Risk and time preferences of entrepreneurs: evidence from a Danish field experiment

Di Girolamo, Amalia; Andersen, Steffen; Harrison, Glenn W.; Lau, Morten I.

DOI:
10.1007/s11238-014-9446-z

Risk and Time Preferences of Entrepreneurs:

Evidence from a Danish Field Experiment

by

Steffen Andersen, Amalia Di Girolamo, Glenn W. Harrison and Morten I. Lau †

March 2014

Abstract. To understand how small business entrepreneurs respond to government policy one has to know their risk and time preferences. Are they risk averse, or have high discount rates, such that they are hard to motivate? We have conducted a set of field experiments in Denmark that will allow a direct characterization of small business entrepreneurs in terms of these traits. We build on experimental tasks that are well established in the literature. The results do not suggest that small business entrepreneurs are more or less risk averse than the general population under the assumption of Expected Utility Theory. However, we generally find an S-shaped probability weighting function for both small business entrepreneurs and non-entrepreneurs, with entrepreneurs being more optimistic about the chance of occurrence for the best outcome in lotteries with real monetary outcomes. The results also point to a significant differences in individual discount rates between entrepreneurs and non-entrepreneurs: entrepreneurs are willing to wait longer for certain rewards than the general population.

† Copenhagen Business School, Denmark (Andersen and Lau); University of Birmingham (Di Girolamo); Department of Risk Management & Insurance and Center for the Economic Analysis of Risk, Robinson College of Business, Georgia State University, USA (Harrison); and Durham University Business School (Lau). E-mail contacts: sa.eco@cbs.dk, a.digirolamo@bham.ac.uk, gharrison@gsu.edu, and

mla.eco@cbs.dk. We thank the Danish Social Science Research Council for research support under project 275-08-0289 and 12-130950, and the Carlsberg Foundation under grant 2008-01-0410.

Government policies are often designed to stimulate the entry of small business entrepreneurs. Entrepreneurial activity is clearly risky, and often involves short term costs in the expectation of long term gain. To predict the responses to those policies one therefore has to know three things about potential entrepreneurs: their risk preferences, their time preferences, and their subjective beliefs about the likelihood of profit. If potential entrepreneurs are particularly risk averse, have relatively high discount rates, or hold pessimistic beliefs, they might be hard to motivate to start a new business.

Equally important, when one is normatively evaluating whether entry is a good or a bad thing, one needs to know what motivated it. If small business entrepreneurs, for instance, are risk loving, do not discount the future, or hold "optimistic" beliefs about their chances of success, it is not obvious that one should encourage entry. Indeed, one of the major themes of policy towards entrepreneurs is to be able to differentiate entry decisions that are socially optimal from those that are excessive, and to facilitate the low-cost exit of small business entrepreneurs that simply made a mistake. If policy is motivated by the oft-cited claim that there is "excess entry" by entrepreneurs, one must have some economically meaningful benchmark for what is meant by "excess."

We conducted field experiments in Denmark that will allow a direct characterization of small business entrepreneurs in terms of these traits. For controls, we sampled the general adult population of Denmark. To find potential and actual small business entrepreneurs we attended trade shows designed for them. We conducted experiments to allow us to infer individual risk attitudes and discount rates, and to draw inferences about probability "optimism" or "pessimism."[1] The experimental tasks involve real monetary outcomes to provide motivation for truthful elicitation of these characteristics.

[1] Field experiments of this kind were first undertaken by Elston, Harrison and Rutström [2005] in the United States. They studied risk attitudes of entrepreneurs and non-entrepreneurs at a trade show catering to entrepreneurs. They did not elicit discount rates, and their evaluation of the risk attitudes did not consider probability optimism or pessimism. Nor was their control group of non-entrepreneurs as representative of the general population as ours.

Risk attitudes are examined by asking subjects to make decisions over choices that involve two lotteries. For example, the subject might be told that they could choose lottery A or lottery B, where lottery A gives them a 50-50 chance of receiving 160 or 200 Danish kroner and lottery B gives them a 50-50 chance of receiving 385 or 10 kroner. The subject picks A or B. The typical experimental task gives the subject 10 such tasks, varying the possibility that the higher prize is received. This design and these parameters were developed by Holt and Laury [2002], and later widely applied in the United States, e.g. Harrison, Johnson, McInnes and Rutström [2005], and Europe, e.g. Harrison, Lau and Rutström [2007] (HLR) and Dohmen, Falk, Huffman, Sunde, Schupp and Wagner [2011]. The typical findings from these experiments are that subjects are averse to risk, and that there is considerable individual heterogeneity in risk attitudes. The Danish field experiments of HLR [2007] were representative of the adult Danish population, and will thus serve as an ideal comparison group for our experiments with entrepreneurs.

There are several psychological paths generating a risk premium. Under Expected Utility Theory (EUT) the risk premium is entirely driven by aversion to variability of outcomes, and is a property of the utility function. However, under Rank Dependent Utility (RDU) and Prospect Theory, risk aversion might also be generated by optimism or pessimism about the chances of success. This possibility of "probability weighting" can be evaluated from our experiments, and provides a basis for determining if the subjective beliefs of potential entrepreneurs are different from the general population.[2]

Time preferences are examined by asking subjects to also make a series of choices, in this case over outcomes that differ in terms of when they will be received. For example, one option is 300 kroner in 30 days, and another option is 330 kroner in 90 days. If the subject

[2] Alternative methods for the direct estimation of subjective beliefs about other naturally occurring events, using popular scoring rules and controls for biases due to risk aversion, have been developed. Andersen, Fountain, Harrison and Rutström [2014] review the literature, and develop methods that extend the approach we adopt here. These methods could be used to undertake a more holistic evaluation of the subjective beliefs of entrepreneurs about other possible events that might motivate their entry, such as the general state of the economy in the future. For instance, Harrison and Phillips [2013] elicit subjective belief distributions about major global financial risks, such as equities risk, interest rate risk, credit risk, and commodities risk.

picks the earlier option we can infer that the discount rate is above 10% for 60 days. By varying the choices so that the later option implies different discount rates, and verifying that the individual does not have access to perfect capital markets, we can identify the discount rate of the individual. In addition, one can vary the time horizon to identify the discount rate function. This method has been widely employed in the United States, e.g., Coller and Williams [1999] (CW), and in Denmark, e.g., Harrison, Lau and Williams [2002] (HLW). The typical findings from these experiments are that subjects have discount rates between 7% and 11% on an annual effective basis, after we control for concave utility functions, see Andersen, Harrison, Lau and Rutström [2008][2011][2013] (AHLR). The evidence also points to considerable heterogeneity in time preferences across identifiable segments of people. We again have an ideal comparison group in the form of a representative sample of the adult Danish population (AHLR [2008]).

1. Experimental Tasks

We build on experimental tasks that are established in the literature, and have been used to study the behavior of university students as well as representative samples of the general adult population in Denmark and elsewhere. Our experimental procedures are documented in detail in AHLR [2008], so we focus here just on the basics. Each subject was asked to respond to 1 risk aversion tasks and 3 discount rate tasks. Each such task involved a series of binary choices, typically 10 per task. Thus each subject typically provides 40 binary choices that can be used to infer risk and time preferences.

A. Risk Preferences: Measuring Risk Aversion

Our design poses a series of binary lottery choices in a multiple price list with 10 rows. In the first row, lottery A gives the individual a 10% chance of receiving 200 kroner and a 90% chance of receiving 160 kroner, and lottery B gives a 10% chance of receiving 385 kroner and a 90% chance of receiving 10 kroner. The probability of receiving the high prize in each lottery increases by 10% as one moves to the next row in the multiple price list until the last choice is between two certain amounts of money. The subject chooses A or B in each row, and one row is later selected at random for payout for that subject.[3]

We take each of the binary choices of the subject as the data, and estimate the parameters of a latent utility function that explains those choices using an appropriate error structure to account for the panel nature of the data. Once the utility function is defined, for candidate values of the parameters of that function, we can construct the expected utility of the two gambles, and then use a linking function to infer the likelihood of the observed choice.

B. Time Preferences: Measuring Individual Discount Rates

[3] There is some evidence that rewarding subjects by selecting one task at random for payment does not distort choices under EUT. On the other hand, there is some evidence that this random lottery payment protocol can affect inferences about risk preferences under RDU: see Harrison and Swarthout [2012]. The reason that this protocol could affect preferences under RDU, but not under EUT, is that it relies on the independence axiom, which is precisely the axiom that RDU assumes to be invalid. We assume here that the protocol does not influence inferred risk attitudes.

The basic experimental design for eliciting individual discount rates was introduced in CW [1999] and expanded in HLW [2002] and AHLR [2008]. Subjects in our experiments were given payoff tables with 10 symmetric intervals. For example, Option A offered 300 kroner in one month and Option B paid 300 kroner + *x* kroner in seven months, where *x* ranged from annual rates of return of 5% to 50% on the principal of 300 kroner, compounded quarterly to be consistent with general Danish banking practices on overdraft accounts. The payoff tables provided the annual and annual effective interest rates for each payment option, and the experimental instructions defined these terms by way of example.[4] Subjects were asked to choose between Option A and B for each of the 10 payoff alternatives, and one decision row was selected at random to be paid out at the chosen date. If a risk-neutral subject prefers the 300 kroner in one month then we can infer that the annual discount rate is higher than *x*%; otherwise, we can infer that it is *x*% or less.[5]

---

[4] CW [1999], HLW [2002] and AHLR [2008] provided annual and annual effective interest rates to help subjects compare lab and field investments. This feature may reduce comparison errors and CW [1999] find that providing information on interest rates has a significant negative effect on elicited discount rates.

[5] We assume that the subject does not have access to perfect capital markets, as explained in CW [1999; p.110] and HLW [2002; p.1607ff.]. This assumption is plausible, but also subject to checks from responses to the financial questionnaire that CW [1999], HLW [2002] and AHLR [2008] ask each subject to complete. The effects of allowing for field borrowing and lending opportunities on elicited discount rates for risk neutral subjects are discussed by CW [1999] and HLW [2002].

We use the multiple-horizon treatment from HLW [2002]. Subjects are asked to evaluate choices over three time horizons that are presented in ascending order, and those horizons are drawn at random from a set of 12 possible horizons (1, 2, 3,..., and 12 months). This design will allow us to obtain a smooth characterization of the discounting function across the sample for time horizons up to one year. We also varied the delay to the sooner payment option on a between-subject basis. One half of the subjects had no delay to the sooner payment option, and the other half had a front-end delay of one month. The front-end delay avoids the potential problem of the subject facing extra risk or transactions costs with the future income option, as compared to the "instant" income option.[6] If the delayed option were to involve such additional transactions costs, then the revealed discount rate would include these subjective transactions costs. By having both options presented as future income we hold these transactions costs constant.

Each subject responded to all three discount rate tasks and one task and row was chosen at random to be played out. Future payments to subjects were guaranteed by Copenhagen Business School, and made by automatic transfer from the Business School's bank account to the subject's bank account. This payment procedure is similar to a post-dated check, and automatic transfers between bank accounts are a common procedure in Denmark.

