{5}]$	$[\frac{4}{5},\ \frac{10}{11}]$	$[\frac{10}{11},\ \frac{20}{21}]$	$[\frac{20}{21},\ \infty]$
Altruism 1 (Unsubsidized)	Hypothetical Transfer (5/	No help when child has 1/3 the income	Help with 1/3 but not 1/2 the income	Help with 1/2 but not 3/4 the income	Help with 3/4 but not 9/10 the income	Help child with 9/10 the income
	Values of g [c]	$[0,\ \frac{1}{3}]$	$[\frac{1}{3},\ \frac{1}{2}]$	$[\frac{1}{2},\ \frac{3}{4}]$	$[\frac{3}{4},\ \frac{9}{10}]$	$[\frac{9}{10},\ \infty]$
Altruism 2 (Subsidized)[d]	Hypothetical Tranfer (2.5% of income)	No help when child has 1/3 the income	Help with 1/3 but not 1/2 the income	Help with 1/2 but not 3/4 the income	Help with 3/4 but not 9/10 the income	Help child with 9/10 the income

Notes: For more detail on these questions, see sections 2.1.3 and 2.1.4 and the questionairre provided at the end of the paper.

[a] Parameter values for EIS are the conventional linear discount factor, β,

[b] Answers to EIS2 depend on γ and β. It turns out that one can simplify the comparison implied by the question to a function of $2^{-\gamma}\beta$, so we report cutoffs for this combination of parameters.

[c] Parameter values for Altruism are for the critical consumption ratio g, the consumption ratio at which a parent is first induced to give to the child.

[d] Parameter values are not given forAltruism 2 because the comparison implied by the question is a complicated function of two parameters, g and γ (or β and γ, which cannot be simplified like EIS2.

Table 4: Inequality Aversion, Double by Selected Characteristics

Population[c]	Categorical Response[a] 0	1	2	3	4	5	Number of responses	Median γ	Mean γ[b]	Mean $\log(\gamma)$
All	0.10	0.12	0.04	0.35	0.18	0.21	252	2.74	2.99	1.01
										(0.04)
Men	0.08	0.17	0.05	0.35	0.18	0.17	112	2.41	2.66	0.88
										(0.06)
Women	0.11	0.09	0.03	0.34	0.18	0.25	140	3.02	3.24	1.11
										(0.05)
Ages 18-34	0.13	0.13	0.02	0.38	0.23	0.13	48	2.67	2.80	0.98
										(0.08)
Ages 35-54	0.10	0.17	0.02	0.35	0.18	0.19	114	2.55	2.77	0.94
										(0.05)
Ages 55+	0.09	0.07	0.08	0.32	0.16	0.29	90	3.10	3.47	1.13
										(0.08)
< 12 years educ.	0.04	0.00	0.04	0.38	0.21	0.33	24	3.29	3.37	1.19
										(0.07)
12 years	0.07	0.07	0.06	0.32	0.21	0.28	72	3.05	3.26	1.11
										(0.07)
13-16 years	0.13	0.14	0.03	0.36	0.17	0.17	120	2.69	2.90	0.99
										(0.05)
> 16 years	0.11	0.25	0.03	0.33	0.14	0.14	36	2.00	2.31	0.69
										(0.12)
Income>$60,000	0.09	0.10	0.05	0.33	0.20	0.24	123	2.90	3.20	1.07
										(0.06)
Income<$60,000	0.11	0.16	0.03	0.34	0.17	0.19	120	2.58	2.80	0.95
										(0.06)
No stocks	0.07	0.05	0.05	0.30	0.19	0.35	81	3.17	3.34	1.15
										(0.06)
Stock value <$60,000	0.09	0.20	0.05	0.35	0.20	0.12	66	2.34	2.63	0.85
										(0.08)
Stock value >$60,000	0.10	0.16	0.03	0.39	0.18	0.15	62	2.44	2.71	0.89
										(0.08)
Married	0.12	0.13	0.05	0.29	0.17	0.24	143	2.79	3.17	1.03
										(0.06)
Never Married	0.13	0.16	0.00	0.39	0.26	0.05	38	2.30	2.35	0.83
										(0.09)
Divorced/Separated	0.04	0.11	0.07	0.39	0.15	0.24	46	2.89	3.09	1.06
										(0.08)
West	0.15	0.13	0.06	0.29	0.17	0.19	52	2.54	2.79	0.93
										(0.09)
Midwest	0.06	0.12	0.06	0.41	0.20	0.15	66	2.53	2.72	0.93
										(0.07)
Northeast	0.08	0.13	0.03	0.33	0.18	0.26	39	2.81	3.05	1.03
										(0.10)
South	0.11	0.12	0.02	0.34	0.17	0.25	95	2.98	3.27	1.09
										(0.06)
No children	0.12	0.13	0.05	0.29	0.18	0.24	147	2.82	3.12	1.04
										(0.06)
Have children	0.07	0.11	0.03	0.43	0.18	0.18	105	2.65	2.85	0.97
										(0.05)
White	0.11	0.14	0.04	0.35	0.17	0.19	202	2.63	2.89	0.97
										(0.04)
Non-White	0.06	0.04	0.04	0.35	0.20	0.31	49	3.20	3.30	1.16
										(0.07)

Notes:
[a] We report categorical responses from Wave 1 only.
[b] This column reports estimates $\mathbb{E}[\gamma]$ for this sub-sample using responses in both waves and accounting for measurement error as described in Section 3.
[c] We split the population according to demographic variables as reported in wave 1 of the survey.

Table 5: Inequality Aversion, Half by Selected Characteristics

Population[c]	Categorical Response[a]						Number of responses	Median γ	Mean γ^b	Mean $\log(\gamma)$
	0	1	2	3	4	5				
All	0.09	0.17	0.08	0.32	0.15	0.19	266	2.28	2.48	0.82
										(0.04)
Men	0.08	0.22	0.08	0.34	0.13	0.16	118	2.01	2.17	0.70
										(0.06)
Women	0.11	0.12	0.09	0.30	0.18	0.21	148	2.52	2.74	0.93
										(0.06)
Ages 18-34	0.12	0.22	0.06	0.30	0.20	0.10	50	2.00	2.12	0.69
										(0.10)
Ages 35-54	0.09	0.17	0.09	0.34	0.12	0.18	122	2.12	2.30	0.75
										(0.06)
Ages 55+	0.09	0.13	0.09	0.29	0.17	0.24	94	2.64	2.86	0.97
										(0.07)
< 12 years educ.	0.04	0.16	0.32	0.08	0.12	0.28	25	2.00	2.20	0.69
										(0.17)
12 years	0.07	0.11	0.08	0.30	0.19	0.26	74	2.62	2.87	0.96
										(0.08)
13-16 years	0.12	0.14	0.06	0.39	0.15	0.15	129	2.34	2.50	0.85
										(0.06)
> 16 years	0.11	0.37	0.00	0.26	0.13	0.13	38	2.00	2.25	0.69
										(0.13)
Income>$60,000	0.09	0.15	0.15	0.23	0.16	0.22	128	2.37	2.56	0.86
										(0.06)
Income<$60,000	0.10	0.18	0.02	0.38	0.16	0.16	128	2.24	2.49	0.81
										(0.06)
No stocks	0.07	0.13	0.18	0.20	0.15	0.27	85	2.36	2.41	0.86
										(0.07)
Stock value <$60,000	0.09	0.23	0.04	0.35	0.14	0.14	69	2.00	2.35	0.69
										(0.09)
Stock value >$60,000	0.09	0.16	0.06	0.40	0.13	0.15	67	2.29	2.54	0.83
										(0.08)
Married	0.11	0.14	0.06	0.34	0.16	0.19	153	2.39	2.59	0.87
										(0.05)
Never Married	0.13	0.28	0.10	0.23	0.15	0.10	39	2.00	2.21	0.69
										(0.15)
Divorced/Separated	0.04	0.10	0.15	0.29	0.19	0.23	48	2.39	2.69	0.87
										(0.11)
West	0.14	0.21	0.05	0.28	0.14	0.18	57	2.00	2.37	0.69
										(0.12)
Midwest	0.06	0.16	0.07	0.30	0.18	0.22	67	2.26	2.35	0.81
										(0.08)
Northeast	0.07	0.20	0.07	0.33	0.13	0.20	40	2.26	2.47	0.81
										(0.11)
South	0.10	0.13	0.11	0.34	0.16	0.17	102	2.44	2.65	0.89
										(0.06)
No children	0.12	0.15	0.09	0.28	0.15	0.22	155	2.41	2.53	0.88
										(0.06)
Have children	0.06	0.19	0.07	0.37	0.16	0.14	111	2.12	2.40	0.75
										(0.06)
White	0.10	0.16	0.07	0.33	0.15	0.18	214	2.27	2.47	0.82
										(0.05)
Non-White	0.06	0.18	0.14	0.27	0.14	0.22	51	2.28	2.55	0.83
										(0.10)

Notes:
[a] We report categorical responses from Wave 1 only.
[b] This column reports estimates $\mathbb{E}[\gamma]$ for this sub-sample using responses in both waves and accounting for measurement error as described in Section 3.
[c] We split the population according to demographic variables as reported in wave 1 of the survey.

