Intertemporal stability of survey-based measures of risk and time preferences over a three-year course

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Intertemporal stability of survey-based measures of risk and time preferences over a three-year course *

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Abstract: Given the importance of risk and time preferences for economics and other disciplines, we seek to examine the intertemporal stability of six related survey-based measures. Using a panel of subjects over a three-year course, between 2013 and 2015, we find aggregate stability of all six measures over the time span of our data. With few exceptions, the measures also show remarkably high individual stability over the examined period. Our results contribute to the wider adoption of survey-based measures, especially considering the ease with which such measures can be incorporated in large-scale surveys.

Keywords: Delay Discounting; Risk Taking; Risk perception.

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PsycINFO classification: 3920.

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1 Introduction

Economic theory suggests that the heterogeneity observed in decisions regarding retirement plans, occupational choices, insurance or other aspects of everyday life can be explained by differences in agents' budget constraints as well as in their Risk and Time Preferences (RTPs). In addition, in almost all theories of economic behavior, utility functions are defined over goods, time periods and states of nature, placing RTPs at the crux of consumer behavior as traditionally studied in economics. Given that cost-benefit analysis calls for welfare calculations involving outcomes that are delayed or uncertain, policy recommendations should be always analyzed through the prism of these two concepts before they are put into action (Harrison et al., 2005).

In economic analysis, individual preferences are considered to be stable over time. Andersen et al. (2008b) argue that the assumption of stable preferences lies in the ability to assign causation between changing opportunity sets and choices in comparative statics exercises or, in Stigler and Becker's (1977) words, "no significant behavior has been illuminated by assumptions of differences in tastes". For example, academics generalize observed choices among lotteries in the lab or in the field to build behavioral models and estimate risk parameters. Similarly, professionals in the financial, insurance and health sector propose long-term products to their clients based on stated RTPs at the time of purchase. Implicitly, for these models/parameters or products to be of any use, stability of subjects or clients RTPs over their lifespan or period of investment is essential (Baucells and Villass, 2010). Otherwise, if individuals' intertemporal trade-offs change over time, preference parameters have to be separately measured and accounted for in each time period (Meier and Sprenger, 2015). In the same spirit, Harrison et al. (2005) note that if preferences are volatile with respect to the passage of time, then researchers and policy-makers using out-of-sample predictions should worry about their conclusions. Aside individual invariance, aggregate stability of RTPs is also a very important concept in policy-making since, according to Meier and Sprenger (2015), if the aggregate distribution of behavior is unstable, then individual preference parameters will also exhibit such property. On the other hand, if choices over time are stable in the aggregate, then individuals' plans and surveys may very well serve as tools in the pursuit of optimal policies in terms of social choice.

A number of methods have been proposed in the literature to measure RTPs. Risk preferences are usually measured in controlled laboratory experiments, using standard procedures such as the elicitation of certainty or probability equivalents of lotteries through incentive-compatible mechanisms (e.g., the Becker, Degroot and Marshak (BDM) mechanism, first- and second-price auctions etc.) or the well-established methods proposed by Holt and Laury

(2002), Lejuez et al. (2002), Gneezy and Potters (1997) and Eckel and Grossman (2002, 2008). Analogously, typical measures of time preferences stem from experiments that either jointly elicit risk and time preferences (Andersen et al., 2008a) using the multiple price list method (e.g., Coller and Williams, 1999), or Andreoni and Sprenger's (2012) convex time budget (CTB). [1]

However, lab experiments do have their limitations and thus, field and laboratory experiments should be treated as complementary tools in the evaluation of risk and time preferences (Andersen et al., 2010). Due to budget constrains, conducting large scale laboratory experiments to elicit preferences from representative samples is usually infeasible. Furthermore, although the methods presented above have been found to perform fairly well in predicting real life RTPs regarding financial decisions, there is doubt on whether they generalize to important domains of life other than financial decision-making. For example, although present bias in an intertemporal choice task has been found to be associated with credit card debt and creditworthiness (Meier and Sprenger, 2010, 2012), savings behavior (Ashraf et al., 2006) and scholastic achievement (Mischel et al., 1989), Chabris et al. (2008) and Borghans and Golsteyn (2006) argue that experimentally elicited discount rates correlate only very weakly with health-related behavior such as exercising and smoking. With respect to risk preferences, Barseghyan et al. (2011) and Einav et al. (2012) found that many individuals do not exhibit comparable degrees of risk aversion in different life domains, such as health, disability or car insurance while Deck et al. (2008) has suggested that this difference might be related to the instability of risk preferences across experimental tasks. Finally, Dreber et al. (2011) show that the risk taking among bridge players differed substantially between the domains of bridge and financial decision-making while MacCrimmon and Wehrung (1990) argue that the risk attitudes of company managers appear to differ for risks in the recreational and financial domain. To this end, questionnaire-based measures of eliciting RTPs in the field and in various domains have witnessed a growing popularity in recent years (e.g., Dohmen et al., 2011).

In this study, we examine the invariance of RTPs using primary longitudinal data on survey-based measures over a three-year course. To our knowledge, very few studies have evolved around the stability of RTPs using such measures in the relevant literature. In addition, our study is one of the very few that elicits preferences more than twice over the same subjects. Finally, the span of our data is one of the the widest (T3−T1=2 years) while our sample size, even after two years of attrition, is at least comparable to many other studies using primary data. Echoing the literature on stability of RTPs we find aggregate

[1] For elaboration on these methods see Charness et al. (2013) and Drichoutis and Nayga (2013); Andreoni et al. (2015) for risk and time preferences, respectively.

stability of RTPs over the three-year course of our study. In addition, we find remarkable individual stability of most RTPs measures we employ over the same period while only a few of our measures show instability.

In the next section we survey the literature that examines stability of RTPs to set the context of our study. We present the details of our survey methods and sample characteristics in Section 3. Next, we present our analysis regarding temporal stability of RTPs at the aggregate and individual level. We conclude in the last section.

2 Literature review

Despite the importance of RTPs for economic research, the results regarding their stability are mixed. Below, we provide a list of published articles examining the stability of time (Table 1) and risk (Table 2) preferences; we acknowledge of course that this list might be non-exhaustive. Note, that we have deliberately excluded studies using secondary data (e.g., Josef et al., 2016; Chuang and Schechter, 2015; Niv et al., 2012; McGlothlin, 1956) since the methods of measurement, the sample sizes as well as time lapses differ vastly not only with our study but with most studies that involve primary data collection in general. We have also included only studies that—like ours—examine time-invariance (in the terminology of Halevy, 2015). That is, we do not consider other types of time-stability such as consistency or stationarity (e.g., Horowitz, 1992; Giné et al., 2016; Li et al., 2013 or some treatments of Halevy, 2015).[2,3] Finally, we exclude studies whose subjects were selected using criteria related to various medical disorders (e.g., Littlefield et al., 2015; Aklin et al., 2009; Bickel et al., 2011; Takahashi et al., 2007).[4]

2.1 Studies on time preferences

Interestingly, as shown in Table 1, most articles regarding the stability of time preferences come from fields outside economics, such as psychology, decision science and neuroscience. All studies that are discussed below involved some kind of choice between sooner-smaller amounts and later-lower rewards; specific money and delay ranges are reported in Table 1.

[2] In the terminology of Horowitz (1992), intertemporal stationarity is similar to Halevy's (2015) time-invariance but different than stationarity as defined in Horowitz (1992).

[3] In Li et al. (2013), although the design would allow for tests of time-invariance, correlations across waves are not reported. However, it is stated that in the case of temporal discounting and loss aversion, common variance and substantial stability over 1 year is observed.

[4] Of course, some could argue that nicotine dependence falls within this category and thus Baker et al.'s (2003) and Johnson et al.'s (2007) studies should also be excluded from the review. However, since nicotine dependence is quite common and might be also present in many other studies that do not control for it, we do not expect to have affected their results.

In particular, Olson et al. (1999) report individual differences in children's willingness to wait for a delayed reward that are relatively stable across 2-years' time. Simpson and Vuchinich (2000) assessed discount rates for hypothetical monetary gains for 15 participants in two sessions separated by 1 week and found a high correlation between sessions. Baker et al. (2003) also examined the 1-week stability of discount rates for 30 current smokers and 30 never-before smokers with also high test-retest correlations while Johnson et al. (2007) replicated this study in a group of 30 light smokers with similar results. Ohmura et al. (2006) compared indifference points and discounting parameters (e.g., hyperbolic k and area under the curve) elicited by the same 22 students in two different occasions within an interval of three months and found that time preferences were invariant across time. In Kable and Glimcher (2007), as part of a screening for an fMRI session, 12 subjects were asked to make incentivized choices in three different sessions conducted within 3 days to 6 months. Results indicate that ten out of the twelve subjects revealed stable discount rates.

Peters and Büchel (2009) compared discount rates derived from a behavioral pretest shortly (median time distance 4 days) before an fMRI session with discount rates observed during fMRI scanning and found a high correlation. To examine long-term stability, they also repeated the experiment after approximately 4 months, using 13 subjects from the initial pool and discount rates showed stability between testing sessions. Ballard and Knutson (2009) faced their 16 subjects with incentivized choice tasks; first in front of a computer and then in a fMRI scanner with choices revealing within-subjects reliability. In a very interesting study, Anokhin et al. (2011) offered subjects the same real choice at two different points in time, with a 2-year time lapse. Subjects were 606 12-year-olds from 303 pairs of mono-zygotic and di-zygotic twins who were re-tested at the age of 14. The choice was given individually to each twin who was unaware of their co-twin's choice. They report a highly significant within-subject association between choices made at ages 12 and 14 but a significant decrease in the prevalence of impulsive choices with age. Finally, in one of the few relevant studies with more than 2 periods, Kirby (2009) collected choices with monetary incentives between sooner immediate and later rewards from student-subjects. The procedure was repeated after 5 weeks and 52 weeks thereafter. The common sample between periods 1-2, 2-3 and 1-3 was 81, 37 and 46, respectively. Their results indicate high temporal aggregate stability and suggest that the discount rate for monetary rewards is a stable individual trait.

In the economics literature, Kirby et al. (2002), used a pool of 154 Tsimane' Amerindians (10-80 years of age) and a series of incentive compatible choices over 4 quarters. Their results indicate that, starting from the second quarter and for both monetary and candy choices, the correlations between the discount rates derived from consecutive periods are reliable (albeit low). Furthermore, excluding the first period, all rates were associated with a single underlying factor.[5] Wölbert and Riedl (2013) report both aggregate stability as well as high test-retest correlations between the incentivized choices made by 53 student-subjects within an interval of 5 to 10 weeks. Dean and Sautmann (2014) and Meier and Sprenger (2015) found that aggregate choice profiles and corresponding estimates of discount parameters are unchanged over a period of one week and one year, respectively. They also report significant within-subjects rate correlations in their samples of 960 individuals in the former and 250 subjects in the latter study. Finally, Halevy (2015) used a sample of 130 student subjects to study various properties of time preferences including time-invariance. Unlike previous findings, his results suggest that average choices are inconsistent with the time invariance assumption since subjects are, on average, more impatient for a one week delay when asked at a later date. In addition, depending on the treatment, the amount of sooner payment and whether choices are interpreted as revealing strict or weak preference, the percentage of subjects that made time-invariant choices ranged from 44% to 68%.

[5]Although Kirby et al. (2002) provide pair-wise correlation coefficients for rates across all periods, they do not discuss their statistical significance, nor perform aggregate comparisons.

