Are Time Preference and Risk Preference Associated with Cognitive Intelligence and Emotional Intelligence?

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ABSTRACT

We investigate whether cognitive intelligence (IQ) and emotional intelligence (EQ) meaningfully correlate with time preference and risk preference, finding solid evidence in support. In the realm of time preference, high-EQ individuals are less subject to present (or future) bias, and they are more patient. Further, high-IQ subjects tend to exhibit preferences that conform to expected utility maximization. While recent research on the relationship between cognitive ability and preferences has provided important insights, our results suggest that *both* cognitive intelligence *and* emotional intelligence matter.

Keywords: time preference, risk preference, prospect theory, emotional intelligence

JEL: C91, D80

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1. Introduction

In today's world, average people must face the responsibility of growing sufficient wealth to provide for retirement. Future wealth depends critically on the ability to save, in addition to a willingness to bear financial risk. The prospect for success, however, is of serious concern. Income inequality is on the rise and many people are severely lacking in their ability to grow wealth. A recent comprehensive study of tax, survey, and national account data provides a disconcerting picture of the financial situation for the typical American citizen (Piketty, Saez, and Zucman 2016). Since 1980, pre-tax income for the bottom 50% has been unchanged while the top 1% has benefited from sharp income increases. In fact, while in 1980 the top 1% earned about 27 times more than the bottom 50%, now the top 1% earns *81 times more* than the bottom 50%. The evidence suggests that this increase in inequality is in large part not due to higher wages at the top but instead results from gains on investments, including stocks and bonds. While the top 1% is certainly in a strong wealth position, one in three Americans has saved nothing whatsoever for retirement (Kirkham 2016).

This environment presents a significant challenge to policymakers who hope to encourage wise financial decisions. In this paper, we report on peoples' time and risk preferences and, in turn, seek to inform theory and policy. Prior research documents significant heterogeneity in financial decision-making, with age, sex, and income, among other variables, having predictive ability (e.g., Agnew, Balduzzi, and Sunden 2003; Barsky *et al.* 1997; Calvet and Sodini 2014). This paper adds to the literature by using an experimental method to explore whether a relationship exists between the key parameters in time- and risk-preference models and proxies for *both* cognitive ability and emotional stability.

There is increasing evidence that cognitive ability, as commonly proxied by an intelligence quotient or IQ figure, has a meaningful relationship with the key preference parameters underlying financial decision-making.[1] For example, Dohmen *et al.* (2010) find that those with higher levels of cognitive ability take on more risk. These people also save more.[2] At the same time, research in psychology shows that those with high levels of emotional stability, as commonly proxied by an emotional quotient or EQ figure, have better life outcomes (Almlund *et al.* 2011), suggesting that EQ also may be an important factor that explains wise financial decisions. Emotional stability is defined by the *American Psychology Association* as "predictability and consistency in emotional reactions, with absence of rapid mood changes" (Almlund *et al.* 2011).[3] Recent work documents the relationship between EQ and a key risk-taking preference parameter (Charupat *et al.* 2013).

Our experiment is designed to explore, uniquely we believe, whether a relationship exists between proxies for *both* cognitive ability (IQ) and emotional stability (EQ) and the key parameters in time and risk preference models. Specifically, we focus on quasi-hyperbolic discounting and (Cumulative) Prospect Theory (PT), both of which nest models grounded in traditional Expected Utility Theory (EUT). To preview, we find that both IQ and EQ independently matter, with EQ dominating for time preference and IQ for risk preference. We observe significant differences in preferences across sex. Interestingly, we

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[1] IQ and cognitive ability are not strictly equivalent (Urbina 2011). However, it is reasonable to say that IQ, a metric resulting from various administered tests, is a noisy estimator of different aspects of multi-faceted cognitive ability. For ease of exposition, we treat the acronym, IQ, and cognitive ability as congruent.

[2] Some evidence suggests that time preference and risk preference are related (Abdellaoui, Diecidue and Oencueler 2011; Andreoni and Sprenger 2012; Gerber and Rohde 2010). Here, like most other researchers, we treat them as separable.

[3] We use emotional stability as a measure of emotional intelligence, though the two are not strictly equivalent. Emotional intelligence is defined as "the subset of social intelligence that involves the ability to monitor one's own and others' feelings and emotions, to discriminate among them, and to use this information to guide one's thinking and actions" (Salovey and Meyer 1990). Emotional stability is a component of a trait family that some call Neuroticism/Emotional Stability and which is within the popular "Big Five" trait family model of personality psychology (Larsen and Buss 2017). Those low in emotional stability (or high in neuroticism) are often said to exhibit Negative Affectivity (NA) (Watson and Clark 1984). As we describe below, the emotion-based metric that we employ is a noisy proxy for emotional stability (as we have also said above in the context of IQ).

also observe that while some people's preferences are consistent with traditional EUT, a majority are not. Many peoples' choices are better categorized as consistent with PT.

The plan of the paper is as follows. In section 2, we review the literature on the impact of cognitive ability and emotional stability on time preference and risk preference, as well as the measurement of IQ and EQ. We also provide background on the time- and risk-preference models employed here (namely quasi-hyperbolic discounting and prospect theory). Section 3 presents our hypotheses, and section 4 details our research design. The penultimate section presents our findings, and section 6 concludes.

2. IQ, EQ, and time- and risk-preference models

2.a. Cognitive ability

An IQ score, derived from standardized tests, is typically used to measure a person's cognitive ability. The IQ test was first developed at the beginning of the 20th century in France by Alfred Binet whose goal was to identify children in need of remedial help and later popularized in the United States with the Stanford-Binet IQ test (Wade and Tavris 2017). Though the IQ test is commonly used to assess intelligence, psychologists continue to debate what aspects of cognitive ability are measured and even exactly what intelligence means (Gould 1994). A vast literature in psychology evaluates the usefulness of IQ in predicting achievement, including occupational success (Schmidt and Hunter 1998).

As for financial decision-making, the evidence suggests that those with higher levels of cognitive ability are able to save more while taking on more risk, and these findings are robust across subject pools. For example, with a sample of subjects at various U.S. universities, Frederick (2005) finds that those with higher cognitive ability are both more patient (i.e., have a lower rate of time preference) and less risk-averse. Dohmen *et al.* (2010) find similar results with a diverse sample of German citizens. Grinblatt, Keloharju, and Linnainmaa (2011), using a large Finnish dataset, show that stock market participation is positively related to IQ after controlling for a host of other possible explanatory variables such as wealth, income, and age. Moreover, high-IQ individuals perform better when trading securities and exhibit fewer behavioral biases (Grinblatt, Keloharju, and Linnainmaa 2012).[4] These tendencies are generally echoed in other research.[5]

These studies use a variety of proxies for cognitive ability. Some study the relationship between IQ and financial decision-making with instruments developed by psychologists. A number of different instruments have been designed for particular practical purposes and to measure distinct facets of cognitive ability (Urbina 2011). The Wechsler Adult Intelligence Scale (WAIS), developed specifically for adults, is widely used. The drawback of this test (with its 11 modules), and many of its adaptations, is the lengthy time for administration, making it impractical for many experimental and survey studies. To alleviate time constraints, some researchers use a subset of the WAIS to measure cognitive ability. One example is Dohmen *et al.* (2010) in which two submodules of the WAIS proxy for cognitive ability. In other cases, due to the availability of unique data, researchers use alternative measures to proxy for IQ. For example, Grinblatt, Keloharju, and Linnainmaa (2011) study data for Finnish men who completed a 120-question test designed to measure intelligence at their induction into required military training.

The Cognitive Reflection Test (CRT) is an IQ measure that has practical benefits because it is a very short survey and responses are easy to evaluate (Frederick 2005). This test employs three simple questions that have correct numerical answers. In each case, there is an incorrect but intuitive answer, while the correct answer requires one to pause and

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[4] For example, higher-IQ investors in their sample are less prone to the disposition effect, the tendency to hold on to poor-performing stocks while selling good performers.

[5] Ballinger *et al.* (2011) report significant correlation between IQ and saving in an experimental setting. Eckel *et al.* (2012) relate IQ and risk taking in a field study of high school students. We note, however, that there is some contrary evidence. Taylor (2013) reports that IQ and risk taking are positively correlated when choices are hypothetical but not in settings with real choices.

"cognitively reflect," hence the name of the test. For example, consider the following question:

A bat and ball cost $1.10. The bat costs one $1.00 more than the ball. How much does the ball cost?

A little thought indicates that the ball costs 5 cents and the bat $1.05 (for the required sum of $1.10 and difference of $1.) The incorrect answer naturally occurring to many people as the cost of the ball, however, is $0.10. People seem to anchor on the difference between $1.10 and $1.00, erroneously arriving at a cost of 10 cents for the ball. The other two questions of the CRT are in the same vein.[6]

We employ the CRT in the present study as a proxy – albeit noisy – for IQ. As noted above, a number of measures are available. In addition to robustness across subject pools, financial behavior is generally consistent across the various tools that assess cognitive ability. Because of its ease of use and the fact that it has been shown to correlate not only with more extensive tests of cognitive ability but also with the behaviors that these tests are associated with (Frederick 2005), we chose the CRT to measure IQ.