Table 6: Risk Aversion, Large, by Selected Characteristics

Population[c]	Categorical Response[a] 1	2	3	4	Number of responses	Median γ	Mean γ[b]	Mean $\log(\gamma)$
All	0.09	0.16	0.16	0.59	273	4.72	6.57	1.55 (0.08)
Men	0.11	0.15	0.17	0.57	123	4.25	6.25	1.45 (0.12)
Women	0.07	0.17	0.15	0.61	150	5.08	6.65	1.62 (0.11)
Ages 18-34	0.16	0.18	0.20	0.46	50	3.28	3.83	1.19 (0.17)
Ages 35-54	0.06	0.17	0.13	0.64	125	4.98	7.66	1.60 (0.13)
Ages 55+	0.08	0.13	0.18	0.60	98	5.21	6.57	1.65 (0.13)
< 12 years educ.	0.04	0.23	0.19	0.54	26	4.63	4.65	1.53 (0.21)
12 years	0.11	0.07	0.15	0.68	74	7.39	15.60	2.00 (0.26)
13-16 years	0.09	0.16	0.16	0.59	132	4.52	6.22	1.51 (0.11)
> 16 years	0.07	0.27	0.17	0.49	41	3.35	4.08	1.21 (0.15)
Income>$60,000	0.09	0.12	0.15	0.64	128	5.70	7.50	1.74 (0.14)
Income<$60,000	0.08	0.19	0.18	0.55	133	4.07	5.67	1.40 (0.10)
No stocks	0.09	0.10	0.14	0.66	86	7.39	12.77	2.00 (0.23)
Stock value <$60,000	0.11	0.14	0.19	0.56	72	3.79	4.51	1.33 (0.13)
Stock value >$60,000	0.04	0.21	0.12	0.63	68	4.63	6.55	1.53 (0.16)
Married	0.06	0.16	0.15	0.63	158	5.02	7.11	1.61 (0.11)
Never Married	0.15	0.15	0.26	0.44	39	2.81	3.23	1.03 (0.16)
Divorced/Separated	0.12	0.16	0.12	0.60	50	6.39	11.64	1.85 (0.31)
West	0.10	0.14	0.22	0.54	59	3.86	4.73	1.35 (0.14)
Midwest	0.10	0.13	0.15	0.62	68	5.20	8.69	1.65 (0.19)
Northeast	0.07	0.14	0.14	0.66	44	5.66	8.81	1.73 (0.23)
South	0.08	0.20	0.15	0.58	102	4.57	5.92	1.52 (0.13)
No children	0.11	0.12	0.17	0.60	161	4.69	6.90	1.55 (0.11)
Have children	0.06	0.21	0.14	0.59	112	4.75	6.19	1.56 (0.12)
White	0.08	0.16	0.18	0.58	221	4.54	6.23	1.51 (0.09)
Non-White	0.10	0.14	0.10	0.67	51	5.99	8.39	1.79 (0.25)

Notes:
[a] We report categorical responses from Wave 1 only.
[b] This column reports estimates $\mathbb{E}[\gamma]$ for this sub-sample using responses in both waves and accounting for measurement error as described in Section 3.
[c] We split the population according to demographic variables as reported in wave 1 of the survey.

Table 7: Risk Aversion, Small, by Selected Characteristics

Population[c]	Categorical Response[a] 1	2	3	4	Number of responses	Median γ	Mean γ[b]	Mean $\log(\gamma)$
All	0.11	0.16	0.25	0.48	271	12.92	23.43	2.56 (0.10)
Men	0.15	0.19	0.26	0.40	121	10.88	23.03	2.39 (0.15)
Women	0.09	0.14	0.23	0.54	150	14.63	22.90	2.68 (0.13)
Ages 18-34	0.22	0.20	0.28	0.30	50	6.73	11.68	1.91 (0.21)
Ages 35-54	0.08	0.15	0.31	0.45	124	12.86	19.29	2.55 (0.13)
Ages 55+	0.10	0.15	0.14	0.60	97	18.29	38.66	2.91 (0.20)
< 12 years educ.	0.04	0.12	0.20	0.64	25	20.09	36.82	3.00 (0.33)
12 years	0.03	0.11	0.19	0.68	75	20.09	24.43	3.00 (0.19)
13-16 years	0.17	0.18	0.28	0.37	130	10.21	16.57	2.32 (0.14)
> 16 years	0.15	0.22	0.29	0.34	41	7.97	16.67	2.08 (0.22)
Income>$60,000	0.07	0.14	0.23	0.56	126	18.07	34.31	2.89 (0.16)
Income<$60,000	0.16	0.17	0.26	0.41	133	9.63	15.39	2.26 (0.13)
No stocks	0.06	0.09	0.27	0.58	86	20.09	35.43	3.00 (0.19)
Stock value <$60,000	0.08	0.25	0.27	0.39	71	10.20	14.20	2.32 (0.15)
Stock value >$60,000	0.12	0.18	0.27	0.43	67	10.02	20.05	2.30 (0.18)
Married	0.10	0.17	0.23	0.50	157	14.15	22.96	2.65 (0.13)
Never Married	0.24	0.16	0.26	0.34	38	6.78	13.13	1.91 (0.24)
Di-vorced/Separated	0.10	0.10	0.35	0.45	49	13.31	25.29	2.59 (0.23)
West	0.16	0.21	0.26	0.38	58	9.99	20.90	2.30 (0.21)
Midwest	0.09	0.15	0.30	0.46	67	13.05	24.75	2.57 (0.19)
Northeast	0.16	0.12	0.19	0.53	43	12.49	25.82	2.53 (0.29)
South	0.09	0.17	0.23	0.51	103	15.00	22.00	2.71 (0.16)
No children	0.13	0.16	0.19	0.52	159	13.45	30.25	2.60 (0.14)
Have children	0.10	0.16	0.33	0.41	112	12.23	17.18	2.50 (0.14)
White	0.12	0.17	0.22	0.49	219	13.25	26.22	2.58 (0.12)
Non-White	0.08	0.12	0.37	0.43	51	12.24	15.31	2.50 (0.17)

Notes:
[a] We report categorical responses from Wave 1 only.
[b] This column reports estimates $\mathbb{E}[\gamma]$ for this sub-sample using responses in both waves and accounting for measurement error as described in Section 3.
[c] We split the population according to demographic variables as reported in wave 1 of the survey.

Table 8: Elasticity of Intertemporal Substitution, by Selected Characteristics

Population[c]	Categorical Response[a] 1	2	3	4	5	Number of responses	Median γ	Mean γ[b]	Mean $\log(\gamma)$
All	0	0.03	0.10	0.03	0.83	274	0.59	0.70	-0.53 $[-0.6399, -0.4236]$
Men	0	0.04	0.11	0.03	0.82	123	0.54	0.64	-0.62 $[-0.7727, -0.4552]$
Women	0.01	0.03	0.09	0.03	0.84	151	0.62	0.76	-0.48 $[-0.6286, -0.3288]$
Ages 18-34	0	0.08	0.14	0.02	0.76	50	0.62	0.66	-0.48 $[-0.6563, -0.2906]$
Ages 35-54	0	0.02	0.09	0.04	0.85	126	0.58	0.64	-0.55 $[-0.6867, -0.4019]$
Ages 55+	0.01	0.02	0.09	0.03	0.85	98	0.52	0.80	-0.66 $[-0.8840, -0.4301]$
< 12 years educ.	0	0.04	0.15	0	0.81	26	0.66	0.72	-0.42 $[-0.6899, -0.1360]$
12 years	0.01	0.05	0.04	0.05	0.84	75	0.64	0.80	-0.44 $[-0.6608, -0.2129]$
>12 no college	0	0	0.11	0.05	0.84	61	0.60	0.70	-0.51 $[-0.7180, -0.2886]$
college and above	0	0.04	0.12	0.02	0.83	112	0.53	0.62	-0.63 $[-0.7872, -0.4622]$
Income<$60,000	0.01	0.03	0.09	0.04	0.83	130	0.58	0.69	-0.54 $[-0.6899, -0.3941]$
Income>$60,000	0	0.04	0.11	0.03	0.83	133	0.60	0.72	-0.51 $[-0.6734, -0.3496]$
No stocks	0.01	0.06	0.11	0.06	0.76	87	0.58	0.68	-0.54 $[-0.7034, -0.3654]$
Stock value <$60,000	0	0.01	0.07	0.03	0.89	72	0.65	0.71	-0.42 $[-0.5888, -0.2519]$
Stock value >$60,000	0	0.04	0.07	0.03	0.85	68	0.46	0.64	-0.77 $[-1.0653, -0.4853]$
Married	0	0.02	0.08	0.03	0.87	157	0.59	0.79	-0.53 $[-0.6949, -0.3671]$
Never Married	0	0.05	0.13	0.05	0.77	39	0.50	0.50	-0.70 $[-0.8605, -0.5306]$
Divorced/Separated	0	0.08	0.12	0.02	0.78	51	0.69	0.75	-0.37 $[-0.5657, -0.1783]$
West	0	0.05	0.14	0.05	0.76	59	0.53	0.60	-0.64 $[-0.8482, -0.4263]$
Midwest	0	0.01	0.10	0.04	0.84	68	0.51	0.78	-0.67 $[-0.9350, -0.3949]$
Northeast	0	0.05	0.11	0.02	0.82	44	0.55	0.58	-0.60 $[-0.8034, -0.4088]$
South	0.01	0.03	0.07	0.02	0.87	103	0.67	0.79	-0.39 $[-0.5678, -0.2154]$
No children	0	0.03	0.10	0.05	0.81	162	0.58	0.71	-0.55 $[-0.6932, -0.4076]$
Have children	0.01	0.04	0.09	0.01	0.86	112	0.57	0.65	-0.56 $[-0.7223, -0.3940]$
White	0	0.03	0.10	0.03	0.84	221	0.55	0.68	-0.60 $[-0.7182, -0.4713]$
Non-White	0.02	0.06	0.10	0.04	0.79	52	0.66	0.74	-0.41 $[-0.6319, -0.1777]$

Notes:
[a] We report categorical responses from the first question type in Wave 1 only.
[b] This column reports estimates $\mathbb{E}[\gamma]$ for this sub-sample using responses in both waves and accounting for measurement error as described in Section 3.
[c] We split the population according to demographic variables as reported in wave 1 of the survey.