Table 1: Literature on temporal stability of time preferences

	Type of sample	N at T1	N at T2	Common N	Time lapse	Methods	Incentives
Olson et al. (1999)	6-yo children	80	89	NA	2 years	Choices between a single treat immediately available or a handful of treats later on	Real
Simpson and Vuchinich (2000)	students	15	15	15	1 week	Choices between a standard larger later option ($1,000) and a smaller immediate option. The magnitude of the sooner option (from $1 to $1000) was adjusted across trials until an indifference point was determined. Delay periods range from 1 week to 25 years	Hypothetical
Kirby et al. (2002)	10-80 year olds	154	≈157 (same in T3&T4)	95-123	3 months	Choices between immediate monetary and food rewards and larger later rewards. Immediate rewards range from $b3.1 to $b8 (6 to 16 candies) and delayed from $b 7.5 to $b 8.5 (15 to 17 candies) for the monetary (food) treatment. Delays range from 7 to 157 days for both treatments	Monetary & food: 1 of the 8 monetary choices and 1 of the 7 candy choices were binding
Baker et al. (2003)	Heavy- and non- smokers	60	60	60	1 week	Choices between a standard larger later option of various magnitudes (e.g., $10, $100, and $1,000) and a smaller immediate option. The magnitude of the sooner option is adjusted across trials until an indifference point is determined. Delay periods range from 1 week to 25 years	Both monetary (1 random choice from $10 and $100 choices is binding) & Hypothetical
Ohmura et al. (2006)	Students	22	22	22	3 months	Choices between a standard larger later option of 100,000 yen and a smaller immediate option. The magnitude of the sooner option ranges between 100 and 100,000 yen. Delay periods range from 1 week to 25 years	Hypothetical
Johnson et al. (2007)	Light smokers	30	30	30	1 week	Choices between a standard larger later option of various magnitudes (e.g., $10, $100, and $1,000) and a smaller immediate option. The magnitude of the sooner option is adjusted across trials until an indifference point is determined. Delay periods range from 1 week to 25 years	Both monetary (1 random from $10 and $100 choices is binding) & Hypothetical
Kable and Glimcher (2007)	Adults	12	12 (T3: 12)	12 (T3:12)	3 days-6 months	Choices between immediate reward of $20 and a larger delayed reward that varies randomly from $20.25 to $110. The delay ranges from 6 h to 180 d	Monetary: subjects are paid according to four randomly selected trials per session (except for the first session, which is hypothetical)

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Table 1: Literature on temporal stability of time preferences (Cont.)

	Type of sample	N at T1	N at T2	Common N	Time lapse	Methods	Incentives
Peters and Büchel (2009)	Adults	22	22(short) 13(Long)	22(short) 13(Long)	Short ≈ 4 days; Long≈ 4 months	Choices between €20 available immediately and greater amounts at different delays or probabilities (not specified)	Monetary: 1 out of 96 trails randomly selected as binding
Ballard and Knutson (2009)	Adults	16	16	16	Not specified but short	Choices between $10 available immediately and greater amounts ($10.00, $10.50, $11.00, $13.00, $15.00, $20.00, $25.00) at different delays (0, 7, 30, 60, 90, 180 days)	Monetary: 1 out of 84 trials randomly selected as binding in T1, same in T2
Kirby (2009)	Students	100	81 (T3:46)	81 (T1&T2&T3:37)	T2-T1=5 weeks; T3-T2=1 year	Choices between immediate rewards and larger later rewards. Delays range from 7 to 186 days. Delayed rewards range from $25 to $85.	Monetary: one subjects out of every sessions is paid for one choice
Anokhin et al. (2011)	12-yo twins	744	606	606	2 years	Choice between $7 in cash immediately or $10 in 7 days	Monetary: Decision is binding
Wölbert and Riedl (2013)	Students	144	53	53	5-10 weeks	Choices between sooner rewards and later rewards. Smaller-sooner amounts range from €11 to €54, and the larger-later amounts range from €25 to €60. Delays range from 7 days to 200 days.	Monetary: 1 decision is randomly chosen as binding
Dean and Sautmann (2014)	Household heads	969	965 (T3:961)	965 (T3:961)	1 week	Choices between sooner rewards and later rewards. Smaller-sooner amounts range from CFA 50 to CFA 400, and the larger-later amount is CFA 300. Delay trade-offs are (A) now vs. next week and (B) next week vs. a week thereafter	Monetary: 1 decision in each wave is randomly chosen as binding
Meier and Sprenger (2015)	Subjects visiting tax assistance sites	890	794	203	≈1 year	Choices between sooner rewards (that vary from $49 to $14) and a larger later reward set at $50. Time frame for sooner reward varies between now and 6 months. Time frame for later reward varies between 1 and 6 months.	Monetary: 10% of individuals is randomly paid one of their choices
Halevy (2015)	First-year Students	149	130	130	4 weeks	Choices between sooner rewards ($10 and $100) and MPLs with later rewards set at $9.9 to $11 and $99 to $110, respectively. Time frame for sooner reward is now and for later reward it is 1 week	Monetary: 1 student is paid according to her choices in the $100 lottery and the rest according to those in the $10 one; 50-50% T1 or T2 decisions on these lotteries are binding

Notes: 'N at T1' and 'N at T2' stand for sample size at Time 1 and 2 respectively. 'Common N' is the sample size left after attrition at T2 or due to other constraints specified by the study. If preferences were elicited at a additional points, these are indicated as T3, T4 etc.

2.2 Studies on risk preferences

The picture of risk preferences studies is quite different than time preferences. As seen in Table 2, the majority of studies regarding the inter-temporal stability of risk preferences comes from the economics literature while many studies have been conducted over the last few years indicating a rising interest. In the non-economics literature, Ohmura et al. (2006) elicited Certainty Equivalents (CE) of hypothetical uncertain amounts in 18 students and found that CE (except those elicited under 10% probability) were correlated within-subjects while, at the aggregate level, most of the mean indifference points in probability discounting had absolute stability over a 3-month period. Levin et al. (2007) conducted a 3-year follow-up to 62 child-parent pairs from Levin and Hart's (2003) study, repeating the real choice tasks between risky and safe options from the original study. Their results are supportive of both aggregate and individual stability in children and parents. White et al. (2008) assessed the performance of 39 volunteers aged 18 to 35 years old in the incentivized Balloon Analogue Risk Task (BART, Lejuez et al., 2002) and concluded that the mean risk behavior (adjusted average pumps) as well as individuals' risk behavior between sessions did not change. Finally, Glöckner and Pachur (2012) repeated all Holt and Laury (2002) tasks and several gain, loss and mixed lottery choice tasks in two sessions, a week apart. They found that in most of the cases, people made the same choice at the two sessions while the correlations of the prospect theory parameters showed a large effect size.

Within the economics literature, Wehrung et al. (1984) using hypothetical investment scenarios, investigated the stability of the Constant Relative Risk Aversion (CRRA) coefficient over a 1-year period for 90 business executives and reported a small but highly significant positive correlation for the personal risk measures, but no stability for business risk propensity. Love and Robison (1984) examined risk preferences of 23 U.S. farmers using hypothetical choices between pairs of distributions of possible after-tax income levels. Their results imply that risk preferences were most stable at the income level representing the majority of the individuals but not for other income levels. Schoemaker and Hershey (1992) elicited CE for gains and losses from 160 MBA students and the same CE questions were administered 3 weeks later. Although some subjects were explicitly given monetary incentives to be consistent with their earlier answers ($10 for those in the highest decile in terms of consistency), test-retest correlations were low in both domains. Smidts (1997) examined long-run (1-year) risk attitudes concerning the market price for potatoes in 205 Dutch farmers. Using the midpoint chaining technique, he observes a strong correlation for the CRRA coefficient. Hey (2001) elicited preferences over 100 choices between pairwise risky lotteries made from 53 students and repeated over 5 periods that were separated by a few days from each other. During the 5 periods, a minimum of 4 to a maximum of 91 consecutive changes in stated preferences were observed. Also, over all 5 waves, the number of differing answers within-subjects ranged from 3 to 48, indicating that on at least half the questions, subjects had fixed stated preferences. Harrison et al. (2005) tested the stability of CRRA coefficients at two points in time using the Holt and Laury (2002) procedure over 5-6 months and found no significant differences. The same procedure was followed by Andersen et al. (2008b), but this time the lapses varied from 3 to 17 months. The CRRA coefficients were significantly correlated across time, although some variation was observed. In Goldstein et al. (2008), roughly 150 participants generated desired return distributions in hypothetical retirement savings scenarios in 2 sessions over a 1 year period (common sample was 85 subjects). Their results indicated that the transformed CRRA model-based risk parameters derived from the two different sessions were significantly correlated, especially when corrected for attenuation and investment experience.

Baucells and Villass (2010) on the other hand, concluded that albeit the statistical pattern among sessions was stable, there was a lot of instability in individual preferences across points in time. They used only two hypothetical lottery choice questions (one in the gain domain and 3 months later one in the loss domain) in 141 MBA student-subjects. Straznicka (2012) examined the 1-week stability of five different risk preference measures which all but one were of hypothetical nature. She observed an important stability of risk measures between sessions while at the individual level, the degree of risk aversion had significantly increased with the exception of survey-based measures that were found to be more stable. Zeisberger et al. (2012) elicited CE for gain, loss and mixed lotteries with real incentives from 73 students and observed considerable instability of risk aversion and probability weighting over a period of one month.

Wölbert and Riedl (2013), using a series of choices between a sure amount and a lottery in 53 student-subjects which were repeated within 5 to 10 weeks, concluded that risk aversion and probability weighting parameter estimates revealed consistency both at the individual and the aggregate level. Finally, in Lönnqvist et al. (2015), 44 student-subjects were called to make the same decisions in the incentivised Holt and Laury (2002) task within a time interval of 13 to 15 months. The results suggest no robust test-retest stability for the lottery-choice measure. However, Lönnqvist et al.'s (2015) design was very distinct because it also allowed the measurement of risk preferences from a risk taking questionnaire from the German Socio-Economic Panel (GSOEP). Unlike the Holt and Laury (2002) measure, these risk-related questions were found to have a very good test-retest stability.

Table 2: Literature on temporal stability of risk preferences

	Type of sample	N at T1	N at T2	Common N	Time lapse	Methods	Incentives
Wehrung et al. (1984)	Senior executives	500	90	90	1 year	Gain equivalences for investment decisions involving personal and corporate resources	Hypothetical
Love and Robison (1984)	farmers	23	23	23	2 years	Choices between pairs of distributions of possible after-tax income levels.	Hypothetical
Schoemaker and Hershey (1992)	MBA Students	160	160	160	3 weeks	Certainty equivalents for gain and loss lotteries	Monetary: $10 for consistency (top 10% of each group)
Smidts (1997)	Farmers	253	238	205	≈1 year	Certainty equivalents for 50-50 lotteries where the monetary amounts are prices for potatoes	Hypothetical
Hey (2001)	Students	53	53	53 (also in T3,T4,T5)	$\geq$ 2 days	100 choices between pairwise risky lotteries with various amounts (-$25, $25, $75 and $125)	Monetary: 1 out of 500 choice tasks is paid out
Harrison et al. (2005)	Students	178	31	31	5-6 months	Holt and Laury (2002) task	Monetary
Ohmura et al. (2006)	Students	18	18	18	3 months	Choices between a larger risky option of 100,000 yen (received with some probability) and a smaller but safe option. The magnitude of the safe option ranged between 100 and 100,000 yen. Probability values of risky option ranged from .95 to .05	Hypothetical
Levin and Hart (2003); Levin et al. (2007)	Students	72	62	62	3 years	Choices between a sure-thing option and a 50-50 or 20-80 risky choice both in the gain and the loss domains	Real: Participants actually experience the consequences of their choices, either winning or losing dimes
Andersen et al. (2008b)	Representative sample of the adult Danish population	253	97	97	3-17 months	MPL based on Holt and Laury (2002) task and iterated MPL	Monetary incentives: 10% chance of a randomly chosen task to be binding
Goldstein et al. (2008)	Working Adults	152	158	75	1 year	Participants use the Sharpe et al.'s (2000) distribution builder to generate desired return distributions in a fictitious retirement savings scenario	Hypothetical

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Table 2: Literature on temporal stability of risk preferences (Cont.)