2.b. Emotional intelligence

Compared to theories of cognitive ability, models of EQ are relatively new. The theory was first introduced in 1990 (Mayer, DiPaolo, and Salovey 1990; Salovey and Mayer 1990) and quickly gained much popular interest. The October 2, 1995 cover of *Time* magazine proclaimed that EQ "may be the best predictor of success in life." Though EQ helps predict life outcomes including well-being, the *Time* claim probably took the predictive ability of the concept too far (Mayer, Roberts, and Barsade 2008).

Psychologists report that people with higher EQ are less likely to procrastinate and less impulsive (Whiteside and Lynam 2001; Lee, Kelly, and Edwards 2006). When it comes to

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[6] The complete survey appears in Appendix 1. The CRT questions are B-1 to B-3.

financial decision-making, research indicates that emotion plays a role in understanding how people respond to stimuli at the individual level. For example, Lo and Repin (2002) measure emotion using skin conductance and report that professional traders become more emotional when the market is moving up or down, as compared to non-event control periods. Another study by Johnson *et al.* (1993) finds that people are more likely to insure against emotionally vivid events. Emotion also has the power to explain individual behavioral anomalies, such as the disposition effect or the tendency to hold, suboptimally, losing investments longer than winning investments (Odean 1998). Summers and Duxbury (2012) provide evidence to support the view that emotion drives the disposition effect.

Researchers have observed that an investor's preference toward risk evolves in response to the external environment. For example, an increase in pessimism or anxiety in response to a negative external event may lead to a decrease in the individual's risk tolerance. Consistent with this argument, Kaplanski and Levy (2010) report negative stock returns following aviation disasters as investors' pessimistic mood depresses stock prices. Evidence also suggests that when individuals' affective assessments change, their preferences change. Indeed, Dhar and Wertenbroch (2000) show that emotional forces mold loss aversion, which is the feeling that "losses loom larger than gains" (Kahneman and Tversky 1979). Loss aversion is associated with non-EUT preferences, including PT. In addition, researchers provide evidence that people's evaluations of decision options change in response to stimuli. In both traditional Expected Utility Theory and Prospect Theory, people use a utility function, $u(\bullet)$, to evaluate outcomes and the option chosen is the one that maximizes the weighted average of the utility of the outcomes. In EUT, the weights are simple probabilities, whereas in PT the weights are probabilities that are transformed based on preferences regarding distance from impossibility and certainty. Rottenstreich and Hsee (2001), Kliger and Levy (2008), and Fehr-Duda *et al.* (2011) report that affective assessments influence probability weighting.

Few studies directly examine emotional stability and financial decision-making. An exception is Charupat *et al.* (2013) who examine whether a precise measure of EQ correlates with curvature of the PT weighting function based on observed preferences. Probability weighting, commonly associated with PT, results in curvature of the weighting function with more curvature reflecting greater sensitivity to extreme probabilities. In contrast, lower curvature in the weighting function reflects preferences that are closer to EUT.[7] Charupat *et al.* conclude that higher EQ is associated with EUT-type preferences.

We follow the approach of Charupat *et al.* (2013) to measure emotional stability. In personality psychology, a five-factor model known as the "Big Five" has received much support.[8] One of the five trait groupings is often termed Neuroticism/Emotional Stability. People who are low in emotional stability exhibit neuroticism or negative affectivity (NA) (Watson and Clark 1984). Those high in emotional stability or EQ tend to exhibit calm and grace under pressure, while those low in EQ are often anxious, excitable and nervous. In gauging EQ, this metric measures the individual's innate tendencies, rather than the ability of individual to overcome emotion.[9]

Specifically, our instrument for EQ is based on the International Positive Affectivity-Negative Affectivity Schedule – Short Form (I-PANAS-SF), proposed and tested for validity by Thompson (2007). Participants are asked how often their feelings tend in the direction of 10 adjectives, some of which correspond to negative emotions ("upset" is an example), others of which correspond to positive emotions ("attentive" is an example).[10] A 5-point Likert scale is used ranging from '1' (never) to '5' (always). The average score

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[7] Recall that the traditional theory assumes the probabilities are the weights, giving a linear relationship.
[8] See Larsen and Buss (2017).
[9] An individual's innate tendencies are one facet of emotional intelligence as first conceptualized by Salovey and Mayer (1990). They defined emotional intelligence as "the ability to monitor one's own and others' feelings and emotions, to discriminate among them and to use this information to guide one's thinking and actions." In their view, there are three fundamental aspects of emotional intelligence: appraisal and expression of emotion, regulation of emotion, and utilization of emotion.
[10] The I-PANAS-SF questions are A-1 to A-10 in Appendix 1.

on the five negative adjectives (which is called "negative affectivity" or NA) is our proxy for EQ, with low average values implying high EQ. In specifying our EQ measure, we use 5 minus NA so that a higher EQ value implies high EQ, which allows easier interpretation of regression results.

Though not our primary focus, we also investigate whether positive affectivity impacts preferences. The average score on the five positive adjectives yields "positive affectivity" (PA), the tendency to experience positive emotions. Prior evidence suggests that positive emotions can play a role in improved decision-making (e.g., Bechara *et al.* 1997) and, thus, it is possible that PA impacts time and risk preferences.

2.c. Time preference and the quasi-hyperbolic discount function parameters

Time preference has important effects on wealth accumulation. In the traditional model, people discount future cash flows exponentially at a constant rate of ρ, with more patient individuals having a lower subjective discount rate. Though discounting over time at a constant rate is taken to be a valid account of conventional behavior at least since Samuelson's (1937) description of utility maximization, the empirical evidence has often not been supportive. As Bernheim, Skinner and Weinberg (2001, p. 855) state, "empirical patterns [in saving]... are more easily explained if one steps outside the framework of rational, far-sighted optimization." In this spirit, Tanaka, Camerer, and Nguyen (2010) estimate the following general function proposed by Benhabib, Bisin, and Schotter (2010):[11]

$$(1) \quad D(t;\ \rho,\ \beta,\ \theta) = \beta(1-(1-\theta)\rho t)^{\frac{1}{(1-\theta)}} \qquad \text{for } t > 0$$

where ρ is the pure rate of time preference, β is present bias, and θ is "hyperbolicity." An individual who is present-biased associates a cost to future cash flows, as compared to a

[11] Frederick, Loewenstein, and O'Donoghue (2002) provide a comprehensive review of time preference.

reward received today (O'Donoghue and Rabin 1999). Hyperbolic discounting implies a declining rate of time preference, as reported in empirical studies on intertemporal choice (Thaler 1981). When θ=1 (in the limit) equation (1) reduces to the quasi-hyperbolic discount function common in much research:

(2) $D(t;\ \rho,\ \beta) = \beta \exp^{-\rho t}$ for $t > 0$

Tanaka, Camerer, and Nguyen (2010) find that when they do not constrain θ, there is little improvement in the R-squared as compared to quasi-hyperbolic discounting. So in the interest of reducing the number of parameters that must be estimated as well as to maintain clarity of interpretation for the remaining parameters, we estimate (2).

2.d. Risk preference and the parameters of prospect theory

In addition to time preference, risk preference significantly impacts people's ability to grow wealth. In traditional EUT, people evaluate the utility of all possible outcomes and choose the option that gives the highest weighted average, where the weights (π_i) are simple probabilities. Similarly, in PT people choose the best outcome but use transformed weights that depend on the distance of the probability from impossibility and certainty (Kahneman and Tversky 1979; Quiggin 1982; Tversky and Kahneman 1992).[12] In either case, the utility function can be expressed as:

(3) $U(P) = \sum_{i=1}^{n} \pi_i u(z_i)$.

As is conventional, the PT utility function is modelled with the following two-part power function:

[12] Prospect theory is not the only positive theory of decision-making under risk and uncertainty. It is however the most popular one, in large part because it generally performs quite well (Barberis 2013). Nevertheless, there are cases where it fails (e.g., Baltussen, Post and van Vliet 2006). See Wakker (2010) for an excellent, comprehensive review.

$$(4a) \quad u(z) = z^{\alpha}, \;\; 0 < \alpha \;\text{ if } z \geq 0$$
$$(4b) \quad u(z) = -\lambda(-z)^{b}, \;\; 0 < b, \lambda \;\text{ if } z < 0$$

where typically it is found that $0 < \alpha < 1$ and $0 < b < 1$, reflecting concavity for gains and convexity for losses; and $\lambda > 1$, because people are loss-averse.

