Gender Differences in Risk Aversion:

A Theory of When and Why

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Abstract

It has become well-accepted that women are more risk averse than men. This research investigates when gender differences in risk aversion are likely to occur and when they are less likely to manifest. We find that gender differences in risk aversion are likely to occur in decisions under *risk*, where the probability of outcomes is known and objectively quantified, such as games of chance, and less likely to occur in decisions under *uncertainty*, where one must rely on their own internal subjective expectancies of the probabilities of outcomes – the kind of decisions that dominate our day-to-day decision-making. We propose and test the mechanism that is responsible for producing gender differences in risk aversion: one's subjective expectancy of the outcome. In decisions under *risk*, when subjective expectancies are accounted for, the gender difference in risk aversion disappears; while in decisions under *uncertainty*, we do not observe any gender differences in risk aversion, but instead find one's subjective expectancies of the outcome to be the only reliable predicator of valuation.

Keywords: gender, sex differences, risk aversion, decision-making, expectancies

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There has been an abundance of research conducted during the last two decades related to gender[1] differences in risk aversion, mostly finding women to be more risk averse than men (Byrnes, Miller, & Schafer, 1999; Croson & Gneezy, 2009; Eckel & Grossman, 2002, 2008). So prevalent is the finding of women's greater risk aversion that further research has proposed mechanisms by which it operates: from avoidance of negative social consequences for non-conformance to stereotypes (Larkin & Pines, 2003), to "feeling more" (Croson & Gneezy, 2009), i.e. having stronger emotional reactions to losing (Eriksson & Simpson, 2010), to higher perceptions of negative outcomes and lower expectations of enjoyment for risk-taking (Harris, Jenkins, & Glaser, 2006). However, some research has not found any differences in risky decision making between the sexes (Carr & Steele, 2010; Demaree, DeDonno, Burns, Feldman, & Everhart, 2009; Fehr-Duda, De Gennaro, & Schubert, 2006; Schubert, Brown, Gysler, & Brachinger, 1999; Vlaev, Kusev, Stewart, Aldrovandi, & Chater, 2010). We propose that the inconsistent findings of prior research are due to contextual factors resulting from gender differences in risk aversion for decisions under *risk*, where outcome probabilities are specified and for decisions under *uncertainty*, where one must rely on one's own subjective expectancies to assess likelihood of outcomes.

We begin with the well-known distinction between decisions under *risk*, and those under *uncertainty*. Decisions under *risk* refer to making decisions in contexts where the probabilities of each outcome are known, for example the toss of a fair coin. In other words, the decision

[1] We use the terms gender and sex interchangeably. Although sex is usually defined as the biological distinction between male and female, and gender refers to social roles that one takes on (Rudman & Glick, 2008), the literature we are building on does not make the distinction between sex and gender. Additionally, some research has suggested that using either terms should be considered correct due to the lack of consensus about how sex and gender differ (Eagly, 2000).

context represents objective outcome probabilities, i.e. there is consensus about these probabilities. Decisions under *uncertainty* refer to decisions in which outcome probabilities are not exactly known, but are inferred by the decision maker based on *subjective expectancies*, which may be based on prior experience or any other relevant information source. Thus, decision makers may have different beliefs and therefore assign different probabilities to an event, e.g. the US winning the most gold medals in the 2012 Olympics. This distinction is important because it serves to separate decisions involving risk into two categories, one in which the decision maker should rely on external cues to optimize their outcomes (decisions under risk), and the other in which the decision maker *must* rely on internal assessments for outcome optimization (decisions under uncertainty).

In this research we suggest that decisions under uncertainty are less likely to lead to gender differences in risk aversion, but those involving risk, with known probability estimates, are more likely to produce gender differences in risk aversion. Our experiments examine situations in which the risk is either objective, where outcome expectancies are known, or the decision is uncertain, where outcome expectancies must be inferred from one's own knowledge. Consistent with current work in decision making, we label the subjective probability estimates or "subjective estimates of the likelihood of future events", as *expectancies* (Roese & Sherman, 2007). Additionally, we propose that it is these subjective expectancies that actually mediate, or account for, the gender differences that appear to be so robust in decisions under risk, i.e. men and women have different internal, subjective expectancies for winning objective probability games.

