CHAPTER 3

WHAT DO WE THINK ABOUT RISK?

In chapter 2, we presented the ways in which economists go about measuring risk aversion and the consequences for investment and business decisions. In this chapter, we pull together the evidence that has accumulated on how individuals perceive risk, by first looking at experimental and survey studies that have focused on risk aversion in the population, and then turn our attention to what we can learn about risk aversion by looking at how risky assets are priced. Finally, the explosion of game shows that require contestants to make choices between monetary prizes has also given rise to some research on the area.

In the process of looking at the evidence on risk aversion, we examine some of the quirks that have been observed in how human beings react to risk, a topic we introduced in chapter 2 in the context of prospect theory. Much of this work falls under the rubric of behavioral finance but there are serious economic consequences and they may be the basis for some well known and hard to explain market anomalies.

General Principles

Before we look at the empirical evidence that has accumulated on how we react to risk, we should summarize what the theory posits about risk aversion in human beings. Most economic theory has been built on the propositions that individuals are risk averse and rational. The notion of diminishing marginal utility, introduced by Bernoulli, still lies at the heart of much of economic discussion. While we may accept the arguments of these economists on faith, the reality is much more complex. As Kahneman and Tversky noted in their alternative view of the world, there are systematic anomalies in human behavior that are incompatible with rationality. We can act as if these aberrations are not widespread and will disappear, but the dangers of doing so are significant. We will both misprice and mismanage risk, if we do not understand how humans really perceive risk.

In this chapter, we will turn away from theoretical measures of risk aversion and arguments for rationality and look at the empirical evidence on risk aversion. In the process, we can determine for ourselves how much of the conventional economic view of

risk can be salvaged and whether the "behavioral" view of risk should replace it or supplement it in analysis.

Evidence on Risk Aversion

In chapter 2, we presented the Arrow-Pratt measure of risk aversion, an elegant formulation that requires only two inputs – the first and the second derivatives of the utility function (relative to wealth, income or consumption) of an individual. The fatal flaw in using it to measure risk aversion is that it requires to specify the utility function for wealth, a very difficult exercise. As a consequence, economists have struggled with how to give form to these unobservable utility functions and have come up with three general approaches – experimental studies, where they offer individuals simple gambles, and observe how they react to changes in control variables, surveys of investors and consumers that seek to flesh out perspectives on risk, and observations of market prices for risky assets, which offer a window into the price that investors charge for risk.

Experimental Studies

Bernoulli's prospective gamble with coin flips, which we used to introduce utility theory in the last chapter, can be considered to be the first significant experimental study, though there were others that undoubtedly preceded it. However, experimental economics as an area is of relatively recent origin and has developed primarily in the last few decades. In experimental economics, we bring the laboratory tools of the physical sciences to economics. By designing simple experiments with subjects in controlled settings, we can vary one or more variables and record the effects on behavior, thus avoiding the common problems of full-fledged empirical studies, where there are too many other factors that need to be controlled.

Experimental Design

In a treatise of experimental economics, Roth presents two ways in which an economic experiment can be designed and run. In the first, which he calls the method of planned experimental design, investigators run trials with a fixed set of conditions, and the design specifies which conditions will be varied under what settings. The results of

the trials are used to fill in the cells of the experimental design, and then analyzed to test hypotheses. This is generally the standard when testing in physical science and can be illustrated using a simple example of a test for a new drug to treat arthritis. The subjects are divided randomly into two groups, with one group being given the new drug and the other a placebo. The differences between the two groups are noted and attributed to the drug; breaking down into sub-groups based upon age may allow researchers to draw extended conclusions about whether the drug is more effective with older or younger patients. Once the experiment is designed, the experimenter is allowed little discretion on judgment and the results from all trials usually are reported. In the second, which he calls the method of <u>independent trials</u>, each trial is viewed as a separate experiment and the researcher reports the aggregate or average results across multiple trials.[1] Here, there is more potential for discretion and misuse since researchers determine which trials to report and in what form, a choice that may be affected by prior biases brought into the analyses. Most experiments in economics fall into this category, and are thus susceptible to its weaknesses.

As experimental economics has developed as a discipline, more and more of conventional economic theory has been put to the test with experiments and the experiments have become more complex and sophisticated. While we have learned much about human behavior from these experiments, questions have also arisen about how the proper design of and reporting on experiments. We can learn from how the physical sciences, where experiments have a much longer tradition, have dealt with a number of issues relating to experiments:

- <u>Data mining and reporting</u>: The National Academy of Science's committee on the Conduct of Science explicitly categorizes as fraud the practice of "selecting only those data that support a hypothesis and concealing the rest". Consequently, researchers are encouraged to make the raw data that they use in their work available to others, so that their findings can be replicated.

- <u>Researcher Biases and Preconceptions</u>: The biases that researchers bring into a study can play a key role in how they read the data. It is for this reason that experimental

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[1] Roth, A.E. 1994, Let's Keep the Con Out of Experimental Econ: A Methodological Note, **Empirical Economics** (Special Issue on Experimental Economics), 1994, 19, 279-289.

methods in the physical sciences try to shield the data from the subjective judgments of researchers (by using double blind trials, for example).