Table 9: Summary of results

Parameter	Inequality Aversion (Double)[a]	Inequality Aversion (Half)[a]	Inequality Aversion (Both w/Bias)[a]	Risk Aversion (Large)	Risk Aversion (Small)	Risk Aversion (Both w/Bias)
Mean $\log(\gamma),\ \hat{\mu}_\theta$	1.01	0.82	0.82	1.55	2.56	1.59
95% C.I.[b]	[0.93,1.08]	[0.74,0.90]	[0.74,0.90]	[1.41,1.69]	[2.38,2.74]	[1.45,1.73]
99% C.I.	[0.91,1.11]	[0.71,0.93]	[0.73,0.91]	[1.37,1.74]	[2.32,2.80]	[1.41,1.78]
Median γ	2.74	2.28	2.28	4.72	12.92	4.91
Mean γ	2.99	2.48	2.46	6.57	23.43	7.46
Std Dev $\log(\gamma),\ \hat{\sigma}_\theta$	0.42	0.42	0.40	0.81	1.09	0.91
95% C.I.	[0.33,0.51]	[0.31,0.53]	[0.33,0.48]	[0.65,1.00]	[0.88,1.33]	[0.77,1.07]
99% C.I.	[0.31,0.54]	[0.27,0.56]	[0.30,0.51]	[0.60,1.07]	[0.81,1.41]	[0.73,1.13]
Std Dev $\varepsilon,\ \hat{\sigma}_\varepsilon$[c]	0.51	0.62	0.53/0.65	0.84	1.12	0.89/1.20
95% C.I.	[0.45,0.58]	[0.54,0.70]	[0.58,0.73]	[0.72,0.99]	[0.97,1.31]	[0.74, 1.00]
			[0.47,0.60]			[1.06,1.37]
99% C.I.	[0.43,0.61]	[0.52,0.73]	[0.45,0.62]	[0.69,1.04]	[0.92,1.38]	[1.02,1.43]
			[0.57,0.76]			[0.71, 1.04]
Error Corr $\hat{\rho}_\varepsilon$			0.33			0.16
95% C.I.			[0.21,0.43]			[0.08,0.24]
99% C.I.			[0.17,0.46]			[0.05,0.28]
Response Error ζ			0.19			0.97
95% C.I.			[0.12,0.25]			[0.82,1.10]
99% C.I.			[0.10,0.26]			[0.78,1.15]
Responses	268	269	269	275	274	275

[a] Individuals who indicate that $1000 does not mean more to a rich person than a poor person are treated as missing in whichever waves they do so.
[b] Confidence intervals are obtained by inverting the Likelihood Ratio Test.
[c] When using both measures of a parameter in the same estimation, we estimate two error variances. The first corresponds IA(half) or RA(large) and the second corresponds to IA(double) or RA(small).

Table 10: Summary of results: Intertemporal Substitution and Altruism

	Intertemporal Substitution	Altruism
Mean $\log(\gamma),\ \hat{\mu}_\theta$	-0.53	2.58
95% C.I.[a]	[-0.64, -0.42]	[2.10, 3.04]
Median γ	0.59	13.20
Mean γ	0.70	24.71
Std Dev $\log(\gamma),\ \hat{\sigma}_\theta$	0.60	1.12
95% C.I.	[0.50, 0.72]	[0.66, 1.53]
Mean $\phi,\ \hat{\mu}_\phi$	0.16	-0.40
95% C.I.	[0.12, 0.20]	[-0.52, -0.29]
Std Dev $\phi,\ \hat{\sigma}_\phi$	0.18	0.41
95% C.I.	[0.12, 0.24]	[0.27, 0.61]
Std Dev $\varepsilon_1,\ \hat{\sigma}_{\varepsilon_1}$[b]	0.28	1.45
95% C.I.	[0.25, 0.33]	[1.15, 1.85]
Std Dev $\varepsilon_2,\ \hat{\sigma}_{\varepsilon_2}$[b]	0.48	0.35
95% C.I.	[0.40, 0.57]	[0.24, 0.48]
Error Corr $\rho_{\varepsilon_1\varepsilon_2}$	0.09	0.78
95% C.I.	[-0.09, 0.25]	[0.56, 0.91]
Auxiliary Parameter ξ	0.92	0.61
95% C.I.	[0.68, 1.19]	[0.54, 0.67]
Responses		

Notes: Refer to Section 3.4 for the statistical model used to generate these estimates.

[a] Confidence intervals are obtained by inverting the Likelihood Ratio Test.

[b] For both question types, the first error term corresponds to errors assigned to the first question asked of recipients, where (for EIS) overall income is the same from one year to the next, or (for altruism) giving is unsubsidized. The second error corresponds to the second question.

Table 11: Summary of results for correlation estimations

	Inequality aversion (double)	Inequality aversion (half)	Risk aversion (big)	Risk aversion (small)	Intertemporal Substitution	Altruism
Inequality aversion (double)	0.18	0.15	0.01	0.16	0.01	0.06
	–	–	–	–	–	–
	–	–	–	–	–	–
Inequality aversion (half)	0.84	0.18	0.10	0.15	0.05	0.09
	[0.63,1.00]	–	–	–	–	–
	[0.55,1.00]	–	–	–	–	–
Risk aversion (big)	0.02	0.34	0.66	0.60	0.01	0.39
	[-0.27, 0.29]	[0.03, 0.62]	–	–	–	–
	[-0.36, 0.38]	[-0.06,0.70]	–	–	–	–
Risk aversion (small)	0.39	0.37	0.87	1.19	-0.05	0.32
	[0.14,0.63]	[0.07, 0.63]	[0.72,0.99]	–	–	–
	[0.05,0.70]	[-0.02, 0.70]	[0.66,1.00]	–	–	–
Intertemporal Substitution	0.03	0.18	0.02	-0.07	0.36	INC
	[-0.04,0.10]	[0.11,0.26]	[-0.03,0.07]	[-0.11,-0.03]	–	–
	[-0.06,0.12]	[0.08,0.29]	[-0.04,0.09]	[-0.12,-0.02]	–	–
Altruism	0.10	0.17	0.33	0.24	See Table 12	1.94
	[-0.07,0.27]	[-0.03,0.34]	[0.06,0.56]	[-0.85,0.82]	–	–
	[-0.13,0.32]	[-0.09,0.40]	[-0.03,0.62]	[-0.93,0.90]	–	–

Note: Below the main diagonal, we report estimates of the parameter using the pairwise maximum likelihood models described in Sections 3.2 and 3.5. On the main diagonal and above it, we report variance (obtained from estimation of the distribution of a single parameter) and covariances implied by estimated correlations and variances. Confidence intervals are obtained by inverting the Likelihood function.

Table 12: Estimate of Altruism-EIS correlation from 2 pairs of cross wave data

correlation estimate	-0.5779	-0.6280
95% C.I.	[-0.6504, -0.4719]	[-0.6726, -0.5705]
99% C.I.	[-0.6701 -0.4359]	[-0.6870, -0.5436]
sample size	75	72

Note: for computational reasons, we estiamte the correlation using Altruism data in W1 and EIS data in wave 2 in the first column, and EIS data in wave 1 and altruism data in wave 2 in the second column.

Table 13: Estimate of Altruism-EIS correlation from 2 pairs of cross wave data, by education

Education	12 years or less	more than 12 years
correlation estimate	-0.6358	-0.5335
95% C.I.	[-0.7100, -0.5367]	[-0.6144, -0.4280]
99% C.I.	[-0.7400, -0.4748]	[-0.6415, -0.3770]
sample size	35	40

Note: for computational reasons, we estiamte the correlation using Altruism data in W1 and EIS data in wave 2. Estimates using using EIS data in wave 1 and altruism data in wave 2 are similar. We use education as reported in Wave 1 of the survey.

A Summary of Numerical Methods

This section briefly describes the numerical methods used in the paper. Most of our code is written in the MATLAB programming environment.

A.1 Numerical integration

To compute multivariate normal distribution values, we use the MATLAB package *mvncdf*. For bivariate and trivariate distributions, *mvncdf* uses adaptive quadrature on a transformation of the t distribution, based on methods developed in Genz (2004). We set the absolute error tolerance for these cases at 10^{-9}. For four or more dimensions, *mvncdf* uses a quasi-Monte Carlo integration algorithm based on methods developed in Genz and Bretz (2002) (see also Genz and Bretz (1999)). We set the absolute error tolerance for these cases at 10^{-5}. We also performed robustness checks using *multivariatenormalcdf* package from the *IMSL* C Stat Library. The *multivariatenormalcdf* package computes the cumulative density by transforming (using the Cholesky decomposition transformation (Genz, 1992)) the problem into a definite integral which is solved numerically using randomized Korobov rules (Keast, 1973). The results from those two approaches are consistent, but *mvncdf* has a better speed performance.

In some of our problems, we also need to perform standard one dimensional integration. In most of those cases we use the *quad* package from MATLAB, which uses an adaptive recursive Simpson's rule (Gander and Gautschi, 2000). We set the absolute error tolerance for these cases at 10^{-6}. Earlier, we performed comparisons with various other quadratures from the numerical integration package in the *NAG* library—which includes most standard quadratures, such as Gaussian quadrature, Gauss-Hermite quadrature and many more. Overall, *quad* had the most reliable results and better performance in terms of speed, due to vectorization.

A.2 Optimization

For most of the optimization problems, we use MATLAB's included solver, *fmincon*. Our benchmark algorithm is the *interior-point* algorithm. Although *fmincon* is a local minimum solver, our robustness checks suggest that the results are reliable. We performed rigorous comparisons among different solvers from different optimization packages. To check against another local solver, we used *ktrlink* from MATLAB, which calls Ziena Optimization's KNITRO library (Byrd etal, 2006). We also tested various local (both gradient and non-gradient based) solvers from the optimization package in the *NAG* library. It turns out that most of those optimization routines can find a local solution to our standard maximum-likelihood estimation problems (although the convergence speed varies), which suggests that our standard likelihood function is well behaved, as expected.