Our estimation strategy is the same as for the lottery task. We take each of the binary choices of the subject as data, and estimate the parameters with an error structure that recognizes the panel nature of the data. Risk attitudes and discount rates are estimated jointly. In effect, the lottery tasks identify risk attitudes and the intertemporal tasks identify discount rates conditional on the utility functions identified from the lottery tasks.

[6] These transactions costs are discussed in CW [1999], and they include things such as remembering to pick up the delayed payment as well as the credibility of the money actually being paid in the future. The design of our experiment was intended to make sure that the credibility of receiving the

2. Experiment with Entrepreneurs

In September 2006 we conducted a field experiment at the Entrepreneurship Fair in Forum, Copenhagen, organized by the Danish IT firm *Multidata* in collaboration with *BG Bank*. This fair attracts aspiring and experienced entrepreneurs from all over Denmark who attend to exchange ideas and find business partners. The fair was attended by 2,300 visitors and featured 80 exhibitors. Our sample of entrepreneurs included firms in agriculture, fishing and quarrying (4%), manufacturing (13%), construction (5%), wholesale and retail trade, hotels and restaurants (7%), transport, post and telecommunication (2%), finance and business activities (18%), public and personal services (15%), and non-identified sectors (36%).

money in the future was high. These considerations may be important in a field context, particularly in less developed countries.

Our experiment was run from a booth set up in the exhibitors' area of the fair with a Copenhagen Business School banner. The booth was run by Andersen, Lau and three students. We started by telling people that this was a study on economic decision making, and if they were interested in participating it would take around 15 minutes for which they would receive at least 50 Danish kroner. We then explained that they would be presented with 3 types of tasks in economic decision making. Each subject worked privately through the tasks.[7]

3. Data Description

Data were collected from 125 subjects, of which 55 subjects reported owning a firm and 70 subjects did not own a firm. Responses to the questionnaires allowed us to also classify subjects with respect to their employment status: (i) self-employed only, (ii) part-time employment in another firm, (iii) full-time employment in another firm, (iv) actively seeking employment, and (v) unemployed. The second column in Table 1 shows the distribution of these employment categories for subjects who own a firm: 29 subjects are self-employed only, 20 subjects report having part-time or full-time employment in another firm, and 6 subjects are seeking employment or are unemployed.

[7] The third task was a laboratory version of the *Deal and No Deal* game, which always followed the risk aversion and discount rate tasks. We provide instructions for the risk aversion and discount rate tasks in Appendix A, available in the working paper version at http://cear.gsu.edu.

We take the 70 subjects who do not own a firm as our control group, along with the samples from the previous field and lab experiments.[8] The third column in Table 1 shows the employment status for those subjects at the entrepreneurial fair who do not own a firm. Two of those subjects report being self-employed; according to Danish tax law, this means that they are VAT-registered and subject to income taxation instead of corporate taxation.

A. Previous Field and Lab Experiments in Denmark

To provide an even broader and more representative control group, we pool the entrepreneurship data with observations from previous Danish field and lab experiments that we conducted between June 2003 and November 2006. Table 2 provides an overview of the number of subjects in each experiment. There are 600 participants in total, with 253 participants in the first field experiment (June 2003), 97 subjects in the second field experiment (September 2003 — November 2004), 90 subjects in the first lab experiment (October 2003), 35 subjects in the second lab experiment (November 2006), and 125 subjects in the experiment that was conducted at the Entrepreneurship Fair in Copenhagen (September 2006).[9]

---

[8] In effect, these 70 subjects allow us to control for possible session effects that might be specific to the field experiments conducted at the Entrepreneurship Fair.

[9] The 97 subjects in the second field experiment were randomly selected from a subsample of the 253 subjects who participated in the first field experiment. These are "artefactual field experiments" in the terminology by Harrison and List [2004], since we essentially took lab experiments to field subjects.

The subjects in these experiments were presented with binary choice options using multiple price lists.[10] We used treatments with relatively high prizes in the risk aversion tasks. Four sets of prizes were used in the two previous field experiment and the two lab experiments, and the prizes in the lotteries varied between 50 and 4,500 kroner.[11] We added a treatment in the second lab experiment where the prizes were scaled by ½ compared to the default with high prizes, and the prizes in the experiment with entrepreneurs were scaled by 1/10 compared to the default. We used a symmetric menu option in the multiple price list in all the experiments, and added two asymmetric menu treatments in the two field experiments and in the first lab experiment.[12] The subjects were given a 10% chance of getting paid for one of the risk aversion tasks, except in the experiment with entrepreneurs where they were paid for certain.

The subjects were also presented with multiple price lists of ordered binary choice options in the discounting tasks, and the sooner payment option was 3,000 kroner in the two field experiments and two lab experiments. We added a treatment in the second lab experiment where the sooner payment option was 1,500 kroner, and the principal was reduced to 300 kroner in the experiment with entrepreneurs. The design of symmetric and asymmetric menu treatments in the multiple price lists is similar to the design of the menu treatments in the risk aversion tasks, and we allow for asymmetric menu treatments in the two field experiments and first lab experiment.[13] There was a delay to the sooner payment option of one month in all experiments, and we added a treatment with immediate payments in the experiment with entrepreneurs. All subjects had a 10% chance of getting paid for one of the discount rate tasks, except in the experiment at

---

[10] Appendix B provides an overview of the treatments in the risk aversion and discounting tasks across the various experiments.

[11] The four sets of prizes (in kroner) are as follows, with the two prizes for lottery A listed first and the two prizes for lottery B listed next: (A1: 2000, 1600; B1: 3850, 100), (A2: 2250, 1500; B2: 4000, 500), (A3: 2000, 1750; B3: 4000, 150), and (A4: 2500, 1000; B4: 4500, 50).

[12] The two asymmetric treatments offered probabilities of (0.3, 0.5, 0.7, 0.8, 0.9, and 1) and (0.1, 0.2, 0.3, 0.5, 0.7, and 1), respectively. These treatments vary the cardinal scale of the multiple price list and yield six decision rows in each treatment.

[13] The two asymmetric treatments offered annual interest rates of (15%, 25%, 35%, 40%, 45%, and 50%) and (5%, 10%, 15%, 25%, 35%, and 50%), respectively. The symmetric treatment offers 10 rows with annual interest rates between 5% and 50%.

the Entrepreneurship Fair where they were paid for certain.[14] Interest rates were compounded quarterly in all experiments.

Finally, the time horizon varied between 1 and 24 months in the first field experiment, between 1 and 21 months in the second field experiment, between 1 and 6 months in the first lab experiment, and between 1 and 12 months in the second lab experiment. The experimental designs in these field and lab experiments allow us to estimate exponential and "smoothly hyperbolic" models of discounting, and we can use data from the immediate payment option in the experiment with entrepreneurs to identify the quasi-hyperbolic discounting specification. We control for non-linear utility and jointly estimate risk and time preferences using different popular specifications of these latent preferences in the literature.

4. Empirical Results

[14] The effect of paying subjects for certain or with a 10% chance has been directly evaluated by HLR [2007; fn.16] and AHLR [2011], and shown to have no effects on estimated risk attitudes or discount rates in this population.

We use maximum likelihood estimation of structural models of the latent decision process, in which the core parameters that define risk attitudes and individual discount rates are estimated. The approach is an extension of the full maximum likelihood specification used in AHLR [2008], with modifications for the specifications of the alternative probability weighting functions.[15]

A. Risk Preferences

Table 3 shows maximum likelihood estimates of risk attitudes assuming EUT and constant relative risk aversion (CRRA).[16] We condition the coefficient r on dummy variables that control for the second field experiment (**DKphase2**), the first lab experiment (**DKlab1**), low and high prizes in the second lab experiment (**lab2_RA_LO** and **lab2_RA_HI**), the session at the Entrepreneurial Fair (**DKentre**), and firm ownership (**firm**).

[15] We review the estimation procedures in Appendix C.

[16] The CRRA specification we use is $U(M)^{(1-r)}/(1-r)$ for $r \neq 1$, where *r* is the CRRA coefficient. With this functional form r = 0 denotes risk neutral behavior, r > 0 denotes risk aversion, and r < 0 denotes risk seeking behavior.

The results show some variation in estimated relative risk aversion across the field and lab experiments. In particular, the marginal effect of the dummy variable for the session at the Entrepreneurial Fair is negative: the coefficient of -0.69 is significant with a *p*-value of less than 0.001. The prizes in the entrepreneurship experiment are one-tenth of the default prizes in the two field and two lab experiments, so these estimates suggest that relative risk aversion is increasing over income when we pool data from all field and lab sessions. To evaluate this inference about relative risk aversion, we also estimate the Expo-Power model by Saha [1993] and find that the estimated α is 0.63 with a 95% confidence interval between 0.51 and 0.74, implying increasing relative risk aversion.[17] The estimated r parameter is 0.25 with a 95% confidence interval between 0.15 and 0.35.

We do not find a significant marginal effect of firm ownership on estimated risk aversion: the coefficient for the CRRA utility function is equal to -0.01 and has a *p*-value of 0.95.[18] Using the Expo-Power specification of utility, a test of the joint hypothesis that the marginal effect of firm ownership on the estimated r and α coefficients is zero cannot be rejected (*p*-value=0.99). These results suggest that entrepreneurs do not have significantly different risk attitudes than the general population.

B. Optimism or Pessimism

---

[17] The Expo-Power function is defined as $U(M) = [1-\exp(-\alpha M^{1-r})]/\alpha$, where α and r are parameters to be estimated. RRA is then $r + \alpha(1-r)M^{1-r}$, so RRA varies with income if $\alpha \neq 0$. This function nests CRRA (as $\alpha \rightarrow 0$) and CARA (as $r \rightarrow 0$).

[18] Table C1 in Appendix C shows ML estimations of the same model with control for employment status instead of firm ownership. The results suggest that self-employed are less risk averse than full-time employed subjects. The estimated coefficient is equal to -0.295 with a *p*-value of 0.099.

We report estimates of the RDU model with the flexible Prelec function in Table 4.[19] The estimated probability weighting functions for entrepreneurial firm owners and others in the general population are displayed in Figure 1, and we find that subjects generally have an S-shaped probability weighting function.[20] We also find a significant effect of firm ownership on subjective probability weighting: the marginal effect of firm ownership on the η (φ) parameter has a *p*-value of 0.016 (0.777), and the joint effect of firm ownership on the η and φ parameters is significant with a *p*-value of 0.04. Since we only have two outcomes in each lottery the probability weight is identical to the decision weight for the best outcome, and the decision weight for the worst outcome is one minus that decision weight. We thus infer from Figure 1 that entrepreneurs are uniformly *more optimistic* about the probability of the best outcome than non-entrepreneurs. With greater probability optimism comes a greater aversion to variability of outcomes, and there is an increase in the concavity of the utility function of entrepreneurs (*p*-value of 0.124).

C. Time Preferences

Turning to individual discount rates, Table 5 shows estimates of the exponential discounting model assuming RDU with the flexible Prelec function. We control for the curvature of the utility function and jointly estimate risk aversion and discount rates, as theory requires. We condition the discount rate on sessions, the immediate payment treatment in the entrepreneurship experiment (**ent_nofed**), and firm ownership.