• Theory Disproved or Failed Experiment: A question that every experimental researcher faces when reporting on an experiment that fails to support an existing theory (especially when the theory is considered to be beyond questioning) is whether to view the contradictory information from the experiment as useful information and report it to other readers or to consider the experiment a failure. If it is the latter, the tendency will be to recalibrate the experiment until the theory is proved correct.

As we draw more and more on the findings in experimental economics, we should also bring a healthy dose of skepticism to the discussion. As with all empirical work, we have to make our own judgments on which researchers we trust more and how much we want to read into their findings.

Experimental Findings

Experimental studies on risk aversion have spanned the spectrum from testing whether human beings are risk averse, and if so, how much, to differences in risk aversion across different subgroups categorized by sex, age and income. The findings from these studies can be categorized as follows:

I. Extent of Risk Aversion

Bernoulli's finding that most subjects would pay relatively small amounts to partake in a lottery with an infinite expected value gave rise to expected utility theory and laid the basis for how we measure risk aversion in economics. As a bookend, the experiments by Allais in the 1950s, also referenced in the last chapter, provided evidence that conventional expected utility theory did not stand up to experimentation and that humans behaved in far more complicated ways than the theory would predict.

In the decades since, there have several studies of risk aversion using experiments. Some of these experiments used animals. One study used rats as subjects and made them choose between a safe alternative (a constant food source) and a risky one (a variable food source). It concluded that rats were risk averse in their choices, and

displayed mildly decreasing risk aversion as their consumption increased.[2] In a depressing after-thought for risk averse human beings, another study concluded that more risk averse rats lived shorter, more stressful lives than their less risk-averse counterparts.[3]

Studies with human subjects have generally concluded that they are risk averse, though there are differences in risk aversion, depending upon how much is at stake and how an experiment is structured. Levy made his subjects, with varying levels of wealth, pick between guaranteed and risky investments. He found evidence of decreasing absolute risk aversion among his subjects – they were willing to risk more in dollar terms as they became wealthier- and no evidence of increasing relative risk aversion – the proportion of wealth that they were willing to put at risk did not decrease as wealth increased.[4]

The experimental research also finds interesting differences in risk aversion when subjects are presented with small gambles as opposed to large. Many of these studies offer their subjects choices between two lotteries with the same expected value but different spreads. For instance, subjects will be asked to pick between lottery A (which offers 50% probabilities of winning $ 50 or $ 100) and lottery B (with 50% probabilities of winning $ 25 or $125). Binswanger presented these choices to 330 farmers in rural India and concluded that there was mild risk aversion with two-thirds of the subjects picking less risky lottery A over the more risky lottery B (with the rest of the respondents being risk lovers who picked the more risky lottery) when the payoffs were small. As the payoffs increased, risk aversion increased and risk loving behavior almost entirely disappeared.[5] Holt and Laury expanded on this experiment by looking for the cross over point between the safer and the riskier lottery. In other words, using lottery A and B as examples again, they framed the question for subjects as: What probability of success would you need on lottery B for it to be preferable to lottery A? Risk averse subjects should require a probability greater than 50%, with higher probabilities reflecting higher

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[2] Battalio, Raymond C., Kagel, John H., and MacDonald, Don N.(1985), "Animals' Choices Over Uncertain Outcomes: Some Initial Experimental Results", *American Economic Review*, Vol. 75, No. 4.

[3] Cavigelli and McClintock

[4] Levy, Hiam (1994) "Absolute and Relative Risk Aversion: An Experimental Study," *Journal of Risk and Uncertainty*, 8:3 (May), 289-307.

[5] Binswanger, Hans P.(1981),"Attitudes Towards Risk: Theoretical Implications of an Experiment in Rural India", *The Economic Journal*, Vol. 91, No. 364.

risk aversion They also found that risk aversion increased as the payoffs increased.[6] Kachmeimeir and Shehata ran their experiments in China, eliciting certainty equivalent values from subjects for lotteries that they were presented with. Thus, subjects were asked how much they would accept as a guaranteed alternative to a lottery; the lower this certainty equivalent, relative to the expected value, the greater the risk aversion. They also varied the probabilities on different lotteries, with some having 50% probabilities of success and others only 10% probabilities. Consistent with the other studies, they found that risk aversion increased with the magnitude of the payoffs, but they also found that risk aversion decreased with high win probabilities. In other words, subjects were willing to accept a smaller certainty equivalent for a lottery with a 90% chance of making $ 10 and a 10% chance of making $110 (Expected value = .9(10) + .1 (110) = 20) than for a lottery with a 50% chance of making $ 10 and a 50% chance of making $ 30 (Expected value = .5(10) + .5 (30) =20).[7]

In summary, there seems to be clear evidence that human beings collectively are risk averse and that they get more so as the stakes become larger. There is also evidence of significant differences in risk aversion across individuals, with some showing no signs of risk aversion and some even seeking out risk.

II. Differences across different gambles/settings

Experimental studies of risk aversion indicate that the risk aversion of subjects varies depending upon how an experiment is structured. For instance, risk aversion coefficients that emerge from lottery choices seem to differ from those that come from experimental auctions, with the same subjects. Furthermore, subjects behave differently with differently structured auctions and risk aversion varies with the information that is provided to them about assets and with whether they have won or lost in prior rounds. In this section, we consider some of the evidence of how experimental settings affect risk aversion and the implications:

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[6] Holt, Charles A., and Laury, Susan K. (2002), "Risk Aversion and Incentive Effects," *American Economic Review*, Vol. 92(5).