For most of our optimization problems, we have also checked whether there are multiple local solutions. We have started our local solvers with different initial guesses (MATLAB has a routine *multistart* which supports both user supplied multiple initial guesses as well as randomly generated ones). We also solved some of our problems using a gradient based package *GlobalSearch* from MATLAB, which employs a scatter-search method of generating trial points (Ugray et al. , 2007). For non-gradient based global methods, we used *patternsearch* (a direct search method) from MATLAB, the Genetic Algorithm, and Simulated Annealing. For our standard maximum-likelihood estimation problems, most of those global methods return the same local minimums as our benchmark local solver does. Methods that did not return the same result failed to converge in allotted time.

B Other Experimental Questions

Another measure of relative risk aversion, questions BC21-BC24 on the questionnaire (see Appendix D), concerns the preference to smooth consumption across states, and to consume more in states of the world where income is higher. The purpose of this question initially was to examine whether the tendency to smooth consumption across states was the same parameter as the one governing risk aversion. Upon viewing the results, however, two things are clear: first, the question confused many respondents. Second, the hypothetical situation should be made more like the risk aversion questions to facilitate the comparison of interest. The results may nevertheless be of some interest, so we report them here.

We ask the respondent to suppose that they have a fifty-fifty chance of getting a new job in a new city, which would double their lifetime income. *Before they know whether they will get the job*, they must choose a state-dependent consumption path. Specifically, they must choose whether to risk losing a small amount of money conditional on not getting the job, or to risk losing a larger amount of money conditional on getting the job.[24] An individual with sufficient curvature should prefer the latter, because the marginal utility loss diminishes with income according to the curvature of the utility function.

The amount they risk losing conditional on not getting the job is \$200, and the other amount varies by question type. The hypothetical scenario implies the following marginal utility comparison:

$$\frac{1}{2}\underbrace{(-200C^{-\gamma})}_{\text{Not get job}}+\frac{1}{2}\underbrace{(0(2C)^{-\gamma})}_{\text{Get job}}\lesseqgtr\frac{1}{2}\underbrace{(0C^{-\gamma})}_{\text{Not get job}}+\frac{1}{2}\underbrace{(-M(2C)^{-\gamma})}_{\text{Get job}}$$

where M is the amount of money lost if the individual risks losing money in the high-income state and then that state is realized. We can solve this for γ for the given values of M and add survey response error like before. The statistical model for the estimation of the distribution for γ and measurement error is the same as that used for risk aversion questions.

Tables 14 through 16 relate the results. The estimated mean and median curvature is significantly lower in these questions than for either of the risk aversion questions. The estimated error standard deviation is very high, so high that it is dubious whether individuals understood the question. Correlations are estimated to be near zero or indistinguishable from zero for all but risk aversion (big), where the correlation is negative. We suspect the reason for this negative correlation is the same as the one for the negative correlation between altruism and EIS, discussed in

[24] We readily acknowledge that this is a complicated comparison. Our results indicate that the question may have confused respondents.

Section 4.5, since state smoothing is also a parameter where we ask about reservation prices.

A fourth measure of relative risk aversion attempts to address the issue of endogenous labor supply in decision-making under uncertainty about future income. Chetty (2006) shows how given data on the labor supply elasticity and consumption-labor complementarity, we can infer the curvature of utility over consumption. Our approach is motivated by this analysis. We attempt to discover how much the estimate of relative risk aversion based on the choice between safe and risky job is biased by assuming consumption and labor are additively separable. We will be limited in our ability to do so, however, because the survey does not contain questions designed to separate consumption-labor complementarity and risk aversion, and because the framing of the question is different here than in the save vs. risky job questions. As such, these results should be considered more experimental than others in this paper.

We use questions BC48-BC53. The questions ask the respondent to suppose that, due to a serious accident, they have a 50-50 chance of not being able to work for the rest of their life. Given this risk, we ask whether they would like to obtain supplemental insurance, increasing their income in the event that they cannot work. Without supplemental insurance, they would consume 50 percent of their current income for the rest of their life if they were not able to work. With the insurance, they could consume instead 60 percent of their current income. We ask if they would be willing to pay a given percent of their income if they *could* work to purchase the additional insurance. The questions on disability insurance were only asked of single respondents who worked for pay; there were 81 such individuals in the first wave and 58 in the second wave.

For this question set, if we are willing to make a simplifying assumption on the role of labor supply in the decision making, we can put individual responses into different boxes similarly as before.[25] For every scenario in the questionnaire, we can compare the expected utility from buying the disability insurance with not buying as follows.

$$\frac{1}{2}\frac{C^{1-\gamma}}{1-\gamma}+\frac{1}{2}\beta\frac{(0.5C)^{1-\gamma}}{1-\gamma}\leqslant\frac{1}{2}\frac{(mC)^{1-\gamma}}{1-\gamma}+\frac{1}{2}\beta\frac{(0.6C)^{1-\gamma}}{1-\gamma}$$

[25]Without a simplifying assumption, more data would be needed to account for the labor supply elasticity and consumption-labor complementarity.

where β summarizes all the changes in preferences when individuals are in the state of not being able to work, and m takes values of 0.9, 0.875, 0.85, 0.8, 0.7 and 0.6. The above formula can be simplified to

$$ln(\beta) \lesseqgtr \frac{1 - m^{1-\gamma}}{0.6^{1-\gamma} - 0.5^{1-\gamma}}$$

To get more robust estimation results, instead of β, we also introduce the consumption ratio $g \equiv \frac{ln(\beta)}{\gamma}$ as the primitive parameter. In that case, we have

$$g \lesseqgtr \gamma \frac{1 - m^{1-\gamma}}{0.6^{1-\gamma} - 0.5^{1-\gamma}}$$

Moreover, we assume there is an i.i.d. error across waves, so that the individual answers their question based on

$$g + \varepsilon \lesseqgtr \gamma \frac{1 - m^{1-\gamma}}{0.6^{1-\gamma} - 0.5^{1-\gamma}}$$

We can interpret the parameter g in this setting as the percentage change in consumption from exogenously decreasing labor supply to zero. We assume a fixed value of γ at a uniform level for all respondents and estimate the distribution of g. We then vary the uniform value of γ. From the literature on the "retirement consumption-puzzle" (Hurd and Rohwedder, 2006), we take that the mean value of g should be about -0.13, which is the average percent change in consumption at retirement. We then look for a value of γ that , and compare it to previous estimates of γ for risk aversion. Table 17 presents the results. The first row examines a wide range of values for γ, the second row a narrower range of γ's where g is close to the target value of -0.13. The results suggest that if our target value of g is to be believed, a typical value of γ is $\gamma \in [0.55, 0.6]$. This is substantially smaller than the estimate of the median γ for large-stakes risk aversion 4.72, and very close to the estimated median γ for state-smoothing, 0.49. A smaller value of γ is consistent with the idea that ignoring consumption-labor complementarity causes us to over-estimate the mean curvature for the lottery-based risk aversion questions in the body of the paper. (RIGHT?)

Table 14: State Smoothing by Selected Characteristics

Population[c]	Categorical Response[a] 1	2	3	4	5	Number of responses	Median γ	Mean γ[b]	Mean $\log(\gamma)$
All	0.40	0.12	0.17	0.17	0.13	260	0.49	0.63	-0.71 (0.08)
Men	0.32	0.10	0.18	0.15	0.25	117	0.68	0.95	-0.39 (0.13)
Women	0.48	0.13	0.17	0.18	0.04	143	0.39	0.44	-0.94 (0.10)
Ages 18-34	0.42	0.06	0.26	0.16	0.10	50	0.46	0.66	-0.79 (0.20)
Ages 35-54	0.38	0.13	0.18	0.18	0.13	123	0.47	0.56	-0.76 (0.11)
Ages 55+	0.43	0.14	0.11	0.16	0.16	87	0.54	0.76	-0.62 (0.15)
< 12 years educ.	0.38	0.13	0.33	0.08	0.08	24	0.55	0.81	-0.59 (0.21)
12 years	0.49	0.11	0.14	0.18	0.08	72	0.36	0.62	-1.03 (0.19)
13-16 years	0.40	0.11	0.18	0.16	0.15	124	0.50	0.53	-0.70 (0.11)
> 16 years	0.30	0.15	0.13	0.23	0.20	40	0.74	0.90	-0.30 (0.20)
Income>$60,000	0.40	0.16	0.15	0.17	0.12	124	0.44	0.58	-0.82 (0.12)
Income<$60,000	0.41	0.08	0.19	0.17	0.16	127	0.55	0.71	-0.60 (0.12)
No stocks	0.49	0.15	0.14	0.12	0.09	85	0.35	0.54	-1.05 (0.16)
Stock value <$60,000	0.33	0.11	0.20	0.17	0.19	70	0.57	0.78	-0.56 (0.16)
Stock value >$60,000	0.40	0.08	0.12	0.22	0.18	65	0.60	0.82	-0.52 (0.18)
Married	0.44	0.11	0.18	0.15	0.13	151	0.48	0.68	-0.74 (0.12)
Never Married	0.33	0.15	0.15	0.23	0.13	39	0.50	0.57	-0.69 (0.17)
Divorced/Separated	0.37	0.15	0.17	0.15	0.15	46	0.50	0.52	-0.69 (0.17)
West	0.30	0.13	0.21	0.18	0.18	56	0.63	0.78	-0.46 (0.14)
Midwest	0.38	0.05	0.14	0.25	0.17	63	0.55	0.92	-0.60 (0.19)
Northeast	0.44	0.10	0.12	0.17	0.17	41	0.34	0.36	-1.07 (0.30)
South	0.46	0.17	0.19	0.11	0.07	100	0.43	0.49	-0.84 (0.12)
No children	0.40	0.13	0.13	0.19	0.15	150	0.51	0.62	-0.68 (0.11)
Have children	0.41	0.10	0.23	0.15	0.12	110	0.47	0.65	-0.76 (0.13)
White	0.41	0.11	0.17	0.17	0.14	211	0.50	0.60	-0.70 (0.09)
Non-White	0.38	0.15	0.19	0.19	0.10	48	0.46	0.76	-0.78 (0.20)

Table 15: Estimated distribution parameters for state smoothing

Mean $\log(\gamma),\ \hat{\mu}_\theta$	-0.71
95% C.I.[a]	[-0.87,-0.56]
99% C.I.	[-0.92,-0.51]
Median γ	0.49
Mean γ	0.63
Std Dev $\log(\gamma),\ \hat{\sigma}_\theta$	0.72
95% C.I.	[0.47,0.95]
99% C.I.	[0.73,1.13]
Std Dev $\varepsilon,\ \hat{\sigma}_\varepsilon$	1.26
95% C.I.	[0.47,0.60]
99% C.I.	[1.11,1.45]

Notes: Note: Correlations are estimated just like the estimates in Table 9. See Section 3 for details on the statistical model.