Instead of weighting values by probabilities as in EUT, prospect theory uses transformed probabilities to generate "decision weights." If all outcomes are non-negative, they are first ordered as $z_1 > z_2 > \ldots > z_{n-1} > z_n$. Corresponding probabilities are written as $q_1, q_2, \ldots q_{n-1}, q_n$. Then the rank of each outcome is calculated, where rank is defined to be the probability of receiving a superior outcome (so the rank of z_k is $\sum_{i=1}^{k-1} q_i$). The appropriate decision weight attached to z_i is the difference between the transformed rank of the next-best outcome z_{i+1} and the transformed rank of z_i,

$$(5) \quad \pi_i = w(q_1 + q_2 + \cdots + q_i) - w(q_1 + q_2 + \cdots + q_{i-1})$$

In our experiment, we only consider simple binary prospects. When both outcomes are in the same domain (3) reduces to (3'):

$$(3') \quad U(P) = w(q_1)v(z_1) + [1 - w(q_1)]u(z_2)$$

For the probability weighting function, Prelec's (1998) single-parameter axiomatically-derived function, which also tends to fit the data well (Stott 2006), is used:

$$(6a) \quad w(q) = exp\,[-(-ln(q))^{\gamma}], \quad 0 < \gamma \; if \; z \geq 0$$
$$(6b) \quad w(q) = exp\,[-(-ln(q))^{\delta}], \quad 0 < \delta \; if \; z < 0$$

Given that typically α and b are close to each other, as are γ and δ (e.g., Tversky and Kahneman 1992), to conserve on parameter estimation we impose equality restrictions for both cases in our estimation, yielding:

$$(4a) \quad u(z) = z^{\alpha}, \;\; 0 < \alpha \;\; \text{if } z \geq 0$$
$$(4b') \quad u(z) = -\lambda(-z)^{\alpha}, \;\; 0 < \alpha, \lambda \;\; \text{if } z < 0$$
$$(6a') \quad w(q) = exp\,[-(-ln(q))^{\gamma}], \quad 0 < \gamma, \quad \text{for all z.}$$

We estimate (4a), (4b'), and (6a') to reduce the number of parameters estimated and to maintain the clarity of interpretation for the remaining parameters. As described subsequently, estimates of α, γ, and λ provide insight into the risk preferences of our experimental participants. If PT preferences describe risk taking, three parameters govern choice when facing risk: utility function curvature, loss aversion, and probability weighting. Each influences the willingness of an individual to bear risk, with greater curvature, loss aversion, and (usually) probability weighting all leading to less risk taking.[13]

2.e. Additional preference determinants

Prior research reports patterns in patience and risk taking related to demographics. Research on behavior related to time preference stresses psychological determinants, including the uncertain nature of future events, the bequest motive and familial altruism, the propensity to exercise self-restraint, and the systematic tendency to underestimate future wants (Frederick, Loewenstein, and O'Donoghue 2002). Recently, Brown, Ivkovic, and Weisbenner (2015) show that patience is associated with good health, longer time horizon, parenthood, income, and few liquidity constraints. Other subtle determinants are important, including nurture (Nguyen 2011), transparency (Mishra *et al.* 2013), and uncertainty surrounding the adequacy of savings (van Schie, Donkers, and Dellaert 2012).

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[13] Low values of the parameter of a single-parameter probability weighting function imply that the weight for the high-wealth outcome is for most probabilities levels less than the probability (hence inducing risk aversion). An exception is for low-probability events, resulting in the popularity of lottery tickets.

For risk preference, older people who are closer to retirement, as they should, take on less risk because they have less time to recover from adverse market outcomes (Ameriks and Zeldes 2004). In contrast, high-income, high-net worth people invest a larger proportion of their portfolios in risky assets because they have a smaller commitment to expenditures on consumption (Calvet and Sodini 2014). Along the same lines, people who have acquired job seniority and are married tend to be less risk-averse because they have more financial security (Agnew, Balduzzi, and Sunden 2003). Holding other factors constant, men are less risk-averse (Barsky *et al.* 1997). In addition to demographic factors, there are other, more subtle determinants of risk preference, including genetics (Barnea, Cronqvist, and Siege 2010; Cesarini *et al.* 2010), culture (Bruhin, Fehr-Duda, and Epper 2010), recent experience (Tinsley, Dillon, and Cronin 2012), school environment (Eckel *et al.* 2012), timing of risk resolution (van Winden, Krawczyk, and Hopfensitz 2011), openness to advice and a planner mentality (Bhandari and Deaves 2008), and expertise (von Gaudecker, van Soest and Wengstroem 2012).

Researchers have documented the importance of sex when it comes to IQ, EQ, and risk and time preferences. In general, women are more risk-averse than men (Barsky *et al.* 1997; Booth *et al.* 2014; Booth and Katic 2012; Frederick 2005; Schubert, *et al.* 1999)). More specifically, women are less risk-taking than men because of differences in probability weighting, rather than in differences in their value functions (Fehr-Duda, de Gennaro, and Schubert 2006). Furthermore, women tend to be less sensitive than men to probability changes, though women more strongly underestimate large probabilities of gains. Other research reports that pre-existing good mood is significantly associated with women's probability weights, whereas men appear to be less sensitive to mood effects (Fehr-Duda *et al.* 2011). Instead, men appear to apply more mechanical decision-making criteria.

While Dohmen *et al.* (2010) find that individuals with high cognitive ability take more risk in lottery experiments and are more patient, the relationship is somewhat weaker for females. In his study on risk and time preferences with the CRT proxy for IQ, Frederick (2005) finds that men have higher CRT scores than women, and that women's mistakes on the CRT tend to be of the intuitive variety more than men's mistakes. They also find that CRT scores are more highly correlated with risk preference for men than for women, and that CRT scores are more highly correlated with time preference for women than for men. The relationship between CRT scores and patience in women is in line with the findings of Shoda *et al.* (1990), who find that patience in preschool girls is strongly related to their subsequent SAT scores (which is one indicator of cognitive ability), but no such relationship exists for boys. Oechssler *et al.* (2009) echo the findings of Frederick (2005), in that they also find that CRT scores for males are higher than those of females.

3. Hypotheses

Though still in its infancy, the existing literature suggests that higher IQ and EQ push people toward the traditional view of preferences. For example, for time preference, the typical assumption is that people discount future cash flows at a constant rate. But, Walther (2010) relates anticipated emotions to hyperbolic discounting, in which case the rate of time preference is not constant. In addition, the evidence presents a strong case against exponential discounting (Benhabib, Bisin, and Schotter 2010). Recall that with present bias $\beta<1$, whereas with future bias $\beta>1$. Therefore, $\beta=1$ can be said to be consistent with a conventional view of time preference. We specify $\beta^*=|1-\beta|$, so that the deviation of β from one (β^*) should equal zero. As for ρ, the pure rate of time preference, there is no "right" answer, but as Dohmen *et al*. (2010) argue, an unreasonably high pure rate of time preference is difficult to rationalize with existing models of preferences.

As for risk preference, EUT (non-weighted) probabilities emerge as γ approaches 1. Further, if $\lambda=1$, there is no loss aversion, again consistent with EUT. For α, the prediction is less clear. Rabin (2000) has shown that EUT implies virtually no risk aversion for small to moderate gambles, because otherwise unreasonably high degress of risk aversion would result for large gambles. Taken together, $\alpha = \gamma = \lambda = 1$ is the gold standard for traditional, EUT-like behavior.[14] Therefore, in our examination of revealed risk preferences, we let $\alpha^*=|1-\alpha|$, $\gamma^*=|1-\gamma|$ and $\lambda^*=|1-\lambda|$, so that EUT implies that $\alpha^* = \gamma^* = \lambda^* = 0$.

This study uniquely examines the role of *both* IQ and EQ in time and risk preferences. We conjecture that the two independently matter: namely, higher IQ and higher EQ should push people in the direction of traditional behavior. We posit two hypotheses are consistent with this conjecture:

> *Hypothesis 1: Higher IQ and higher EQ are associated with time preferences that are closer to traditional time preferences.*

> *Hypothesis 2: Higher IQ and higher EQ are associated with risk preferences that are closer to traditional, EUT-type risk preferences.*

If the time preferences of people with higher IQ and higher EQ are closer to traditional expectations, we will observe that they are more present-indifferent (lower β^*) and have a lower rate of pure time preference (lower ρ). As for risk preferences, if the risk preferences of people with higher IQ and higher EQ are closer to traditional expectations, we will observe that they are closer to risk neutral (lower α^*), more neutral to losses (lower λ^*), and have less probability weighting (lower γ^*). In the following section, we describe our experimental method before turning to tests of these hypotheses.

4. Experimental design

4.a. Basic setup

The experiment was conducted at a large, public university on back-to-back days, with

[14] Koebberling and Wakker (2005) provide a decomposition of risk aversion into these three parameters.

four sessions being held on the first day and three on the second. There were 146 useable participant responses.[15] Subjects, recruited via advertisements and a mass e-mails to all junior and senior undergraduate business students, were given paper-and-pencil question sets, which included detailed instructions on procedures. These appear in Appendices 1, 2 and 3.

The survey consists of 25 questions in 5 blocks. There are 4 versions of the survey with the only difference being the positioning of the question blocks in order to obviate ordering effects. We include one version in Appendix 1 for illustration. In this version of the experimental instrument, section A consists of the 10 I-PANAS-SF questions, section B includes the 3 CRT questions, section C uses 3 question sets to elicit 3 risk-preference parameters, section D gives the 2 sets of questions designed to elicit the 2 time-preference parameters, and section E includes demographic questions such as sex, age, year in university, and the number of university courses potentially helpful for the exercise at hand previously completed or currently in progress.[16] It took virtually all subjects less than one hour to complete the survey.

4.b. Elicitation of risk-preference parameters

The risk-preference elicitation procedure follows closely Tanaka, Camerer, and Nguyen (2010).[17] The survey includes three question sets, each comprised of a series of paired prospects (A vs. B). Subjects choose the preferred prospect for each pair. Going down the rows of paired prospects, B becomes relatively more attractive to A, as was clearly detailed for subjects in the instructions. Thus, if preference switched from A to B at a

[15] While there were 150 participants, 4 responses were not useable. One participant was a geology major, and was discarded to keep the pool entirely business students. Another excluded participant was taking a behavioral finance course with one of the experiment administrators. According to the university's ethics board, students currently taking courses with the experiment administrator cannot be included in the subject pool. A third participant's time preference response was contrary to dominance suggesting obvious confusion. The fourth participant did not complete the question sets.
[16] Specifically, the survey refers to courses in economics, finance, math, and statistics. All participants had taken at least basic courses in finance/economics and probability/statistics.
[17] This instrument follows Holt and Laury (2002).

particular row, it was clearly illogical to switch back later. There were then three possibilities: a subject could always prefer A; she could always prefer B; or initially she could prefer A, but switch to a preference for B. We calculated certainty equivalents based on the row at which a subject switched between A and B. The first two question sets yielded estimates of the risk-preference parameters, α and γ, while the third question set yielded estimates of λ, the loss-aversion parameter.