	Type of sample	N at T1	N at T2	Common N	Time lapse	Methods	Incentives
White et al. (2008)	Volunteers	39	39	39	2 weeks	Balloon Analogue Risk Task (BART)	Monetary: Real payments based on outcomes of BART
Baucells and Villass (2010)	MBA students	210	141	141	3 months	Two lottery choice questions, one for gains and one for losses	Hypothetical
Glöckner and Pachur (2012)	Students	66	64	64	1 week	Holt and Laury (2002) task, several other gain, loss and mixed lottery choice tasks. Only 38 choice tasks are the same across Time 1 and Time 2.	Monetary incentives: 1 out of 138 choice tasks is paid out at a 100:1 exchange rate
Straznicka (2012)	Students	183	183	183	1 week	Evaluate riskiness of a gamble on a 0 to 10 scale, choose how much out of 100 to invest between a lottery and a risk free asset, certainty equivalent of a lottery, rate willngness to take risks in financial decisions on a 0 to 5 scale, Holt and Laury (2002) task	Monetary: one choice from the Holt and Laury (2002) task is randomly chosen; all other tasks are hypothetical
Zeisberger et al. (2012)	Students	86	86	73	1 month	Certainty equivalents for gain, loss and mixed lotteries	Monetary: One subject every 10 subjects is paid out for a lottery outcome
Wölbert and Riedl (2013)	Students	144	53	53	5-10 weeks	Choices between a sure amount and a lottery	Monetary: One decision is randomly chosen as binding
Lönnqvist et al. (2015)	Students	232	44	44	13-15 months	Holt and Laury (2002) task, Dohmen et al. (2011) survey questions (evaluated on a 0 to 10 scale)	Monetary: one choice of the Holt and Laury (2002) task was paid out; the Dohmen et al. (2011) is non-incetivized

Notes: 'N at T1' and 'N at T2' stand for sample size at Time 1 and 2 respectively. 'Common N' is the sample size left after attrition at T2 or due to other constraints specified by the study. If preferences were elicited at a additional points, these are indicated as T3, T4 etc.

3 Methods

3.1 The Survey

To study the stability of RTPs, we chose to use a number of survey-based measures that pertain to patience, impulsiveness and risk (both financial and in other domains). All measures have been employed in previous studies and have been shown to correlate with the usual RTPs measures. Table 3 presents the specific questions and cites the sources of these measures which we briefly describe below.

Patience as a measure of the rate of time preferences has been validated as a survey measure in Vischer et al. (2013). In the same study, the authors draw the distinction of impatience with another measure, that of impulsiveness or impulsivity (the terms are used interchangeably in the literature). Impulsiveness is a psychological construct that is also thought to be closely related to intertemporal choice since the inability to delay gratification is considered the core problem of impulsive behaviors. Vischer et al. (2013) highlight that the distinction between impatience and impulsiveness is important, especially in situations where impulsive behavior may lead to decisions that are not in accordance with one's time preferences. For years, both self-reported measures have been included in a large and representative data set, the German Socio-Economic Panel Study (GSOEP).

In addition, GSOEP includes two risk preferences measures. The first resembles the ones discussed above, in that it is a general measure of risk-taking propensity derived from a one-item survey question asking respondents to state their risk perception of themselves on a 0-10 scale. As simple as it may appear, this risk measure has been shown to be significantly related to actual risky behavior regarding investment in stocks, being self-employed, participating in sports, and smoking, even after controlling for a large number of observables (Dohmen et al., 2011). The answers to the second measure, called 'the Risk investment question' (also known as 'the €100,000 question') have been found to be strong predictors for decisions in the financial domain (Dohmen et al., 2011). On top of that, Leuermann and Roth (2012) reported a significant relationship between this lottery question and an incentivized Holt and Laury (2002) risk preferences elicitation task.

For a non-unidimensional measure of risk, we opted for the Domain-Specific Risk-Taking (DOSPERT) scale (Weber et al., 2002). DOSPERT is a 40-item scale that assesses risk taking in five domains: financial decisions (F), health/safety (H/S), recreational (R), ethical, and social decisions. A shorter 30-item scale (Blais and Weber, 2006) has appeared in the literature as well as an ultra short 4-item scale (Coppola, 2014) with good predictive validity. In this study, we took a middle point by adopting a limited (15-item) DOSPERT scale. To construct this limited scale, we started with the 30-item scale (Blais and Weber, 2006) and eliminated the ethical and social subscales which were out of the scope of our research agenda. This left us with 18-items. We used 12 of these items in verbatim form (items 1-5, 8-9, 11-15 shown in Table 3) while we eliminated three questions: a) the unprotected sex question as inappropriate to address to parents (we discuss the characteristics of our sample in the next section), given the context of the rest of the questions which concerned the dietary habits of children b) two questions about investing in a diversified fund and business venture which we thought it would be difficult to explain given the 'take home and return' nature of our questionnaire. We replaced the 'Drinking heavily at a social function' (H/S domain) and 'Going whitewater rafting at high water in the spring' (R domain) with two questions from the limited DOSPERT scale of Szrek et al. (2012) (items 6 and 10 for the R and H/S domains, respectively; shown in Table 3). The remaining item 'Betting a day's income on the outcome of a sporting event' was modified as 'Betting 10% of your monthly income on the outcome of a sporting event' since it is more common for people to think about income in monthly terms.

Finally, we have also included the well-known Cognitive Reflection Test (CRT) that has been shown to correlate well with a variety of risk and time preferences measures (Frederick, 2005).

3.2 Sample

A questionnaire consisting of all the above measures was delivered to schoolchildren aged 6-8 year old through two different schools in the city of [undisclosed] and during three measurement periods; baseline (T1:May-June 2013), after one year (T2:May-June 2014) and a year thereafter (T3:May-June 2015). The pupils were asked to deliver the questionnaire to their caretakers who, during two group-meetings with one of the researchers, had received an earlier notice and briefing about the purpose of the main study which was unrelated to this paper (discussed momentarily) as well as about the longitudinal nature of their responses. Because data collection was conducted through schools and in order to avoid confounding by social desirability or other such issues, we focused on ensuring the confidentiality of the responses. In particular, each school provided the unique register number (RN) of each student (but not their names); we gave back open envelopes that were labelled with the RN of the student to be handled and enclosed the questionnaires. When completed, the questionnaires were placed inside the same envelope by the respondents and the envelope was sealed and returned to the school; then sent by mail to the researchers. The same procedure was repeated over all waves. Thus, schools did not have access to the responses, since they were receiving and mailing closed envelopes, while we did not have access to the

Table 3: Measures of risk and time preferences

Measure	Question	Measurement	Reference
Patience	Are you generally an impatient person, or someone who always shows great patience?	0-10 scale	Vischer et al. (2013)
Impulsiveness	Are you generally an impulsive person, or someone who always shows great caution?	0-10 scale	Vischer et al. (2013)
Risk	Are you generally a person who is fully prepared to take risks or do you try to avoid taking risks?	0-10 scale	Dohmen et al. (2011)
Risk investment	How much of a €100,000 prize would you invest in a lottery with a 50-50 chance of doubling it or losing half?	6 point scale ranging from €100,000 to nothing with steps of €20,000	Dohmen et al. (2011); Leuermann and Roth (2012)
Cognitive Reflection Test	A bat and a ball cost €1.10 in total. The bat costs €1.00 more than the ball. How much does the ball cost?	Open ended	Frederick (2005)
	If it takes 5 machines 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets?	Open ended	
	In a lake, there is a patch of lily pads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long would it take for the patch to cover half of the lake?	Open ended	
DOSPERT	1. Going camping in the wilderness. (R) 2. Betting a days income on lotto or scratch cards. (F) 3. Investing 5% of your annual income in a very speculative stock. (F) 4. Betting a days income at a high-stake poker game. (F) 5. Going down a ski run that is beyond your ability. (R) 6. Cool off in a fast-flowing river with shoulder-deep water on a hot summer day. (R) 7. Betting 10% of your monthly income on the outcome of a sporting event (F) 8. Driving a car without wearing a seat belt. (H/S) 9. Taking a skydiving class. (R) 10. Sit in the front seat of a car without a seat belt. (H/S) 11. Riding a motorcycle without a helmet. (H/S) 12. Sunbathing without sunscreen. (H/S) 13. Bungee jumping off a tall bridge. (R) 14. Piloting a small plane. (R) 15. Walking home alone at night in an unsafe area of town. (H/S)	1-7 scale	Blais and Weber (2006); Szrek et al. (2012)

identities of the subjects. Aside the group-meetings, this procedure was also described in detail in the informed consent that children were asked to return signed by their parents, prior to the administration of the baseline questionnaires.

Table 4: Number of subjects per year and panel sample

	Year:	2013	2014	2015
	Returned questionnaires	159	157	130
	Responded to at least one risk/time measure	122	130	106
Three year panel sample	Patience	80	80	80
	Impulsiveness	80	80	80
	Risk	80	80	80
	Risk (investment)	78	78	78
	CRT	61	61	61
	DOSPERT	62	62	62
Two year panel sample (2013-2014)	Patience	25	25	-
	Impulsiveness	26	26	-
	Risk	26	26	-
	Risk (investment)	26	26	-
	CRT	21	21	-
	DOSPERT	23	23	-
Two year panel sample (2014-2015)	Patience	-	15	15
	Impulsiveness	-	15	15
	Risk	-	15	15
	Risk (investment)	-	14	14
	CRT	-	11	11
	DOSPERT	-	12	12
Two year panel sample with gap (2013 and 2015)	Patience	6	-	6
	Impulsiveness	6	-	6
	Risk	6	-	6
	Risk (investment)	7	-	7
	CRT	5	-	5
	DOSPERT	6	-	6

The purpose for choosing the specific sample is that our questionnaire was an appendix to that of an unrelated main questionnaire which collected various data regarding the socio-economic characteristics of the parents and the dietary, sedentary and sleeping behavior of the child as well as other family-environmental variables. This questionnaire allowed the identification of the respondent (in terms of his/her relation to the child) and thus we were able to perform individual matches in the measures of RTPs across waves. The selection of schools was made to serve the critical requirements of the main survey which was to assure the recruitment of families with both higher and lower socio-economic status but without worrying too much about the differences in ethnicity/culture. Although the main survey took place in seven European countries, the appendix questionnaire with RTPs measures was only administered to one of these [country removed for peer review]. For details on the design and methodology of the survey see Mantziki et al. (2014).

Respondents were asked to return the questionnaires in two-weeks' time. Response rates were high, reaching 88.3% in the first year, 87% in the second year and 72.2% in the third year. However, as Table 4 shows, about 80% of the returned questionnaires contained some information regarding the purpose of this study, lowering the actual response rates to 59%-72%. In terms of follow-up rates, the number of matched responses in all three waves ranges from sixty-one to eighty subjects, depending on the specific measure. Finally, depending on the specific measure, five to twenty-six respondents were only tracked in two out of the three points in time. We do not analyze data points related with the two-year panel at T1 and T3 (bottom panel of Table 4) due to very small number of observations.

In terms of demographics, respondents are mostly female, older than the age of 36 years old and of medium to high education level (Table 5). They mainly live in households with 2 to 4 adults and 1 or 2 children. As per income status, half of the respondents self-reported to be in the lower classes while the other half in the higher ones. This profile was of course to be expected, considering the target audience that were primary caretakers of 6- to 8-year old children in both high and low socio-economic-status families. Overall, although our sample is far from representative of the general population, it is comparable to most other studies presented above while the time span of our study is one of the longest in the literature.