Following is an overview of the subjective expected utility model that has been widely accepted for evaluating decisions under risk and uncertainty.

Subjective Expected Utility Model

Under the subjective expected utility model, valuation of a bet depends on one's beliefs (probability) and tastes (utility). Consider a bet on an event, E, in which a participant receives $X if the event occurs; otherwise he or she receives nothing ($0). The subjective probability of the occurrence of event E is assessed to be p(E), and the participant provides his or her valuation of the bet, v(E). Rationally, p(E) lies between 0 and 1 and v(E) should lie between $0 and $X. If the participant is risk neutral, the relationship between p(E) and v(E) would be linear, as depicted in the graph below by the dashed line labeled "Risk Neutral". However, since research has documented the robustness of risk aversion, the relationship between p(E) and v(E) is expected to be non-linear as shown in Figure 1 by the lower curved line.

Insert Figure 1 about here

A widely accepted form for the utility function is the following power form (Keeney & Raiffa, 1976; Tversky & Kahneman, 1992):

$$\left[\frac{v(E)}{X}\right]^{\alpha}.$$

In this form, α is the curvature of the utility function. In Figure 1, α=1 corresponds to a risk neutral valuation, α<1 corresponds to a risk averse valuation, and α>1 corresponds to a risk seeking valuation.

In the expected utility model, utility of the valuation of the bet is equal to the expected utility of the bet:

$$\left[\frac{v(E)}{X}\right]^{\alpha} = p(E).$$

Taking the natural logarithm of both sides:

$$\alpha\ LN(v(E)/X) = LN(p(E)) \text{ or } LN(v(E)) = LN(X)+1/\alpha\ LN(p(E))$$

Alternatively, we can write:

$$LN(v) = b_0 + b\ LN(p) \textit{ or } LN(Valuation) = b_0 + b\ LN(Probability)$$

This basic model can be used to estimate the valuation of bets for a population.

A participant who believes that event E has a higher probability of occurrence than another participant should provide a higher valuation for the bet if their utility functions are similar. Therefore, a comparison of the valuations for bets contingent on real events must control for the participant's probability estimate (expectancy) of the event. ***A multiple regression model permits us to control for probability so we can isolate gender differences in valuation and therefore establish whether women are more risk averse than men.*** We use both a linear and non-linear multiple regression model throughout this manuscript. Following is the non-linear model:

$$LN(Valuation) = b_0 + b_1Sex + b_2LN(Probability)$$

In this Model both valuation and probability are normalized between 0 and 1, and sex is a dummy variable with Male=1, and Female=0. Therefore, if the coefficient $\mathbf{b_1}$ is positive and statistically significant, one can assert that on average men have a higher valuation of the bet than women, (after controlling for subjective expectancies), and can be deemed less risk averse. We also use a linear model.

$$Valuation = b_0 + b_1Sex + b_2Probability$$

Since our participants differ in age and education, both of which may influence risky decisions, we include controls for these two variables. Additionally, in some experiments, we measure the knowledge a participant has with the domain (on a 5-point Likert scale) and vary the domain and conditions of the risky prospect, which are dummy coded variables. If these

variables were relevant in the experiment, we included controls for them as well. Therefore for each experiment we provide full regression models with these controls included.

Non-Linear Model

$$\mathbf{LN(Valuation) = b_0 + b_1Sex + b_2LN(Probability) + b_3Age + b_4Education + b_5Knowledge + b_6Domain1 + b_7Domain2 + \ldots}$$

Linear Model

$$\mathbf{Valuation = b_0 + b_1Sex + b_2Probability + b_3Age + b_4Education + b_5Knowledge + b_6Domain1 + b_7Domain2 + \ldots}$$

In each of the above models, our focus is on the sign and statistical significance of $\mathbf{b_1}$. If $\mathbf{b_1}$ is statistically significant then one can establish that on average:

Non-Linear Model

$$\frac{\textbf{Valuation of Men}}{\textbf{Valuation of Women}} = \mathbf{Exp(b_1)}.$$

Linear Model

$$\mathbf{Valuation\ of\ Men - Valuation\ of\ Women = b_1}.$$

Study 1: Games of Chance

In the first study we sought to replicate prior research to ensure that the gender differences in risk aversion replicated with the traditional economic method of measuring risk aversion: valuation of gambles in which the probability of the outcome is provided. Again, recent research is robust with findings in economics of gender differences in risk aversion: see Croson and Gneezy (2009) for an overview. For this experiment, we adapted the methodology employed from prior research (Chow & Sarin, 2001), and examined various levels of outcome probability.