4.c. Elicitation of time-preference parameters

The elicitation procedure for the two time-preference parameters is similar to that for the risk-preference parameters and included two sets of questions.[18] The first set asks subjects to make choices between money received in one week and money received in two weeks, yielding an estimate of the (pure) rate of time preference. The second set asks for choices between money received "today" vs. money received in one week, yielding an estimate of present bias.[19]

4.d. Incentive compatibility

The time- and risk-preference questions were rendered incentive-compatible as follows. As the instructions detailed, 4 students were randomly selected at the end of each session. Two of the selected students received monetary compensation based on their responses to the time-preference questions and the other 2 selected students received compensation based on the risk-preference questions. For time preference, the survey included 35 questions (18 choices in the first question set and 17 more in the second (choices 19-35)). Each of the 4 selected students randomly chose a card (independently and with

[18] There are critics of this sort of elicitation procedure. For example, it has been shown that time preference may be impacted by market conditions (Krupka and Stephens 2013).
[19] More specifically, "today" meant that a student had to report to the office of one of the experimenters at the end of the day to collect payment. This approach is designed to equalize the "hassle factor" for immediate vs. deferred choices.

replacement) from a set numbered '1' to '35.' The number chosen was then the row that determined their cash payment according to stated time preference. For example, if in the case of a time-preference question card '25' were chosen (corresponding to the seventh row of the second time-preference question set), a student who had chosen A would receive $100 today while a student who had chosen B would receive $110 in one week. As for the risk-preference instrument, the survey also included 35 questions (14 choices in the first question set, 14 more in the second (choices 15-28), and 7 more in the third (29-35)).[20] The risk-preference questions required a *third* level of randomness. While as in the case of the time-preference questions, the first level dictated which students were eligible and the second level which choice was operative, the third level "played out" the random draw. Specifically, the subject chose a card from a set numbered '1' to '10,' with high card numbers corresponding to high-payout probabilities. For example, for row 10 and a subject choice of B, the card '10' awarded the subject $150 (because there was a 10% probability of the high payout) and all other cards awarded $2.50.

5. Empirical findings

5.a. Characteristics of the data

Panel A of Table 1 details variable definitions, Panel B reports descriptive statistics for all variables, and Panel C presents a correlation matrix. Measurement of IQ, EQ, and PA is described above in sections 2.a. and 2.b. In addition to the demographic variables SEX, AGE, YR, and EDU, a number of time- and risk-preference variables are of interest.

The first variable reported in the descriptive statistics is the CRT score, our measure of IQ. For our sample, the average CRT score is 1.60, somewhat below the 2.18 found among MIT students but above the 0.57 found among University of Toledo students (Frederick 2005). The average EQ score is 2.73, quite close to the 2.42 level found by Charupat *et al.*

[20] One question in the third question set is identical to the previous row, allowing for a check on inattentiveness. None of the participants were deemed to be inattentive.

(2013) using the same NA proxy for EQ. As for positive affectivity, the average is 3.36. Our sample includes more female participants (56%) than male. Our average participant is 21-years-old, in the third year of university study, and has completed 10 relevant courses in economics, finance, and statistics.

The time-preference parameter, β, measures present bias. Somewhat surprisingly, this sample lacks present bias in the aggregate.[21] While many participants do exhibit present bias ($\beta < 1.0$), many others exhibit future bias ($\beta > 1.0$), and our average is quite close to one ($\beta = 1.023$). In addition, while the pure rate of time preference is quite high, with a mean of 10% per week, others have also reported implausibly high subjective discount rates (Frederick, Loewenstein, and O'Donoghue 2002).

Panel B of Table 1 next reports on our risk-preference measures. With the exception of loss aversion (λ), the risk-preference parameters are, on average, quite close to those reported elsewhere. The median values are $\alpha = 0.86$, $\gamma = 0.75$, and $\lambda = 1.60$, as compared to the estimates of 0.88, 0.61, and 2.25 reported by Tversky and Kahneman (1992). It is important to note that for some participants there are estimates of α above unity (implying risk seeking) and of γ above unity (implying reverse-S-shaped probability weighting). As for λ, below one (implying loss seeking) is almost as common as above one (i.e., loss aversion).

Correlations give us a sense of what we might find when we perform regression analysis. In the regression analysis reported subsequently, we specify the dependent variables as absolute deviations from the values expected in traditional models, as reflected in Hypotheses 1 and 2. We believe that regressions with α^*, γ^* and λ^* as dependent variables are more meaningful because lower values of α^*, γ^* and λ^* indicate preferences that are more consistent with EUT-type preferences. Turning to the third panel of Table 1, a few salient tendencies are apparent. IQ and EQ are virtually uncorrelated, suggesting the two

[21] Indeed, hyperbolic or quasi-hyperbolic discounting is quite often not found (e.g., Meyer 2013).

key psychometric variables are different constructs. High IQ is positively correlated with being male (SEX = 1.0 for males) and negatively correlated with the 3 risk-preference parameter deviations. We observe a weak positive correlation between EQ and SEX ($p = 0.091$), while there is significant negative correlation between EQ and both weighting function curvature and present or future bias. Further, most of the parameter deviation pair-wise correlations are positive, implying that preference deviations from traditional models are systematic. Interestingly, present bias, β, and pure rate of time preference, ρ, are significantly positively correlated. Finally, consistent with Charupat *et al.* (2013), EQ and PA are positively correlated.

5.b. Do IQ and EQ explain time preference?

In Table 2 we present regression results for the absolute deviation from one of present bias (β^*) and the pure rate of time preference (ρ). These two parameters are regressed on IQ, EQ, and positive affectivity (PA) and the demographic variables SEX, AGE, YR, and EDU, as well as the interactions of all variables with SEX. As reflected in Hypothesis 1, our expectation for IQ and EQ is that the estimated coefficients will be negative: higher IQ and EQ are expected to lead to preferences that are in line with the traditional view, which should imply lower values of β^* and ρ. For each dependent variable, we present 2 regressions: first, with IQ, EQ, PA, SEX, and interactions as dependent variables; and, second, with additional demographic variables including AGE, YR, and EDU plus their interactions. We include these control variables as prior research, as discussed earlier, reports that time preference is related to demographics.

The estimates indicate some statistically significant relationships. Beginning with β^*, the coefficient of EQ is negative and statistically significant at 10%, but only in the expanded regression, suggesting that EQ is associated with the lack of present (or future) bias. The only other significant determinant of β^* is the interaction of age and sex, which suggests that older men are less likely to exhibit present (or future) bias. For the pure rate of time preference, EQ is significantly associated with lower rates of time preference in both regressions. While SEX alone does not play a role in the rate of time preference, its interaction with EQ is a significant determinant. The evidence suggests that men with higher EQ have lower discount rates and are thus more patient.

In sum, the evidence provides some support for our first hypothesis. There is evidence that participants with higher EQ have lower values of both β* and ρ, suggesting their preferences are more consistent with the traditional view. [22]

5.c. Do IQ and EQ explain risk preference?

In Table 3 we present regression results for the risk-preference parameters. More precisely, the dependent variables include the absolute deviations from one of utility function curvature (α*), probability weighting (γ*), and loss aversion (λ*). The explanatory variables are as in the previous section. Once again, our expectations as reflected in Hypothesis 2 are that the coefficients of IQ and EQ will be negative: higher IQ and EQ are anticipated to lead to EUT-type preferences, which in turn implies lower deviations of α, γ and λ from one.

The estimates reported in Table 3 suggest that cognitive capacity has a strong impact on risk preference. The coefficients of all three parameter deviations are negative and significantly different from zero in all regressions. Participants with higher measured IQ exhibit preferences that are more in line with traditional EUT. We also observe that SEX has an important influence on risk preference. For both probability weighting (γ*) and loss aversion (λ*), the preferences of men are more consistent with the traditional view. In the case of γ*, several additional regularities emerge. First, the tendency of IQ to push preferences in the direction of the traditional view is stronger for males. Second,

[22] As mentioned in the introduction, there is a strand of literature that investigates the relationship between risk and time preferences for individuals. Their main finding is that there is a correlation between risk and time preferences. We test whether including risk preference deviation parameters (α*, γ*, λ*) would change the results of time preference regressions that have β* and ρ as the dependent variables. In untabulated results, we find that for both β* and ρ, EQ is negative and significant. It is important to note that EQ remains a significant factor in predicting time preferences even after controlling for risk preferences.

consistent with Charupat *et al.* (2013), higher EQ leads to less probability weighting (but only for males). And, third, higher PA also leads to more traditional preferences. This finding is consistent with prior evidence that positive emotions impact decision-making (e.g., Bechara *et al*. 1997).

In sum, we produce evidence supporting our second hypothesis. While EQ, more narrowly, is shown to have impact for males in the case of probability weighting, IQ is the dominant psychometric measure that affects risk preference, and the relationship is stronger for men.