[7] Kachelmeier, Steven J., and Shehata, Mohamed (1992), "Examining Risk Preferences Under High Monetary Incentives: Experimental Evidence from the People's Republic of China", *The American Economic Review*, Vol. 82, No. 5.

- Lotteries versus Auctions: Berg and Rietz found that subjects who were only slightly risk averse or even risk neutral in lottery choices became much more risk averse in bargaining games and in interactive auctions. They argued that interpersonal dynamics may play a role in determining risk aversion. If we carry this to its logical limit, we would expect investors buying stocks online (often sitting alone in front of their computer) to be less risk averse than investors who buy stocks through a broker or on a trading floor.[8]

- Institutional setup: Berg, Dickhaut and McCabe compared how the same set of subjects priced assets (and thus revealed their risk preferences) under an English clock auction and a first-price auction and found that subjects go from being risk-loving in the English clock auction to risk averse in the first-price auction.[9] Isaac and James come to similar conclusions when comparing first-price auction markets to other auction mechanisms.[10] Since different markets are structured differently, this suggests that asset prices can vary depending upon how markets are set up. To provide an illustration, Reynolds and Wooders compare auctions for the same items on Yahoo! and eBay and conclude that prices are higher on the former.[11]

- Information effects: Can risk aversion be affected by providing more information about possible outcomes in an experiment? There is some evidence that it can, especially in the context of myopic loss aversion – the tendency of human beings to be more sensitive to losses than equivalent gains and to become more so as they evaluate outcomes more frequently. Kahneman, Schwartz, Thaler and Tversky find

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[8] Berg, Joyce E., and Thomas A. Rietz (1997) "Do Unto Others: A Theory and Experimental Test of Interpersonal Factors in Decision Making Under Uncertainty," University of Iowa, Discussion Paper. This is backed up by Dorsey, R. E., and L. Razzolini (1998) "Auctions versus Lotteries: Do Institutions Matter?," University of Mississippi, Discussion Paper, presented at the Summer 1998 ESA Meeting.

[9] Berg, J, J. Dickhaut and K. McCabe, 2005, Risk Preference Instability across Institutions: A Dilemma", PNAS, vol 102, 4209-4214. In an English clock auction, the price of an asset is set at the largest possible valuation and potential sellers then exit the auction as the price is lowered. The last remaining seller sells the asset at the price at which the second to last seller exited the auction. In a first-price auction, potential buyers of an asset submit sealed bids simultaneously for an asset and the highest bidder receives the asset at her bid-price.

[10] Isaac, R Mark & James, Duncan, 2000. "Just Who Are You Calling Risk Averse?," Journal of Risk and Uncertainty, Springer, vol. 20(2), pages 177-87.

[11] Reynolds, S.S. and J. Wooders, 2005, Auctions with a Buy Price, Working Paper, University of Arizona. The key difference between the two auctions arises when the seller specified a buy-now price; in the eBay auction, the buy-now option disappears as soon as a bid is placed, whereas it remains visible in the Yahoo! auction.

that subjects who get the most frequent feedback (and thus information about their gains and losses) are more risk averse than investors who get less information.[12] Camerer and Weigelt investigated the effects of revealing information to some traders and not to others in experiments and uncovered what they called "information mirages" where traders who did not receive information attributed information to trades where such information did not exist. These mirages increase price volatility and result in prices drifting further from fair value.[13]

In summary, the risk aversion of human beings depends not only on the choices they are offered, but on the setting in which these choices are presented. The same investment may be viewed as riskier if offered in a different environment and at a different time to the same person.

III. Risk Aversion Differences across sub-groups

While most would concede that some individuals are more risk averse than others, are there significant differences across sub-groups? In other words, are females more risk averse than males? How about older people versus younger people? What effect do experience and age have on risk aversion? In this section, we consider some of the experimental evidence in this regard:

- Male versus Female: There seems to be some evidence that women, in general, are more risk averse than men, though the extent of the difference and the reasons for differences are still debated. In a survey of 19 other studies, Byrnes, Miller and Schafer conclude that women are decidedly more risk averse than men.[14] In an investment experiment, Levy, Elron and Cohen also find that women are less willing to take on investment risk and consequently earn lower amounts.[15] In contrary evidence, Holt and Laury find that increasing the stakes removes the sex differences

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[12] Kahneman, D., A. Schwartz, R. Thaler and A. Tversky, 1997, The Effect of Myopic Loss Aversion on Risk Taking: An Experimental Test, Quarterly Journal of Economics, v112, 647-661.

[13] Camerer, C. and K. Weigelt, 1991, Information Mirages in Experimental Asset Markets, Journal of Business, v64, 463-493.

[14] Byrnes, James P., Miller, David C., and Schafer, William D. "Gender Differences in Risk Taking: A Meta-Analysis." *Psychological Bulletin*, 1999, 125: 367-383.