4 Results

Results are presented in the following sections. First, aggregate response profiles over the three years of the study are presented for each of the risk and time preferences measures. Second, we restrict our attention to the three year panel sample in order to examine their temporal stability at the individual level. We also examine temporal stability of responses from the two year panel sample, that is, for subjects that participated in years 2013-2014 or 2014-2015.

4.1 Temporal stability in aggregate

In this section we examine stability of preferences by looking at the aggregate distribution of responses for each risk/time preferences measure. We examine responses for all subjects that responded to at least one of the risk/time measures (sample size for each year is given

Table 5: Summary statistics (%) for 2013, 2014 and 2015 samples

	Year:	2013	2014	2015	Test statistic
Gender	Female	90.91	89.15	90.48	$\chi^2 = 0.24$
	Male	9.09	10.85	9.52	p = 0.89
	N	121	129	105	
Age	≤ 35	15.83	14.73	13.33	
	36-40	40.83	41.86	31.43	$\chi^2 = 3.29$
	≥ 41	43.33	43.41	55.24	p = 0.19
	N	120	129	105	
Education	6-8 years	4.10	5.38	1.98	
	9-11 years	6.56	2.31	6.93	$\chi^2 = 1.12$
	12-14 years	36.07	33.85	28.71	p = 0.57
	15-17 years	39.34	43.85	49.50	
	$\geq$ 18 years	13.93	14.62	12.87	
	N	122	130	101	
N of adults in household	1	3.31	6.20	4.72	
	2	66.94	62.79	74.53	$\chi^2 = 3.20$
	3-4	23.14	25.58	18.87	p = 0.20
	≥ 5	6.61	5.43	1.89	
	N	121	129	106	
N of minors in household	1	18.85	17.83	23.58	
	2	63.11	63.57	66.98	$\chi^2 = 4.23$
	3	10.66	12.40	6.60	p = 0.12
	≥ 4	7.38	6.20	2.83	
	N	122	129	106	
Present income	Living comfortable	11.57	13.18	22.55	
	Coping	38.84	39.53	37.25	$\chi^2 = 4.92$
	Difficult	29.75	32.56	28.43	p = 0.09
	Very difficult	19.83	14.73	11.76	
	N	121	129	102	

Notes: The 'test statistic' column displays Pearson's chi-squared test (and corresponding p-value) for Gender and Kruskal-Wallis tests (and corresponding p-values) for all the other variables. Sample is constrained to subjects that have non-missing values for at least one of the risk/time measures.

in second row of Table 4); we do not restrict analysis to the panel sample. This is justified by the fact that sample pools are similar across the three years of the study as shown in Table 5.

Figure 1 plots distributions of responses by year, separately for each risk/time measure. Distributions of responses are depicted in the form of histograms with percent of responses on the vertical axis. The only exception is the DOSPERT measure which, given the wide

Table 6: Descriptive statistics per year

	2013			2014			2015			2013 vs. 2014		2014 vs. 2015	
	Mean	S.D.	Median	Mean	S.D.	Median	Mean	S.D.	Median	Statistic	p	Statistic	p
Patience	6.64	2.30	7.00	6.74	2.39	7.00	6.53	2.26	7.00	W_2 =3.58	0.47	W_2 =1.94	0.75
Impulsiveness	5.07	2.39	5.00	5.67	2.37	6.00	5.42	2.54	5.00	W_2 =5.32	0.26	W_2 =6.87	0.14
Risk	5.23	2.49	5.00	5.25	2.15	5.00	4.66	2.43	5.00	W_2 =4.17	0.38	W_2 =6.65	0.16
Risk (investment)	5.28	0.95	6.00	5.12	0.95	5.00	5.10	1.01	5.00	W_2 =3.83	0.43	W_2 =3.68	0.45
DOSPERT	35.50	13.79	32.50	36.08	14.11	33.00	36.05	14.77	33.00	D = 0.09	0.73	D =0.08	0.85
DOSPERT-f	8.79	4.51	8.00	9.22	4.55	8.00	8.73	4.51	8.00	D =0.09	0.61	D =0.08	0.88
DOSPERT-h/s	12.94	6.81	11.00	13.33	6.97	11.00	13.31	7.28	12.00	D =0.10	0.50	D =0.12	0.34
DOSPERT-r	13.77	7.62	12.00	13.44	7.97	11.00	13.96	7.86	13.00	D =0.08	0.74	D =0.11	0.46
CRT	1.08	1.16	1.00	1.35	1.21	1.00	1.41	1.19	1.00	Z =-1.72	0.09	Z =-0.34	0.73
CRT_1	0.25	0.43	0.00	0.29	0.46	0.00	0.30	0.46	0.00	Z =-0.72	0.47	Z =-0.17	0.86
CRT_2	0.37	0.48	0.00	0.50	0.50	0.50	0.50	0.50	0.50	Z =-2.09	0.04	Z =0.00	1.00
CRT_3	0.41	0.49	0.00	0.54	0.50	1.00	0.57	0.50	1.00	Z =-1.90	0.06	Z =-0.49	0.63

Notes: DOSPERT-f stands for the Domain-Specific Risk-Taking scale on the financial domain, DOSPERT-h/s is for the health/safety domain, DOSPERT-r is for the recreational domain. Their sum composes the DOSPERT scale. CRT_1, CRT_2 and CRT_3 stand for the three components of the Cognitive Reflection Test (CRT). 'Statistic' columns show the W_2 statistic of the EppsSingleton test, the D statistic of the Kolmogorov-Smirnov test, and the Z-statistic for the Wilcoxon-Mann-Whitney test (CRT variable) and proportion tests (CRT_1, CRT_2, CRT_3 variables). The 'p' column shows p-values for the respective calculated statistics.

range of scores, it is depicted with a kernel density plot.[6] Eyeballing Figure 1 reveals a consistent pattern of responses across years with just a few exceptions here and there. What matters for aggregate stability, however, is not a few differences in the scale of a measure but the overall distribution of responses.

Table 6 shows mean, standard deviation and median for each risk/time preferences measure and their subscales. Summary statistics provide some, albeit incomplete, information about the underlying distribution of the data. For example, looking at the median, we see that there are just small shifts in the location of the distributions from one year to the other. Statistical tests can inform us whether two samples are drawn from the same population. Typically, Kolmogorov-Smirnov (KS) tests (Kolmogorov (1933), reprinted in English by Shiryayev (1992); Smirnov (1948)) and Wilcoxon-Mann-Whitney rank-sum (WMW) tests (Wilcoxon, 1945; Mann and Whitney, 1947) are employed to test whether the underlying distributions of the two samples are equal. The WMW test detects only locational shifts while the KS detects differences in distributions due to location, scale, or family. A drawback of the KS test for our case, is the assumption that the data are drawn from a continuous distribution, while most of our risk/time measures are discrete and ordinal in nature. An alternative to the KS test is the Epps-Singleton test, where both continuous and discrete data may be used and has been shown to be more powerful than the KS test (Epps and Singleton, 1986).[7]

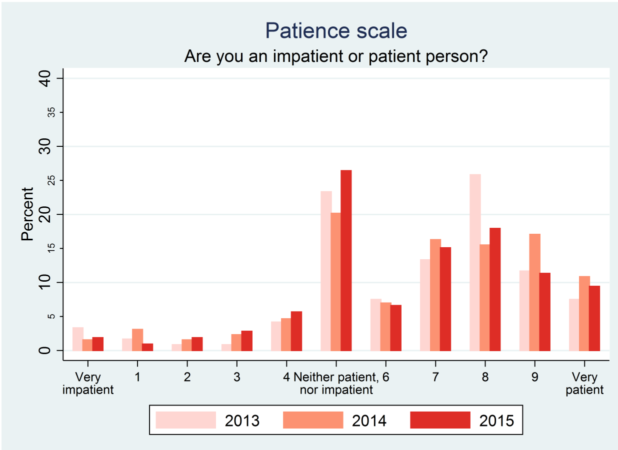
The last two columns of Table 6 show results for: a) the Epps-Singleton test for the Patience, Impulsiveness, Risk and Risk/investment measures b) the KS test for the DOSPERT measure and its subscales c) the WMW test for the CRT and d) proportion tests for the CRT individual questions (CRT_1, CRT_2 and CRT_3). As shown, most of the tests fail to reject the null that the underlying distributions of the two samples are equal. There is one minor exception for the CRT_2 and CRT_3 questions when looking at the change between 2014 and 2013. However, the statistical significant results fail to show up in the aggregate CRT measure.[8]

All in all, the analysis in this section echoes the results from the literature about aggregate stability of risk and time preferences. This should not downplay the importance of our results since they concern preference stability over a wide time frame of three consecutive years, one of the largest in the literature. Although aggregate preference stability is important, Meier and Sprenger (2015) note that a stable distribution of responses could be obtained without

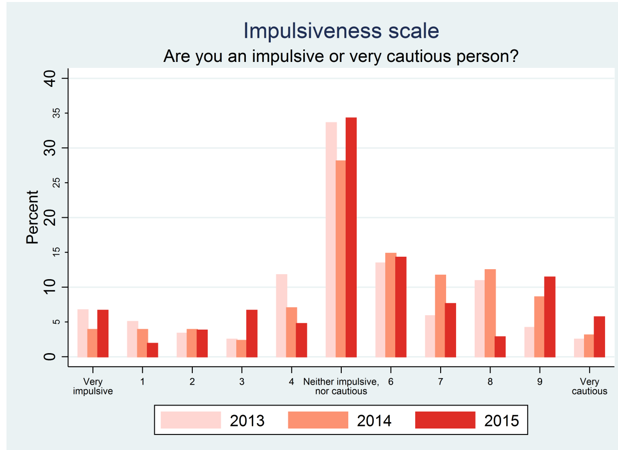
[6]Figure A.1 in Apendix A shows additional graphs for the DOSPERT subscales and the individual questions of the CRT.

[7]See Goerg and Kaiser (2009) for a Stata implementation.

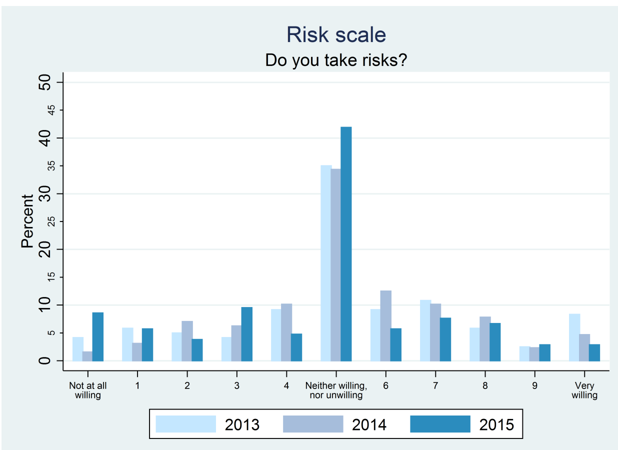
[8]In Figure A.1e and A.1f it appears that less subjects give a wrong answer to these two particular CRT questions in 2014 as compared to 2013 which is what the statistical test might be picking up.