5.d. Risk-preference types

Bruhin, Fehr-Duda, and Epper (2010) argue that models should allow for differences in preferences. People simply do not have identical preferences so a model that incorporates heterogeneity may be superior to one that posits a representative agent. They report two distinct groups. The preferences of the majority (73%) of their subjects indicate non-linear probability weighting, whereas the minority have preferences that are consistent with EUT.[23]

The last row of Table 4 reports the number of our participants falling into each of three preference categories: EUT, PT, or 'Other.' The EUT category includes all observations that have γ and λ within 10% of unity. PT includes all participants with γ values 10% below unity and λ values 10% above unity. 'Other' is any observation not categorized as PT or EUT. As has been found in past research, a significant minority of our subjects have risk preferences approximating EUT-type behavior. We find that of our 146 participants, 32 (22%) can be characterized as having EUT-type preferences. In fact, 25 of the 32 participants in the EUT category chose the *exact same* responses for the three risk-

[23] They and others (e.g., Charupat *et al.* (2013)) equate EUT-type preferences and "rationality," unlike the more agnostic view we take here.

preference questions.[24] It is notable that this percentage is quite comparable to the results of Bruhin, Fehr-Duda, and Epper (2010) and Charupat *et al.* (2013), who find that 20% and 29% of subjects, respectively, could be characterized as having EUT-type preferences. More subjects, however, had preferences that were consistent with PT (39%), which is also consistent with Bruhin, Fehr-Duda, and Epper (2010) and Charupat *et al.* (2013). Nevertheless, it is important to note that an even greater fraction (40%) had preferences that were inconsistent with either EUT or PT.

Table 4 also reports mean values for each of the variables included in our empirical analysis by preference category. We observe statistically significant differences in IQ, EQ, PA, and SEX across categories. Participants with EUT-type preferences, on average, have higher IQ, EQ, and PA, and are more likely to be men. Naturally, the average values of the PT parameter deviations (α^*, γ^*, and λ^*) are significantly higher for those who fall into the PT preferences category. Finally, it is noteworthy that the time-preference parameters are not significantly different across preference categories.

6. Conclusion

We find that both cognitive ability (IQ) and emotional stability (EQ) correlate with preferences. Interestingly, EQ appears to be the dominant force in the realm of time preference. Those with higher EQ tend to have less present or future bias and a lower rate of time preference. In addition, high-EQ males appear to be more patient as they have a lower subjective discount rate. On the other hand, IQ is the dominant factor in explaining risk preference. The preferences of high-IQ subjects are consistent with less curvature in the utility function, probability weighting, and aversion to losses. The preferences of men more closely align with traditional, EUT-type preferences.

[24] By far the most common set of choices for the three risk- preference question sets was the seventh choice for the first question set, the first choice (or choice 15 overall) for the second question set (i.e., always B), and the second choice (or choice 30 overall) for the third. In fact, 25 of 146 subjects (or 17%) answered these questions in the exact same fashion. In all three cases unity falls within their choice intervals.

Our research has important implications for policymakers whose goal is to encourage wealth accumulation among citizens who must fund their own retirement. While cognitive ability is often highly prized, alone it may not ensure success. And, neither does emotional stability. Our evidence suggests that wise financial planning depends on two facets. First, people need to change their savings behavior and emotional intelligence is key. Fisher and Montalto (2010) find that those taking the long view save more today. Our evidence suggests that emotional stability, as measured by EQ, has a significant relationship with time preference. Those with higher EQ are less prone to present/future bias and are more patient. Second, people who save must take some risk to grow wealth. Our evidence indicates that higher cognitive ability is associated with lower utility function curvature, less probability weighting, and reduced aversion to losses. These preferences are more closely associated with EUT-type preference and may promote wiser investment decisions.

This research also suggests avenues for future theoretical work. While many people have preferences that are consistent with expected utility theory or prospect theory, many others do not fit neatly in either category. While representative-agent models can provide useful insights in some domains, when it comes to understanding individual behavior the development of appropriate policy may require the recognition that one size does not fit all.

TABLE 1: Variable definitions, descriptive statistics, and correlations

Panel A is a key describing the variables computed from subject responses collected in the experiment, including demographic variables, cognitive ability (IQ), emotional stability (EQ) and risk and time preference parameters. Panel B reports descriptive statistics of the variables. Panel C provides correlations.

A. Definition of variables

IQ	A measure of cognitive ability. IQ is measured based on the response to the 3-question Cognitive Reflection Test (CRT) and the value of this variable can range from 0-3; where 3 indicates that a participant has answered all three questions correctly. A higher IQ value implies higher cognitive ability.
EQ	A measure of emotional stability. EQ is 5 minus the average response to 5 Negative Affectivity (NA) questions from I-PANAS-SF. A 5-point Likert scale is used for these questions. A higher value implies higher emotional balance.
PA	A measure of positive emotions. PA is the average response to the 5 Positive Affectivity (PA) questions from I-PANAS-SF. A 5-point Likert scale is used for these questions. A higher value implies a higher tendency to experience positive emotions.
SEX	An indicator variable set to 1 if the participant is male and 0 if female.
AGE	Participant age (in years).
YR	The number of years of postsecondary education completed by the participant.
EDU	Number of relevant courses (including finance, economics, statistics and probability) that the participant has completed or is currently enrolled in.
β	Time preference parameter. β measures present bias using the general time function estimated by Tanaka, Camerer, and Nguyen (2010). This parameter is estimated for each participant using the estimated value of ρ and the response to a question set where the participant makes a choice between money to be received today and money to be received in one week.
β*	$\lvert 1-\beta \rvert$.
ρ	Time preference parameter. ρ measures the pure rate of time preference. This parameter is estimated using a question set where the choice is between money to be received in one week and money to be received in two weeks. A higher ρ implies a higher deviation from rationality.
α	Risk preference parameter. Measures the concavity/convexity of prospect theory's utility function for a participant in the positive/negative domain. α is estimated for each participant based on their responses to two questions in which participants are asked to choose between a series of paired prospects.
α*	$\lvert 1-\alpha \rvert$.
γ	Risk preference parameter. Measures the probabilistic insensitivity of Prelec's 1998 single parameter probability weighting function for a participant in the positive/negative domain. γ is estimated for each participant based on their responses to the same two questions used to estimate α.
γ*	$\lvert 1-\gamma \rvert$.
λ	Risk preference parameter. Measures loss aversion. Estimated using the estimates of α and γ along with a question set from the survey.
λ*	$\lvert 1-\lambda \rvert$.

B. Descriptive statistics

	Mean	Median	Minimum	Maximum	SD	Observations
IQ	1.603	2	0	3	1.047	146
EQ	2.733	2.8	0.8	3.8	0.543	146
PA	3.364	3.4	1.4	4.8	0.598	146
SEX	0.438	0	0	1	0.498	146
AGE	21.007	21	19	25	1.054	146
YR	2.949	3	2	6	0.756	146
EDU	10.048	9	1	29	4.211	146
β	1.023	1.002	0.871	1.567	0.084	146
β*	0.039	0.010	0.000	0.567	0.078	146
ρ	0.099	0.054	0.001	0.454	0.114	146
α	0.858	0.907	0.033	1.614	0.342	146
α*	0.293	0.209	0.006	0.967	0.226	146
γ	0.747	0.735	0.028	1.500	0.302	146
γ*	0.310	0.273	0.003	0.972	0.243	146
λ	1.602	1.043	0.084	6.934	1.206	145
λ*	0.793	0.506	0.009	5.934	1.089	145

C. Correlation matrix

	IQ	EQ	PA	SEX	AGE	YR	EDU	β	β*	ρ	α	α*	γ	γ*	λ	λ*
IQ	1.000															

EQ	-0.052	1.000														
	0.532	-----														
PA	-0.119	**0.310**	1.000													
	0.153	**0.000**	-----													
SEX	**0.244**	**0.140**	-0.048	1.000												
	0.003	**0.091**	0.565	-----												
AGE	0.002	0.056	-0.024	0.034	1.000											
	0.976	0.500	0.777	0.687	-----											
YR	0.031	-0.076	0.042	-0.050	**0.533**	1.000										
	0.713	0.364	0.618	0.551	**0.000**	-----										
EDU	0.073	0.010	0.017	-0.089	0.098	**0.159**	1.000									
	0.380	0.900	0.843	0.285	0.240	**0.055**	-----									
β	0.043	-0.070	0.101	-0.094	0.116	0.081	-0.023	1.000								
	0.608	0.404	0.224	0.260	0.165	0.334	0.779	-----								
β*	-0.004	**-0.211**	0.065	-0.049	0.113	**0.153**	0.067	**0.848**	1.000							
	0.961	**0.011**	0.434	0.554	0.175	**0.066**	0.424	**0.000**	-----							
ρ	-0.085	-0.124	0.041	0.014	0.091	0.121	**0.165**	**0.468**	**0.673**	1.000						
	0.308	0.135	0.623	0.864	0.272	0.147	**0.046**	**0.000**	**0.000**	-----						
α	0.130	0.122	-0.010	0.113	-0.016	-0.009	**0.174**	**-0.087**	**-0.148**	**-0.046**	1.000					
	0.117	0.141	0.904	0.173	0.847	0.912	**0.036**	**0.292**	**0.075**	**0.578**	-----					
α *	**-0.172**	-0.050	0.057	-0.114	-0.083	-0.072	-0.098	0.109	**0.145**	0.130	**-0.656**	1.000				
	0.038	0.553	0.492	0.171	0.321	0.390	0.238	0.192	**0.082**	0.117	**0.001**	-----				
γ	**0.210**	**0.214**	0.100	**0.261**	**0.172**	0.036	0.072	-0.024	-0.078	0.006	**0.569**	**-0.501**	1.000			
	0.011	**0.009**	0.228	**0.001**	**0.037**	0.671	0.390	0.777	0.347	0.940	**0.000**	**0.000**	-----			
γ*	**-0.169**	**-0.191**	-0.128	**-0.265**	**-0.163**	-0.035	-0.116	0.030	0.083	-0.004	**-0.609**	**0.465**	**-0.917**	1.000		
	0.042	**0.021**	0.124	**0.001**	**0.049**	0.674	0.163	0.718	0.321	0.960	**0.000**	**0.000**	**0.000**	-----		
λ	**-0.160**	0.043	0.078	**-0.216**	-0.021	-0.067	-0.101	-0.013	**-0.032**	-0.044	0.017	**0.269**	**-0.216**	**0.199**	1.000	
	0.054	0.607	0.351	**0.009**	0.803	0.419	0.225	0.872	**0.697**	0.597	0.835	**0.001**	**0.009**	**0.016**	-----	
λ *	**-0.197**	0.016	0.022	**-0.223**	-0.048	-0.077	-0.104	0.000	0.005	0.000	-0.082	**0.367**	**-0.292**	**0.272**	**0.940**	1.000
	0.017	0.851	0.796	**0.007**	0.566	0.355	0.211	0.997	0.954	1.000	0.323	**0.000**	**0.000**	**0.001**	**0.000**	-----