[a] Confidence intervals are obtained by inverting the Likelihood Ratio Test.

Table 16: Correlation between State Smoothing and Other Curvature Parameters

	Correlation with state-smoothing
Inequality aversion (double)	-0.03
95% CI	[-0.32,0.29]
99%CI	[-0.41,0.39]
Inequality aversion (half)	-0.09
95% CI	[-0.43, 0.24]
99%CI	[-0.53,0.35]
Risk aversion (big)	-0.35
95% CI	[-0.65,-0.05]
99%CI	[-0.73,0.04]
Risk aversion (small)	-0.10
95% CI	[-0.39,0.22]
99%CI	[-0.48,0.32]
Intertemporal substitution	-0.03
95% CI	[-0.59,0.63]
99%CI	[-0.69,0.75]
Altruism	-0.10
95% CI	[-0.85,0.82]
99%CI	[-0.93,0.90]

Note: Correlations are estimated just like the estimates in Table 11. See Section 3 for details on the statistical model.

C Cross-Tabulations

This section provides several cross-tabulations of indexed categorical variables for measures of a preference parameter, to give interested readers a view of the variation in the data which imposes less structure than the maximum-likelihood approach employed in the body of the paper.

Table 17: Summary of results for disability insurance estimation

	$\gamma = 0.1$	$\gamma = 0.5$	$\gamma = 0.8$	$\gamma = 1$	$\gamma = 1.2$	$\gamma = 1.5$	$\gamma = 2$	$\gamma = 5$	$\gamma = 10$	$\gamma = 50$
g	1.7269	-0.0714	-0.2400	-0.2962	-0.3336	-0.3710	-0.4085	-0.4758	-0.4985	-0.5221
	[0.5765,2.8772]	[-0.3080,0.1653]	[-0.3910,-0.0889]	[-0.4187,-0.1735]	[-0.4372,-0.2300]	[-0.4557,-0.2863]	[-0.4743,-0.3427]	[-0.5084,-0.4432]	[-0.5212,-0.4758]	[-0.5405,-0.5037]
σ	3.0653	0.6365	0.4091	0.3334	0.2831	0.2329	0.1828	0.0954	0.0705	0.0629
	[1.4897,4.5056]	[0.3174,0.9314]	[0.2077,0.5968]	[0.1712,0.4854]	[0.1468,0.4113]	[0.1226,0.3373]	[0.0985,0.2636]	[0.0566,0.1344]	[0.0452,0.0971]	[0.0443,0.0836]
σ_ε	5.6285	1.1525	0.7332	0.5936	0.5006	0.4077	0.3151	0.1509	0.1006	0.0744
	[4.8292,6.6017]	[0.9881,1.3527]	[0.6283,0.8610]	[0.5084,0.6972]	[0.4286,0.5882]	[0.3489,0.4793]	[0.2694,0.3707]	[0.1283,0.1785]	[0.0848,0.1198]	[0.0615,0.0901]

	$\gamma = 0.30$	$\gamma = 0.40$	$\gamma = 0.50$	$\gamma = 0.55$	$\gamma = 0.60$	$\gamma = 0.65$	$\gamma = 0.70$	$\gamma = 0.75$	$\gamma = 0.80$	$\gamma = 0.90$
g	0.2283	0.0410	-0.0714	-0.1122	-0.1463	-0.1751	-0.1998	-0.2212	-0.2400	-0.2712
	[-0.1606,0.6172]	[-0.2527,0.3347]	[-0.3080,0.1653]	[-0.3281,0.1037]	[-0.3449,0.0523]	[-0.3591,0.0089]	[-0.3713,-0.0284]	[-0.3818,-0.0606]	[-0.3910,-0.0889]	[-0.4064,-0.1359]
σ	1.0411	0.7882	0.6365	0.5814	0.5354	0.4965	0.4632	0.4344	0.4091	0.3671
	[0.5127,1.5269]	[0.3906,1.1547]	[0.3174,0.9314]	[0.2907,0.8503]	[0.2687,0.7827]	[0.2499,0.7254]	[0.2338,0.6764]	[0.2199,0.6340]	[0.2077,0.5968]	[0.1874,0.5349]
σ_ε	1.8983	1.4322	1.1525	1.0509	0.9661	0.8944	0.8330	0.7798	0.7332	0.6556
	[1.6282,2.2273]	[1.2281,1.6806]	[0.9881,1.3527]	[0.9009,1.2334]	[0.8281,1.1341]	[0.7667,1.0501]	[0.7139,0.9780]	[0.6682,0.9156]	[0.6283,0.8610]	[0.5617,0.7700]

Note: We report the estimated distribution of g given a uniform value of γ, for the model described in the Appendix.

Table 18: Frequencies, Inequality Aversion (Half) Across Waves

	Wave 1						
Wave 2	0	1	2	3	4	5	# of Responses[b]
0	62.5	8.3	0	6.3	4.3	5.4	20
1	0	38.9	7.1	21.9	0	16.2	35
2	6.3	8.3	21.4	4.7	4.3	5.4	13
3	12.5	30.6	35.7	51.6	60.9	18.9	72
4	18.8	8.3	7.1	6.3	13	27	24
5	0	5.6	28.6	9.4	17.4	27	26
# of Responses [a]	16	36	14	64	23	37	190
Total Responses [c]	25	44	22	84	41	50	266

Notes: Percentages are tallied by column. For the meaning of categorical variables, refer to Table 2 and/or Section 2.1.1 of the paper.
[a] This row reports the number of responses in wave 1 for each category of inequality aversion (half) *among respondents who were present in both waves of the sample.*
[b] This column reports the number of responses in wave 2 for each category of inequality aversion (half) *among respondents who were present in both waves of the sample.*
[c] This row reports the number of responses in wave 1 for each category of inequality aversion (half) among all respondents in wave 1.

Table 19: Frequencies, Inequality Aversion (Double) Across Waves

	Wave 1						
Wave 2	0	1	2	3	4	5	# of Responses[b]
0	62.5	8.0	0	5.3	8.6	5.0	20
1	6.3	32.0	12.5	15.8	2.9	2.5	21
2	0	4.0	12.5	3.5	2.9	5.0	7
3	6.3	32.0	37.5	33.3	28.6	12.5	41
4	25.0	20.0	25.0	26.3	28.6	47.5	40
5	0	4.0	12.5	15.8	28.6	47.5	40
# of Responses [a]	16	25	8	57	35	40	181
Total Responses [c]	25	31	10	87	45	54	252

Notes: Percentages are tallied by column. For the meaning of categorical variables, refer to Table 2 and/or Section 2.1.1 of the paper.
[a] This row reports the number of responses in wave 1 for each category of inequality aversion (double) *among respondents who were present in both waves of the sample.*
[b] This column reports the number of responses in wave 2 for each category of inequality aversion (double) *among respondents who were present in both waves of the sample.*
[c] This row reports the number of responses in wave 1 for each category of inequality aversion (double) among all respondents in wave 1.

Table 20: Frequencies, Inequality Aversion by Question Type in Wave 1

	Half						
Double	0	1	2	3	4	5	# of Responses [b]
0	100[c]	0	0	0	0	0	25
1	0	40	5	15.8	0	4.1	31
2	0	0	10	5.3	7.3	2	10
3	0	37.5	30	52.6	43.9	16.3	87
4	0	17.5	15	18.4	31.7	16.3	45
5	0	5	40	7.9	17.1	61.2	53
# of Responses [a]	25	40	20	76	41	49	251

Notes: Percentages are tallied by column. For the meaning of categorical variables, refer to Table 2 and/or Section 2.1.1 of the paper.
[a] This row reports the number of responses in wave 1 for each category of inequality aversion (half) *among respondents who answered both question types.*
[b] This column reports the number of responses in wave 1 for each category of inequality aversion (double) *among respondents who answered both question types.*
[c] Respondents who indicate that $1000 does not mean more to a poor family than to a rich one are assigned a categorical value of 0 for both question types.

Table 21: Frequencies, Risk Aversion (Large) Across Waves

	Wave 1				
Wave 2	1	2	3	4	# of Responses [b]
1	20.0	14.7	14.7	2.7	16
2	26.7	26.5	20.6	11.6	33
3	20.0	29.4	23.5	14.3	37
4	33.3	29.4	41.2	71.4	109
# of Responses [a]	15	34	34	112	195
Total Responses [c]	24	43	44	162	273

Notes: Percentages are tallied by column. For the meaning of categorical variables, refer to Table 2 and/or Section 2.1.2 of the paper.
[a] This row reports the number of responses in wave 1 for each category of risk aversion (large) *among respondents who were present in both waves of the sample.*
[b] This column reports the number of responses in wave 2 for each category of risk aversion (large) *among respondents who were present in both waves of the sample.*
[c] This row reports the number of responses in wave 1 for each category of risk aversion (large) among all respondents in wave 1.