Method

Design and Procedure

One hundred and six participants were recruited and paid through M-Turk and the study was run online. Five participants were excluded from the analysis because their responses came from IP addresses that had already responded to the survey, and there was no way to ensure that these participants did not take the survey twice. The final sample includes 101 participants: 57 women and 44 men. Several recent studies have verified the advantages and appropriateness of the M-Turk subject population for conducting experimental research related to judgment and decision making (Eriksson & Simpson, 2010; Paolacci, Chandler, & Ipeirotis, 2010) finding it to be superior to university subject pools.

Participants first completed a consent form and then were given brief instructions that stated, "*We are interested in your judgments. There is no right answer. Please take your time and think about each question carefully, and then answer the questions that follow to the best of your ability.*" Then participants were asked to provide price estimates for three questions adapted from prior research (Chow & Sarin, 2001) on a scale of $0 to $100. The first question was exactly like the question presented below, and the other two were similar, but provided for ascending probabilities of 50% white balls, then 66% white balls.

Imagine that there is a bag filled with exactly 10 white balls and 20 yellow balls. You get to select a single ball from the bag without looking. If the ball you draw is white you win $100; if it's yellow, you get nothing.

Bag Ball Distribution
10 white balls
20 yellow balls
30 total balls

What is the ***most*** *you would pay to play this game?*

After participants had completed the three valuation questions, they were asked to provide demographic information including gender, age, and education. Finally, participants were thanked and given a code to enter into the M-Turk system.

Results and Discussion

This study effectively replicates prior work that finds that women are more risk averse than men. Again, what we tested in this experiment were objective probability gambles, and the findings indicated that for this type of decision, women are behaving in a more risk averse manner than men, at each given level of objective probability.

Variables representing the natural log were created for two variables: the amount the participant was willing to accept for the ticket, scaled between 0 and 1, by dividing the amount the participant indicated by 100; and the probability variable scaled between 0 and 1. In this study, the natural log was calculated for the variables of interest: likelihood of outcome and participant valuation (price). Additionally, for all the studies included in this manuscript the education variable is dummy coded as either less than a four year college degree (0), or a four year college degree or higher (1). As expected, women and men showed significant differences in risk aversion for the three questions asked: Question 1 with a probability of 1/3, M_{women}=10.05, M_{men}=20.64, p<.001; Question 2 with a probability of ½, M_{women}=15.46, M_{men}=29.66, p<.001; and Question 3 with a probability of 2/3, M_{women}=20.82, M_{men}=43.77, p<.001. In fact, we can see that the effect of male gender effectively doubles the willingness to pay to play these games of chance. This effect is significant even when controlling for the stated probability of the gamble, participants' age and education (see Table 1). In the non-linear regression, the coefficient of the sex variable (Male=1) is .80 which means that on average men pay exp(.8) or 2.2 times the amount women pay for these objective probability gambles (games

of chance). In the linear regression, the coefficient of the sex variable (Male=1) is 16.43, which means that on average men pay $16.43 more than women pay for the same gambles. Both models confirm that for these gambles, under conditions of risk, women are showing greater risk aversion than men.

Insert Table 1 about here

Study 2: Mediation of Subjective Expectancies in Decisions with Risk

We can see from the first experiment that when probabilities are objective, or provided to the participant, we do find gender differences in risk aversion. We hypothesized that perhaps in decisions under risk, where probabilities are objective and known to participants, women and men may have different subjective expectancies of these objective risks[2]. Therefore, we sought to create a situation where participants could provide a valuation to a risky gamble, and measure their subjective assessment of likelihood of winning to determine if one's subjective expectancies mediate behaviors in objective probability gambles.