Note: Correlations that are significantly different from zero at $p < 0.10$ appear in bold.

TABLE 2: Time-preference regressions

	Beta deviation (β*)		Rho (ρ)	
	(1)	(2)	(3)	(4)
Intercept	0.07 (0.83)	-0.05 (-0.44)	0.13 (2.01)	-0.10 (-0.54)
IQ	0.00 (0.28)	0.00 (0.13)	-0.01 (-0.74)	-0.01 (-1.04)
IQxSEX	0.02 (1.21)	0.02 (1.28)	0.02 (1.15)	0.02 (1.29)
EQ	-0.04 (-1.60)	-0.04* (-1.69)	-0.04** (-2.06)	-0.04* (-1.73)
EQxSEX	-0.02 (-0.55)	-0.02 (-0.47)	-0.11*** (-2.70)	-0.10** (-2.24)
PA	0.02 (1.48)	0.02 (1.52)	0.02 (1.33)	0.02 (1.29)
PAxSEX	0.03 (0.96)	0.03 (0.92)	0.03 (0.74)	0.03 (0.79)
SEX	0.00 (-0.14)	0.00 (0.03)	0.01 (0.72)	0.02 (1.01)
AGE		0.00 (0.37)		0.01 (0.76)
AGExSEX		-0.04** (-2.17)		-0.02 (-1.22)
YR		0.01 (1.61)		0.01 (0.76)
YRxSEX		0.01 (0.69)		-0.01 (-0.21)
EDU		0.00 (0.69)		0.00 (1.47)
EDUxSEX		0.00 (0.08)		0.00 (-0.64)
$\overline{R^2}$	0.04	0.08	0.04	0.07
Observations	146	146	146	146
White Test	<0.0001	<0.0001	0.003	0.156
HCSE	Yes	Yes	Yes	No

Notes: t-values are in parentheses below coefficient estimates. The White test indicates p-values for a test of the null of homoscedasticity in regression errors. As a result of this test, HCSE indicates whether standard errors are corrected for heteroscedasticity. See Panel A of Table 1 for variable definitions. All interaction terms are orthogonalized. Significant at * 10%, ** 5%, and *** 1%.

TABLE 3: Risk-preference regressions

	Alpha deviation (α*)		Gamma deviation (γ*)		Lambda deviation (λ*)	
	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	0.38 (2.72)	0.84 (2.35)	0.76 (6.77)	1.65 (4.29)	1.21 (1.91)	3.41 (2.14)
IQ	-0.04* (-1.85)	-0.04* (-1.84)	-0.04* (-1.97)	-0.04* (-1.84)	-0.18** (-2.00)	-0.17** (-2.56)
IQxSEX	-0.06 (-1.37)	-0.06 (-1.54)	-0.08** (-2.15)	-0.08** (-2.10)	-0.08 (-0.41)	-0.11 (-0.87)
EQ	-0.02 (-0.52)	-0.02 (-0.39)	-0.05 (-1.56)	-0.04 (-1.32)	0.09 (0.48)	0.07 (0.35)
EQxSEX	-0.01 (-0.13)	0.01 (0.11)	0.13** (2.17)	0.14** (2.22)	0.23 (0.61)	0.33 (1.04)
PA	0.01 (0.37)	0.01 (0.34)	-0.06* (-1.91)	-0.07** (-2.10)	-0.05 (-0.33)	-0.05 (-0.31)
PAxSEX	-0.10 (-1.53)	-0.11* (-1.80)	-0.07 (-1.04)	-0.07 (-1.14)	-0.44 (-1.36)	-0.53* (-1.77)
SEX	-0.03 (-0.79)	-0.03 (-0.87)	-0.11*** (-2.61)	-0.11*** (-2.71)	-0.41** (-2.21)	-0.42** (-2.54)
AGE		-0.02 (-1.07)		-0.04* (-2.16)		-0.09 (-1.06)
AGExSEX		-0.06 (-1.46)		0.02 (0.40)		-0.11 (-0.61)
YR		0.00 (0.11)		0.02 (0.52)		-0.02 (-0.20)
YRxSEX		0.05 (0.85)		0.01 (0.09)		0.70*** (3.27)
EDU		-0.02 (-1.07)		-0.01 (-1.50)		-0.02 (-1.14)
EDUxSEX		-0.06 (-1.46)		0.00 (-0.59)		0.01 (0.34)
$\overline{R^2}$	0.0018	0.004	0.116	0.201	0.039	0.061
Observations	146	146	146	146	146	146
White Test	0.000	<0.0001	0.048	0.000	0.348	0.035
HCSE	Yes	Yes	Yes	Yes	No	Yes

Notes: t-values are in parentheses below coefficient estimates. The White test indicates p-values for a test of the null of homoscedasticity in regression errors. As a result of this test, HCSE indicates whether standard errors are corrected for heteroscedasticity. See Panel A of Table 1 for variable definitions. All interaction terms are orthogonalized. Significant at * 10%, ** 5%, and *** 1%.

Table 4: Preference Categories

	Preference Category			F-Test
	EUT	PT	Other	
IQ	1.875	1.339	1.707	3.240**
EQ	2.913	2.711	2.655	2.440*
PA	3.625	3.405	3.179	6.380***
SEX	0.625	0.321	0.448	3.960**
AGE	21.188	20.839	21.069	1.280
YR	3.000	2.830	3.034	1.140
EDU	10.813	9.500	10.155	1.020
β*	0.040	0.033	0.045	0.360
ρ	0.095	0.097	0.104	0.090
α*	0.152	0.412	0.255	18.410***
γ*	0.054	0.459	0.307	45.980***
λ*	0.019	1.555	0.484	35.640***
Observations	32	56	58	

Notes: The table reports the mean of each variable by preference category. Individuals are categorized as having risk preferences in line with expected utility theory (EUT), prospect theory (PT), and other. Individuals whose estimates of both λ and γ are within 10% of unity are labelled as EUT, while those with estimates of γ 10% below unity and λ 10% above unity are labelled as PT. Individuals who do not conform to EUT or PT are categorized as Other. The F-test is for a test of the null hypothesis of equal mean values across preference categories. See Panel A of Table 1 for variable definitions. Significant at * 10%, ** 5%, and *** 1%.

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APPENDIX 1: Experimental Survey

SURVEY ANSWER SHEET (S1)

Sect.	No.	Question	Answer	Answer unit
A	**1**	Thinking about yourself and how you normally feel, to what extent do you generally feel UPSET?		**1-5 scale** **1 = NEVER** **5 = ALWAYS**
A	**2**	Thinking about yourself and how you normally feel, to what extent do you generally feel HOSTILE?		**As above**
A	**3**	Thinking about yourself and how you normally feel, to what extent do you generally feel ALERT?		**As above**
A	**4**	Thinking about yourself and how you normally feel, to what extent do you generally feel ASHAMED?		**As above**
A	**5**	Thinking about yourself and how you normally feel, to what extent do you generally feel INSPIRED?		**As above**
A	**6**	Thinking about yourself and how you normally feel, to what extent do you generally feel NERVOUS?		**As above**
A	**7**	Thinking about yourself and how you normally feel, to what extent do you generally feel DETERMINED?		**As above**
A	**8**	Thinking about yourself and how you normally feel, to what extent do you generally feel ATTENTIVE?		**As above**
A	**9**	Thinking about yourself and how you normally feel, to what extent do you generally feel AFRAID?		**As above**
A	**10**	Thinking about yourself and how you normally feel, to what extent do you generally feel ACTIVE?		**As above**
B	**1**	A bat and ball cost $1.10 in total. The bat costs $1.00 more than the ball. How much does the ball cost?		**Cents**
B	**2**	If it takes 5 machines 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets?		**Minutes**
B	**3**	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?		**Days**

SURVEY ANSWER SHEET cont.