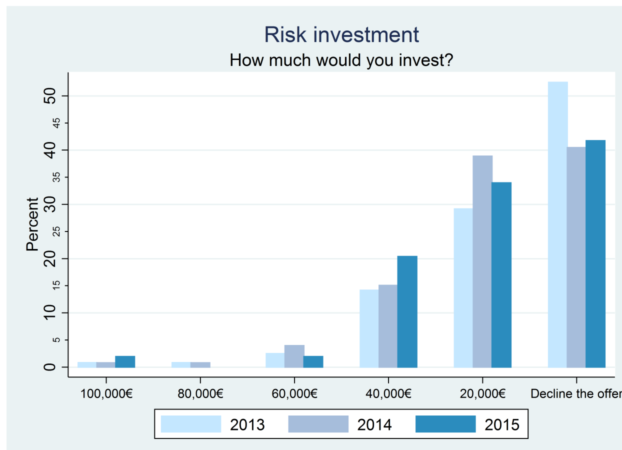
(a) Percentage distribution of patience scale



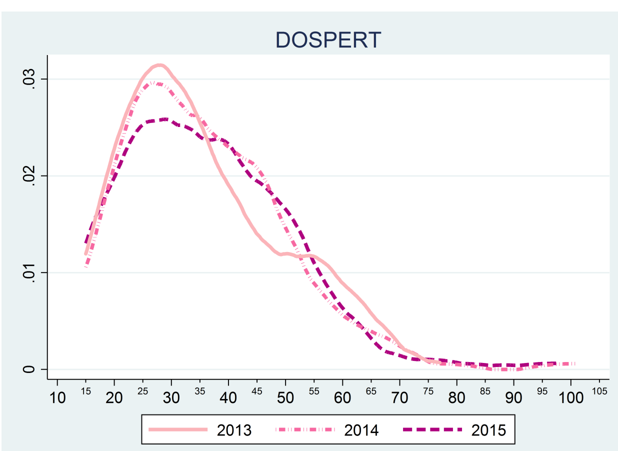
(b) Percentage distribution of impulsiveness scale



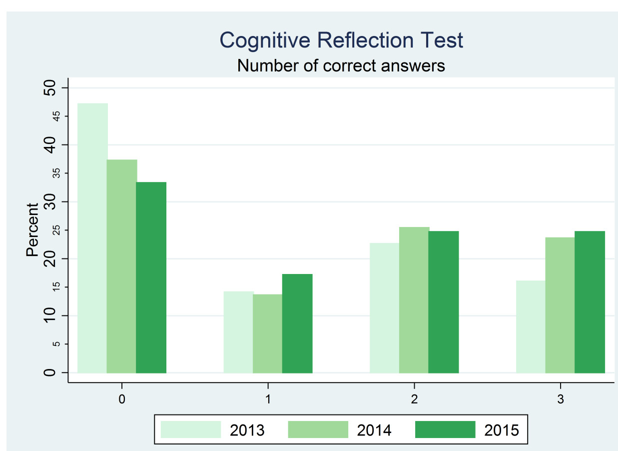
(c) Percentage distribution of willingness to take risks scale



(d) Percentage distribution of lottery investment question



(e) Kernel density of Domain-Specific Risk-Taking scale



(f) Percentage distribution of number of correct answers in the Cognitive Reflection Test

Figure 1: Distribution of responses across years for the risk/time measures

individual stability. Next section tackles the issue of individual level stability of preferences by analyzing only the panel samples.

4.2 Temporal stability in individual behavior

Given the voluntary nature of responding to the questionnaire and the three time points at which the questionnaires were filled, we ended up with two types of panels. In the first panel, we have individuals that respondent to all three waves of the survey. Table 4 shows that the number of subjects which have complete responses in all three waves for each risk/time measure varies from 61 subjects (for CRT) to 80 subjects (for Patience, Impulsiveness and Risk). These numbers are reduced even further if one tries to combine responses to the risk/time measures with demographics, since a few more subjects have incomplete information regarding one or more demographic variables.

One way to analyze data from the three year panel is to calculate the difference between values in two consecutive years.[9] A person with stable responses in the two years should have a score of differences equal to zero. Subjects with instability would deviate from zero, so that larger differences would indicate greater instability. Figure 2 shows scatter graphs of changes in year 2014 with respect to 2013 (horizontal axis) and changes in year 2015 with respect to 2014 (vertical axis). Points that fall exactly on the dashed cross lines intersection, that is, on coordinates [0,0], indicate subjects with response stability for the full three year period. To get a sense of proportions, marks are depicted as bubbles with bubble sizes proportional to the frequency of occurrence of each case.[10] Bubbles that fall on either the vertical or the horizontal dashed cross lines, show subjects that gave the same response in at least two time points.[11] By looking at the graphs in Figure 2 one can see that there is some heterogeneity in terms of stability of responses. However, there are enough subjects that fall on either one of the cross dashed lines, which indicates stability of preferences for at least two time

[9]Since most of our RTPs measures are ordinal in nature, taking their difference does not ensure the ordinality of the resulting measure nor it is permissible to make interpretations in continuous terms. Thus, we do not use this technique for conducting statistical tests or econometric analysis but rather as a trick to graph stability of responses.

[10]To illustrate this, consider Figure 2a which depicts the Patience scale. This figure shows that 18 subjects fall exactly on the cross intersection which is to say that 18 subjects gave the exact same response on the Patience scale in the three years of the survey.

[11]Consider Figure 2a again. The figure shows 15 (=7+5+2+1) subjects on the horizontal cross line and 12 (=2+1+2+3+2+1+1) subjects on the vertical cross line. These subjects gave the exact same response on the patience scale in at least two time points. These are different subjects than the 18 subjects that fall on the cross intersection. Table A.1 in Appendix A depicts the number and percent of subjects that fall on the intersection of the dashed cross lines, on either one of the cross lines and the cumulative percent. As shown in Table A.1, if we use the cumulative percent as the desired metric, highest individual stability is achieved by the Risk/investment measure, followed by the DOSPERT measure, while the least stable measure is the CRT.

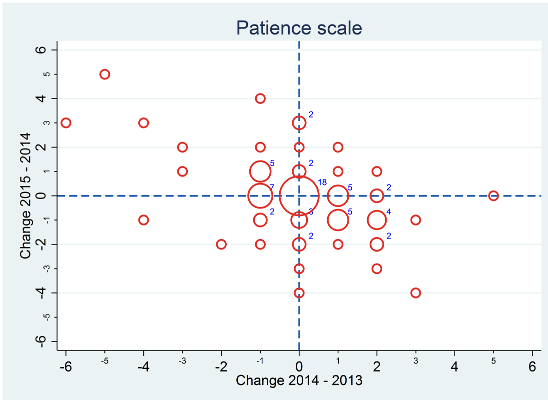
points. The percent of subjects that fall on either one of the dashed cross lines is quantified in Table A.1 in Appendix A and can be as high as 80.8% of subjects for the Risk/investment measure or as low as 27.4% for the CRT. This indicates large variability between risk/time measures in terms of their temporal stability for the three year panel sample.

The analysis above is, of course, deterministic in that it allows no error in the decision making process. To account for the panel data structure, we explore individual stability by means of random effects regressions. Given the nature of the risk/time measures we estimate random effects ordered logit models for the Patience, Impulsiveness, Risk and Risk/investment measures and random effects linear regression models for DOSPERT and CRT. To test for individual stability we are mainly interested on the coefficient estimates of the year dummies. Results are shown in Table 7 while Table A.2 in Appendix A shows results for the DOSPERT subscales and CRT individual questions. The upper panel shows results without any demographic control variables included in the model specification while the lower panel includes as controls the set of demographic variables shown in Table 5. Table 7 omits estimated parameters for ancillary parameters and coefficients for demographic controls in order to focus attention to the year dummies (the year 2014 serves as the base category).

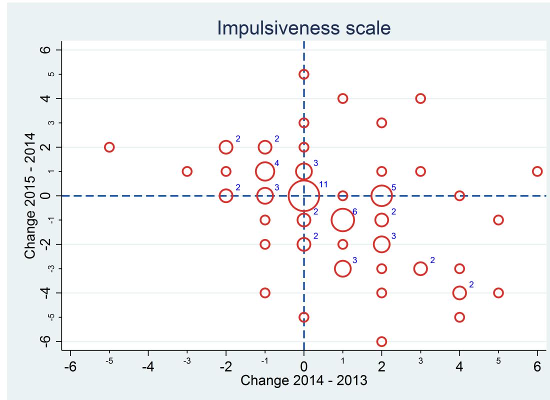
Table 7 shows that for the Patience and Risk/investment measures, none of the year dummies is statistically significant in both panels of the table (with and without demographic controls), indicating high temporal stability of these measures. We reach a similar conclusion for the DOSPERT measure looking at the upper panel of the table. Even though the 2015 year dummy reaches statistical significance levels once we control for demographics, this is only significant at the 10% level. For the CRT measure, the upper panel shows a highly statistically significant result for 2013 with respect to the 2014 year dummy. However, when we control for demographics we fail to reject the null for both year dummies. Thus, we can plausibly group the DOSPERT and CRT measures to the list of measures that exhibit high temporal stability in the three year panel. On the other hand, both the Impulsiveness and Risk measures exhibit statistically significant coefficients for the year dummies in Table 7, which is consistent with temporal instability.

The second type of panel concerns subjects that responded to two consecutive waves but not in the third one. These are subjects with responses at time points 2013-2014 and 2014-2015. The number of subjects that responded to each of the risk/time measures is shown in the third and fourth panels of Table 4. We pool together responses from both two year panels in order to maximize available sample size.

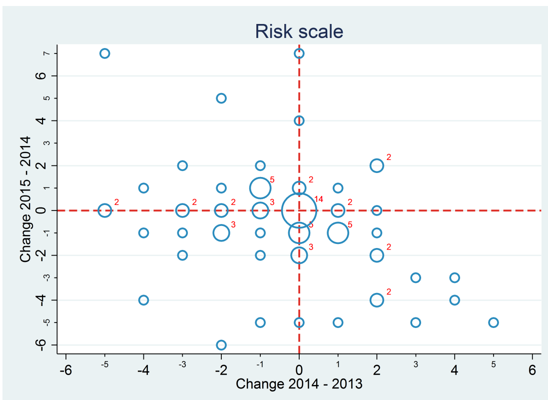
Table 8 shows the percent of subjects that exhibited stability in their responses in the two consecutive years of the survey. As shown, the Risk/investment measure exhibits very



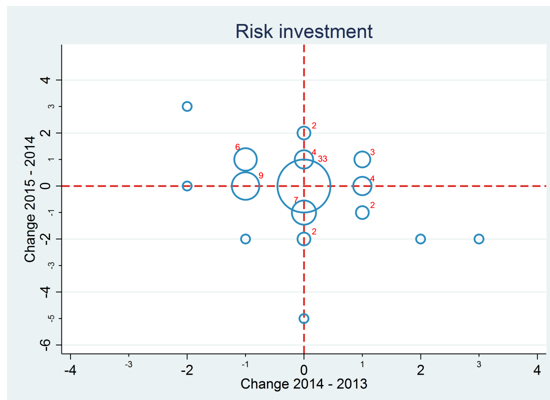
(a) Changes in Patience scale



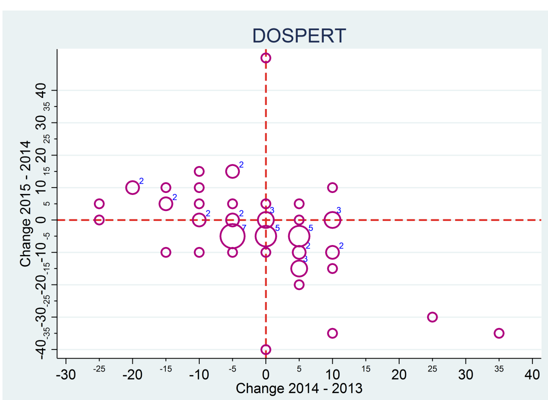
(b) Changes in Impulsiveness scale



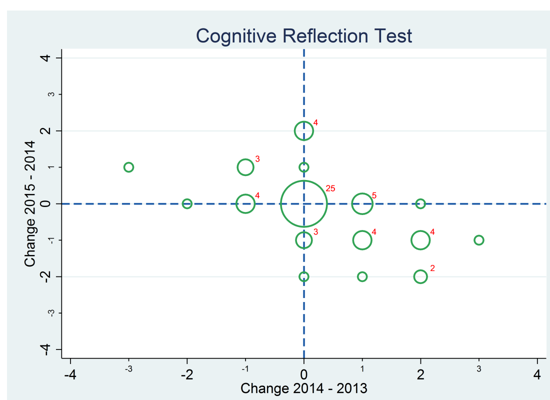
(c) Changes in Risk scale



(d) Changes in Risk/investment question



(e) Changes in the Domain-Specific Risk-Taking scale



(f) Changes in number of correct answers in the Cognitive Reflection Test

Figure 2: Scatter graph of changes for the risk/time measures for the three year period weighted by frequency

Notes: In each graph, the horizontal axis shows differences in scores for 2014 vs. 2013. The vertical axis shows differences for 2015 vs. 2014. Marks that fall on the cross in each graph indicate subjects that showed stability of the respective measure (i.e., the score difference is exactly zero) for at least a one year time lapse. Marks that fall exactly on the cross intersection show subjects that are consistent in their responses for all three years. Bubble size is proportional to the frequency of each. A small number near the bubble indicates the frequency of each case. Bubbles with no numbers are single cases. Given the wide range of the DOSPERT scale, data are grouped in intervals of range of five (the first category being the [-2,2]) to allow small deviations from one year to the other to be classified as consistent. That is, any particular bubble for the DOSPERT scale counts observations within a range and not on a specific data point.