[15] Levy, Haim, Elron, Efrat, and Cohen, Allon. "Gender Differences in Risk Taking and Investment Behavior: An Experimental Analysis." Unpublished manuscript, The Hebrew University, 1999.

in risk aversion.[16] In other words, while men may be less risk averse than women with small bets, they are as risk averse, if not more, for larger, more consequential bets.

- Naïve versus Experienced: Does experience with an asset class make one more or less risk averse? A study by Dyer, Kagel and Levin compared the bids from naïve student participants and experts from the construction industry for a common asset and concluded that while the winner's curse (where the winner over pays) was prevalent with both groups, the former (the students) were more risk averse than the experts.[17]

- Young versus Old: Risk aversion increases as we age. In experiments, older people tend to be more risk averse than younger subjects, though the increase in risk aversion is greater among women than men. Harrison, Lau and Rustrom report that younger subjects (under 30 years) in their experiments, conducted in Denmark, had much lower relative risk aversion than older subjects (over 40 years). In a related finding, single individuals were less risk averse than married individuals, though having more children did not seem to increase risk aversion.[18]

- Racial and Cultural Differences: The experiments that we have reported on have spanned the globe from rural farmers in India to college students in the United States. The conclusion, though, is that human beings have a lot more in common when it comes to risk aversion than they have as differences. The Holt and Laury study from 2002, which we referenced earlier, found no race-based differences in risk aversion.

It should come as no surprise to any student of human behavior but there are wide differences in risk aversion across individuals. The interesting question for risk management is whether policies on risk at businesses should be tailored to the owners of these businesses. In other words, should risk be perceived more negatively in a company where stockholders are predominantly older women than in a company held primarily by young males? If so, should there be more risk hedging at the former and strategic risk

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[16] Holt, Charles A. and Susan K. Laury, Susan K. "Risk Aversion and Incentive Effects." *American Economic Review*, 2002, 92(5): 1644-55

[17] Dyer, Douglas, John H. Kagel, and Dan Levin (1989) "A Comparison of Naive and Experienced Bidders in Common Value Offer Auctions: A Laboratory Analysis," Economic Journal, 99:394 (March), 108-115.

[18] Harrison, G.W., M.I.Lau and E.E. Rutstrom, 2004, Estimating Risk Attitudes in Denmark,: A Field Experiment, Working Paper, University of Central Florida.

taking at the latter? Casual empiricism suggests that this proposition is not an unreasonable one and that the risk management practices at firms reflect the risk aversion of both the owners and the managers of these firms.

IV. Other Risk Aversion Evidence

The most interesting evidence from experiments, though, is not in what they tell us about risk aversion in general but in what we learn about quirks in human behavior, even in the simplest of settings. In fact, Kahneman and Tversky's challenge to conventional economic utility theory was based upon their awareness of the experimental research in psychology. In this section, we will cover some of the more important of these findings:

I. Framing: Kahneman and Tversky noted that describing a decision problem differently, even when the underlying choices remain the same, can lead to different decisions and measures of risk aversion. In their classic example, they asked subjects to pick between two responses to a disease threat: the first response, they said, would save 200 people (out of a population of 600), but in the second, they noted that "there is a one-third probability that everyone will be saved and a two-thirds probability that no one will be saved". While the net effect of both responses is exactly the same – 400 die and 200 are saved – 72% of the respondents pick the first option. They termed this phenomenon "framing" and argued that both utility models and experimenters have to deal with the consequences. In particular, the assumption of invariance that underlies the von Neumann-Morgenstern rational choice theory is violated by the existence of framing.[19]

II. Loss Aversion: Loss aversion refers to the tendency of individuals to prefer avoiding losses to making comparable gains. In an experiment, Kahneman and Tversky offer an example of loss aversion. The first offered subjects a choice between the following:

    a. Option A: A guaranteed payout of $ 250

    b. Option B: A 25% chance to gain $ 1000 and a 75% chance of getting nothing

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[19] Tversky, A. and Kahneman, D. (1981), "The Framing of Decisions and the Psychology of Choice," *Science* 211. 453–458.

Of the respondents, 84% chose the sure option A over option B (with the same expected payout but much greater risk), which was not surprising, given risk aversion. They then reframed the question and offered the same subjects the following choices:

    c. Option C: A sure loss of $750

    d. Option D: A 75% chance of losing $ 1000 and a 25% chance to lose nothing.

Now, 73% of respondents preferred the gamble (with an expected loss of $750) over the certain loss. Kahneman and Tversky noted that stating the question in terms of a gain resulted in different choices than framing it in terms of a loss.[20] Loss aversion implies that individuals will prefer an uncertain gamble to a certain loss as long as the gamble has the possibility of no loss, even though the expected value of the uncertain loss may be higher than the certain loss.

Benartzi and Thaler combined loss aversion with the frequency with which individuals checked their accounts (what they called "mental accounting") to create the composite concept of <u>myopic loss aversion</u>.[21] Haigh and List provided an experimental test that illustrates the proposition where they ran a sequence of nine lotteries with subjects, but varied how they provided information on the outcomes.[22] To one group, they provided feedback after each round, allowing them to thus react to success or failure on that round. To the other group, they withheld feedback until three rounds were completed and provided feedback on the combined outcome over the three rounds. They found that people were willing to bet far less in the frequent feedback group than in the pooled feedback group, suggesting that loss aversion becomes more acute if individuals have shorter time horizons and assess success or failure at the end of these horizons.