Method

Design and Procedure

One hundred and twenty-one participants were recruited and paid through Amazon's Mechanical Turk (M-Turk) and the study was administered online. Two participants were excluded from the study because their IP address was a repeat, and we wanted to eliminate the possibility that multiple responses from the same participant were included in the final sample. Another three participants were excluded because they took longer than 3 standard deviations above the mean in terms of time spent of the survey, (there were no participants who spent less

[2] We thank Wendy Wood, USC Provost Professor of Psychology and Business for suggesting this mechanism.

than 3 standard deviations below the mean in time taken to complete the survey). The final sample included 116 participants (62 women, 54 men).[3] Participants answered some unrelated questions along with the question of interest, which was a decision under risk, how much they would pay to play a game involving a 50% probability of winning by drawing a ball from an urn. For the 50-50 gamble, we also measured participants' subjective likelihood of winning by asking the following question at the end of survey, *"On the scale below, please indicate how likely you believe you are to win the Urn gamble."* Participants then indicated on a sliding scale which of the following options expressed their beliefs as to the degree to which they believed they would win the gamble, *Almost Impossible, Unlikely, Possible, Toss-Up, Good Chance, Probable, Almost Certain*. This measure was adapted from prior research related to the terminology used to express probability expectations (Wallsten, Budescu, Rapoport, Zwick, & Forsyth, 1986). Participants did not see any values, but instead saw the words listed to describe how likely they felt the event would be, however the scale recorded a value for the participant's response depending of the location of the sliding bar, from 0 to 10. "*Toss up"* was in the exact middle of the scale which was recorded by the survey program as a response of 5 on the scale, indicating a 50% likelihood of winning. Finally, participants were asked to provide some demographic information, then thanked and given a code to enter into M-Turk.

Results and Discussion

We hypothesized that subjective expectancies would mediate the gender difference in objective probability gambles (decisions under risk). To test this hypothesis we followed the directions outlined by Baron and Kenny (1986), which stipulates the steps for mediation testing.

[3] Participants were randomly assigned to one of two conditions. Condition 1 was identical to one used in study 1. In condition 2 there was an extra sentence in the instructions: "*Your responses will be evaluated by our research team against other same sex participants, and the results of the choices provided may be disclosed on a decision making research website."* There were no statistical differences in the results between the two conditions; therefore the two conditions are collapsed for the remaining analyses.

We used the linear model for testing mediation. First, we confirmed that there was a gender difference in the valuation of the urn gamble, $b = 7.15$, $t(112) = 2.14$, $p = .035$. Next, we established the relationship between the independent variable, participant sex, and the proposed mediator, subjective expectancies, $b = .80$, $t(111) = 2.61$, $p = .010$. Finally, we included both participant sex, the independent variable, and subjective expectancies, the proposed mediator in the regression to find that the effect of participant sex on the dependent variable was no longer significant $b = 5.29$, $t(111) = 1.54$, $p = .127$; while the mediator remained highly significant, $b = 2.57$, $t(111) = 2.48$, $p = .015$. A Sobel test confirmed that subjective expectancies fully mediates the effect of participant gender on risk aversion ($z = 1.95$, $p = .05$).

Insert Figure 2 about here

Next, we investigated if these differences in subjective expectancies were driven by men perceiving a higher likelihood of winning than the objective probability would suggest (50%), or women perceiving a lower likelihood of winning than the stated probability, or if both effects were present concurrently. Although women's subjective expectancies were slightly below the expected value of 5, indicating 50% probability (labeled "toss-up"), ($M_{\text{Women}}=4.85$), a t-test confirmed that this value was not significantly different from the expected value, $t(58) = -.73$, $p = .47$. On the contrary, men's subjective expectancy of the likelihood of winning ($M_{\text{Men}}=5.65$) was significantly higher than the mean scale value indicating the gamble was a *toss-up*, and closer to the *good chance* scale label, $t(53) = 2.91$, $p < .01$, indicating slight optimism in men. This result is not surprising in light of the prior research which has found evidence of men's overconfidence (Barber & Odean, 2001; Bengtsson, Persson, & Willenhag, 2005; Klayman, Soll, Gonzalez-Vallejo, & Barlas, 1999). It seems that men's optimism is contributing to a higher

gamble valuation as compared to women's, whose subjective expectancies are in line with the objective probabilities.