---

[19] Prelec [1998] offers a two-parameter probability weighting function that exhibits considerable flexibility. This function is $w(p) = \exp\{-\eta(-\ln p)^{\varphi}\}$, and is defined for $0<p<1$, $\eta>0$ and $\varphi>0$.

[20] We also find that the probability weighting function generally has an S-shape when we control for employment status instead of firm ownership.

We do indeed find a statistically significant effect of firm ownership on estimated discount rates: the estimated coefficient is equal to -0.017 with a *p*-value of 0.084. This result suggests that entrepreneurs are more oriented towards future outcomes and willing to wait longer for a certain return than the general population. We also find a significant marginal effect of the variable that controls for the session at the Entrepreneurial Fair. Individual discount rates are significantly higher in that session compared to the two field and two lab experiments, and the coefficient of 0.23 has a *p*-value less than 0.001.[21]

Finally, Table 6 shows ML estimates from a Quasi-Hyperbolic model.[22] We condition the β-parameter on firm ownership and do not find any evidence of quasi-hyperbolic discounting. The estimated coefficient for the constant term is equal to 0.998, with a standard deviation of 0.027 and a 95% confidence interval between 0.945 and 1.051. The marginal effect of firm ownership on β is equal to -0.009 with a *p*-value of 0.79. We cannot reject the hypothesis that β is equal to 1 for both entrepreneurs and non-entrepreneurs (*p*-value of 0.56 and 0.83, respectively), which implies that the discounting function is exponential for both groups.[23]

---

[21] Prizes in the discount rate tasks are only one-tenth of those in the first field experiment, so we cannot rule out the hypothesis that individual discount rates are falling over the range of income considered in all experiments. This result is consistent with the so-called "magnitude effect" on individual discounting. AHLR [2013] provide direct evidence *against* this hypothesis and magnitude effect in later experiments with Danes.

[22] The discount factor for the Quasi-Hyperbolic specification is defined as $D^{QH}(t) = 1$ if $t=0$ and $D^{QH}(t) = \beta/(1+\delta)^t$ if $t>0$, where $\beta<1$ implies quasi-hyperbolic discounting and $\beta=1$ is exponential discounting.

[23] We find similar results in the model with control for employment status. Table C3 reports estimates of the quasi-hyperbolic discounting function assuming RDU. We cannot reject the hypothesis that $\beta=1$ when we control for employment status.

It is possible to condition our core parameters on individual demographic covariates, just like we consider treatment variables. We consider total demographic effects of sex, age (below and above 40 years of age), short and long education, and low and high income. Our main results are robust to controls for observable individual characteristics: we find a significant effect of firm ownership on subjective probability weighting, a negative association with the level of discounting, and no evidence of Quasi-Hyperbolic discounting. The only demographic covariate to have a significant effect on the estimated parameters is age. Table C4 shows that younger subjects below 40 years of age have a significantly more concave utility function and a lower implied discount rate than those above 40 years of age.

D. Comparison to the Literature

There have been several attempts to elicit individual risk attitudes of entrepreneurs using financial instruments, but we have not come across any studies that investigate the association between entrepreneurship and individual discount rates. Elston, Harrison and Rutström [2005] collected data from 182 participants at two conventions for small business entrepreneurs in Atlanta, Georgia and Omaha, Nebraska. They elicited individual risk attitudes using the multiple price list design by Holt and Laury [2002], with prizes of $20 and $16 in lottery A, and prizes of $1 and $38.50 in lottery B. The results suggest that full-time entrepreneurs have significantly lower aversion to risk than part-time entrepreneurs and non-entrepreneurs, and that part-time entrepreneurs are not significantly different in terms of risk attitudes than non-entrepreneurs. In particular, the estimated CRRA coefficient for non-entrepreneurs is 0.29 with a standard error of 0.24, and the marginal effect of being a full-time entrepreneur is -0.20, which is significantly different from 0 (*p*-value of 0.068). In comparison, we find that the estimated CRRA coefficient for entrepreneurs is equal to 0.14 with a standard error of 0.11, and we cannot reject the hypothesis that entrepreneurs are risk neutral over the income interval in our experiments (*p*-value of 0.225).

The other studies that have used the multiple price list design to elicit individual risk attitudes of entrepreneurs rely on non-parametric estimation methods. Holm, Opper and Nee [2013] use a randomly selected sample of entrepreneurs from local business registers in the Yangzi delta region in China. The sample contains 700 entrepreneurs who have been in business for at least three years and employ at least 10 salaried workers, and the control group consists of 200 individuals selected randomly from household registers in the same region. The stakes in the lotteries vary between 15 and 580 Chinese yuan, and are comparable to the median daily income for entrepreneurs in the sample. They use the number of safe choices in the multiple price list as the dependent variable and find that entrepreneurs do not have significantly lower risk aversion than the control group.

Finally, List and Mason [2011] use a random lottery pair design to infer risk attitudes of CEOs working in the coffee industry in

Costa Rica. This design was used by Hey and Orme [1994] to estimate utility functions for individuals under EUT and RDU, *inter alia*, and is a popular method for individual-level estimation since one can include a large number of binary choice tasks in the experimental design. List and Mason [2011] presented the subjects with 40 pairs of lotteries in which the stakes were losses[24] of $80, $30 or $0 for a group of 29 CEOs and losses of $8, $3 or $0 for a control group of 101 undergraduate students in Costa Rica. They estimate risk attitudes for each individual and find no evidence of a significant difference in risk attitudes between CEOs and students under the assumption of EUT. However, they conclude that there may be some significant differences in risk attitudes under RDU, although it is not clear in what way risk attitudes differ between CEOs and students.

5. Conclusion

We investigate the hypothesis that small business entrepreneurs in Denmark have significantly different individual risk attitudes and discount rates than the general population. The results do not suggest that small business entrepreneurs are more or less risk averse than the general population under the assumption of EUT. However, we generally find an S-shaped probability weighting function for both small business entrepreneurs and non-entrepreneurs, with entrepreneurs being more optimistic about the chance of occurrence for the best outcome in lotteries with real monetary outcomes. Thus the nature of the risk attitudes of entrepreneurs differs: they are more optimistic about good outcomes than the general population, but also more averse to variability of outcomes. The net results is that they exhibit the same risk premium, but for different reasons. The results also point to a significant difference in individual discount rates between entrepreneurs and non-entrepreneurs: entrepreneurs are willing to wait longer for monetary rewards than the general population.

[24] These were losses from earnings in an unrelated, prior experimental task.

Table 1. Firm Ownership and Employment Status in Entrepreneurship Data

	Firm	No Firm
Self-employed only	29	2
Part-time employment in another firm	8	17
Full-time employment in another firm	12	34
Actively seeking employment	3	10
Unemployed	3	7
Total	55	70

Table 2. Sample Size in Danish Field and Lab Experiments

Experiment	Subjects
Field 1	253
Field 2	97
Lab 1	90
Lab 2	35
Entrepreneurship	125
All	600

Table 3: Estimation of Risk Aversion Assuming EUT and CRRA

(N=16,250 observations, based on 503 subjects)

Parameters	Coefficient	Robust Standard Error	p-value	[95% Confidence Interval]	
r					
DKphase2	-0.019	0.126	0.881	-0.266	0.229
DKlab1	-0.078	0.087	0.371	-0.249	0.093
lab2_RA_LO	-0.201	0.123	0.104	-0.443	0.042
lab2_RA_HI	-0.181	0.186	0.329	-0.546	0.183
DKentre	-0.690	0.107	0.000	-0.900	-0.479
firm	-0.009	0.141	0.949	-0.285	0.267
constant	0.837	0.067	0.000	0.707	0.968
LNmuRA					
DKphase2	0.194	0.128	0.129	-0.056	0.444
DKlab1	-0.628	0.126	0.000	-0.874	-0.382
lab2_RA_LO	-0.465	0.301	0.123	-1.056	0.125
lab2_RA_HI	-0.148	0.228	0.515	-0.594	0.298
DKentre	0.002	0.151	0.987	-0.294	0.299
constant	-0.991	0.074	0.000	-1.136	-0.846

Table 4: Risk Attitudes Assuming RDU with Prelec Probability Weighting
(N=16,250 observations, based on 503 subjects)

Parameters	Coefficient	Robust Standard Error	p-value	[95% Confidence Interval]	
r					
DKphase2	0.006	0.169	0.973	-0.326	0.337
DKlab1	-0.079	0.116	0.494	-0.306	0.148
lab2_RA_LO	-0.283	0.148	0.056	-0.573	0.007
lab2_RA_HI	-0.261	0.170	0.124	-0.595	0.072
DKentre	-0.828	0.158	0.000	-1.138	-0.518
firm	0.326	0.212	0.124	-0.090	0.742
constant	0.847	0.083	0.000	0.684	1.009
eta					
DKphase2	-0.179	0.454	0.693	-1.069	0.710
DKlab1	-0.449	0.415	0.279	-1.262	0.364
lab2_RA_LO	-0.316	0.689	0.647	-1.667	1.035
lab2_RA_HI	-0.803	0.622	0.196	-2.022	0.415
DKentre	0.578	0.970	0.551	-1.323	2.479
firm	-1.548	0.401	0.000	-2.335	-0.761
constant	2.417	0.252	0.000	1.923	2.910
phi					
DKphase2	0.157	0.336	0.641	-0.502	0.816
DKlab1	-0.511	0.288	0.076	-1.076	0.054
lab2_RA_LO	-0.472	0.482	0.327	-1.416	0.472
lab2_RA_HI	-0.838	0.317	0.008	-1.460	-0.216
DKentre	0.924	0.646	0.153	-0.342	2.190
firm	-0.408	1.457	0.780	-3.264	2.448
constant	2.394	0.189	0.000	2.024	2.764
LNmuRA					
DKphase2	0.159	0.101	0.115	-0.039	0.358
DKlab1	-0.538	0.116	0.000	-0.766	-0.311
lab2_RA_LO	-0.390	0.288	0.175	-0.955	0.174
lab2_RA_HI	-0.171	0.204	0.400	-0.570	0.228
DKentre	0.028	0.115	0.806	-0.197	0.253
constant	-0.759	0.057	0.000	-0.870	-0.647

Figure 1. Prelec Probability Weighting Function

Table 5. Estimates of Exponential Discounting Function Assuming RDU

(N= 350,732 observations, based on 503 subjects)