C	**QN SET 1**	When you had to choose between Option A and Option B, did you always choose A, always choose B, or switch from A to B beginning at a particular choice?		**Choice number or A = always A or B = always B**
C	**QN SET 2**	When you had to choose between Option A and Option B, did you always choose A, always choose B, or switch from A to B beginning at a particular choice?		**Choice number or A = always A or B = always B**
C	**QN SET 3**	When you had to choose between Option A and Option B, did you always choose A, always choose B, or switch from A to B beginning at a particular choice?		**Choice number or A = always A or B = always B**
D	**QN SET 1**	When you had to choose between Option A and Option B, did you always choose A, always choose B, or switch from A to B beginning at a particular choice?		**Choice number or A = always A or B = always B**
D	**QN SET 2**	When you had to choose between Option A and Option B, did you always choose A, always choose B, or switch from A to B beginning at a particular choice?		**Choice number or A = always A or B = always B**
E	**1**	What is your sex?		**M = male or F = female**
E	**2**	What is your age?		**Years**
E	**3**	How many years of post-secondary school education have you completed?		**Number of years**
E	**4**	How many economics and finance courses have you successfully completed at the university level?		**Number of courses**
E	**5**	How many economics and finance courses are you currently enrolled in?		**Number of courses**
E	**6**	How many probability and statistics courses have you successfully completed at the university level?		**Number of courses**
E	**7**	How many probability and statistics courses are you currently enrolled in?		**Number of courses**

APPENDIX 2: Experimental Question Sets

SECTION C: QUESTION SET 1 Choose between Option A and Option B

	Option A					Option B					Prefer A or B?
	Cash	with prob		Cash	with prob	Cash	with prob		Cash	with prob	
Choice 1	$20	30%	or	$5	70%	$34.00	10%	or	$2.50	90%	
Choice 2	$20	30%	or	$5	70%	$37.50	10%	or	$2.50	90%	
Choice 3	$20	30%	or	$5	70%	$41.50	10%	or	$2.50	90%	
Choice 4	$20	30%	or	$5	70%	$46.50	10%	or	$2.50	90%	
Choice 5	$20	30%	or	$5	70%	$53.00	10%	or	$2.50	90%	
Choice 6	$20	30%	or	$5	70%	$62.50	10%	or	$2.50	90%	
Choice 7	$20	30%	or	$5	70%	$75.00	10%	or	$2.50	90%	
Choice 8	$20	30%	or	$5	70%	$92.50	10%	or	$2.50	90%	
Choice 9	$20	30%	or	$5	70%	$110.00	10%	or	$2.50	90%	
Choice 10	$20	30%	or	$5	70%	$150.00	10%	or	$2.50	90%	
Choice 11	$20	30%	or	$5	70%	$200.00	10%	or	$2.50	90%	
Choice 12	$20	30%	or	$5	70%	$300.00	10%	or	$2.50	90%	
Choice 13	$20	30%	or	$5	70%	$500.00	10%	or	$2.50	90%	
Choice 14	$20	30%	or	$5	70%	$850.00	10%	or	$2.50	90%	

SECTION C: QUESTION SET 2 Choose between Option A and Option B

	Option A					Option B					Prefer A or B?
	Cash	with prob		Cash	with prob	Cash	with prob		Cash	with prob	
Choice 15	$20	90%	or	$15	10%	$27.00	70%	or	$2.50	30%	
Choice 16	$20	90%	or	$15	10%	$28.00	70%	or	$2.50	30%	
Choice 17	$20	90%	or	$15	10%	$29.00	70%	or	$2.50	30%	
Choice 18	$20	90%	or	$15	10%	$30.00	70%	or	$2.50	30%	
Choice 19	$20	90%	or	$15	10%	$31.00	70%	or	$2.50	30%	
Choice 20	$20	90%	or	$15	10%	$32.50	70%	or	$2.50	30%	
Choice 21	$20	90%	or	$15	10%	$34.00	70%	or	$2.50	30%	
Choice 22	$20	90%	or	$15	10%	$36.00	70%	or	$2.50	30%	
Choice 23	$20	90%	or	$15	10%	$38.50	70%	or	$2.50	30%	
Choice 24	$20	90%	or	$15	10%	$41.50	70%	or	$2.50	30%	
Choice 25	$20	90%	or	$15	10%	$45.00	70%	or	$2.50	30%	
Choice 26	$20	90%	or	$15	10%	$50.00	70%	or	$2.50	30%	
Choice 27	$20	90%	or	$15	10%	$55.00	70%	or	$2.50	30%	
Choice 28	$20	90%	or	$15	10%	$65.00	70%	or	$2.50	30%	

SECTION C: QUESTION SET 3 Choose between Option A and Option B

	Option A					Option B					Prefer A or B?
	Cash	with prob		Cash	with prob	Cash	with prob		Cash	with prob	
Choice 29	$12.50	50%	or	($2.00)	50%	$15.00	50%	or	$(10.50)	50%	
Choice 30	$2.00	50%	or	($2.00)	50%	$15.00	50%	or	$(10.50)	50%	
Choice 31	$0.50	50%	or	($2.00)	50%	$15.00	50%	or	$(10.50)	50%	
Choice 32	$0.50	50%	or	($2.00)	50%	$15.00	50%	or	$(8.00)	50%	
Choice 33	$0.50	50%	or	($2.00)	50%	$15.00	50%	or	$(8.00)	50%	
Choice 34	$0.50	50%	or	($2.00)	50%	$15.00	50%	or	$(7.00)	50%	
Choice 35	$0.50	50%	or	($2.00)	50%	$15.00	50%	or	$(5.50)	50%	

SECTION D: QUESTION SET 1 Choose between Option A and Option B

	What would you rather have?		Prefer A or B?
	Option A	Option B	
Choice 1	$100 in one week	$100.25 in 2 weeks	
Choice 2	$100 in one week	$100.50 in 2 weeks	
Choice 3	$100 in one week	$101 in 2 weeks	
Choice 4	$100 in one week	$102 in 2 weeks	
Choice 5	$100 in one week	$103 in 2 weeks	
Choice 6	$100 in one week	$104 in 2 weeks	
Choice 7	$100 in one week	$105 in 2 weeks	
Choice 8	$100 in one week	$106 in 2 weeks	
Choice 9	$100 in one week	$108 in 2 weeks	
Choice 10	$100 in one week	$110 in 2 weeks	
Choice 11	$100 in one week	$112 in 2 weeks	
Choice 12	$100 in one week	$114 in 2 weeks	
Choice 13	$100 in one week	$117 in 2 weeks	
Choice 14	$100 in one week	$120 in 2 weeks	
Choice 15	$100 in one week	$125 in 2 weeks	
Choice 16	$100 in one week	$130 in 2 weeks	
Choice 17	$100 in one week	$140 in 2 weeks	
Choice 18	$100 in one week	$150 in 2 weeks	

SECTION D: QUESTION SET 2 Choose between Option A and Option B

	What would you rather have?		Prefer A or B?
	Option A	Option B	
Choice 19	$100 today	$101 in one week	
Choice 20	$100 today	$102 in one week	
Choice 21	$100 today	$103 in one week	
Choice 22	$100 today	$104 in one week	
Choice 23	$100 today	$105 in one week	
Choice 24	$100 today	$107.50 in one week	
Choice 25	$100 today	$110 in one week	
Choice 26	$100 today	$115 in one week	
Choice 27	$100 today	$120 in one week	
Choice 28	$100 today	$125 in one week	
Choice 29	$100 today	$130 in one week	
Choice 30	$100 today	$135 in one week	
Choice 31	$100 today	$140 in one week	
Choice 32	$100 today	$145 in one week	
Choice 33	$100 today	$150 in one week	
Choice 34	$100 today	$160 in one week	
Choice 35	$100 today	$170 in one week	

APPENDIX 3: Instructions

SURVEY INSTRUCTIONS (S1)

1. Thank you for attending this survey session. Your participation will be of great benefit to us in our research into financial decision-making. You will be paid a $15 participation fee. Proper, careful completion of this survey, which consists of 25 questions, should take no more than 45 minutes. During this session, there is to be no use of electronic devices such as computers and phones. All phones should be turned off (not just set to vibrate). And there should be no communication of any kind with other participants. The only aids allowed are writing utensils, scrap paper and (if you wish) a calculator.

2. The 25 questions of this survey appear in 5 sections, Section A to Section E. The 3 questions of Section C and the 2 questions of Section D are actually closely-related question sets, and are described carefully below. The remaining questions are self-explanatory and require little explanation.

3. The two components of financial decision-making that we will explore in this session are called risk preference and time preference. Your risk preference is how comfortable you are with risk taking. Your time preference reveals how much you wish to be compensated for receiving money later rather than sooner. Risk preference is investigated in Section C and time preference is addressed in Section D. There are no correct or incorrect answers to these questions since answers are based on personal preferences.

4. All answers should be clearly written **in pen** in the appropriate answer boxes on the two-sided **SURVEY ANSWER SHEET** provided. Please pay careful attention to the units (e.g., years, cents, etc.). **The questions must be done in order.** Also, after writing in an answer, please do not go back and change it as you move to later questions. If, however, you were confused and erroneously wrote an answer and wish to *immediately* change it before moving to the next question, raise your hand and an experimenter will initial the change.

5. The rest of these instructions guide you through the survey. Please read the description of each section before you answer the questions of that section.