In summary, it appears that in games of chance men have more optimistic expectations of winning than women, and therefore are willing to pay more to play the game. This finding is consistent with the well accepted subjective utility model for decisions involving risk, because even for an objective probability gamble, e.g. toss of a fair coin, if people have different expectancies, then they should provide different valuations. This result implies that gender differences in risk valuation are non-existent when participants rely on their subjective expectancies when assessing valuations. Therefore, we hypothesized that decisions under uncertainty, where one must rely on one's subjective expectancies, would not produce gender differences in risk aversion. We tested this hypothesis in studies 3, 4 and 5.

Study 3: Golden Globe and NFL Playoffs: Willingness to Accept

In this study, we explored decisions under uncertainty to determine if gender differences held for real events when valuations are based on one's subjective expectancies of outcomes, rather than on objective probabilities.

Method

Design and Procedure

One hundred and eighty-five participants (98 women; 87 men) were recruited and paid through Amazon's Mechanical Turk (M-Turk) and the survey was run online. Participants first completed a consent form and then were randomly assigned either a block of four questions related to the upcoming 2011 Golden Globe awards, or the upcoming NFL playoffs. When the first block of questions was complete, the second block of questions was administered. The questions about the Golden Globe awards asked participants to select the option that they thought

would win the award from the list of nominees for each of the following categories: best motion picture, best director, best actor and best actress. The questions related to the NFL playoff games asked participants to select which team would win each of the four upcoming NFL playoff games: Seattle vs. Chicago, Baltimore vs. Pittsburgh, New York vs. New England, or Green Bay vs. Atlanta. Each prediction task was followed by a question asking the participants to imagine they had a ticket that would pay them $10 if the option they selected won (and nothing otherwise), and to indicate the minimum price they would be *willing to sell* the ticket for (indicated on a sliding scale of $0 to $10). Next, participants were asked to indicate on a scale of 0 to100% how confident they were that the option they selected would win (expectancy measure or p(E)) (Roese & Sherman, 2007). After completing this question, participants were asked to indicate, on a five point Likert scale, how knowledgeable they were for each topic (movies, directors, actors and actresses nominated, and the teams playing in that particular NFL playoff game). Finally, participants were asked to report their gender, age and education, thanked and given a code to enter into M-Turk.

Results and Discussion

For the non-linear model, variables representing the natural log were created for two variables: the amount the participant was willing to accept to sell the ticket, scaled between 0 and 1, by dividing the amount the participant indicated by 10; and the expectancy variable (probability or subjective likelihood) scaled between 0 and 1, by dividing the value indicated by 100. For the linear model the valuation was unaltered and ranged from $0 to $10. Initially, each bet was dummy coded, however there were no statistical differences in bet valuation between any of the movies, or any of the NFL games. Therefore we dummy coded whether the gamble was related to a Golden Globe movie award (1), or an NFL game (0), for simplicity in

interpreting the results. Additionally, as in all other regressions herein, participant education is dummy coded as a 4 year college degree or higher (1), or less than a four year college degree (0).

Insert Table 2 about here

We can see from the regression results in Table 2 that, as expected, the coefficient of the variable representing the participants' gender is not statistically significant in either the non-linear or the linear model. All the questions in this experiment were decisions under uncertainty, where the participant must rely on his or her own subjective expectancies, prior experience or knowledge to select the most probable winner, and value a bet of their selection actually winning. In these circumstances we find no evidence of any effect of gender, although interestingly we find that several other control variables are significant. The regressions provide evidence that what matters most to ticket valuation (risk aversion), carrying the highest $\boldsymbol{\beta}$ weight in both the linear and non-linear models, is one's own subjective estimate of the likelihood of winning, or expectancy, consistent with the subjective expected utility model. Additionally, although domain knowledge and age also significantly predict how much one is willing to accept to sell a ticket, their effects are very small. Education does seem to matter to ticket valuation, such that if one has a least a four-year college education, he or she is on average paying 50 cents less. Finally, in this sample it seems that participants were willing to bet more on movies than NFL games. Although we do not know for sure why that is, we speculate that participants may feel more competent about their ability to predict movie award winners than NFL playoff winners.