III. <u>House Money Effect</u>: Generically, the house money effect refers to the phenomenon that individuals are more willing to takes risk (and are thus less risk

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[20] Tversky, A. and Kahneman, D. (1991), "Loss Aversion in Riskless Choice: A Reference-Dependent Model," Quarterly Journal of Economics 106, 1038–1061

[21] Benartzi, Shlomo, and Richard Thaler, 1995, Myopic loss aversion and the equity premium puzzle, Quarterly Journal of Economics 110, 73–92.

averse) with found money (i.e. money obtained easily) than with earned money. Consider the experiment where ten subjects were each given $ 30 at the start of the game and offered the choice of either doing nothing or flipping a coin to win or lose $9; seven chose the coin flip. Another set of ten subjects were offered no initial funds but offered a choice of either taking $ 30 with certainty or flipping a coin and winning $ 39, if it came up heads, or $21, if it came up tails. Only 43% chose the coin flip, even though the final consequences (ending up with $21 or $39) are the same in both experiments. Thaler and Johnson illustrate the house money effect with an experiment where subjects are offered a sequence of lotteries. In the first lottery, subjects were given a chance to win $15 and were offered a subsequent lottery where they had a 50:50 chance of winning or losing $4.50. While many of these same subjects would have rejected the second lottery, offered as an initial choice, 77% of those who won the first lottery (and made $15) took the second lottery.[23]

IV. <u>Break Even Effect</u>: The break even effect is the flip-side of the house money effect and refers to the attempts of those who have lost money to make it back. In particular, subjects in experiments who have lost money seem willing to gamble on lotteries (that standing alone would be viewed as unattractive) that offer them a chance to break even. The just-referenced study by Thaler and Johnson that uncovered the house money effect also found evidence in support of the break even effect. In their sequenced lotteries, they found that subjects who lost money on the first lottery generally became more risk averse in the second lottery, except when the second lottery offered them a chance to make up their first-round losses and break even.[24]

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[22] Haigh, M.S. and J.A. List, 2005, Do Professional Traders exhibit Myopic Loss Aversion? An Experimental Analysis, Journal of Finance, v45, 523-534.

[23] Thaler, R.H. and Johnson, E.J. (1990), "Gambling with the House Money and Trying to Break Even: The Effects of Prior Outcomes on Risky Choice," *Management Science* 36, 643–660. They also document a house-loss effect, where those who lose in the initial lottery become more risk averse at the second stage but the evidence from other experimental studies on this count is mixed.

[24] Battalio, R.C., Kagel, J.H., and Jiranyakul K. (1990), "Testing Between Alternative Models of Choice Under Uncertainty: Some Initial Results," *Journal of Risk and Uncertainty* 3, 25–50.

In summary, the findings from experimental studies offer grist for the behavioral finance mill. Whether we buy into all of the implications or not, there can be no arguing that there are systematic quirks in human behavior that cannot be easily dismissed as irrational or aberrant since they are so widespread and longstanding.

As a side note, many of these experimental studies have been run using inexperienced subjects (usually undergraduate students) and professionals (traders in financial markets, experienced business people) to see if age and experience play a role in making people more rational. The findings are not promising for the "rational" human school, since the consensus view across these studies is that experience and age do not seem to confer rationality in subjects and that some of the anomalies noted in this section are exacerbated with experience. Professional traders exhibit more myopic loss aversion than undergraduate students, for instance. The behavioral patterns indicated in this section are also replicated in experiments using business settings (projects with revenues, profits and losses) and experienced managers.[25]

Finally, we should resist the temptation to label these behaviors as irrational. Much of what we observe in human behavior seems to be hard wired into our systems and cannot be easily eliminated (if at all). In fact, a study in the journal Psychological Science in 2005 examined the decisions made by fifteen people with normal IQ and reasoning skills but with damage to the portions of the brain that controls emotions.[26] They confronted this group and a control group of normal individuals with 20 rounds of a lottery, where they could win $2.50 or lose a dollar and found that the inability to feel emotions such as fear and anxiety made the brain damaged individuals more willing to take risks with high payoffs and less likely to react emotionally to previous wins and losses. Overall, the brain impaired participants finished with about 13% higher winnings than normal people who were offered the same gambles. If we accept these findings, a computer or robot may be a much better risk manager than the most rational human being.

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[25] Sullivan, K., 1997, Corporate Managers's Risky Behavior: Risk Taking or Avoiding, Journal of Financial and Strategic Decisions, v10, 63-74.

[26] Baba, S., G. Lowenstein, A. Bechara, H. Damasio and A. Damasio, Investment Behavior and the Negative Side of Emotion, Psychological Science, v16, pp435-439. The damage to the individuals was created by strokes or disease and prevented them from feeling emotions.

If we take these findings to heart, there are some interesting implications for risk management. First, it may be prudent to take the human element out of risk management systems since the survival skills we (as human beings) have accumulated as a result of evolution undercut our abilities to be effective risk managers. Second, the notion that better and more timely information will lead to more effective risk management may be misplaced, since more frequent feedback seems to affect our risk aversion and skew our actions. Finally, the reason risk management systems break down in a big way may be traced to one or more these behavioral quirks. Consider the example of Amaranth, a hedge fund that was forced to close down because a single trader exposed it to a loss of billions of dollars by doubling up his bets on natural gas prices, even as the market moved against him. The behavior is consistent with the break-even effect, as the trader attempted to make back what he had lost in prior trades with riskier new trades.