Table 7: Random effects ordered logit and linear regression for the three year panel sample

		Patience	Impulsiveness	Risk	Risk investment	DOSPERT	CRT
w/o demographics	Constant					36.758***	1.426***
						(1.762)	(0.147)
	2013	-0.122	-0.969***	0.290	0.377	-0.855	-0.246**
		(0.303)	(0.295)	(0.294)	(0.351)	(1.517)	(0.121)
	2015	-0.159	-0.653**	-0.661**	-0.016	-1.516	-0.115
		(0.303)	(0.298)	(0.298)	(0.344)	(1.517)	(0.121)
	N	240	240	240	234	186	183
	Log-L	-413.781	-455.837	-443.535	-248.060	-716.783	-244.903
w/ demographics	Constant					38.845***	0.932*
						(6.267)	(0.479)
	2013	-0.448	-1.239***	0.149	0.488	-0.437	-0.167
		(0.331)	(0.327)	(0.316)	(0.384)	(1.598)	(0.115)
	2015	-0.359	-0.544*	-0.672**	0.219	-2.833*	-0.190
		(0.340)	(0.328)	(0.331)	(0.387)	(1.639)	(0.120)
		(0.332)	(0.322)	(0.321)	(0.383)	(1.607)	(0.124)
	N	213	213	213	207	171	165
	Log-L	-358.393	-395.968	-388.388	-213.913	-652.372	-199.502

Notes: Random effects ordered logit models are estimated for Patience, Impulsiveness, Risk and Risk investment. Random effects linear regression models are estimated for DOSPERT and CRT. Ancillary parameter estimates are omitted. The lower panel of the table shows results from models including demographic controls shown in Table 5. Coefficient estimates for demographic controls are omitted. * p<0.1, ** p<0.05, *** p<0.01.

high stability for 57.5% of subjects. The least stable measures are the overall DOSPERT measure, followed closely by Patience and Impulsiveness.

In Table 9 we show results from random effects ordered logit and random effects linear regressions where the respective risk/time preferences measure of interest is regressed on a year dummy taking the value of 1 for the second year of the two year panel.[12] The upper panel shows results without any demographic control variables while the lower panel includes as controls the set of demographic variables shown in Table 5. Table 9 omits estimated parameters for ancillary parameters and coefficients for demographic controls.

In the upper panel of Table 9 only the year dummy for the CRT measure is statistically significant. When demographics are controlled for in the lower panel of the table, statistical significance for CRT is taken away. This is a good indication of temporal stability across all risk/time preferences measures for the two year panel sample.

Given that we analyzed separately the three year and two year panels, one might worry for robust statistical inference with respect to reduced sample sizes. In Table A.4 and Table A.5 in the Appendix A we show additional results for the main risk/time measures and their

[12] Table A.3 in Appendix A shows results for the DOSPERT subscales and CRT individual questions.

Table 8: Percent of subjects showing stability/instability for the two year panel sample

	Stability	Instability
Patience	30.00	70.00
Impulsiveness	31.71	68.29
Risk	41.46	58.54
Risk (investment)	57.50	42.50
DOSPERT	28.57	71.43
DOSPERT-f	55.26	44.74
DOSPERT-h/s	35.00	65.00
DOSPERT-r	36.84	63.16
CRT	53.13	46.88
CRT_1	83.78	16.22
CRT_2	67.57	32.43
CRT_3	73.53	26.47

Notes: For the DOSPERT measure, data are grouped in intervals of range of five to allow small deviations from one year to the other to be classified as consistent. Given the narrower range of the DOSPERT subscales, data are grouped in intervals of range of three for DOSPERT-f, DOSPERT-h/s and DOSPERT-r.

subscales, respectively, where we pool together the three year panel and the two year panel. Results echo what was discussed above in that we can safely assume highly temporal stability with the exception of the Impulsiveness and Risk measures.

5 Conclusions

Despite the noise and the absence of real incentives for truthful answers, using survey-based measures of RTPs is of paramount importance for researchers. In this paper, we investigated the empirical power of a questionnaire consisting of such measures in an effort to learn more about the stability of these concepts that are crucial in economic research. To do so, we analysed patterns of aggregate differences as well as of individual-level changes in six measures of RTPs.

In line with existing literature, we observe important temporal stability of RTPs measures at the aggregate level. This is extremely useful in policy-making where the allocation of resources should be based on the interest of the groups and not of the individuals. Even if agents move between groups throughout the implementation of a designed policy, the alloca-

Table 9: Random effects ordered logit and linear regression for the two year panel samples

		Patience	Impulsiveness	Risk	Risk investment	DOSPERT	CRT
w/o demographics	Constant					35.000***	1.313***
						(2.427)	(0.214)
	2nd year	-0.129	0.090	-0.095	0.072	1.086	0.375**
		(0.407)	(0.413)	(0.424)	(0.480)	(3.180)	(0.181)
	N	80	82	82	80	70	64
	Log-L	-165.467	-170.803	-166.752	-87.924	-285.486	-94.504
w/ demographics	Constant					34.553***	-0.916
						(12.002)	(0.786)
	2nd year	-0.295	-0.259	-0.454	-0.107	1.307	0.285
		(0.463)	(0.481)	(0.500)	(0.552)	(3.384)	(0.218)
	N	78	80	80	80	68	64
	Log-L	-151.149	-158.201	-147.230	-80.907	-272.176	-78.579

Notes: Random effects ordered logit models are estimated for Patience, Impulsiveness, Risk and Risk investment. Random effects linear regression models are estimated for DOSPERT and CRT. Ancillary parameter estimates are omitted. The lower panel of the table shows results from models including demographic controls shown in Table 5. Coefficient estimates for demographic controls are omitted. * p<0.1, ** p<0.05, *** p<0.01.

tion may still be optimal if group interests remain stable. At the individual level, our results reveal that there is heterogeneity in terms of stability with some of the measures achieving a high degree of intertemporal stability while others failing to do so. Using appropriate econometric methods to control for demographics and random effects, we conclude that four out of six RTPs measures exhibit intertemporal stability within-subjects.

Aside the importance of our findings, we acknowledge a number of limitations related to our study. First of all, the profile of our respondents is very specific and cannot be considered as representative of the general population. However, there is little evidence suggesting that the results could be completely driven by differences in the pool of respondents; a fact that is also the cornerstone of the validity of lab experiments, that usually involve student-subjects (Belot et al., 2010).

Second, as with all survey-based measures, our approach does not provide respondents with incentives to reveal their preferences. In addition, since we do not have data on actual behavior with respect to risky or intertemporal choices, we cannot establish links between RTPs, as measured by the employed survey instruments, with real choices in the field; for this, we have to rely on previous studies. Finally, as Harrison et al. (2005) note, the stability over longer periods of time requires that one take into account possible changes in the 'states of nature'. While we do record possible changes in states of nature we do not know for sure whether we have recorded every possible change. Thus, whether our results point towards the (in)stability of the behavioral concepts we seek to examine or toward measurement error, is a question that we cannot answer with high confidence. The inclusion of questions like the ones we have employed in our study, in large longitudinal surveys that allow their observation over time in conjunction with other behavioral patterns and characteristics of respondents, is definitely a step towards the right direction; data stemming from such sources are valuable for the study of preference stability. Judging from the recent flourishing literature on intertemporal stability of such data, we feel that this is a direction currently well-understood by economists, psychologists and other social and behavioral scientists.

References

Aklin, W. M., M. T. Tull, C. W. Kahler, and C. Lejuez (2009). Risk-Taking Propensity Changes Throughout the Course of Residential Substance Abuse Treatment. *Personality and individual differences 46*(4), 454–459.

Andersen, S., G. W. Harrison, M. I. Lau, and E. E. Rutström (2008a). Eliciting risk and time preferences. *Econometrica 76*(3), 583–618.

Andersen, S., G. W. Harrison, M. I. Lau, and E. E. Rutström (2008b). Lost in state space: Are preferences stable? *International Economic Review 49*(3), 1091–1112.

Andersen, S., G. W. Harrison, M. I. Lau, and E. E. Rutström (2010). Preference heterogeneity in experiments: Comparing the field and laboratory. *Journal of Economic Behavior and Organization 73*(2), 209–224.

Andreoni, J., M. A. Kuhn, and C. Sprenger (2015). Measuring time preferences: A comparison of experimental methods. *Journal of Economic Behavior & Organization 116*, 451–464.

Andreoni, J. and C. Sprenger (2012). Risk preferences are not time preferences. *The American Economic Review 102*(7), 3357–3376.

Anokhin, A. P., S. Golosheykin, J. D. Grant, and A. C. Heath (2011). Heritability of Delay Discounting in Adolescence: A Longitudinal Twin Study. *Behavior genetics 41*(2), 175–183.

Ashraf, N., D. Karlan, and W. Yin (2006). Tying Odysseus to the mast: Evidence from a commitment savings product in the Philippines. *The Quarterly Journal of Economics*, 635–672.

Baker, F., M. W. Johnson, and W. K. Bickel (2003). Delay discounting in current and never-before cigarette smokers: similarities and differences across commodity, sign, and magnitude. *Journal of abnormal psychology 112*(3), 382.

Ballard, K. and B. Knutson (2009). Dissociable neural representations of future reward magnitude and delay during temporal discounting. *NeuroImage 45*(1), 143–150.

Barseghyan, L., J. Prince, and J. C. Teitelbaum (2011). Are risk preferences stable across contexts? Evidence from insurance data. *The American Economic Review 101*(2), 591–631.

Baucells, M. and A. Villass (2010). Stability of risk preferences and the reflection effect of prospect theory. *Theory and Decision 68*(1), 193–211.

Belot, M., R. Duch, and L. Miller (2010). Who should be called to the lab? A comprehensive comparison of students and non-students in classic experimental games. Discussion Paper 2010001, University of Oxford, Nuffield College.

Bickel, W. K., R. Yi, R. D. Landes, P. F. Hill, and C. Baxter (2011). Remember the future: working memory training decreases delay discounting among stimulant addicts. *Biological psychiatry 69*(3), 260–265.

Blais, A.-R. and E. U. Weber (2006). A domain-specific risk-taking (DOSPERT) scale for adult populations. *Judgment and Decision Making 1*(33-47).

Borghans, L. and B. H. Golsteyn (2006). Time discounting and the body mass index: Evidence from the Netherlands. *Economics & Human Biology 4*(1), 39–61.

Chabris, C. F., D. Laibson, C. L. Morris, J. P. Schuldt, and D. Taubinsky (2008). Individual laboratory-measured discount rates predict field behavior. *Journal of Risk and Uncertainty 37*(2-3), 237–269.