Table 22: Frequencies, Risk Aversion (Small) Across Waves

	Wave 1				
Wave 2	1	2	3	4	# of Responses [b]
1	27.8	22.9	6.4	2.2	18
2	16.7	14.3	14.9	4.3	19
3	38.9	28.6	34.0	29.0	60
4	16.7	34.3	44.7	64.5	96
# of Responses [a]	18	35	47	93	193
Total Responses [c]	31	44	67	129	271

Notes: Percentages are tallied by column. For the meaning of categorical variables, refer to Table 2 and/or Section 2.1.2 of the paper.
[a] This row reports the number of responses in wave 1 for each category of risk aversion (small) *among respondents who were present in both waves of the sample.*
[b] This column reports the number of responses in wave 2 for each category of risk aversion (small) *among respondents who were present in both waves of the sample.*
[c] This row reports the number of responses in wave 1 for each category of risk aversion (small) among all respondents in wave 1.

Table 23: Frequencies, Risk Aversion Across Question Types in Wave 1

	Large				
Small	1	2	3	4	# of Responses [b]
1	45.8	16.3	13.6	4.4	31
2	20.8	27.9	29.6	8.9	44
3	20.8	32.6	22.7	23.4	66
4	12.5	23.3	34.1	63.3	128
# of Responses [a]	24	43	44	158	269

Notes: Percentages are tallied by column. For the meaning of categorical variables, refer to Table 2 and/or Section 2.1.2 of the paper.
[a] This row reports the number of responses in wave 1 for each category of risk aversion (large) *among respondents who answered both question types.*
[b] This column reports the number of responses in wave 1 for each category of risk aversion (small) *among respondents who answered both question types.*

Table 24: Frequencies, Elasticity of Intertemporal Substitution (Income Same) Across Waves

Wave 2	Wave 1: 1	2	3	4	5	# of Responses [b]
1	0	0	0	16.7	1.7	4
2	0	50.0	5.6	33.3	5.8	14
3	0	50.0	55.6	0	14.0	35
4	0	0	5.6	0	3.5	7
5	100.0	0	33.3	50.0	75.0	139
# of Responses [a]	1	2	18	6	172	199
Total Responses [c]	1	9	27	9	228	274

Notes: Percentages are tallied by column. For the meaning of categorical variables, refer to Table 2 and/or Section 2.1.3 of the paper.
[a] This row reports the number of responses in wave 1 for each category of the first set of EIS questions—where income is assumed to be the same this year and next—*among respondents who were present in both waves of the sample.*
[b] This column reports the number of responses in wave 2 for each category of the first set of EIS questions *among respondents who were present in both waves of the sample.*
[c] This row reports the number of responses in wave 1 for each category of the first set of EIS questions among all respondents in wave 1.

Table 25: Frequencies, Elasticity of Intertemporal Substitution (Income Double) Across Waves

Wave 2	Wave 1: 1	2	3	4	5	# of Responses [b]
1	33.3	12.5	6.5	8.7	4.6	15
2	22.2	75.0	19.6	17.4	10.2	34
3	11.1	0	39.1	32.6	10.2	43
4	11.1	0	13.0	15.2	15.9	28
5	22.2	12.5	21.7	26.1	59.1	77
# of Responses [a]	9	8	46	46	88	197
Total Responses [c]	9	14	61	65	123	272

Notes: Percentages are tallied by column. For the meaning of categorical variables, refer to Table 2 and/or Section 2.1.3 of the paper.
[a] This row reports the number of responses in wave 1 for each category of the second set of EIS questions—where income is assumed to double next year—*among respondents who were present in both waves of the sample.*
[b] This column reports the number of responses in wave 2 for each category of the second set of EIS questions *among respondents who were present in both waves of the sample.*
[c] This row reports the number of responses in wave 1 for each category of the second set of EIS questions among all respondents in wave 1.

Table 26: Frequencies, Elasticity of Intertemporal Substitution Across Question Types in Wave 1

Income Doubles	Income Same 1	2	3	4	5	# of Responses [b]
1	0	0	3.9	11.1	3.1	9
2	0	0	7.7	11.1	4.9	14
3	0	33.3	23.1	33.3	21.7	61
4	0	55.6	34.6	22.2	21.7	65
5	100.0	11.1	30.8	22.2	48.7	122
# of Responses [a]	1	9	26	9	226	271

Notes: Percentages are tallied by column. For the meaning of categorical variables, refer to Table 2 and/or Section 2.1.3 of the paper.
[a] This row reports the number of responses in wave 1 for each category of the first set of EIS questions—where income is assumed to be the same this year and next—*among respondents who answered both question types.*
[b] This column reports the number of responses in wave 1 for each category of the second set of EIS questions—where income is assumed to double next year—*among respondents who answered both question types.*

Table 27: Frequencies, Altruism (Unsubsidized) Across Waves

Wave 2	Wave 1 1	2	3	4	5	# of Responses [b]
1	55.6	0	23.1	0	2.6	9
2	0	0	0	0	5.3	2
3	11.1	100.0	38.5	40.0	10.5	13
4	11.1	0	23.1	40.0	23.7	15
5	22.2	0	15.4	20.0	57.9	27
# of Responses [a]	9	1	13	5	38	66
Total Responses [c]	13	2	26	6	50	97

Notes: Percentages are tallied by column. For the meaning of categorical variables, refer to Table 2 and/or Section 2.1.4 of the paper.
[a] This row reports the number of responses in wave 1 for each category of the first set of Altruism questions—where giving is unsubsidized—*among respondents who were present in both waves of the sample.*
[b] This column reports the number of responses in wave 2 for each category of the first set of Altruism questions *among respondents who were present in both waves of the sample.*
[c] This row reports the number of responses in wave 1 for each category of the first set of Altruism questions among all respondents in wave 1.

Table 28: Frequencies, Altruism (Subsidized) Across Waves

	Wave 1					
Wave 2	1	2	3	4	5	# of Responses [b]
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	100.0	8.3	6.5	8
4	0	0	0	41.7	19.4	11
5	0	0	0	50.0	74.2	29
# of Responses [a]	0	0	5	12	31	48
Total Responses [c]	0	0	16	22	44	82

Notes: Percentages are tallied by column. For the meaning of categorical variables, refer to Table 2 and/or Section 2.1.4 of the paper.

[a] This row reports the number of responses in wave 1 for each category of the second set of Altruism questions—where giving is subsidized—*among respondents who were present in both waves of the sample.*

[b] This column reports the number of responses in wave 2 for each category of the second set of Altruism questions *among respondents who were present in both waves of the sample.*

[c] This row reports the number of responses in wave 1 for each category of the second set of Altruism questions among all respondents in wave 1.

Table 29: Frequencies, Altruism Across Question Types in Wave 1

	Wave 1					
Wave 2	1	2	3	4	5	# of Responses [b]
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	80.0	0	27.8	100.0	0	16
4	0	0	50.0	0	26.0	22
5	20.0	100.0	22.2	0	74.0	44
# of Responses [a]	10	1	18	3	50	82

Notes: Percentages are tallied by column. For the meaning of categorical variables, refer to Table 2 and/or Section 2.1.4 of the paper.

[a] This row reports the number of responses in wave 1 for each category of the first set of Altruism questions—where giving is unsubsidized—*among respondents who answered both question types.*

[b] This column reports the number of responses in wave 1 for each category of the second set of Altruism questions—where giving is subsidized—*among respondents who answered both question types.*

Table 30: Frequencies, State Smoothing Across Waves

	Wave 1					
Wave 2	1	2	3	4	5	# of Responses [b]
1	37.9	45.5	44.1	41.2	22.6	66
2	18.2	13.6	5.9	8.8	9.7	22
3	18.2	18.2	20.6	2.9	3.2	34
4	12.1	18.2	20.6	20.6	16.1	34
5	13.6	4.5	8.8	26.5	48.4	31
# of Responses [a]	66	22	34	34	31	187
Total Responses [c]	105	31	45	44	35	260

Notes: Percentages are tallied by column. For the meaning of categorical variables, refer to Section B of the paper.
[a] This row reports the number of responses in wave 1 for each category of State Smoothing *among respondents who were present in both waves of the sample.*
[b] This column reports the number of responses in wave 2 for each category of State Smoothing *among respondents who were present in both waves of the sample.*
[c] This row reports the number of responses in wave 1 for each category of State Smoothing among all respondents in wave 1.

Table 31: Frequencies, Disability Insurance Across Waves, Ignorning New Questions in Wave 2

	Wave 1							
Wave 2	-1	0	1	2	3	4	5	# of Responses [b]
-1	66.7	0	0	27.3	28.6	0	0	15
0	26.7	50	33.3	9.1	28.6	0	0	8
1	0	0	0	9.1	14.3	0	0	3
2	6.7	25	66.7	36.4	28.6	0	0	11
3	0	25	0	18.2	0	100	100	7
4	0	0	0	0	0	0	0	2
5	0	0	0	0	0	0	0	1
# of Responses [a]	15	8	3	11	7	2	1	47
Total Responses [c]	26	12	5	20	12	4	2	81

Notes: Percentages are tallied by column. We ignore that Wave 2 contained several questions not included in the first wave for this table. For the meaning of categorical variables, refer to Section B of the paper.
[a] This row reports the number of responses in wave 1 for each category of DI preferences *among respondents who were present in both waves of the sample.*
[b] This column reports the number of responses in wave 2 for each category of DI preferences *among respondents who were present in both waves of the sample.*
[c] This row reports the number of responses in wave 1 for each category of DI preferences among all respondents in wave 1.