Survey Measures

In contrast to experiments, where relatively few subjects are observed in a controlled environment, survey approaches look at actual behavior – portfolio choices and insurance decisions, for instance- across large samples. Much of the evidence from surveys dovetails neatly into the findings from the experimental studies, though there are some differences that emerge.

Survey Design

How can we survey individuals to assess their risk attitudes? Asking them whether they are risk averse and if so, by how much, is unlikely to yield any meaningful results since each individual's definition of both risk and risk aversion will be different. To get around this problem, there are three ways in which risk surveys are done:

- Investment Choices: By looking at the proportion of wealth invested in risky assets and relating this to other observable characteristics including level of wealth, researchers have attempted to back out the risk aversion of individuals. Friend and Blume estimate the Arrow-Pratt risk aversion measure using this approach and conclude that they invest smaller proportions in risky assets, as they get wealthier, thus exhibiting decreasing relative risk aversion. However, if wealth is defined to

include houses, cars and human capital, the proportion invested in risky assets stays constant, consistent with constant relative risk aversion.[27] Other studies using the same approach also find evidence that wealthier people invest smaller proportions of their wealth in risky assets (declining relative risk aversion) than poorer people.

- Questionnaires: In this approach, participants in the survey are asked to answer a series of questions about the willingness to take risk. The answers are used to assess risk attitudes and measure risk aversion. In one example of this approach, 22000 German individuals were asked about their willingness to take risks on an 11-point scale and the results were double-checked (and found reasonable) against alternative risk assessment measures (including a conventional lottery choice).[28]

- Insurance Decisions: Individuals buy insurance coverage because they are risk averse. A few studies have focused on insurance premia and coverage purchased by individuals to get a sense of how risk averse they are. Szpiro looked at time series data on how much people paid for insurance and how much they purchased to conclude that they were risk averse.[29] Cichetti and Dubin confirm his finding by looking at a dataset of insurance for phone wiring bought by customers to a utility.. They note that the insurance cost is high ($0.45, a month) relative to the expected loss ($0.26) but still find that 57% of customers bought the insurance, which they attributed to risk aversion.[30]

Survey Findings

The evidence from surveys about risk aversion is for the most part consistent with the findings from experimental studies. Summarizing the findings:

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[27] Friend, I. and M.E. Blume. "The Demand for Risky Assets", *American Economic Review*, December 1975: 900-22.

[28] Dohmen, T., J., A. Falk, D. Huffman, J. Schuupp, U.Sunde and G.G. Wagner, 2006, Individual Risk Attitudes: New Evidence from a Large, Representative, Experimentally-Validated Survey, Working Paper, CEPR.

[29] Szpiro, George G, 1986. "Measuring Risk Aversion: An Alternative Approach," The Review of Economics and Statistics, MIT Press, vol. 68(1), pages 156-59.

[30] Cichetti, C.J. y J.A. Dubin (1994), "A microeconometric analysis of risk aversion and the decision to self insure", Journal of Political Economy, Vol. 102, 169-186. An alternate story would be that the personnel selling this insurance are so persistent that most individuals are willing to pay $0.19 a month for the privilege of not having to listen to more sales pitches.

- Individuals are risk averse, though the studies differ on what they find about relative risk aversion as wealth increases. Most find decreasing relative risk aversion, but there are exceptions that find constant relative risk aversion.

- Surveys find that women are more risk averse than men, even after controlling for differences in age, income and education. Jianakoplos and Bernasek use the Friend-Blume framework and data from the Federal Reserve's Survey of Consumers to estimate relative risk aversion by gender. They conclude that single women are relatively more risk averse than single men and married couples.[31] Riley and Chow also find that women are more risk averse than men, and they also conclude that never married women are less risk averse than married women, who are, in turn, less risk averse than widowed and separated women.

- The lifecycle risk aversion hypothesis posits that risk aversion should increase with age, but surveys cannot directly test this proposition, since it would require testing the same person at different ages. In weak support of this hypothesis, Morin and Suarez find that older people are, in fact, more risk averse than younger people because they tend to invest less of their wealth in riskier assets. [32] In a rare study that looks at choices over time, Bakshi and Chen claim to find support for the lifecycle hypothesis by correlating the increase in equity risk premiums for the overall equity market to the ageing of the population.[33]

- There is evidence linking risk aversion to both race/ethnicity and to education, but it is mixed. Though some studies claim to find a link between racial makeup and risk aversion, it is difficult to disentangle race from income and wealth, which do have much stronger effects on risk aversion. With respect to education, there have been contradictory findings, with some studies concluding that more educated people are more risk averse[34] and others that they are less.[35]

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[31] Jianakoplos N. A. and A. Bernasek, 1998, "Are Women More Risk Averse", *Economic Inquiry*.

[32] Morin, R.A. and F. Suarez. "Risk Aversion Revisited", *Journal of Finance*, September 1983: 1201-16.

[33] Bakshi, G. and Z. Chen. "Baby Boom, Population Aging, and Capital Markets", Journal of Business, Vol. 67, No. 2, 1994: 165-202.