Charness, G., U. Gneezy, and A. Imas (2013). Experimental methods: Eliciting risk preferences. *Journal of Economic Behavior & Organization 87*, 43–51.

Chuang, Y. and L. Schechter (2015). Stability of experimental and survey measures of risk, time, and social preferences: A review and some new results. *Journal of Development Economics 117*, 151–170.

Coller, M. and M. Williams (1999). Eliciting individual discount rates. *Experimental Economics 2*(2), 107–127.

Coppola, M. (2014). Eliciting risk-preferences in socio-economic surveys: How do different measures perform? *The Journal of Socio-Economics 48*(0), 1–10.

Dean, M. and A. Sautmann (2014). Credit constraints and the measurement of time preferences. *Unpublished Manuscript*.

Deck, C. A., J. Lee, J. A. Reyes, and C. Rosen (2008). Measuring risk attitudes controlling for personality traits. *Available at SSRN 1148521*.

Dohmen, T., A. Falk, D. Huffman, U. Sunde, J. Schupp, and G. G. Wagner (2011). Individual risk attitudes: Measurement, determinants, and behavioral consequences. *Journal of the European Economic Association 9*(3), 522–550.

Dreber, A., D. G. Rand, N. Wernerfelt, J. R. Garcia, M. G. Vilar, J. K. Lum, and R. Zeckhauser (2011). Dopamine and risk choices in different domains: Findings among serious tournament bridge players. *Journal of Risk and Uncertainty 43*(1), 19–38.

Drichoutis, A. C. and R. M. J. Nayga (2013). A reconciliation of time preference elicitation methods. *Munich Personal RePEc Archive Paper No. 46916*.

Eckel, C. C. and P. J. Grossman (2002). Sex differences and statistical stereotyping in attitudes toward financial risk. *Evolution and human behavior 23*(4), 281–295.

Eckel, C. C. and P. J. Grossman (2008). Forecasting risk attitudes: An experimental study using actual and forecast gamble choices. *Journal of Economic Behavior & Organization 68*(1), 1–17.

Einav, L., A. Finkelstein, I. Pascu, and M. R. Cullen (2012). How general are risk preferences? Choices under uncertainty in different domains. *The American economic review 102*(6), 2606–2638.

Epps, T. W. and K. J. Singleton (1986). An omnibus test for the two-sample problem using the empirical characteristic function. *Journal of Statistical Computation and Simulation 26*(3-4), 177–203.

Frederick, S. (2005). Cognitive reflection and decision making. *Journal of Economic Perspectives 19*(4), 25–42.

Giné, X., J. Goldberg, D. Silverman, and D. Yang (2016). Revising Commitments: Field Evidence on the Adjustment of Prior Choices. *The Economic Journal*, n/a–n/a.

Glöckner, A. and T. Pachur (2012). Cognitive models of risky choice: Parameter stability and predictive accuracy of prospect theory. *Cognition 123*(1), 21–32.

Gneezy, U. and J. Potters (1997). An experiment on risk taking and evaluation periods. *The Quarterly Journal of Economics*, 631–645.

Goerg, S. J. and J. Kaiser (2009). Nonparametric testing of distributions-the epps-singleton two-sample test using the empirical characteristic function. *The Stata Journal 9*(3), 454–465.

Goldstein, D. G., E. J. Johnson, and W. F. Sharpe (2008). Choosing outcomes versus choosing products: Consumer-focused retirement investment advice. *Journal of Consumer Research 35*(3), 440–456.

Halevy, Y. (2015). Time Consistency: Stationarity and Time Invariance. *Econometrica 83*(1), 335–352.

Harrison, G. W., E. Johnson, M. M. McInnes, and E. E. Rutström (2005). Temporal stability of estimates of risk aversion. *Applied Financial Economics Letters 1*(1), 31–35.

Harrison, G. W., M. I. Lau, E. E. Rutstrm, and M. B. Sullivan (2005). Eliciting risk and time preferences using field experiments: Some methodological issues. *Field experiments in economics 10*, 125–218.

Hey, J. D. (2001). Does repetition improve consistency? *Experimental economics 4*(1), 5–54.

Holt, C. A. and S. K. Laury (2002). Risk aversion and incentive effects. *The American Economic Review 92*(5), 1644–1655.

Horowitz, J. K. (1992). A test of intertemporal consistency. *Journal of Economic Behavior & Organization 17*(1), 171–182.

Johnson, M. W., W. K. Bickel, and F. Baker (2007). Moderate drug use and delay discounting: a comparison of heavy, light, and never smokers. *Experimental and clinical psychopharmacology 15*(2), 187.

Josef, A. K., D. Richter, G. R. Samanez-Larkin, G. G. Wagner, R. Hertwig, and R. Mata (2016). Stability and Change in Risk-Taking Propensity Across the Adult Life Span. *Journal of Personality and Social Psychology*.

Kable, J. W. and P. W. Glimcher (2007). The neural correlates of subjective value during intertemporal choice. *Nature Neuroscience 10*(12), 1625–1633.

Kirby, K. N. (2009). One-year temporal stability of delay-discount rates. *Psychonomic Bulletin & Review 16*(3), 457–462.

Kirby, K. N., R. Godoy, V. Reyes-Garca, E. Byron, L. Apaza, W. Leonard, E. Perez, V. Vadez, and D. Wilkie (2002). Correlates of delay-discount rates: Evidence from Tsimane'Amerindians of the Bolivian rain forest. *Journal of Economic Psychology 23*(3), 291–316.

Kolmogorov, A. N. (1933). Sulla determinazione empirica di una legge di distribuzione. *Giornale dell' Istituto Italiano degli Attuari 4*, 83–91.

Lejuez, C. W., J. P. Read, C. W. Kahler, J. B. Richards, S. E. Ramsey, G. L. Stuart, D. R. Strong, and R. A. Brown (2002). Evaluation of a behavioral measure of risk taking: the Balloon Analogue Risk Task (BART). *Journal of Experimental Psychology: Applied 8*(2), 75.

Leuermann, A. and B. Roth (2012). Does good advice come cheap? - on the assessment of risk preferences in the lab and the field. *SOEPpapers on Multidisciplinary Panel Data Research No 475*.

Levin, I. P. and S. S. Hart (2003). Risk preferences in young children: Early evidence of individual differences in reaction to potential gains and losses. *Journal of Behavioral Decision Making 16*(5), 397–413.

Levin, I. P., S. S. Hart, J. A. Weller, and L. A. Harshman (2007). Stability of choices in a risky decision-making task: a 3-year longitudinal study with children and adults. *Journal of Behavioral Decision Making 20*(3), 241–252.

Li, Y., M. Baldassi, E. J. Johnson, and E. U. Weber (2013). Complementary Cognitive Capabilities, Economic Decision-Making, and Aging. *Psychology and aging 28*(3), 595–613.

Littlefield, A. K., A. K. Stevens, S. Cunningham, R. E. Jones, K. M. King, J. A. Schumacher, and S. F. Coffey (2015). Stability and change in multi-method measures of impulsivity across residential addictions treatment. *Addictive Behaviors 42*, 126–129.

Lönnqvist, J.-E., M. Verkasalo, G. Walkowitz, and P. C. Wichardt (2015). Measuring individual risk attitudes in the lab: Task or ask? an empirical comparison. *Journal of Economic Behavior & Organization 119*, 254–266.

Love, R. O. and L. J. Robison (1984). An empirical analysis of the intertemporal stability of risk preference. *Southern Journal of Agricultural Economics 16*(01), 159–166.

MacCrimmon, K. R. and D. A. Wehrung (1990). Characteristics of risk taking executives. *Management science 36*(4), 422–435.

Mann, H. B. and D. R. Whitney (1947). On a test of whether one of two random variables is stochastically larger than the other. *The Annals of Mathematical Statistics 18*(1), 50–60.

Mantziki, K., A. Vassilopoulos, G. Radulian, J.-M. Borys, H. du Plessis, M. J. a. Gregório, P. Graça, S. de Henauw, S. Handjiev, T. L. Visscher, and J. C. Seidell (2014). Promoting health equity in European children: Design and methodology of the prospective EPHE (Epode for the Promotion of Health Equity) evaluation study. *BMC Public Health 14*, 303.

McGlothlin, W. H. (1956). Stability of Choices among Uncertain Alternatives. *The American Journal of Psychology 69*(4), 604–615.

Meier, S. and C. Sprenger (2010). Present-biased preferences and credit card borrowing. *American Economic Journal: Applied Economics 2*(1), 193–210.

Meier, S. and C. D. Sprenger (2012). Time Discounting Predicts Creditworthiness. *Psychological Science 23*(1), 56–58.

Meier, S. and C. D. Sprenger (2015). Temporal stability of time preferences. *The Review of Economics and Statistics 97*(2), 273–286.

Mischel, W., Y. Shoda, and M. L. Rodriguez (1989). Delay of gratification in children. *Science 244*(4907), 933–938.

Niv, S., C. Tuvblad, A. Raine, P. Wang, and L. A. Baker (2012). Heritability and Longitudinal Stability of Impulsivity in Adolescence. *Behavior Genetics 42*(3), 378–392.

Ohmura, Y., T. Takahashi, N. Kitamura, and P. Wehr (2006). Three-month stability of delay and probability discounting measures. *Experimental and Clinical Psychopharmacology 14*(3), 318–328.

Olson, S. L., E. M. Schilling, and J. E. Bates (1999). Measurement of Impulsivity: Construct Coherence, Longitudinal Stability, and Relationship with Externalizing Problems in Middle Childhood and Adolescence. *Journal of Abnormal Child Psychology 27*(2), 151–165.

Peters, J. and C. Büchel (2009). Overlapping and Distinct Neural Systems Code for Subjective Value during Intertemporal and Risky Decision Making. *The Journal of Neuroscience 29*(50), 15727–15734.

Schoemaker, P. and J. C. Hershey (1992). Utility measurement: Signal, noise, and bias. *Organizational Behavior and Human Decision Processes 52*(3), 397–424.

Sharpe, W. F., D. G. Goldstein, and P. W. Blythe (2000). The distribution builder: A tool for inferring investor preferences. *Unpublished Manuscript*.

Shiryayev, A. N. (1992). On the empirical determination of a distribution law. In A. N. Shiryayev (Ed.), *Selected Works of A. N. Kolmogorov: Volume II Probability Theory and Mathematical Statistics*, pp. 139–146. Dordrecht: Springer Netherlands.

Simpson, C. A. and R. E. Vuchinich (2000). Reliability of a measure of temporal discounting. *The Psychological Record 50*(1), 3.

Smidts, A. (1997). The relationship between risk attitude and strength of preference: A test of intrinsic risk attitude. *Management Science 43*(3), 357–370.

Smirnov, N. (1948). Table for estimating the goodness of fit of empirical distributions. *The Annals of Mathematical Statistics 19*(2), 279–281.

Stigler, G. J. and G. S. Becker (1977). De Gustibus Non Est Disputandum. *The American Economic Review 67*(2), 76–90.

Straznicka, K. (2012). Temporal stability of risk preference measures. *Groupe d'Analyse et de Théorie Économique Lyon - St Étienne Working Paper No. 1236*.

Szrek, H., L.-W. Chao, S. Ramlagan, and K. Peltzer (2012). Predicting (un)healthy behavior: A comparison of risk-taking propensity measures. *Judgment and Decision Making 7*(6), 716–727.

Takahashi, T., A. Furukawa, T. Miyakawa, H. Maesato, and S. Higuchi (2007). Two-month stability of hyperbolic discount rates for delayed monetary gains in abstinent inpatient alcoholics. *Neuro Endocrinology Letters 28*(2), 131–136.