Table 32: Frequencies, Disability Insurance Across Waves, Including New Questions in Wave 2

	Wave 1							
Wave 2	-1	0	1	2	3	4	5	# of Responses [b]
-5	40.0	0	0	9.1	0	0	0	7
-4	13.3	0	0	9.09	0	0	0	3
-3	6.67	0	0	0	28.6	0	0	3
-2	6.67	0	0	0	0	0	0	1
-1	0	0	0	9.1	0	0	0	12
0	26.7	50.0	33.3	9.1	28.6	0	0	12
1	0	0	0	9.1	14.3	0	0	2
2	6.7	25	66.7	36.4	28.6	0	0	11
3	0	25	0	18.2	0	100	100	7
4	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
# of Responses [a]	15	8	3	11	7	2	1	47
Total Responses [c]	26	12	5	20	12	4	2	81

Notes: Percentages are tallied by column. Unlike the previous table, we create additional categorical variables for Wave 2, since Wave 2 contained several questions not included in the first wave for this table. For the meaning of categorical variables, refer to Section B of the paper.

[a] This row reports the number of responses in wave 1 for each category of DI preferences *among respondents who were present in both waves of the sample.*

[b] This column reports the number of responses in wave 2 for each category of DI preferences *among respondents who were present in both waves of the sample.*

[c] This row reports the number of responses in wave 1 for each category of DI preferences among all respondents in wave 1.

D Questionnaire

In this section, we attach the full questionnaire which implemented those research designs described in Section 2.1 and Appendix B.

SECTION BC: WEALTH, WORK, INCOME, AND SPENDING PREFERENCES

BC0. **INTERVIEWER CHECKPOINT**:

- 1. RDD
- 2. RECON —--> **GO TO NEXT SECTION**

BC1. It is often said that one thousand dollars is worth more to a poor family than to a rich family. Do you agree?

- 1. YES
- 5. NO **GO TO BC10**

BC2. Think of two families like yours, one with the same income as your family, the other with twice your family's income. Thinking of how much a given amount of money would mean to these two families, which would make a bigger difference, one thousand dollars to the family with an income like yours or four thousand dollars to the family with twice your family's income?

- 1. $1000 TO FAMILY LIKE YOURS **GO TO BC4**
- 5. $4000 TO FAMILY WITH TWICE THE INCOME

BC3. Which would make a bigger difference, one thousand dollars to the family with an income like yours or two thousand dollars to the family with twice your family's income?

- 1. $1000 TO FAMILY LIKE YOURS
- 5. $2000 TO FAMILY WITH TWICE THE INCOME

GO TO BC6

BC4. Which would make a bigger difference, one thousand dollars to the family with an income like yours or eight thousand dollars to the family with twice your family's income?

- 1. $1000 TO FAMILY LIKE YOURS
- 5. $8000 TO FAMILY WITH TWICE THE INCOME **GO TO BC6**

BC5. Which would make a bigger difference, one thousand dollars to the family with an income like yours or fifteen thousand dollars to the family with twice your family's income?

1. $1000 TO FAMILY LIKE YOURS	5. $15,000 TO FAMILY WITH TWICE THE INCOME

BC6. Again, think of two families like yours: one with half the income of your family, the other with the same income as your family. Which would make a bigger difference, one thousand dollars to the family with half your family's income or four thousand dollars to the family with an income like yours?

1. $1000 TO FAMILY WITH HALF THE INCOME	5. $4000 TO FAMILY LIKE YOURS
GO TO BC8	↓

BC7. Which would make a bigger difference, one thousand dollars to the family with half your family's income or two thousand dollars to the family with an income like yours?

1. $1000 TO FAMILY WITH HALF THE INCOME	5. $2000 TO FAMILY LIKE YOURS

GO TO BC10

BC8. Which would make a bigger difference, one thousand dollars to the family with half your family's income or eight thousand dollars to the family with an income like yours?

1. $1000 TO FAMILY WITH HALF THE INCOME	5. $8000 TO FAMILY WITH TWICE THE INCOME
↓	**GO TO BC10**

BC9. Which would make a bigger difference, one thousand dollars to the family with half your family's income or fifteen thousand dollars to the family with an income like yours?

1. $1000 TO FAMILY WITH HALF THE INCOME	5. $15,000 TO FAMILY LIKE YOURS

BC10. Now we have a few questions about how you deal with uncertainty. Compared to the average person, when there is uncertainty, are you more likely to take precautions, less likely to take precautions, or about average?

1. MORE LIKELY	3. AVERAGE	5. LESS LIKELY

BC11. Compared to the average person, are you more pessimistic, more optimistic, or about average in your optimism or pessimism?

1. MORE PESSIMISTIC	3. AVERAGE	5. MORE OPTIMISTIC

BC12. Are you quite willing to take risks, not very willing to take risks, or about average in your willingness to take risks?

1. QUITE WILLING	3. AVERAGE	5. NOT VERY WILLING

BC13. Now we would like to ask about some financial decisions in a number of different situations. First, suppose you are sure that your overall income and spending next year will be exactly the same as this year and that there will be no inflation. When you go to make a necessary purchase, you have the choice between paying two hundred dollars now or a larger amount a year from now. Would you prefer to pay two hundred dollars now or two hundred ten dollars a year from now?

1. $200 NOW — **GO TO BC17**

5. $210 ONE YEAR FROM NOW

BC14. Would you prefer to pay two hundred dollars now or two hundred twenty dollars a year from now?

1. $200 NOW — **GO TO BC17**

5. $220 ONE YEAR FROM NOW

BC15. Would you prefer to pay two hundred dollars now or two hundred fifty dollars a year from now?

1. $200 NOW — **GO TO BC17**

5. $250 ONE YEAR FROM NOW

BC16. Would you prefer to pay two hundred dollars now or three hundred dollars a year from now?

1. $200 NOW

5. $300 ONE YEAR FROM NOW

BC17. Second, suppose an established business has hired you with a start date a little less than a year from now. This employer values your skills so highly that, as soon as you start the new job, your family income will double, and you plan to double your family spending as well. You cannot increase your total spending now because you cannot do any more borrowing than you now plan.

It is necessary for you to make a purchase now, before the new job starts. You are given the choice between paying two hundred dollars now, which would require you to reduce other expenditures, or you can pay a larger amount twelve months from now after your income and spending double. Would you prefer to pay two hundred dollars now or two hundred fifty dollars a year from now after your income doubles?

1. $200 NOW
GO TO BC21

5. $250 ONE YEAR FROM NOW

BC18. Would you prefer to pay two hundred dollars now or three hundred dollars a year from now after your income doubles?

1. $200 NOW
GO TO BC21

5. $300 ONE YEAR FROM NOW

BC19. Would you prefer to pay two hundred dollars now or four hundred dollars a year from now after your income doubles?

1. $200 NOW
GO TO BC21

5. $400 ONE YEAR FROM NOW

BC20. Would you prefer to pay two hundred dollars now or eight hundred dollars a year from now after your income doubles?

1. $200 NOW

5. $800 ONE YEAR FROM NOW

BC21. In the third situation, suppose you have a fifty-fifty chance of getting a great new job in another city. The new job would double your lifetime family income, so you plan to take it if you get the offer.

If you do move to take the new job, there is a card you will need to obtain any services in the new city. Before you know whether you will be moving or not, you have to choose whether or not to make a two hundred dollar deposit for that card. If you move to take the new job, you will get the two hundred dollar deposit back when you actually buy the card. However, you will lose the money if you don't end up moving. If you don't pay the two hundred dollar deposit now, the price of the card will be higher. This won't matter if you don't end up moving, but if you do end up moving, you will have lost money by not making the deposit.

Keep in mind that getting the new job and not getting the job are equally likely, but that you will have double the life-time income if you get the new job. Would you prefer to risk losing two hundred fifty dollars if you do get the new job or risk losing two hundred dollars if you don't get the job offer?

1. $250 IF GET NEW JOB

5. $200 IF DON'T GET JOB
GO TO BC25

BC22. Would you prefer to risk losing three hundred dollars if you do get the new job or risk losing two hundred dollars if you don't get the job offer?

1. $300 IF GET NEW JOB

5. $200 IF DON'T GET JOB
GO TO BC25

BC23. Would you prefer to risk losing four hundred dollars if you do get the new job or risk losing two hundred dollars if you don't get the job offer?

1. $400 IF GET NEW JOB

5. $200 IF DON'T GET JOB
GO TO BC25

BC24. Would you prefer to risk losing eight hundred dollars if you do get the new job or risk losing two hundred dollars if you don't get the job offer?

1. $800 IF GET NEW JOB

5. $200 IF DON'T GET JOB

BC25. Now consider a fourth situation. Suppose that you are the only income earner in the family. Your doctor recommends that you move because of allergies, and you have to choose between two possible jobs.

The first would guarantee your current total family income for life. The second is possibly better paying, but the income is also less certain. There is a fifty-fifty chance that the second job would increase your total lifetime income by twenty percent and a fifty-fifty chance that it would cut it by ten percent. Which job would you take –- the job that would guarantee your current income or the job that might increase or decrease it?

1. JOB THAT GUARANTEES CURRENT INCOME	2. JOB THAT MIGHT INCREASE OR DECREASE INCOME

GO TO BC25b

BC25a. Suppose the chances were fifty-fifty that the second job would increase your total lifetime income by twenty percent, and fifty-fifty that it would cut it by fifteen percent. Would you still take this job or would you take the job that guarantees your family income?

2. JOB THAT MIGHT INCREASE OR DECREASE INCOME	1. JOB THAT GUARANTEES CURRENT INCOME

GO TO BC26

BC25b. Suppose the chances were fifty-fifty that the other job would increase your lifetime income by twenty percent and fifty-fifty that it would cut it by five percent. Would you still take the job that guarantees your current family income or would you take the job that might increase or decrease it?

1. JOB THAT GUARANTEES CURRENT INCOME	2. JOB THAT MIGHT INCREASE OR DECREASE INCOME

BC26. The fifth situation is similar, but the size of the risk is different. Again, suppose you are the only income earner in the family. You have to choose between two new jobs. The first would guarantee your current total family income for life. The second job has a fifty-fifty chance of doubling your total lifetime family income and a fifty-fifty chance of cutting your total lifetime family income by a third. Would you take the job that guarantees your current income or the job that might increase or decrease it?