Parameters	Coefficient	Robust Standard Error	p-value	[95% Confidence Interval]	
r					
DKphase2	-0.001	0.173	0.998	-0.339	0.338
DKlab1	-0.090	0.118	0.448	-0.322	0.142
lab2_RA_LO	-0.294	0.150	0.050	-0.589	0.000
lab2_RA_HI	-0.271	0.172	0.115	-0.609	0.066
DKentre	-0.799	0.152	0.000	-1.097	-0.501
firm	0.243	0.181	0.180	-0.112	0.598
constant	0.859	0.087	0.000	0.689	1.028
eta					
DKphase2	-0.174	0.455	0.702	-1.067	0.718
DKlab1	-0.439	0.416	0.291	-1.254	0.376
lab2_RA_LO	-0.305	0.690	0.659	-1.658	1.049
lab2_RA_HI	-0.795	0.622	0.201	-2.013	0.424
DKentre	0.476	0.922	0.606	-1.332	2.283
firm	-1.451	0.414	0.000	-2.263	-0.639
constant	2.406	0.253	0.000	1.911	2.902
phi					
DKphase2	0.147	0.341	0.665	-0.521	0.815
DKlab1	-0.528	0.291	0.070	-1.099	0.043
lab2_RA_LO	-0.489	0.483	0.311	-1.436	0.458
lab2_RA_HI	-0.854	0.321	0.008	-1.482	-0.225
DKentre	0.947	0.643	0.141	-0.312	2.206
firm	-0.545	1.467	0.710	-3.421	2.331
constant	2.411	0.193	0.000	2.032	2.790
delta					
DKphase2	-0.006	0.026	0.803	-0.057	0.044
DKlab1	0.009	0.020	0.663	-0.030	0.047
lab2_IDR_LO	0.044	0.037	0.232	-0.028	0.116
lab2_IDR_HI	0.085	0.044	0.054	-0.002	0.172
DKentre	0.228	0.059	0.000	0.112	0.343
ent_nofed	-0.006	0.008	0.415	-0.022	0.009
firm	-0.017	0.010	0.084	-0.036	0.002
constant	0.048	0.014	0.001	0.020	0.077
LNmuRA					
DKphase2	0.157	0.102	0.122	-0.042	0.357
DKlab1	-0.541	0.116	0.000	-0.770	-0.313

lab2_RA_LO	-0.394	0.288	0.172	-0.958	0.171
lab2_RA_HI	-0.174	0.204	0.393	-0.574	0.225
DKentre	0.028	0.115	0.809	-0.197	0.253
constant	-0.755	0.057	0.000	-0.868	-0.643
LNmuIDR					
DKphase2	-0.323	0.230	0.160	-0.775	0.128
DKlab1	-1.224	0.163	0.000	-1.544	-0.904
lab2_IDR_LO	-0.624	0.227	0.006	-1.070	-0.178
lab2_IDR_HI	-0.236	0.264	0.371	-0.753	0.281
DKentre	-1.483	0.218	0.000	-1.910	-1.056
ent_nofed	-0.125	0.228	0.583	-0.572	0.322
constant	-1.314	0.114	0.000	-1.539	-1.090

Table 6. Estimates of Quasi-Hyperbolic Discounting Function Assuming RDU
(N= 350,732 observations, based on 503 subjects)

Parameters	Coefficient	Robust Standard Error	p-value	[95% Confidence Interval]	
r					
DKphase2	-0.001	0.172	0.997	-0.337	0.336
DKlab1	-0.090	0.118	0.446	-0.320	0.141
lab2_RA_LO	-0.294	0.150	0.049	-0.587	-0.001
lab2_RA_HI	-0.268	0.172	0.120	-0.605	0.070
DKentre	-0.812	0.153	0.000	-1.112	-0.512
firm	0.275	0.183	0.134	-0.085	0.634
constant	0.858	0.085	0.000	0.691	1.026
eta					
DKphase2	-0.174	0.455	0.702	-1.066	0.718
DKlab1	-0.440	0.416	0.290	-1.255	0.375
lab2_RA_LO	-0.305	0.690	0.659	-1.658	1.048
lab2_RA_HI	-0.800	0.621	0.197	-2.016	0.416
DKentre	0.511	0.934	0.584	-1.319	2.341
firm	-1.485	0.403	0.000	-2.275	-0.696
constant	2.407	0.253	0.000	1.911	2.903
phi					
DKphase2	0.147	0.340	0.665	-0.519	0.813
DKlab1	-0.527	0.291	0.070	-1.097	0.043
lab2_RA_LO	-0.489	0.483	0.312	-1.435	0.458
lab2_RA_HI	-0.850	0.320	0.008	-1.478	-0.223
DKentre	0.934	0.645	0.147	-0.329	2.198
firm	-0.494	1.468	0.737	-3.371	2.383
constant	2.410	0.192	0.000	2.033	2.788
delta					
DKphase2	-0.007	0.011	0.532	-0.028	0.014
DKlab1	-0.011	0.008	0.159	-0.026	0.004
lab2_IDR_LO	0.004	0.015	0.792	-0.025	0.033
lab2_IDR_HI	0.030	0.018	0.102	-0.006	0.066
DKentre	0.085	0.026	0.001	0.034	0.135
ent_nofed	0.026	0.014	0.056	-0.001	0.053
firm	-0.009	0.005	0.084	-0.020	0.001
constant	0.024	0.007	0.001	0.010	0.038
beta					
firm	-0.009	0.032	0.787	-0.070	0.053
constant	0.998	0.027	0.000	0.945	1.051

LNmuRA					
DKphase2	0.157	0.102	0.122	-0.042	0.356
DKlab1	-0.541	0.116	0.000	-0.769	-0.313
lab2_RA_LO	-0.393	0.288	0.172	-0.958	0.171
lab2_RA_HI	-0.173	0.204	0.396	-0.572	0.226
DKentre	0.027	0.115	0.815	-0.198	0.252
constant	-0.755	0.057	0.000	-0.868	-0.643
LNmuIDR					
DKphase2	-0.300	0.263	0.253	-0.815	0.215
DKlab1	-1.251	0.173	0.000	-1.590	-0.912
lab2_IDR_LO	-0.553	0.275	0.044	-1.092	-0.015
lab2_IDR_HI	-0.479	0.267	0.073	-1.003	0.045
DKentre	-1.699	0.233	0.000	-2.155	-1.244
ent_nofed	-0.260	0.250	0.299	-0.750	0.230
constant	-0.953	0.125	0.000	-1.198	-0.708

References

Andersen, Steffen; Fountain, John; Harrison, Glenn W., and Rutström, E. Elisabet, "Estimating Subjective Probabilities," *Journal of Risk and Uncertainty*, 2014 forthcoming.

Andersen, Steffen; Harrison, Glenn W., Lau, Morten I., and Rutström, E. Elisabet, "Eliciting Risk and Time Preferences" *Econometrica*, 76(3), 2008, 583-618.

Andersen, Steffen; Harrison, Glenn W.; Lau, Morten I., and Rutström, E. Elisabet, "Discounting Behavior: A Reconsideration," *Working Paper 2011-03*, Center for the Economic Analysis of Risk, Robinson College of Business, Georgia State University, January 2011.

Andersen, Steffen; Harrison, Glenn W., Lau, Morten I., and Rutström, E. Elisabet, "Discounting Behavior and the Magnitude Effect: Evidence from a Field Experiment in Denmark," *Economica*, 2013, 80, 670-697.

Coller, Maribeth, and Williams, Melonie B., "Eliciting Individual Discount Rates," *Experimental Economics*, 2, 1999, 107-127.

Dohmen, Thomas; Falk, Armin; Huffman, David; Sunde, Uwe; Schupp, Jürgen, and Wagner, Gert G., "Individual Risk Attitudes: New Evidence From a Large Representative, Experimentally-Validated Survey," *Journal of the European Economic Association*, 9(3), 2011, 522-550.

Elston, Julie A.; Harrison, Glenn W., and Rutström, E. Elisabet, "Characterizing the Entrepreneur Using Field Experiments," *Working Paper 05-30*, Department of Economics, College of Business Administration, University of Central Florida, 2005.

Harrison, Glenn W.; Johnson, Eric; McInnes, Melayne M., and Rutström, E. Elisabet, "Risk Aversion and Incentive Effects: Comment," *American Economic Review*, 95(3), June 2005, 897-901.

Harrison, Glenn W.; Lau, Morten I., and Rutström, E. Elisabet, "Estimating Risk Attitudes in Denmark: A Field Experiment," *Scandinavian Journal of Economics*, 109(2), June 2007, 341-368.

Harrison, Glenn W.; Lau, Morten I., and Williams, Melonie B., "Estimating Individual Discount Rates for Denmark: A Field Experiment," *American Economic Review*, 92(5), December 2002, 1606-1617.

Harrison, Glenn W., and List, John A., "Field Experiments," *Journal of Economic Literature*, 42(4), December 2004, 1013-1059.

Harrison, Glenn W., and Phillips, Richard D., "Subjective Beliefs and Statistical Forecasts of Financial Risks: The Chief Risk Officer Project," *Working Paper 2013-08*, Center for the Economic Analysis of Risk, Robinson College of Business, Georgia State University, 2013.

Harrison, Glenn W., and Swarthout, J. Todd, "Experimental Payment Protocols and the Bipolar Behaviorist," *Working Paper 2012-01*, Center for the Economic Analysis of Risk, Robinson College of Business, Georgia State University, 2012.

Holm, Håkan J.; Opper, Sonja, and Nee, Victor, "Entrepreneurs Under Uncertainty: An Economic Experiment in China," *Management Science*, 59(7), 2013, 1671-1687.

Holt, Charles A., and Laury, Susan K., "Risk Aversion and Incentive Effects," *American Economic Review*, 92(5), December 2002, 1644-1655.

List, John A., and Mason, Charles F., "Are Ceo's Expected Utility Maximizers?," *Journal of Econometrics*, 162(1), 2011, 114-123.

Saha, Atanu, "Expo-Power Utility: A Flexible Form for Absolute and Relative Risk Aversion," *American Journal of Agricultural Economics*, 75(4), November 1993, 905-913.

Appendix A: Instructions
(INCLUDED IN ONLINE WORKING PAPER)

A. General Introduction

OUR RESEARCH STUDY

This is a study of economic decision making for academic research purposes. We will present you with a series of tasks. For each task you will be asked to select your preferred choice. This is not a test. The only right answer is your preferred choice.

If you agree to participate, you will be presented with three different types of tasks. You will get a set of written instructions for each type of task, and you will then be asked to choose between the relevant alternatives on a computer.

You will be paid 50 kroner for your participation *and* you will earn additional money. How much you earn will depend partly on chance and partly on the choice you make in the tasks we present you with. The instructions are simple and you will benefit from following them carefully.

B. Risk Aversion Task

Task A

An example of your decision task is shown on the right. Each decision is a paired choice between an **Option A** and an **Option B**. When presented with the actual decisions we ask that you select your preferred option in each row and record these in the final column. You will enter your choices using a computer.

The decisions all have a similar format. For example, look at Decision 1 at the top. Option A pays 60 kroner if the throw of a ten-sided die is 1, and it pays 40 kroner if the throw is 2-10. Option B pays 90 kroner if the throw of the die is 1 and 10 kroner if the throw is 2-10. The only difference in the nine other decisions is that as you move down the table the chances of the higher payoff for each option increase.

You have a 1-in-10 chance of being paid for one of these decisions. This will be decided by rolling a ten-sided die. If the number 1 is drawn you will be paid for one of your decisions.

If you are to be paid for one of your decisions we will select that decision by rolling the ten-sided die a second time. A third draw with the same die determines what the payment is for the option you choose. As you will not know in advance which decision may affect your earnings you should treat each decision as if it is to count for payment.

For the selected decision we will pay you according to your selected option. You will then receive the money at the end of the experiment.

C. Discount Rate Task

Task B

An example of your decision task is shown on the right. Each decision is a paired choice between an **Option A** and an **Option B**. When presented with the actual decisions we ask that you select your preferred option in each row and record these in the final column. You will enter your choices using a computer.