Study 4: Certainty Equivalent and Selling Price: Baseball and Reality TV

Because of the robust, well accepted finding that women are more risk averse than men, we sought to replicate the results of the prior experiment in another context, with a different value elicitation method – but still frame the decision as one involving uncertainty instead of risk. Prior literature has found that different value elicitation methods may result in different valuations (Simonsohn, 2009). We designed this follow-up study to explore whether the certainty equivalent method and the willingness to accept (e.g. selling price) method would yield gender differences in valuation when one must rely on internal subjective expectancies to determine valuation.

Method

Design and Procedure

Two hundred and ten participants were recruited and paid through M-Turk, and again, the study was run online. Four participants were excluded from the analysis because they responded to the survey from an IP address that had already responded and there was no way to ensure that the same participant did not take the survey twice under a separate M-Turk account. The final sample included 206 participants (103 women; 103 men). Participants first completed a consent form and then answered questions about baseball and reality TV; it was randomly determined for each participant whether they answered the questions about baseball or reality TV first. In this study, two different value elicitation methods were employed and randomly assigned for each domain (e.g. baseball or TV shows): certainty equivalence (CE) and selling price (SP). For each domain, there were four questions: the first question asked participants to predict a future outcome of an event (see details below), the second question was the value elicitation question of a gamble related to their prediction, the third question asked participants to indicate their

confidence that their prediction was correct (expectancy), and the final question asked about their knowledge of the domain of the event.

We included event prediction questions for an upcoming baseball game, and Nielsen ratings for primetime TV shows. The baseball question was worded as follows: "*On Thursday, April 21, the Atlanta Braves will be playing against the LA Dodgers. Which team do you expect to win the baseball game?"* Participants then chose between the two teams. The primetime TV show question was worded as follows: "*Which of the following two primetime TV shows do you expect to have a larger audience for the upcoming week (as measured by Nielsen Ratings)?"* Participants then chose between Dancing with the Stars or American Idol (Weds).

For each prediction task the participant was randomly assigned either a certainty equivalent or willingness to accept (e.g. selling price) question that elicited the value of a ticket (on a sliding scale of $0 to $100) that would pay $100 if the prediction was correct (and nothing otherwise). The certainty equivalent question was worded as follows, *"Please indicate below the amount of money that would be of equal value to you as the ticket so that you would be indifferent between receiving that amount of money or receiving the ticket"* (Hershey & Schoemaker, 1985). The selling price question was worded as follows, *"What is the minimum amount of money you would sell the ticket for?"* Participants were then asked to provide demographic information including gender, age and education, thanked for their participation and given a code to enter into M-Turk.

Results and Discussion

For the non-linear model, valuations and expectancies were scaled between 0 and 1; but for the linear model valuations were unaltered and ranged from $0 to $100, or 0 to 100% for expectancy. A dummy code was created to indicate the domain (TV Shows =1, Baseball = 0).

Again, participants answered both blocks of questions: those related to their predictions of the baseball game *and* the Nielsen ratings of TV shows. However, for each of these question topics, the value elicitation method was randomized to either solicit a selling price *or* certainty equivalence valuation. In contrast to some prior research, we did not find any significant differences in the valuations obtained between the two elicitation methods employed (Baseball: M_{SP}= 49.94, M_{CE}= 49.81, p=.97; TV Shows: M_{SP}= 57.18, M_{CE}= 57.71, p=.88). Table 3 shows the regression results by valuation elicitation method.

Insert Table 3 about here

Again, we found no evidence that men and women are valuing outcomes differently in these decisions under uncertainty using either the linear or non-linear model. Again, we can see that what matters to valuing decisions under uncertainty is one's own subjective expectancies of the likelihood of outcomes. Although participant age is a significant predictor for the selling price elicitation method, its effect is tiny. The results of this study replicate those of Study 3, and illustrate that the findings are robust across valuation elicitation methods: no gender differences in risk aversion for decisions under uncertainty.

Study 5: Real Incentives: Certainty Equivalent

Finally, to address a potential critique of our work, we sought to replicate the results when participants had real economic incentives for providing true valuations, even though research has found that participant responses are consistent across decisions for hypothetical gambles and those for real payoffs (Kuhberger, Schulte-Mecklenbeck, & Perner, 2002). Therefore, for this study we randomly selected some participants to play the gambles according to their preference. We provided yet another context for valuations under uncertainty, where

one's subjective expectancies dominate the valuation – and this time the experiment was conducted in person, at a large West Coast University.