1. JOB THAT GUARANTEES CURRENT INCOME	2. JOB THAT MIGHT INCREASE OR DECREASE INCOME
GO TO BC26b	↓

BC26a. Suppose the chances were fifty-fifty that the second job would double your lifetime income and fifty-fifty that it would cut it in half. Would you still take this job or would you take the job that would guarantee your current family income?

2. JOB THAT MIGHT INCREASE OR DECREASE INCOME	1. JOB THAT GUARANTEES CURRENT INCOME

GO TO BC27

BC26b. Suppose the chances were fifty-fifty that the other job would double your lifetime income and fifty-fifty that it would cut it by twenty percent. Would you still take the job that would guarantee your current family income or would you take the job that might increase or decrease it?

1. JOB THAT GUARANTEES CURRENT INCOME	2. JOB THAT MIGHT INCREASE OR DECREASE INCOME

BC27. **INTERVIEWER CHECKPOINT**:

☐ 1. R IS 40 YEARS OLD OR OVER
☐ 2. OTHERS ---> **GO TO BC37**

BC28. Do you have any living grown children, age 30 or over?

1. YES	5. NO **GO TO BC37**

BC29. We would like to find out about situations in which you (and your (husband/ wife/partner)) might be willing to give substantial financial help to a grown son or daughter. You should suppose that any help you give will not be repaid and that your child has been unlucky rather than lazy.

Suppose that one of your grown children had only half as much income per person to live on as you do. Would you be willing to give your child five percent of your own income each month to help out until things change -- which might be several years?

1. YES	5. NO **GO TO BC32**

BC30. Suppose now that this child had three-quarters as much income per person as you do. Would you be willing to give your child five percent of your own income each month?

1. YES	5. NO **GO TO BC33**

BC31. Suppose now that this child had nine-tenths as much income per person as you do. Would you be willing to give your child five percent of your own income each month?

1. YES	5. NO

GO TO BC33

BC32. Suppose now that this child had one-third as much income per person as you do. Would you be willing to give your child five percent of your own income each month?

1. YES | 5. NO

BC33. Now, suppose that the government gave you a fifty percent tax credit for any gifts of money that you give your grown children, so that every hundred dollars you give your child costs you only fifty dollars after you get the tax break.

Suppose that one of your grown children had only half as much income per person to live on as you do. Would you be willing to give your child five percent of your own income each month, if you received this tax credit?

1. YES | 5. NO
GO TO BC36

BC34. Suppose now that this child had three-quarters as much income per person as you do, would you be willing to give your child five percent of your own income each month, if you received this tax credit?

1. YES | 5. NO
GO TO BC37

BC35. Suppose now that this child had nine-tenths as much income per person as you do. Would you be willing to give your child five percent of your own income each month if you received this tax credit?

1. YES | 5. NO

GO TO BC37

BC36. Suppose now that this child had one-third as much income per person as you do. Would you be willing to give your child five percent of your own income each month, if you received this tax credit?

1. YES | 5. NO

BC37. Are you doing any work for pay at the present time?

1. YES

5. NO

BC38. INTERVIEWER CHECKPOINT

1. R IS MARRIED/LIVING WITH A PARTNER --> **GO TO BC39**
2. R IS NOT MARRIED --> **GO TO BC40**

BC39. Does your (husband/wife/partner) do any work for pay at the present time?

1. YES

5. NO

BC40. INTERVIEWER CHECKPOINT

1. R IS SINGLE AND WORKS FOR PAY (BC37=1 AND BC38=2) OR R IS MARRIED/LIVING WITH A PARTNER AND ONLY R WORKS FOR PAY (BC37=1 AND BC38=1 AND BC39 NOT 1) --> **GO TO BC41**
2. OTHER --> **GO TO NEXT SECTION**

BC41. About how many hours do you work for pay in a typical week?

________________ HOURS PER WEEK

BC42. Could you work <u>fewer</u> than [RESPONSE IN BC41] hours per week if you wanted to?

1. YES — **GO TO BC43**

5. NO

BC42a. Would you like to work fewer than [RESPONSE IN BC41] hours per week?

1. YES

5. NO — **GO TO BC43**

BC42b. How many <u>fewer</u> hours per week would you like to work?

________________ HOURS PER WEEK

BC43. Could you work <u>more</u> than [RESPONSE IN BC41] hours per week if you wanted to?

1. YES — **GO TO BC44**

5. NO

BC43a. Would you like to work more than [RESPONSE IN BC41] hours per week?

1. YES

5. NO — **GO TO BC44**

BC43b. How many <u>additional</u> hours per week would you like to work?

________________ HOURS PER WEEK

BC44. At what age do you expect to retire?
[IF R SAYS HE/SHE IS RETIRED, ENTER ZERO]

________________ AGE

BC45. Now we would like to ask how three possible events might affect your decision about how many hours you would like to work. In each case, please answer as if you are able to choose the number of hours you work.

First, suppose that your hourly pay rate was doubled for the rest of your life. Compared to the [RESPONSE BC41] hours per week you currently work, would you increase your work hours, decrease your work hours, or keep them the same?

1. INCREASE	3. NO CHANGE	5. DECREASE	6. WOULD QUIT WORK ENTIRELY
↓	**GO TO BC45b BOX**	↓	**GO TO BC46**

BC45a. By about how many hours per week would you (increase/decrease) your work hours?

________________ HOURS PER WEEK INCREASE/DECREASE

IF BC45 IS MARKED 1,3,5 THEN GO TO BC45b
ELSE GO TO BC46

BC45b. [SKIP IF BC44 NOT ANSWERED, ZERO OR DK/NA]
You told me before that you expect to retire at age [RESPONSE IN BC44]. With the doubling of your pay rate, at what age would you plan to retire?

________________ AGE

BC46. Second, instead of having your pay rate doubled, suppose that you won a lottery that would pay you every year an amount equal to half of last year's (family) income for as long as you live. We'd like to know what effect the lottery money would have on your work hours if your work hours were flexible.

Compared to the [RESPONSE IN BC41] hours per week you currently work, would the lottery money cause you to increase your work hours, decrease your work hours, or keep them the same?

1. INCREASE	3. NO CHANGE	5. DECREASE	6. WOULD QUIT WORK ENTIRELY
↓	**GO TO BC46b BOX**	↓	**GO TO BC47**

BC46a. By about how many hours per week would you (increase/decrease) your work hours?

________________ HOURS PER WEEK INCREASE/DECREASE

IF BC46 IS MARKED 1,3,5 THEN GO TO BC46b
ELSE GO TO BC47

BC46b. [SKIP IF BC44 NOT ANSWERED, ZERO OR DK/NA]
You told me before that you expect to retire at age [RESPONSE IN BC44]. With the extra income from the lottery, at what age would you plan to retire?

________________ AGE

BC47. Third, instead of winning the lottery or having your pay rate doubled, suppose your work is so badly needed that your employer offers to pay you one and a half times your regular hourly pay rate for any extra hours you work above your current schedule of [RESPONSE in BC41] hours per week. For the rest of your working life, you will be able to work as many extra hours as you choose at time and a half pay.

If you were paid time and a half for any hours worked in addition to your current schedule of [RESPONSE in BC41], would you increase your work hours, decrease your work hours, or keep them the same?

1. INCREASE	3. NO CHANGE	5. DECREASE	6. WOULD QUIT WORK ENTIRELY
↓	**GO TO BC47b BOX**	↓	**GO TO BC48**

BC47a. By about how many hours per week would you (increase/decrease) your work hours?

________________ HOURS PER WEEK INCREASE/DECREASE

IF BC47 IS MARKED 1,3,5 THEN GO TO BC47b
ELSE GO TO BC48

BC47b. [SKIP IF BC44 NOT ANSWERED, ZERO OR DK/NA]
You told me before that you expect to retire at age [RESPONSE IN BC44]. If you were paid time and a half for extra hours, at what age would you plan to retire?

________________ AGE

BC48. Suppose you have a serious accident that may affect your ability to work and earn a living but will not otherwise affect your life. Fortunately, your (family's) medical expenses will be covered by government medical insurance for the rest of your life. (Even if you can't work, your spouse does not plan to get a job). If you are not able to work, your current disability insurance will only allow your family to spend half as much every month as you do now. But you have the opportunity to buy additional disability insurance.

Both you and the insurance company think you have a fifty-fifty chance of never being able to work again and a fifty-fifty chance of being able to return to work as usual in a few months. The insurance company offers you a contract in which they agree to pay you an additional ten percent of your current income per month until you are sixty-five if you are not able to work, while you agree to pay them a larger amount every month until you are sixty-five if you can work.

Keep in mind that without additional disability insurance, being unable to work would mean that you could only spend half as much every month as you do now. Would you be willing to pay fifteen percent of your income if you can work in order to get the ten percent of your current income if you are not able to work?

1. YES — **GO TO BC51**

5. NO ↓

BC49. Would you be willing to pay twelve and a half percent of your income if you can work in order to get the ten percent of your current income if you are not able to work?

1. YES — **GO TO NEXT SECTION**

5. NO ↓ **GO TO BC50**

BC50. Would you be willing to pay ten percent of your income if you can work in order to get the ten percent of your current income if you are not able to work?

1. YES | 5. NO

GO TO NEXT SECTION

BC51. Would you be willing to pay twenty percent of your income if you can work in order to get the ten percent of your current income if you are not able to work?

1. YES | 5. NO **GO TO NEXT SECTION**

BC52. Would you be willing to pay thirty percent of your income if you can work in order to get the ten percent of your current income if you are not able to work?

1. YES | 5. NO **GO TO NEXT SECTION**

BC53. Would you be willing to pay forty percent of your income if you can work in order to get the ten percent of your current income if you are not able to work?

1. YES | 5. NO