The decisions all have a similar format. For example, look at Decision 1 at the top. Option A pays 100 kroner today and Option B pays 105.09 kroner twelve months from now. If you choose Option B you will earn an annual return of 5% on the 100 kroner you choose to receive 12 months from now. Since this is compounded quarterly your annual *effective* interest rate is 5.09%. The annual effective interest rate is the rate earned on the initial balance, 100 kroner here, plus interest earned on all interest accumulated in the preceding compounding periods. The only difference in the other nine decisions is that as you move down the table the payoffs for Option B increase.

We will present you with three sets of ten such decision problems. The only difference between them is that the payment date for Option B will differ.

You have a 1-in-10 chance of being paid for one of the decision problems in one of the three tasks. This will be decided by rolling a ten-sided die. If the number 1 is drawn you will be paid for one of your decisions.

If you are to be paid for one of your decisions we will select that decision by first rolling a six-sided die numbered 1 to 6 to determine which task is used for your payment. The first task will be used for your payment if the number on the die is 1-2, the second task is used if the number on the die 3-4, and the third task is used for your payment if the number on the die is 5-6. When the task is selected, we will then roll a ten-sided die numbered 1 to 10 to determine which decision is used for your payment. As you will not know in advance which decision may affect your earnings you should treat each decision as if it is to count for payment.

For the selected decision we will pay you according to your selected option. You will then receive the money at the date you choose. You will receive written confirmation of your payment today, and we will transfer the money to your personal bank account at the specified date.

D. Socio-demographic Questionnaire

In this survey most of the questions asked are descriptive. The questions may seem personal, but they will help us analyze the results of the experiments. Your responses are completely confidential. Please think carefully about each question and give your best answer.

1. What is your age? ____________ years

2. What is your sex?

01 Male
02 Female

3. Where do you live?

01 Copenhagen including suburbs
02 Other municipalities in Copenhagen Capital Region
03 Municipality with towns of more than 100,000 inhabitants
04 Municipality with towns of 40,000 – 99,999 inhabitants
05 Municipality with towns of 20,000 – 39,999 inhabitants
06 Municipality with towns of 10,000 – 19,999 inhabitants
07 Other

4. What type of residence do you live in?

01 Owner-occupied house
02 Owner-occupied apartment
03 Rented house
04 Rented apartment
05 Multi-ownership of residence, cooperative
06 Rented room
07 Official residence, etc.

5. What has been your primary occupation during the last 12 months?

(Primary occupation is defined as the type of occupation where you spend most of your working time.)

01 Farmer
02 Other self-employed
03 Assisting spouse
04 White collar worker
05 Skilled worker
06 Unskilled worker
07 Apprentice
08 Student
09 Retired
10 Unemployed
11 Other

6. What is your highest level of education?

01 Basic school
02 General upper secondary education
03 Vocational upper secondary education
04 Vocational education and training

05 Short higher education
06 Medium higher education
07 Long higher education

A. *Vocational education and training:*
01 Commercial and clerical vocational courses
02 Metal manufacturing vocational courses
03 Construction vocational courses
04 Graphic vocational courses
05 Service-related vocational courses
06 Food-related vocational courses
07 Health-related auxiliary programs
08 Other vocational courses

B. *Short higher education:*
01 Social sciences and humanities
02 Technical and natural sciences
03 Health-related sciences
04 Other

C. *Medium higher education:*
01 Social sciences
02 Technical and natural sciences
03 Health-related sciences
04 Educational courses and humanities
05 Officers

D. *Long higher education:*
01 Social sciences
02 Technical and natural sciences
03 Health-related sciences
04 Educational courses and humanities
05 Veterinary and agricultural courses

7. What are the characteristics of your household?

(A household is an economic unit, and it is defined as a group of people who live in the same residence and each person contributes to general expenditures.)

01 Single under 30 years
02 Single 30 – 59 years
03 Single older than 59 years
04 2 adults, oldest person is under 30 years
05 2 adults, oldest person is 30 – 59 years
06 2 adults, oldest person is older than 59 years
07 Single with children, oldest child 0 – 9 years

08 Single with children, oldest child 10 – 17 years
09 2 adults with children, oldest child 0 – 9 years
10 2 adults with children, oldest child 10 – 17 years
11 Household with at least 3 adults

8. How many persons (including children) are there in your household?

01 1 person
02 2 people
03 3 people
04 4 people
05 5 or more people

9. What was the amount of total income before tax earned in 2005 by all members of your household (including children)?

(Consider all forms of income, including salaries, income from unincorporated business enterprises, pension scheme contributions, interest earnings and dividends, retirement benefits, student grants, scholarship support, social security, unemployment benefits, parental support, alimony, child support, and other types of income.)

01 Below 150,000 kroner
02 150,000 – 299,999 kroner
03 300,000 – 499,999 kroner
04 500,000 – 799,999 kroner
05 800,000 kroner or more

10. How often do you participate in extreme sports?

(Extreme sports include bungee-jumping, para-gliding, parachute jumping, gliding, rafting, diving and other dangerous sports.)

01 Never
02 A few times
03 Occasionally
04 Often
05 Every chance I get

11. Do you currently smoke cigarettes?

01 No
02 Yes

A. If yes, how much do you smoke in one day? _______ cigarettes

12. What is your height? ______ cm

13. What is your weight? _______ kg

14. Do you suffer from stress symptoms such as fatigue, head or chest pain, high blood pressure, depression, fear or anxiety?

    01 Yes
    02 No

15. Did you vote at the latest general election in February 2005?

    01 Yes
    02 No

16. Where in the political spectrum do you consider yourself?

    01 Left wing
    02 Center
    03 Right wing
    04 I look at it differently
    05 Don't know

17. Taking all things together, would you say you are:

    01 Very happy
    02 Rather happy
    03 Not very happy
    04 Not at all happy

18. How satisfied are you with your life as a whole these days? Please answer on a scale of 1 to 10, where 1 is least satisfied and 10 is most satisfied? _______

E. Entrepreneurship Questionnaire

We will ask you to answer some more questions about yourself. The questions may seem personal, but they will help us analyze the results of the experiments. Your responses are completely confidential. Please think carefully about each question and give your best answer.

1. What is your current employment status?

    01 Self-employed only
    02 Part-time employment in another firm
    03 Full-time employment in another firm
    04 Actively seeking employment
    05 Unemployed

2. Do you own a firm?

01 Yes
02 No

3. How old is your firm, in years? ____________

4. What type of industry does your firm belong to?

01 Agriculture, fishing and quarrying
02 Manufacturing
03 Electricity, gas and water supply
04 Construction
05 Wholesale and retail trade, hotels and restaurants
06 Transport, post and telecommunication
07 Finance and business activities
08 Public and personal services
09 Activity not stated

5. How many people are employed in your firm, including yourself? ____________

6. What is the ownership structure of your firm?

01 Sole proprietorship
02 Partnership and limited partnership
03 Public limited company
04 Funds, societies, etc
05 Private limited company
06 Co-operative society
07 Other

7. Have you ever experienced a shortage of capital in running your firm?

01 Never
02 Rarely
03 Occasionally
04 Often
05 Always

8. Do you have a shortage of capital now?

01 Yes
02 No

9. How did you primarily finance your firm's start up?

01 Inheritance
02 Gift

03 Credit cards
04 Earnings from another job
05 Grants
06 Private loan from a bank or person
07 Other

10. How do you finance your firm now? Enter rough percentages for each:

01 Government loans or grants __________ percent
02 Private loans from banks or people __________ percent
03 Credit cards __________ percent
04 Earnings from another job __________ percent
05 Cash from operations __________ percent
06 Equity capital __________ percent
07 Other __________ percent

11. What would you estimate to be the annual turnover in 2005 of your firm? _____________ dollars

12. What proportion of your annual personal income in 2005 is revenue from your firm? __________ percent

13. What would you estimate to be the current value of the assets of your firm? _________________ dollars

Appendix B: Treatments in Danish Field and Lab Experiments (INCLUDED IN ONLINE WORKING PAPER)

Table B1. Treatments in Risk Aversion Tasks

Treatment	Experiment
High prizes (default)	Field 1+2, Lab 1+2
Medium prizes (50% of default)	Lab 2
Low prizes (10% of default)	Entrepreneurship
Symmetric menu in MPL	All
Asymmetric menu in MPL	Field 1+2, Lab 1

Table B2. Treatments in Discount Rate Tasks

Treatment	Experiment
High prizes (default)	Field 1+2, Lab 1+2
Medium prizes (50% of default)	Lab 2
Low prizes (10% of default)	Entrepreneurship
Symmetric menu in MPL	All
Asymmetric menu in MPL	Field 1+2, Lab 1
Delayed sooner payment	All
Immediate sooner payment	Entrepreneurship

Table B3. Time Horizons in Discount Rate Tasks

Experiment	Time Horizons in Months
Field 1	1, 4, 6, 12, 18 and 24
Field 2	1, 3, 7, 9, 13, 15, 19 and 21

Lab 1	1, 4 and 6
Lab 2	1, 4, 6 and 12
Entrepreneurship	1, 2,… , 11 and 12

Appendix C: Estimation Results with Control for Employment Status (INCLUDED IN ONLINE WORKING PAPER)

Table C1: Estimation of Risk Aversion Assuming EUT and CRRA
(N=16,250 observations, based on 503 subjects)

Parameters	Coefficient	Robust Standard Error	p-value	[95% Confidence Interval]	
r					
DKphase2	-0.019	0.126	0.881	-0.266	0.229
DKlab1	-0.078	0.087	0.371	-0.249	0.093
lab2_RA_LO	-0.201	0.123	0.104	-0.443	0.042
lab2_RA_HI	-0.181	0.186	0.329	-0.546	0.183
DKentre	-0.576	0.131	0.000	-0.832	-0.320
self_emp	-0.295	0.178	0.099	-0.644	0.055
part_time	-0.086	0.180	0.633	-0.439	0.267
no_emp	-0.155	0.211	0.463	-0.570	0.259
constant	0.837	0.067	0.000	0.707	0.968
LNmuRA					
DKphase2	0.194	0.128	0.129	-0.056	0.444
DKlab1	-0.628	0.126	0.000	-0.874	-0.382
lab2_RA_LO	-0.465	0.301	0.123	-1.056	0.125
lab2_RA_HI	-0.148	0.228	0.515	-0.594	0.298
DKentre	0.000	0.152	1.000	-0.298	0.298
constant	-0.991	0.074	0.000	-1.136	-0.846

Table C2: Estimates of Risk Aversion Assuming RDU and Prelec Probability Weighting
(N=16,250 observations, based on 503 subjects)