[34] Jianakoplos N. A. and A. Bernasek, 1998, "Are Women More Risk Averse", *Economic Inquiry*.

[35] Riley, W.B. and K.V. Chow. "Asset Allocation and Individual Risk Aversion", *Financial Analysts Journal*, November/December 1992: 32-7.

Critiquing Survey Evidence

Comparing experiments to surveys, surveys have the advantage of larger sample sizes, but the disadvantage of not being able to control for other factors. Experiments allow researchers to analyze risk in tightly controlled environments, resulting in cleaner measures of risk aversion. However, as we noted earlier, the measures themselves are highly sensitive to how the experiments are constructed and conducted.

The quality of the survey evidence is directly related to how carefully constructed a survey is. A good survey will draw a high proportion of the potential participants, have no sampling bias and allow the researcher to draw clear distinctions between competing hypotheses. In practice, surveys tend to have low response rates and there are serious problems with sampling bias. The people who respond to surveys might not be a representative sample. To give credit to the authors of the studies that we quote in this section, they are acutely aware of this possibility and try to minimize in through their survey design and subsequent statistical tests.

Pricing of Risky Assets

The financial markets represent experiments in progress, with millions of subjects expressing their risk preferences by how they price risky assets. Though the environment is not tightly controlled, the size of the experiment and the reality that large amounts of money are at stake (rather than the small stakes that one sees in experiments) should mean that the market prices of risky assets provide more realistic measures of risk aversion than either simple experiments or surveys. In this section, we will consider how asset prices can be used to back measures of risk aversion, and whether the evidence is consistent with the findings from other approaches.

Measuring the Equity Risk Premium

If we consider in investing in stocks as a risky alternative to investing risklessly in treasury bonds, we can use level of the stock market to back out how much investors are demanding for being exposed to equity risk. This is the idea behind an implied equity risk premium. Consider, for instance, a very simple valuation model for stocks.

$$\text{Value} = \frac{\text{Expected Dividends Next Period}}{(\text{Required Return on Equity} \; - \; \text{Expected Growth Rate in Dividends})}$$

This is essentially the present value of dividends growing at a constant rate in perpetuity. Three of the four variables in this model can be obtained externally – the current level of the market (i.e., value), the expected dividends next period and the expected growth rate in earnings and dividends in the long term. The only "unknown" is then the required return on equity; when we solve for it, we get an implied expected return on stocks. Subtracting out the riskfree rate will yield an implied equity risk premium. As investors become more risk averse, they will demand a larger premium for risk and pay less for the same set of cash flows (dividends).

To illustrate, assume that the current level of the S&P 500 Index is 900, the expected dividend yield on the index for the next period is 3% and the expected growth rate in earnings and dividends in the long term is 6%. Solving for the required return on equity yields the following:

$$900 = \frac{900(0.03)}{r - 0.06}$$

Solving for r,

$$r - 0.06 = 0.03$$
$$r = 0.09 = 9\%$$

If the current riskfree rate is 6%, this will yield an equity risk premium of 3%.

This approach can be generalized to allow for high growth for a period and extended to cover cash flow based, rather than dividend based, models. To illustrate this, consider the S&P 500 Index on January 1, 2006. The index was at 1248.29 and the dividend yield on the index in 2005 was roughly 3.34%.[36] In addition, assume that the consensus estimate[37] of growth in earnings for companies in the index was approximately 8% for the next 5 years and the 10-year treasury bond rate on that day was 4.39%. Since a growth rate of 8% cannot be sustained forever, we employ a two-stage valuation model, where we allow dividends and buybacks to grow at 8% for 5 years and then lower the

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[36] Stock buybacks during the year were added to the dividends to obtain a consolidated yield.

[37] We used the average of the analyst estimates for individual firms (bottom-up). Alternatively, we could have used the top-down estimate for the S&P 500 earnings.

growth rate to the treasury bond rate of 4.39% after the 5 year period.[38] Table 3.1 summarizes the expected cash flows for the next 5 years of high growth and the first year of stable growth thereafter.

Table 3.1: Expected Cashflows on S&P 500

Year	Cash Flow on Index
1	44.96
2	48.56
3	52.44
4	56.64
5	61.17
6	61.17(1.0439)

ªCash flow in the first year = 3.34% of 1248.29 (1.08)

If we assume that these are reasonable estimates of the cash flows and that the index is correctly priced, then

$$\text{Index level} = 1248.29 = \frac{44.96}{(1+r)} + \frac{48.56}{(1+r)^2} + \frac{52.44}{(1+r)^3} + \frac{56.64}{(1+r)^4} + \frac{61.17}{(1+r)^5} + \frac{61.17(1.0439)}{(r-.0439)(1+r)^5}$$

Note that the last term of the equation is the terminal value of the index, based upon the stable growth rate of 4.39%, discounted back to the present. Solving for r in this equation yields us the required return on equity of 8.47%. Subtracting out the treasury bond rate of 4.39% yields an implied equity premium of 4.08%.

The advantage of this approach is that it is market-driven and current and it does not require any historical data. Thus, it can be used to estimate implied equity premiums in any market. It is, however, bounded by whether the model used for the valuation is the right one and the availability and reliability of the inputs to that model.