Vischer, T., T. Dohmen, A. Falk, D. Huffman, J. Schupp, U. Sunde, and G. G. Wagner (2013). Validating an ultra-short survey measure of patience. *Economics Letters 120*(2), 142145.

Weber, E. U., A.-R. Blais, and N. E. Betz (2002). A domain-specific risk-attitude scale: measuring risk perceptions and risk behaviors. *Journal of Behavioral Decision Making 15*(4), 263–290.

Wehrung, D. A., K. R. MacCrimmon, and K. M. Brothers (1984). Utility assessment: Domains, stability, and equivalence procedures. *INFOR: Information Systems and Operational Research 22*(2), 98–115.

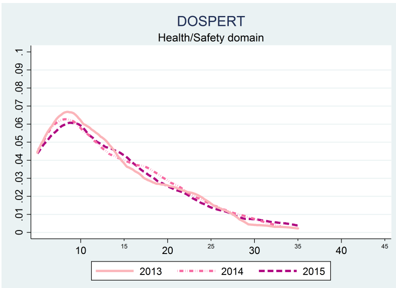
White, T. L., C. W. Lejuez, and H. de Wit (2008). Test-Retest Characteristics of the Balloon Analogue Risk Task (BART). *Experimental and clinical psychopharmacology 16*(6), 565–570.

Wilcoxon, F. (1945). Individual comparisons by ranking methods. *Biometrics Bulletin 1*(6), 80–83.

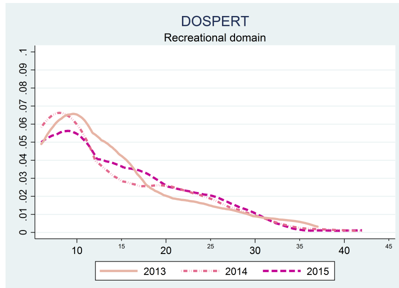
Wölbert, E. and A. Riedl (2013). Measuring time and risk preferences: Reliability, stability, domain specificity. *CESifo Working Paper Series No. 4339*.

Zeisberger, S., D. Vrecko, and T. Langer (2012). Measuring the time stability of prospect theory preferences. *Theory and Decision 72*(3), 359–386.

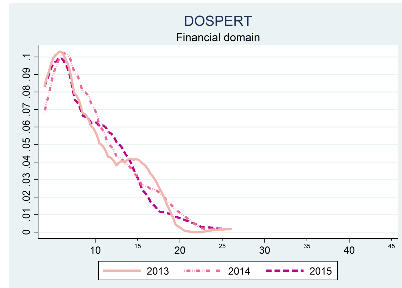
A Appendix: Additional tables/figures



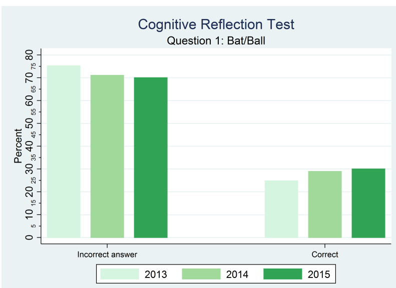
(a) % distribution of willingness to take risks scale



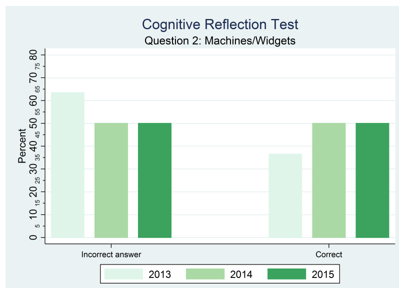
(b) % distribution of lottery investment question



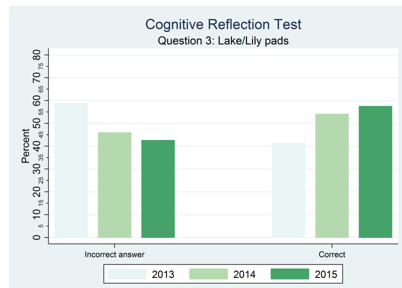
(c) % distribution of lottery investment question



(d) % distribution of answers in the bat/ball CRT



(e) % distribution of answers in the machines/widgets CRT



(f) % distribution of answers in the lake/lily pad CRT

Figure A.1: Distribution of responses across years for the CRT and DOSPERT subscales

Table A.1: Percentage and number of subjects with temporal stability for the three-year panel sample

	No change in response in …						
	2013-2014-2015		2013-2014		2014-2015		Cumulative
	N	%	N	%	N	%	%
Patience	18	22.50	12	15.00	15	18.75	56.25
Impulsiveness	11	13.75	11	13.75	12	15.00	42.50
Risk	14	17.50	13	16.25	12	15.00	48.75
Risk (investment)	33	42.31	16	20.51	14	17.95	80.77
DOSPERT	25	40.98	9	14.75	11	18.03	73.77
CRT	3	4.84	6	9.68	8	12.90	27.42

Table A.2: Random effects logit and linear regressions for the three year panel sample

		DOSPERT-f	DOSPERT-h/s	DOSPERT-r	CRT_1	CRT_2	CRT_3
w/o demographics	Constant	9.205***	12.819***	13.730***	-2.286***	0.019	1.393**
		(0.512)	(0.813)	(0.883)	(0.645)	(0.616)	(0.706)
	2013	-0.356	0.361	0.284	-0.307	-1.039*	-1.351**
		(0.559)	(0.671)	(0.831)	(0.556)	(0.571)	(0.628)
	2015	-0.575	0.014	-0.405	0.000	-0.439	-0.515
		(0.559)	(0.671)	(0.831)	(0.546)	(0.546)	(0.593)
	N	219	216	222	216	210	186
	Log-L	-617.772	-676.441	-732.511	-101.293	-112.181	-98.512
w/ demographics	Constant	10.496***	13.508***	18.396***	-1.118	-0.242	-1.706
		(2.540)	(3.634)	(3.857)	(2.940)	(3.994)	(4.115)
	2013	-0.101	0.479	0.910	-0.167	-0.801	-1.332
		(0.587)	(0.715)	(0.918)	(0.656)	(0.700)	(0.854)
	2015	-0.860	0.085	-1.044	-0.171	-0.702	-1.174
		(0.590)	(0.736)	(0.933)	(0.655)	(0.697)	(0.891)
	N	198	195	201	195	192	156
	Log-likelihood	-546.811	-602.139	-649.120	-79.067	-90.355	-70.108

Notes: Random effects linear regression models are estimated for DOSPERT-f, DOSPERT-h/s and DOSPERT-r. Random effects logit models are estimated for CRT_1, CRT_2, CRT_3. Ancillary parameter estimates are omitted. The lower panel of the table shows results from models including demographic controls shown in Table 5. Coefficient estimates for demographic controls are omitted. * p<0.1, ** p<0.05, *** p<0.01.

Table A.3: Random effects logit and linear regressions for the two year panel samples

		DOSPERT-f	DOSPERT-h/s	DOSPERT-r	CRT_1	CRT_2	CRT_3
w/o demographics	Constant	9.500***	13.750***	11.947***	-1.609	-0.259	-0.891
		(0.779)	(1.070)	(1.194)	(1.151)	(0.529)	(0.922)
	2nd year	-0.184	0.800	0.184	-0.000	0.693	2.087*
		(0.898)	(1.068)	(1.319)	(0.821)	(0.612)	(1.068)
	N	76	80	76	74	74	68
	Log-L	-224.846	-260.658	-256.437	-40.730	-48.260	-40.105
w/ demographics	Constant	11.895**	3.704	6.807	-3.465	-3.531	-9.936
		(5.232)	(7.437)	(8.900)	(4.111)	(3.735)	(6.102)
	2nd year	-0.521	1.264	0.217	-0.394	0.402	2.128*
		(0.953)	(1.205)	(1.453)	(0.832)	(0.676)	(1.133)
	N	74	78	74	74	74	58
	Log-L	-207.912	-245.835	-244.859	-32.581	-30.515	-18.890

Notes: Random effects linear regression models are estimated for DOSPERT-f, DOSPERT-h/s and DOSPERT-r. Random effects logit models are estimated for CRT_1, CRT_2, CRT_3. Ancillary parameter estimates are omitted. The lower panel of the table shows results from models including demographic controls shown in Table 5. Coefficient estimates for demographic controls are omitted. * p<0.1, ** p<0.05, *** p<0.01.

Table A.4: Random effects ordered logit and linear regression pooling together the three year and two year panel samples

		Patience	Impulsiveness	Risk	Risk investment	DOSPERT	CRT
w/o demographics	Constant					36.784***	1.473***
						(1.415)	(0.121)
	2013	-0.167	-0.665***	0.190	0.253	-1.437	-0.268**
		(0.253)	(0.249)	(0.252)	(0.296)	(1.455)	(0.106)
	2015	-0.256	-0.359	-0.612**	-0.165	-1.725	-0.052
		(0.264)	(0.262)	(0.261)	(0.304)	(1.529)	(0.111)
	N	320	322	322	314	256	247
	Log-L	-590.471	-635.041	-627.976	-341.463	-1009.078	-340.848
w/ demographics	Constant					39.289***	0.785*
						(5.736)	(0.435)
	2013	-0.395	-0.819***	0.166	0.362	-1.272	-0.193*
		(0.271)	(0.267)	(0.265)	(0.317)	(1.522)	(0.104)
	2015	-0.562*	-0.220	-0.519*	-0.106	-2.544	-0.143
		(0.295)	(0.288)	(0.288)	(0.336)	(1.676)	(0.113)
	N	291	293	293	287	239	229
	Log-L	-525.558	-572.641	-562.543	-306.023	-936.852	-292.934

Notes: Random effects ordered logit models are estimated for Patience, Impulsiveness, Risk and Risk investment. Random effects linear regression models are estimated for DOSPERT and CRT. Ancillary parameter estimates are omitted. The lower panel of the table shows results from models including demographic controls shown in Table 5. Coefficient estimates for demographic controls are omitted. * p<0.1, ** p<0.05, *** p<0.01.

Table A.5: Random effects logit and linear regressions pooling together the three year and two year panel samples

		DOSPERT-f	DOSPERT-h/s	DOSPERT-r	CRT_1	CRT_2	CRT_3
w/o demographics	Constant	9.252***	13.607***	13.286***	-2.149***	0.313	0.936*
		(0.427)	(0.649)	(0.714)	(0.556)	(0.447)	(0.518)
	2013	-0.249	-0.363	0.010	-0.161	-1.262***	-1.236**
		(0.494)	(0.589)	(0.725)	(0.478)	(0.465)	(0.509)
	2015	-0.407	-0.479	-0.426	0.191	-0.497	-0.013
		(0.509)	(0.618)	(0.759)	(0.487)	(0.466)	(0.504)
	N	295	296	298	290	284	254
	Log-L	-843.866	-938.888	-990.656	-143.401	-160.194	-140.846
w/ demographics	Constant	10.360***	13.068***	16.513***	-2.083	0.347	-2.970
		(2.343)	(3.263)	(3.602)	(1.994)	(2.019)	(2.089)
	2013	-0.169	-0.500	0.419	-0.013	-1.038**	-1.071*
		(0.514)	(0.626)	(0.776)	(0.515)	(0.507)	(0.552)
	2015	-0.555	-0.340	-0.720	-0.143	-0.738	-0.267
		(0.546)	(0.685)	(0.842)	(0.545)	(0.549)	(0.585)
	N	272	273	275	269	266	214
	Log-L	-770.360	-860.349	-905.216	-116.900	-141.221	-108.519

Notes: Random effects linear regression models are estimated for DOSPERT-f, DOSPERT-h/s and DOSPERT-r. Random effects logit models are estimated for CRT_1, CRT_2, CRT_3. Ancillary parameter estimates are omitted. The lower panel of the table shows results from models including demographic controls shown in Table 5. Coefficient estimates for demographic controls are omitted. * p<0.1, ** p<0.05, *** p<0.01.