Parameter	Coefficient	Robust Standard Error	p-value	[95% Confidence Interval]	
r					
DKphase2	0.006	0.169	0.973	-0.326	0.337
DKlab1	-0.079	0.116	0.494	-0.306	0.148
lab2_RA_LO	-0.283	0.148	0.056	-0.573	0.007
lab2_RA_HI	-0.261	0.170	0.124	-0.595	0.072
DKentre	-0.664	0.150	0.000	-0.958	-0.370
self_emp	-0.080	0.256	0.754	-0.582	0.421
constant	0.847	0.083	0.000	0.684	1.009
eta					
DKphase2	-0.179	0.454	0.693	-1.069	0.710
DKlab1	-0.449	0.415	0.279	-1.262	0.364
lab2_RA_LO	-0.316	0.689	0.647	-1.667	1.035
lab2_RA_HI	-0.803	0.622	0.196	-2.022	0.415
DKentre	-0.040	0.631	0.950	-1.276	1.197
self_emp	-1.328	0.512	0.009	-2.332	-0.325
constant	2.417	0.252	0.000	1.923	2.910
phi					
DKphase2	0.157	0.336	0.641	-0.502	0.816
DKlab1	-0.511	0.288	0.076	-1.076	0.054
lab2_RA_LO	-0.472	0.482	0.327	-1.416	0.472
lab2_RA_HI	-0.838	0.317	0.008	-1.460	-0.216
DKentre	0.966	0.564	0.087	-0.139	2.071
self_emp	-0.794	1.578	0.615	-3.887	2.299
constant	2.394	0.189	0.000	2.024	2.764
LNmuRA					
DKphase2	0.159	0.101	0.115	-0.039	0.358
DKlab1	-0.538	0.116	0.000	-0.766	-0.311
lab2_RA_LO	-0.390	0.288	0.175	-0.955	0.174
lab2_RA_HI	-0.171	0.204	0.400	-0.570	0.228
DKentre	0.039	0.115	0.734	-0.187	0.265
constant	-0.759	0.057	0.000	-0.870	-0.647

Table C3: Estimates of Quasi-Hyperbolic Discounting Function Assuming RDU
(N=350,732 observations, based on 503 subjects)

Parameters	Coefficient	Robust Standard Error	p-value	[95% Confidence Interval]	
r					
DKphase2	-0.001	0.172	0.997	-0.337	0.336
DKlab1	-0.090	0.118	0.446	-0.320	0.141
lab2_RA_LO	-0.294	0.150	0.049	-0.587	-0.001
lab2_RA_HI	-0.268	0.172	0.120	-0.605	0.070
DKentre	-0.678	0.149	0.000	-0.970	-0.386
self_emp	-0.048	0.205	0.815	-0.450	0.354
constant	0.858	0.085	0.000	0.691	1.026
eta					
DKphase2	-0.174	0.455	0.702	-1.066	0.718
DKlab1	-0.440	0.416	0.290	-1.255	0.375
lab2_RA_LO	-0.305	0.690	0.659	-1.658	1.048
lab2_RA_HI	-0.800	0.621	0.197	-2.016	0.416
DKentre	-0.022	0.630	0.972	-1.257	1.213
self_emp	-1.364	0.458	0.003	-2.263	-0.466
constant	2.407	0.253	0.000	1.911	2.903
phi					
DKphase2	0.147	0.340	0.665	-0.519	0.813
DKlab1	-0.527	0.291	0.070	-1.097	0.043
lab2_RA_LO	-0.489	0.483	0.312	-1.435	0.458
lab2_RA_HI	-0.850	0.320	0.008	-1.478	-0.223
DKentre	0.943	0.566	0.096	-0.166	2.052
self_emp	-0.747	1.622	0.645	-3.927	2.433
constant	2.410	0.192	0.000	2.033	2.788
delta					
DKphase2	-0.007	0.011	0.532	-0.028	0.014
DKlab1	-0.011	0.008	0.159	-0.026	0.004
lab2_IDR_LO	0.004	0.015	0.792	-0.025	0.033
lab2_IDR_HI	0.030	0.018	0.102	-0.006	0.066
DKentre	0.064	0.020	0.002	0.024	0.104
ent_nofed	0.025	0.013	0.058	-0.001	0.051
self_emp	0.002	0.009	0.829	-0.016	0.020
constant	0.024	0.007	0.001	0.010	0.038
beta					
self_emp	-0.005	0.036	0.881	-0.076	0.065
constant	0.993	0.018	0.000	0.957	1.029

LNmuRA					
DKphase2	0.157	0.102	0.122	-0.042	0.356
DKlab1	-0.541	0.116	0.000	-0.769	-0.313
lab2_RA_LO	-0.393	0.288	0.172	-0.958	0.171
lab2_RA_HI	-0.173	0.204	0.396	-0.572	0.226
DKentre	0.035	0.115	0.759	-0.191	0.262
constant	-0.755	0.057	0.000	-0.868	-0.643
LNmuIDR					
DKphase2	-0.300	0.263	0.253	-0.815	0.215
DKlab1	-1.251	0.173	0.000	-1.590	-0.912
lab2_IDR_LO	-0.553	0.275	0.044	-1.092	-0.015
lab2_IDR_HI	-0.479	0.267	0.073	-1.003	0.045
DKentre	-1.624	0.251	0.000	-2.116	-1.131
ent_nofed	-0.436	0.231	0.059	-0.889	0.017
constant	-0.958	0.123	0.000	-1.199	-0.716

Table C4: Demographic Effects: Quasi-Hyperbolic Discounting Function Assuming RDU
(N=350,732 observations, based on 503 subjects)

Parameters	Coefficient	Robust Standard Error	p-value	[95% Confidence Interval]	
r					
female	0.844	0.089	0.000	0.670	1.019
male	0.848	0.097	0.000	0.657	1.038
younger	1.057	0.095	0.000	0.871	1.242
older	0.773	0.099	0.000	0.579	0.967
shortedu	0.833	0.091	0.000	0.655	1.011
longedu	0.908	0.104	0.000	0.704	1.111
IncLow	0.822	0.102	0.000	0.621	1.022
IncHigh	0.906	0.084	0.000	0.741	1.071
eta					
female	2.396	0.392	0.000	1.627	3.166
male	2.360	0.297	0.003	1.778	2.941
younger	3.881	0.610	0.000	2.685	5.077
older	1.709	0.236	0.000	1.246	2.171
shortedu	2.170	0.283	0.000	1.616	2.725
longedu	2.880	0.494	0.000	1.912	3.848
IncLow	2.409	0.267	0.000	1.886	2.932
IncHigh	2.439	0.580	0.000	1.302	3.576
phi					
female	2.172	0.263	0.000	1.656	2.688
male	2.563	0.211	0.000	2.149	2.976
younger	2.550	0.257	0.000	2.047	3.052
older	2.240	0.327	0.000	1.599	2.880
shortedu	2.319	0.206	0.000	1.916	2.723
longedu	2.579	0.350	0.000	1.892	3.265
IncLow	2.357	0.219	0.000	1.927	2.787
IncHigh	2.483	0.388	0.000	1.722	3.243
delta					
female	0.027	0.008	0.001	0.011	0.042
male	0.024	0.008	0.029	0.008	0.039

younger	0.010	0.005	0.035	0.001	0.019
older	0.034	0.010	0.001	0.013	0.054
shortedu	0.028	0.008	0.001	0.012	0.045
longedu	0.017	0.007	0.011	0.004	0.031
IncLow	0.029	0.010	0.003	0.010	0.048
IncHigh	0.019	0.006	0.002	0.007	0.031
beta					
female	0.990	0.037	0.000	0.919	1.062
male	1.001	0.031	0.000	0.940	1.061
younger	0.958	0.040	0.000	0.880	1.037
older	0.981	0.071	0.000	0.842	1.120
shortedu	0.993	0.036	0.000	0.922	1.065
longedu	0.985	0.028	0.000	0.929	1.040
IncLow	0.992	0.035	0.000	0.924	1.059
IncHigh	0.987	0.035	0.000	0.918	1.055

Note: Variable *female* indicates a female; *younger* is someone aged less than 40; *longedu* is someone who has substantial higher education (completion of medium-cycle or longer-cycle higher education); and *IncHigh* is someone with household income in 2009 of 500,000 kroner or more.

Appendix D: Econometric Specification

(INCLUDED IN ONLINE WORKING PAPER)

A. Estimating the Utility Function

Assume for the moment that utility of income M is defined by

$$U(M) = M^{(1-r)}/(1-r) \quad (1)$$

where M is the lottery prize and $r \neq 1$ is a parameter to be estimated. Thus r is the coefficient of constant relative risk aversion (CRRA): r=0 corresponds to risk neutrality, r<0 denotes risk loving, and r>0 denotes risk aversion. Let there be two possible outcomes in a lottery. Under EUT the probabilities for each monetary outcome M_j, $p(M_j)$, are those that are induced by the experimenter, so expected utility is simply the probability weighted utility of each outcome in each lottery i:

$$EU_i = [\ p(M_1) \times U(M_1)\ ] + [\ p(M_2) \times U(M_2)\ ] \quad (2)$$

The EU for each lottery pair is calculated for a candidate estimate of r, and the index

$$\nabla EU = EU_B - EU_A \quad (3)$$

calculated, where EU_A is option A and EU_B is option B as presented to subjects. This latent index, based on latent preferences, is then linked to observed choices using the cumulative logistic distribution function $\Lambda(\nabla EU)$. This "logit" function takes any argument between $\pm\infty$ and transforms it into a number between 0 and 1. The logit link function is:

$$\text{prob(choose lottery B)} = \Lambda(\nabla EU) \quad (4)$$

The index defined by (3) is linked to the observed choices by specifying that the B lottery is chosen when $\Lambda(\nabla EU) > \frac{1}{2}$, which is implied by (4).

Thus the likelihood of the observed responses, conditional on the EUT and CRRA specifications being true, depends on the estimates of r given the above statistical specification and the observed choices. The conditional log-likelihood is then

$$\ln L(r; y, \omega, \mathbf{X}) = \sum_i [\ (\ln \Lambda(\nabla EU) \times \mathbf{I}(y_i = 1)) + (\ln (1-\Lambda(\nabla EU)) \times \mathbf{I}(y_i = -1))\ ] \quad (5)$$

where $\mathbf{I}(\cdot)$ is the indicator function, y_i =1(-1) denotes the choice of the Option B (A) lottery in risk aversion task i, and $\mathbf{X}$ is a vector of treatments and individual characteristics. The parameter r is defined as a linear function of the characteristics in vector **X**.[25]

Extensions of the basic model are easy to implement, and this is the major attraction of the structural estimation approach. For example, one can easily extend the functional forms of utility to allow for varying degrees of relative risk aversion (RRA). Consider, as one important example, the Expo-Power (EP) utility function proposed by Saha [1993]. Following Holt and Laury [2002], the EP function is defined as

$$U(M) = [1-\exp(-\alpha M^{1-r})]/\alpha, \tag{1'}$$

where α and r are parameters to be estimated. RRA is then $r + \alpha(1-r)M^{1-r}$, so RRA varies with income if $\alpha \neq 0$. This function nests CRRA (as $\alpha \rightarrow 0$) and CARA (as $r \rightarrow 0$).

An important extension of the core model is to allow for subjects to make some errors. The notion of error is one that has already been encountered in the form of the statistical assumption that the probability of choosing a lottery is not 1 when the EU of that lottery exceeds the EU of the other lottery. This assumption is clear in the use of a link function between the latent index ∇EU and the probability of picking one or other lottery; in the case of the logistic CDF, this link function is $\Lambda(\nabla EU)$. If there were no errors from the perspective of EUT, this function would be a step function: zero for all values of $\nabla EU<0$, anywhere between 0 and 1 for $\nabla EU=0$, and 1 for all values of $\nabla EU>0$.