Method

Design and Procedure

Participants were recruited from the main walkway of a major west coast university two days before a Division 1 collegiate baseball game between that university's team and its closest rival in the league. Passerby's were asked to participate in a short survey in exchange for their choice of cookie, candy bar, bag of nuts, or fruit and a chance to be randomly selected to play the game on the survey for cash value rewards. Sixty-four people participated: 33 women and 31 men. Participants were handed a two-part lottery ticket along with the questionnaire and asked to provide their name and contact information on one part of the ticket and return it to the experimenter. They were told that some participants would be randomly selected to actually play the game according to the choices indicated on their survey. Four participants were randomly selected to play their gambles and the average compensation per participant selected was $10.25 paid via Amazon gift e-mail.

The survey asked participants to provide their first name, gender, age, and education level. A consent paragraph was included in the survey and the survey indicated that the UCLA baseball team would be playing against Arizona State in two days, and asked participants to indicate who they thought would win the game. Next, the survey indicated that, "*You are being offered a ticket to play a game that pays you $20 if the team you selected (Arizona St or UCLA) wins the game (and pays nothing if they lose)*", and it asked, *"What is this ticket worth to you?"* Participants were presented with 19 choices; for each choice they indicated if they would prefer a sure sum of money or to play the game (take the gamble). The sure sum of money varied from

$19 to $1 in decrements of $1. Thus, the first choice was $19 or the gamble, the second choice was $18 or the gamble, and so on, ending with the last (19th) choice which was $1 or the gamble. The following information was provided: "**Note:** ***Some participants will be selected to play for real money.*** *If you are selected to play, then one of your choices will be selected at random and you would receive either the amount of money indicated or play the game according to your preference indicated. It is in your best interest to represent your preferences correctly."* Participants were then asked to indicate (as a %) how confident they were that the team they selected would actually win (expectancy measure) and how often they watch college baseball games.

Results and Discussion

For the non-linear model, the dependent variable is the natural log of the certainty equivalent valuation provided by the participant. The certainty equivalent is inferred from the crossover point in the valuation choices. The regression results are shown in Table 4. The coefficient for the dummy variable sex is insignificant in both the linear and non-linear models; implying that there are no gender differences in valuation when real incentives and a choice-based procedure is used to elicit valuations. Again we find that men and women are not exhibiting systematic differences in decisions under conditions of uncertainty.

Insert Table 4 about here

SUMMARY

It is generally accepted that women are more risk averse than men (Croson & Gneezy, 2009), and that these differences cut across domains (Byrnes et al., 1999). In this research we analyze decisions under risk, when the probability of outcomes is known, and under uncertainty,

when one must rely on one's own internal guidance systems to estimate subjective probabilities of the events. In several experiments using established economic measures for eliciting risk preferences, we identify the conditions under which gender differences in risk aversion are more likely to manifest (decisions involving risk) and when they are less likely to manifest (decisions under uncertainty). We used alternative value elicitation methods (willingness to pay, selling price, and certainty equivalent) to ensure the robustness of the results. Prior research related to gender differences in risk aversion has failed to differentiate between objective probability gambles (risk) and how risk aversion operates in "real world" settings via subjective assessments, or *expectancies* of the outcomes. Objective probability gambles have become the standard for measuring and quantifying risk attitudes in economics (Holt & Laury, 2002), and is perhaps the reason why the findings of gender differences in risk aversion have not always been replicated in other behavioral domains. For example, several studies related to financial decision making do not find gender differences in risk tolerance (Demaree et al., 2009; Fehr-Duda et al., 2006; Schubert et al., 1999; Vlaev et al., 2010), which at first glance appears inconsistent with the research in economics that consistently finds robust gender differences in decisions with risk. However, studies involving financial decisions represent a domain in which decisions are made under conditions of uncertainty, a framework which slightly differs from the traditional economic method of measuring risk aversion.