6. The 13 questions in Sections A and B explore your personality/mood.

7. **Section A:** This section has 10 questions. Think about yourself, and how you normally feel. You are asked to say how often you feel a certain way. Please answer these questions to the best of your ability using a 5-point scale. If you always feel a certain way '5' should be your answer. If you never feel that way '1' should be your answer. Frequency of feelings between these extremes should be answered with '4' or '3' or '2,' with higher numbers reflecting higher frequency.

8. **Section B:** The 3 items in this section vary in difficulty. Try to answer as best you can. Please pay careful attention to the units.

9. **Section C:** The 3 question sets of Section C explore your risk preference. Refer to page 1 of the two-sided **QUESTION SET SHEET**. Let's make sure you understand these question sets and the choices that you need to make.

10. Begin with **Section C: Question Set 1**. First look at this question set and then read the description below. You have to make 14 choices – sounds like a lot of work but it's actually much simpler than it sounds. Consider Choice 1. You have to choose between 2 options, A and B. These options are both gambles. If you choose A, you have a 30% chance of getting $20 and a 70% chance of receiving $5. Or you could choose Option B. If you choose B, you have a 10% chance of getting $34 and a 90% chance of receiving $2.50. Do you prefer Option A or Option B? Remember there is no right answer. It's just a matter of personal preference.

11. Before choosing it is important to know that your answer is not merely hypothetical. Four students will be randomly selected at the end of this session, and will (if they so choose) be allowed to participate in either a Risk Preference Game or a Time Preference Game. The 2 students who are selected to participate in the Risk Preference Game will have one of their Section C choices determine an **actual** payment made to them (as will be described in detail later). Since you don't know in advance which row (choice) may matter, you are of course well advised to answer all questions by using your true preferences.

12. Now go ahead and make your choice. You should write your answer (A or B) in the last column of Choice 1 of the QUESTION SET SHEET.

13. Suppose you prefer Option A for Choice 1. Now go to Choice 2. Notice Option A does not change. The only thing about Option B that changes is the high-cash outcome, which is now $37.50 instead of $34. Obviously Option B is more attractive than it was before. Since you chose Option A for Choice 1 there is a chance that you will switch preference, now preferring Option B to Option A. Suppose instead you continue to prefer Option A. Then go on to Choice 3. Once gain the only thing that changes is that Option B becomes more attractive, creating the possibility that you might switch preference from A to B. The pattern now becomes clear. As you move down the rows (choices), Option B looks better and better and assuming you initially preferred A there may come a particular row (say row 9 or Choice 9) where you first prefer B. After that point, it is only logical that you will continue to prefer B because B continues to become more attractive. You should now be able to fill in 'A' or 'B' in all the QUESTION SET SHEET rows for this question set (C-1).

14. Turning to the SURVEY ANSWER SHEET, locate the relevant answer box for C-1. You are prompted that there are three possibilities. You might always prefer Option A to Option B – in which case you write 'A' in the answer box. Or you might always prefer Option B to Option A – in which case you write 'B' in the answer box. Or you might first prefer Option A but then at a certain point switch to Option B. If this switch occurs at Choice 9, you would write '9' in the answer box. Now answer according to what you wrote on the QUESTION SET SHEET.

15. Note that for the rest of the questions of Section C and for both of the Section D questions the same pattern will hold. Specifically, as you move down the rows (choices) Option B will become more and more attractive relative to Option A. This means that there will be three possibilities: you might always prefer A; you might always prefer B; or you might first prefer A but then switch preference to B at a particular row (choice).

16. The next question set -- **Section C: Question Set 2** – is similar in structure, and so it requires little further explanation. While the cash outcomes and probabilities are different, it remains true that the only thing that changes from row to row (choice to choice) is one of the Option B cash outcomes, with as before B becoming increasingly attractive as you move down the rows (choices). Note that the row (choice) numbering continues from the previous question. Please look at Section C: Question Set 2, make your choices, and provide your answer on the SURVEY ANSWER SHEET according to your preference.

17. The final question set of this section, **Section C: Question Set 3**, is again quite similar except for one important difference. The difference is that in all cases one of the cash outcomes is negative. For example, consider Choice 29. Selecting Option A means you are accepting a gamble with a 50% chance of receiving $12.50 and a 50% chance of **losing** $2. Accepting Option B on the other hand means you are accepting a gamble with a 50% chance of receiving $15 and a 50% chance of **losing** $10.50. As one moves down the rows (choices) a single cash outcome from one of the options (either from Option A or Option B) changes. Still, as before, as you move down the rows (choices), B becomes increasingly more attractive relative to A. Please look at Section C: Question Set 3 now, make your choices, and provide your answer on the SURVEY ANSWER SHEET according to your preference.

18. As was said earlier, 2 students will be randomly selected to participate in the Risk Preference Game (if they so desire). This will be done as follows. All students will be at numbered desks (say, 1-50 if there are 50 students participating in a session). At the end we will ask a student in attendance to blindly select 2 cards from a deck of numbered cards. The students whose desk numbers come up will be able to participate in the Risk Preference Game. (The identical procedure will be used for the Time Preference Game.) If they choose to participate, these 2 students will be able to receive a payment from one of the rows (choices) in Section C according to their stated preferences and a draw from the relevant probability distribution. More specifically, after these students are selected, they will be asked to choose one of 35 cards which are numbered 1 to 35. Their card selection will then signify which row (i.e., Choices 1-35) they will receive payments from. Suppose one of these 2 students selects card #20, and for this row (Choice 20) she expressed a preference for Option B over Option A. Then she gets to "play" Option B. Using a random device she will receive $32.50 with a 70% probability and $2.50 with a 30% probability. Note that the students participating in the game will receive both their Risk Preference Game payment and their $15 participation fee. As stated earlier, since you don't know in advance which row (choice) may matter, you are of course well advised to answer all questions by using your true preferences.

19. **One thing that needs to be stressed is that the students who are randomly chosen to participate in the Risk Preference Game have the option to decline**. (The same is true with the Time Preference game, but in reality it would always be unwise to decline participation in this case because all outcomes are positive.) With this in mind note that if cards #29-35 are chosen then these students may face negative payments. In other words, they may **lose money**. Note that since 7 of 35 rows (20%) *potentially* lead to losses, and when these rows are selected losses occur 50% of the time, this implies that one should expect that **losses will on average happen 10% (20% * 50%) of the time**. But it is important to understand that the worst negative outcome is -$10.50. So if even if this occurs, the worst that can happen is the student in question will end up with $4.50, which is the participation fee minus the worst possible outcome ($15.00 - $10.50 = $4.50). Still, if a student is fearful of such negative events he/she may simply decline to participate. **This is a private decision and will not occur with other students witnessing it.**

20. **Section D:** These 2 question sets explore your time preference. Refer to page 2 of the two-sided QUESTION SET SHEET. Let's make sure you understand these question sets and the choices that you need to make.

21. As before it is important to take your choices seriously because they are not merely hypothetical. Again, as previously noted, 2 of the 4 students randomly selected at the end of each the session will be allowed to participate in the Time Preference Game. This means their Section D choices will be paid out to them, again based on a random selection of the 35 choices (rows) making up the two Section D question sets.

22. Like Section C, you have to express a preference for Option A vs. Option B over a series of choices. Also like Section C, as you move down the rows (choices) Option B becomes relatively more attractive vs. Option A. Note that the choices are simpler in the sense that no gambles are involved. In all cases you have to express a preference for $x received today or at some future time vs. $y received at a more distant future time. It's as simple as that.

23. Begin with **Section D: Question Set 1**, Choice 1. The choice is between $100 received in one week (Option A) vs. $100.25 received in 2 weeks (Option B). Say you prefer Option A. As you continue down the rows (choices) notice that Option B becomes increasingly more attractive. This is because in the case of Option B you receive more and more money in 2 weeks. As a result at some point you may switch from Option A to Option B. When this happens you know that you will continue to prefer B as you move down the rows (choices).

24. To clarify payment timing for those choosing to participate in the Time Preference Game, if you are due to receive a payment today you can pick it up between 4:00pm and 4:30pm today in DSB/303. If a payment is specified as "in one week" this means payment is made one week from today between 4:00pm and 4:30pm in DSB/303, while if a future payment is specified as "in 2 weeks" this means payment is made two weeks from today between 4:00pm and 4:30pm in DSB/303.

25. Turning to the SURVEY ANSWER SHEET you will notice that once again there are 3 possibilities. You might always prefer A to B – in which case you write 'A' in the answer box. Or you might always prefer B to A – in which case you write 'B' in the answer box. Or you might first prefer A but then at a certain point switch to B. If this switch occurs at Choice 4, you would write '4' in the answer box. Please look at Section D: Question Set 1 again, make your choices, and provide your answer on the SURVEY ANSWER SHEET according to your preference.

26. **Section D: Question Set 2** operates in a similar fashion. Option A always entails receiving $100 today. Option B involves receiving more than $100 in one week. Since this amount increases as you go down the rows (choices) Option B (as elsewhere) becomes more and more attractive. Please look at this question set, make your choices, and provide your answer on the SURVEY ANSWER SHEET according to your preference.

27. **Section E:** We end with some basic demographic questions on your gender, age and educational background. Please answer these 7 questions of Section E now.

28. You have now finished the survey. Please check that you have answered all questions, and that your printing can be read. While you wait for everyone else to finish the survey, we kindly ask you to remain silent and to not use any electronic devices (such as phones or computers).

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