We also allow for "behavioral errors" using a specification originally due to Fechner and popularized by Hey and Orme [1994]. This behavioral error specification posits the latent index

$$\nabla EU = (EU_B - EU_A)/\mu \tag{3'}$$

[25] Harrison and Rutström [2008; Appendix F] review procedures that can be used to estimate structural models of this kind, as well as more complex non-EUT models. It is a simple matter to correct for stratified survey responses, multiple responses from the same subject ("clustering"), or heteroskedasticity, as needed.

instead of (3), where μ is a structural "noise parameter" used to allow some errors from the perspective of the deterministic EUT model. This is just one of several different types of error story that could be used, and Wilcox [2008] provides a masterful review of the implications of the alternatives.[26] As $\mu \rightarrow 0$ this specification collapses to the deterministic choice EUT model, where the choice is strictly determined by the EU of the two lotteries; but as μ gets larger and larger the choice essentially becomes random. When μ=1 this specification collapses to (3), where the probability of picking one lottery is given by the ratio of the EU of one lottery to the sum of the EU of both lotteries. Thus μ can be viewed as a parameter that flattens out the link functions as it gets larger.

An important contribution to the characterization of behavioral errors is the "contextual error" specification proposed by Wilcox [2011]. It is designed to allow robust inferences about the primitive "more stochastically risk averse than." It posits the latent index

$$\nabla EU = ((EU_B - EU_A)/\mathbf{V})/\mu \qquad (3'')$$

instead of (3′), where **V** is a new, normalizing term for each lottery pair A and B. The normalizing term **V** is defined as the maximum utility over all prizes in this lottery pair minus the minimum utility over all prizes in this lottery pair. The value of **V** varies, in principle, from lottery choice to lottery choice: hence it is said to be "contextual." For the Fechner specification, dividing by **V** ensures that the *normalized* EU difference $[(EU_B - EU_A)/\mathbf{V}]$ remains in the unit interval.

The likelihood of the risk aversion task responses, conditional on the EUT and CRRA specifications being true, depends on the estimates of r and μ. The conditional log-likelihood is

$$\ln L(r, \mu; y, \mathbf{X}) = \Sigma_i \left[(\ln \Lambda(\nabla EU)\times \mathbf{I}(y_i=1)) + (\ln (1-\Lambda(\nabla EU))\times \mathbf{I}(y_i=-1)) \right] \qquad (6)$$

where y_i =1(-1) denotes the choice of Option B (A) in risk aversion task i, and **X** is a vector of individual characteristics. The value of **V** depends on the data, and not on the estimated preference parameters r and μ.

B. Estimating the Discounting Function

Assume EUT holds for choices over risky alternatives and that discounting is exponential. A subject is indifferent between two income options M_t and $M_{t+\tau}$ if and only if

[26] Some specifications place the error at the final choice between one lottery or after the subject has decided which one has the higher expected utility; some place the error earlier, on the comparison of preferences leading to the choice; and some place the error even earlier, on the determination of the expected utility of each lottery.

$$(1/(1+\delta)^t)\, U(M_t) = (1/(1+\delta)^\tau)\, U(M_{t+\tau}) \tag{7}$$

where $U(M_t)$ is the utility of monetary outcome M_t for delivery at time t, δ is the discount rate, τ is the horizon for delivery of the later monetary outcome at time $t+\tau$, and the utility function U is separable and stationary over time. The left hand side of equation (7) is the discounted utility of receiving the monetary outcome M_t at time t, and the right hand side is the discounted utility of receiving the outcome $M_{t+\tau}$ at time $t+\tau$. Thus δ is the discount rate that equalizes the present value of the utility of the two monetary outcomes M_t and $M_{t+\tau}$.

We can write out the likelihood function for the choices that our subjects made and jointly estimate the risk parameter r in equation (1) and the discount rate parameter δ in (7). We use the same stochastic error specification as in (3$'$), albeit with a different Fechner error term υ for the discount choices. Instead of (3$'$) we have

$$\nabla PV = (PV_B - PV_A)/\eta, \tag{8}$$

where the discounted utility of Option A is given by

$$PV_A = (1/(1+\delta)^t)(M_A)^{(1-r)}/(1-r) \tag{9}$$

and the discounted utility of Option B is

$$PV_B = (1/(1+\delta)^{t+\tau})\, (M_B)^{(1-r)}/(1-r), \tag{10}$$

and M_A and M_B are the monetary amounts in the choice tasks presented to subjects. The parameter η captures noise for the discount rate choices, just as μ was a noise parameter for the risk aversion choices.[27] We assume here that the utility function is stable over time and is perceived *ex ante* to be stable over time.[28] We also assume that the parameter $r<1$, to ensure that $\delta>0$.

Thus the likelihood of the discount rate responses, conditional on the EUT, CRRA and exponential discounting specifications being true, depends on the estimates of r, δ, μ and η, given the assumed value of ω and the observed choices. The conditional log-likelihood is

---

[27] It is not obvious that $\mu=\eta$, since these are cognitively different tasks. Our own priors are that the risk aversion tasks are harder, since they involve four outcomes compared to two outcomes in the discount rate tasks, so we would expect $\mu>\eta$. Error structures are things one should always be agnostic about since they capture one's modeling ignorance, so we allow the error terms to differ between risk and discount rate tasks.

[28] Direct evidence for the former proposition is provided by Andersen, Harrison, Lau and Rutström [2008], who examine the temporal stability of risk attitudes in the Danish population. The second proposition is a more delicate matter: even if utility functions are stable over time, they may not be subjectively perceived to be, and that is what matters for use to assume that the same r that appears in (1) appears in (9) and (10). When there is no front end delay, this assumption is immediate for (9), but not otherwise. But whether or not individuals suffer from a "projection bias" is a deep matter,

$$\ln L(r, \delta, \mu, \eta; y, \omega, \mathbf{X}) = \Sigma_i [(\ln \Lambda(\nabla PV) \times \mathbf{I}(y_i=1)) + (\ln (1-\Lambda(\nabla PV)) \times \mathbf{I}(y_i=-1))] \quad (11)$$

where y_i =1(-1) again denotes the choice of Option B (A) in discount rate task i, and **X** is a vector of individual characteristics.

The joint likelihood of the risk aversion and discount rate responses is then

$$\ln L(r, \delta, \mu, \eta; y, \omega, \mathbf{X}) = \ln L^{RA} + \ln L^{DR} \quad (12)$$

where L^{RA} is defined by (6) and L^{DR} is defined by (11). This expression can then be maximized using standard numerical methods.

Nothing in this inferential procedure relied on the use of EUT, or the CRRA functional form. Nor did anything rely on the use of the exponential discounting function. These methods generalize immediately to alternative models of decision making under risk, and to alternative discounting functions. We illustrate both extensions below.

C. Estimating Subjective Optimism or Pessimism

---

demanding more research: see Ainslie [1992; p. 144-179, §6.3], Kirby and Guastello [2001] and Loewenstein, O'Donoghue and Rabin [2003].

We also provide estimates from a RDU model, to ascertain if entrepreneurs exhibit optimism or pessimism in comparison to the general population.[29] To calculate decision weights under RDU one replaces expected utility $EU_i = \sum_{k=1,K} [p_k \times u_k]$ with RDU

$$RDU_i = \sum_{k=1, K} [w_k \times u_k], \tag{13}$$

where

$$w_i = \omega(p_i + ... + p_n) - \omega(p_{i+1} + ... + p_n) \tag{14a}$$

for i=1,... , n-1, and

$$w_i = \omega(p_i) \tag{14b}$$

for i=n, the subscript indicates outcomes ranked from worst to best, and where $\omega(p)$ is some probability weighting function.

Picking the right probability weighting function is obviously important for RDU specifications. The simplest specification is the power function

$$\omega(p) = p^{\eta} \tag{15}$$

This probability weighting function is useful pedagogically, since values of $\eta>1$ imply pessimism with respect to lottery probabilities, and values of $\eta<1$ imply optimism. *Ceteris paribus* the utility function curvature, estimates of $\eta<1$ provide an additional psychological source for a positive risk premium (since better prizes are given lower decision weight than their objective probabilities, and poorer prizes are given higher decision weight). The "inverse-S" weighting function proposed by Tversky and Kahneman [1992] has also been widely employed. It is assumed to have well-behaved endpoints such that $\omega(0)=0$ and $\omega(1)=1$ and to imply weights

$$\omega(p) = p^{\gamma}/[p^{\gamma} + (1-p)^{\gamma}]^{1/\gamma} \tag{16}$$

[29] When we use the short-hand expression "general population" in comparison to entrepreneurs owning firms we actually mean the general population *other than* those entrepreneurs.

for $0<p<1$.[30] Finally, Prelec [1998] presents a two-parameter probability weighting function that includes (15) and (16) as special cases. This function is written as

$$\omega(p) = \exp\{-\eta(-\ln(p))^{\varphi}\} \tag{17}$$

and is defined for $0<p<1$, $\eta>0$ and $\varphi>0$. We generally use the flexible specification (17).

Additional References

Ainslie, George, *Picoeconomics* (New York: Cambridge University Press, 1992).

Andersen, Steffen, Harrison, Glenn W.; Lau, Morten I., and Rutström, E. Elisabet, "Lost in State Space: Are Preferences Stable?" *International Economic Review*, 49(3), 2008, 1091-1112.

Gonzalez, Richard, and Wu, George, "On the Shape of the Utility Function," *Cognitive Psychology*, 38, 1999, 129-166.

Harrison, Glenn W., and Rutström, E. Elisabet, "Risk Aversion in the Laboratory," in J.C. Cox and G.W. Harrison (eds.), *Risk Aversion in Experiments* (Bingley, UK: Emerald, Research in Experimental Economics, Volume 12, 2008).

Hey, John D., and Orme, Chris, "Investigating Generalizations of Expected Utility Theory Using Experimental Data," *Econometrica*, 62(6), November 1994, 1291-1326.

Kirby, Kris N., and Guastello, Barbarose, "Making Choices in Anticipation of Similar Future Choices Can Increase Self-Control," *Journal of Experimental Psychology: Applied*, 7(2), 2001, 154-164.

Loewenstein, George; O'Donoghue, Ted, and Rabin, Matthew, "Projection Bias in Predicting Future Utility," *Quarterly Journal of Economics*, 118(4), November 2003, 1209-1248.

Prelec, Drazen, "The Probability Weighting Function," *Econometrica*, 66, 1998, 497-527.

Tversky, Amos, and Kahneman, Daniel, "Advances in Prospect Theory: Cumulative Representations of Uncertainty," *Journal of Risk & Uncertainty*, 5, 1992, 297-323.