We also identify the key mechanism that produces gender differences in risk aversion (in objective probability gambles): differences in subjective expectancies. We find that gender differences in subjective expectancies of outcomes, in decisions under risk, mediate the different valuations men and women have for the same gamble. Our findings suggest that men pay more than women for the same objective probability gamble because men have higher subjective

expectancies of positive outcomes than justified by the objective probabilities in decisions involving risk – an effect which partially mitigates their risk premium. When subjective expectancies are accounted for the differential risk aversion between men and women disappears in decisions under risk.

The main contribution of this work is that we refute the simplistic commonly held assumption that women are more risk averse than men. We do find a large and statistically significant gender difference in games of chance. Men pay more than women for the same gamble, and make up the vast majority of professional gamblers. However, these kinds of gambles represent only one specific kind of decision, in which the outcome probabilities are known. The vast majority of decisions we face on a day-to-day basis are those where the probability of the outcomes is unknown, i.e. decisions under uncertainty. In three studies we examine gender differences in risk aversion in decisions involving uncertainty, when the participant must rely on their own internal subjective expectancies. We find no evidence of gender differences in risk aversion in decisions under uncertainty.

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TABLES

Table 1: Regression Results for Study 1: Valuation of Games of Chance

	Non-Linear		Linear	
Variable	***β***	***SE***	***β***	***SE***
Constant	.77***	.20	.42	4.56
Sex (Male=1)	***.80*** ***	***.10***	***16.43*** ***	***1.93***
Probability	1.19***	.17	48.92***	7.02
Age	-0.02***	.00	-0.37***	.08
Education	.17	.10	4.68*	1.95
Adjusted R^2	.33		.33	
F	35.44***		35.76***	
N	291		300	

* p < .05; ** p < .01; *** p < .001

Table 2: Regression Results for Study 3: Golden Globe Awards and NFL Playoffs

	Non-Linear		Linear	
Variable	***β***	***SE***	***β***	***SE***
Constant	-.62***	.07	.18	.34
Sex (Male=1)	***-.05***	***.03***	***-.10***	***.13***
Expectancies	.75***	.05	7.48***	.40
Domain Knowledge	.05***	.01	.08	.06
Age	.01***	.00	.02***	.01
Education Dummy	-.10***	.03	-.50***	.13
Domain Dumm (Movies =1)	.14***	.03	.62***	.14
Adjusted R^2	.30		.33	
F	95.16***		109.97***	
N	1305		1309	

* p < .05; ** p < .01; *** p < .001

Table 3: Regression Results for Study 4: Certainty Equivalent (CE) & Selling Price (SP)

	Certainty Equivalent				Selling Price			
	Non-Linear		Linear		Non-Linear		Linear	
Variable	***β***	***SE***	***β***	***SE***	***β***	***SE***	***β***	***SE***
Constant	-.37	.27	16.46	12.26	-.02	.22	19.65*	9.30
Sex (Male=1)	***-.07***	***.09***	***-1.63***	***3.51***	***-.06***	***.08***	***-.81***	***2.86***
Expectancies	.83**	***.31***	53.55***	16.16	.92***	.24	65.17***	11.62
Age	-.01	***.00***	-.14	.14	-.01*	.00	-.29*	.13
Education Dummy	.06	.10	3.85	3.59	.12	.08	4.22	2.93
Domain (Baseball=1)	.04	.11	.81	3.96	-.10	.09	-1.71	3.01
Domain Knowledge	.02	.05	.78	1.98	-.02	.04	-.98	1.43
Adjusted R^2	.07		.10		.13		.20	
F	3.75***		4.91***		5.84***		8.89***	
N	206				195			

* p < .05; ** p < .01; *** p < .001

Table 4: Regression Results for Study 5 using Real Incentives: Certainty Equivalent

	Non-Linear		Linear	
Variable	***β***	***SE***	***β***	***SE***
Constant	-.45	.32	.92	2.14
Sex (Male=1)	***.10***	***.15***	***.85***	***.96***
Expectancies	.94**	.30	13.22***	2.98
Domain Knowledge	.02	.09	.03	.59
Age	.00	.01	-.01	.06
Education Dummy	.05	.17	.96	1.12
Adjusted R2	.12		.24	
F	2.67*		5.01***	
N	64			

* p < .05; ** p < .01; *** p < .001