[30] The normal assumption in the empirical folklore, reviewed by Gonzalez and Wu [1999], is that $0<\gamma<1$. This gives the weighting function an "inverse S-shape," characterized by a concave section signifying the overweighting of small probabilities up to a crossover-point where $\omega(p)=p$, beyond which there is then a convex section signifying underweighting. Hence this specification with $\gamma<1$, implies, again *ceteris paribus* the curvature of the utility function, optimism or risk-loving with respect to small objective probabilities and pessimism or risk aversion with respect to larger objective probabilities. If $\gamma>1$ the function takes the less conventional "S-shape," with convexity for smaller probabilities and concavity for larger probabilities. Nothing in the *theory* of the RDU model, or the *theory* of the Prospect Theory model, requires $\gamma<1$.

Wilcox, Nathaniel T., "Stochastic Models for Binary Discrete Choice Under Risk: A Critical Primer and Econometric Comparison," in J. Cox and G.W. Harrison (eds.), *Risk Aversion in Experiments* (Bingley, UK: Emerald, Research in Experimental Economics, Volume 12, 2008).

Wilcox, Nathaniel T., "'Stochastically More Risk Averse:' A Contextual Theory of Stochastic Discrete Choice Under Risk," *Journal of Econometrics*, 162(1), May 2011, 89-104.

Appendix E. Literature Review on Entrepeneurship and Risk Taking

(INCLUDED IN ONLINE WORKING PAPER)

Schade [2005; p.417] provides a survey of experimental studies in entrepreneurship and lists 14 studies, only 2 of which actually use real entrepreneurs. Of the remaining 12 studies, students are the most common type of experimental subject; there are obvious doubts about the value of using students to generalize about real entrepreneurs, as correctly noted by Robinson, Hueffner and Hunt [1991]. Moreover, the studies discussed by Schade [2005] all use hypothetical surveys, and none of the tasks were incentivized in the sense that subjects earned more or less money depending on different choices. The use of real, controlled incentives has been a hallmark of experimental economics since Smith [1982] defined the "salience" and "dominance" precepts of an experimental micro-economy, and there is clear, direct evidence of bias from hypothetical studies of risk aversion (Holt and Laury [2002][2005] and Harrison [2006a]).[31]

Several studies have used experimental methods with real incentives to study the behavior of entrepreneurs in controlled laboratory settings. We have not come across any studies on entrepreneurship and individual discount rates, and focus here on experimental studies that elicit individual risk attitudes. These studies rely on three methods to elicit individual risk attitudes, reviewed by Harrison and Rutström [2008a]: the multiple price list design, the random lottery pair design, and the ordered lottery selection design.

[31] The studies reviewed by Schade [2005] are better described as using the so-called "questionnaire-experimental method," where different hypothetical survey questions are exogenously posed to subjects with some experimental design. Amiel and Cowell [1999] illustrate the method, and note that their "approach involves presenting individuals with questionnaires in a way that uses many of the features of experimental methodology" (p. 24). The use of hypothetical questionnaires also has a long tradition in psychology and environmental valuation: see Harrison [2006a][2006b], Harrison and Rutström [2008b] and Hertwig and Ortmann [2001] for surveys of experimental evidence on the biases introduced by eliciting hypothetical responses.

The most popular elicitation method of risk attitudes in studies of entrepreneurs is the multiple price list (MPL) design popularized by Holt and Laury [2002].[32] Subjects are presented with an array of binary choice tasks, ordered by the probability of the high prize, and asked to pick their preferred lottery in each decision task. The binary choice tasks are organized in an MPL, which typically contains 10 decision tasks. One decision task is then picked at random and the preferred lottery in the selected decision task is played out for actual payment. This elicitation method has been applied to study entrepreneurs by Elston, Harrison and Rutström [2005], Holm, Opper and Nee [2013] and Sandri, Schade, Musshoff and Odeling [2010].

One can analyze the data from this elicitation method in various ways. Elston, Harrison and Rutström [2005] use maximum likelihood estimation of an interval regression model with relative risk aversion as the dependent variable. The stakes in the lotteries vary between $1 and $38.50, and are equal to ten times the amounts used in the 1x treatment in Holt and Laury [2002]. The experiments took place at two conventions for small business entrepreneurs in Atlanta, Georgia and Omaha, Nebraska. Data is collected from 182 individuals, where 42 are classified as being full-time entrepreneurs, 38 are classified as part-time entrepreneurs, 92 are classified as salaried non-entrepreneurs, and 10 do not fit in any of those categories. They find that full-time entrepreneurs have significantly lower aversion to risk than part-time entrepreneurs and non-entrepreneurs, and that part-time entrepreneurs are not significantly different in terms of risk attitudes than non-entrepreneurs.

[32] Andersen, Harrison, Lau and Rutström [2006] examine the properties of the MPL procedure in detail, and the older literature using it. Harrison and Rutström [2008a] evaluate the strengths and weaknesses of alternative elicitation procedures for risk attitudes.

Holm, Opper and Nee [2013] and Sandri, Schade, Musshoff and Odeling [2010] are agnostic about parametric specifications of utility and probability weighting functions, and use the number of safe choices in the MPL as the dependent variable.[33] Holm, Opper and Nee [2013] use a randomly selected sample of entrepreneurs from local business registers in the Yangzi delta region in China. The sample contains 700 entrepreneurs who have been in business for at least three years and employ at least 10 salaried workers, and the control group consists of 200 individuals selected randomly from household registers in the same region. The stakes in the lotteries vary between 15 and 580 Chinese yuan, and are in the same range as the median daily income for the entrepreneurs in the sample. They find that entrepreneurs do not have significantly lower risk aversion than subjects in the control group: using data and statistical tests at the individual level, there is no significant difference in the average switch point in the MPL between the two groups. Sandri, Schade, Musshoff and Odeling [2010] find similar results using a sample of 15 founders of high-tech enterprises in Berlin-Adlershof and a control group of 84 students and non-students at Humboldt University. The stakes in the lotteries are not reported, and they do not find any significant difference in risk attitudes between entrepreneurs and the control group.

The random lottery pair design is used by List and Mason [2011] to infer risk attitudes of CEOs working in the coffee industry in Costa Rica. This design was used by Hey and Orme [1994] to estimate utility functionals for individuals under EUT and RDU, *inter alia*, and is a popular method for individual-level estimation since one can include a large number of binary choice tasks in the experimental design. List and Mason [2011] presented the subjects with 40 pairs of lotteries in which the stakes were losses[34] of \$80, \$30 or \$0 for a group of 29 CEOs and losses of \$8, \$3 or \$0 for a control group of 101 undergraduate students in Costa Rica. They estimate risk attitudes for each individual and find no evidence of a significant difference in risk attitudes between CEOs and students under the assumption of EUT. However, List and Mason [2011] find a statistically significant difference in behavior between CEOs and students when the EUT model is replaced by RDU. It is not clear in what way risk attitudes differ between CEOs and students, and the comparison of risk attitudes between the two groups could be facilitated by using structural estimation of utility and probability weighting functions. Hence, the evidence in List and Mason [2011] does not point to any significant differences in risk attitudes between CEOs and students under EUT, but they conclude that there may be some significant differences in risk attitudes under RDU.

[33] This dependent variable is correlated with risk premia, but does not allow one to say how much of any risk premia derives from diminishing marginal utility or probability pessimism.

[34] These were losses from earnings in an unrelated, prior experimental task.

Finally, Macko and Tyszka [2009] use an ordered lottery selection design developed by Binswanger [1980][1981]. Each subjects is presented with a choice of 6 lotteries and asked to select one. The payoffs to subjects in the decision tasks are lottery entry tickets to a local Polish lottery, so the incentives involved in these tasks are a compound lottery beyond the risk involved in the decision task with lottery tickets. They compare risk attitudes among three groups of students: (i) 42 students who did not express any intention of starting up a business, (ii) 44 students who had an intention of starting a business, and (iii) 40 students who had already started a business. Using integer values for the 6 lotteries in the decision task as the dependent variable, Macko and Tyszka [2009] do not find a statistically significant difference in risk attitudes between the three different student groups.[35]

The evidence from experimental designs thus far is mixed with respect to differences in risk attitudes between entrepreneurs and non-entrepreneurs.

Additional References

Amiel, Yoram, and Cowell, Frank A., *Thinking About Inequality* (New York: Cambridge University Press, 1999).

Andersen, Steffen; Harrison, Glenn W.; Lau, Morten I., and Rutström, E. Elisabet, "Elicitation Using Multiple Price Lists," *Experimental Economics*, 9(4), December 2006, 383-405.

Binswanger, Hans P., "Attitudes Toward Risk, Experimental Measurement in Rural India,"*American Journal of Agricultural Economics*, 62, August 1980, 395-407.

Binswanger, Hans P., "Attitude Toward Risk, Theoretical Implications of an Experiment in Rural India," *Economic Journal*, 91, December 1981, 867-890.

Harrison, Glenn W., "Hypothetical Bias Over Uncertain Outcomes," in J.A. List (ed)., *Using Experimental Methods in Environmental and Resource Economics* (Northampton, MA: Elgar, 2006a).

Harrison, Glenn W., "Experimental Evidence on Alternative Environmental Valuation Methods," *Environmental & Resource Economics*, 34(1), 2006b, 125-162.

Harrison, Glenn W., and Rutström, E. Elisabet, "Risk Aversion in the Laboratory," in J.C. Cox and G.W. Harrison (eds.), *Risk Aversion in Experiments* (Bingley, UK: Emerald, Research in Experimental Economics, Volume 12, 2008a).

[35] They assign integer values between 1 and 6 to the lottery chosen and report an F-test of the statistical hypothesis. It is not clear if this test uses an ordered logit model, an ordinary least squares model, or some other measure of association.

Harrison, Glenn W., and Rutström, E. Elisabet, "Experimental Evidence on the Existence of Hypothetical Bias in Value Elicitation Methods," in C.R. Plott and V.L. Smith (eds.), *Handbook of Experimental Economics Results* (North-Holland: Amsterdam, 2008b).

Hertwig, Ralph, and Ortmann, Andreas, "Experimental practices in economics: A challenge for psychologists?" *Behavioral & Brain Sciences*, 24, 2001, 383-451.

Hey, John D., and Orme, Chris, "Investigating Generalizations of Expected Utility Theory Using Experimental Data," *Econometrica*, 62(6), November 1994, 1291-1326.

Holt, Charles A., and Laury, Susan K., "Risk Aversion and Incentive Effects: New Data Without Order Effects," *American Economic Review*, 95(3), June 2005, 902-912.

Macko, Anna, and Tyszka, Tadeusz, "Entrepreneurship and Risk Taking," *Applied Psychology*, 58(3), 2009, 469-487.

Robinson, P. B.; Hueffner, J. C., and Hunt, K. H., "Entrepreneurial Research on Student Subjects Does Not Generalize to Real World Entrepreneurs," *Journal of Small Business Management*, 29(2), 1991, 42-50.

Sandri, Serena; Schade, Christian; Musshoff, Oliver, and Odening, Martin, "Holding on for too long? An experimental study on inertia in entrepreneurs' and non-entrepreneurs' disinvestment choices," *Journal of Economic Behavior & Organization*, 76(1), 2010, 30-44.

Schade, Christian, "Dynamics, Experimental Economics, and Entrepreneurship," *Journal of Technology Transfer*, 30(4), 2005, 409-431.

Smith, Vernon, "Microeconomic Systems as an Experimental Science," *American Economic Review*, 72(5), 1982, 923-55.