Equity Risk Premium over Time

The implied equity premiums change over time much more than historical risk premiums. In fact, the contrast between these premiums and the historical premiums is best illustrated by graphing out the implied premiums in the S&P 500 going back to 1960 in Figure 3.1.

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[38] The treasury bond rate is the sum of expected inflation and the expected real rate. If we assume that real growth is equal to the real rate, the long term stable growth rate should be equal to the treasury bond rate.

Figure 3.1: Implied Premium for US Equity Market
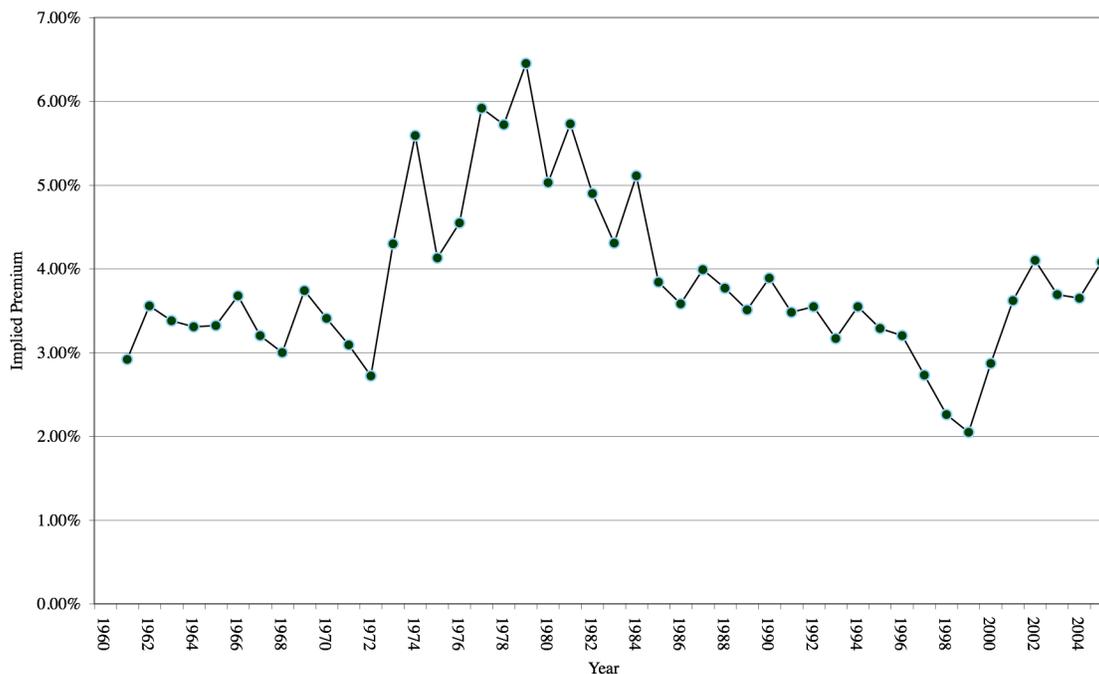
In terms of mechanics, we use historical growth rates in earnings as our projected growth rates for the next five years, set growth equal to the risfree rate beyond that point in time and value stocks using a two-stage dividend discount model. There are at least two conclusions that we can draw from this table.

1. <u>Investors are risk averse</u>: The fact that the implied equity risk premium is positive indicates that investors require a reward (in the form of higher expected returns) for taking on risk.

2. <u>Risk aversion changes over time</u>: If we the risk premium as a measure of risk aversion for investors collectively, there seems to be clear evidence that investors becomes more risk averse over some periods and less risk averse in others. In figure 3.1, for instance, this collective measure of risk aversion increased during the inflationary seventies, and then went through a two-decade period where it declined to reach historic lows at the end of 1999 (coinciding with the peak of the bull market of the 1990s). It bounced back again in the short and sharp market correction that followed and has remained fairly stable since 2001.

The implied equity risk premium also brings home an important point. Risk premiums and stock prices generally move in opposite directions. Stock prices are highest when investors demand low risk premiums and should decrease as investors become more risk averse, pushing up risk premiums.

The Equity Risk Premium Puzzle

While the last section provided a forward-looking estimate of equity risk premiums, we can also obtain a historical equity risk premium by looking at how much investors have earned investing in stocks, as opposed to investing in government securities in the past. For instance, an investment in stocks in the United States would have earned 4.80% more annually, on a compounded basis between 1928 and 2005, than an investment in ten-year treasury bonds over the same period.[39] While the premium does change depending upon the time period examined, stocks have consistently earned three to five percent more, on an annual basis, than government bonds for much of the last century.

In a widely cited paper, Mehra and Prescott argued that the observed historical risk premiums (which they estimated at about 6% at the time of their analysis) were too high, and that investors would need implausibly high risk aversion coefficients to demand these premiums.[40] In the years since, there have been many attempts to provide explanations for this puzzle:

- Statistical Artifact: The historical risk premium obtained by looking at U.S. data is biased upwards because of a survivor bias, induced by picking one of the most successful equity markets of the twentieth century. The true premium, it is argued, is much lower because equity markets in other parts of the world did not do as well as the U.S. market during this period. Consequently, a wealthy investor in 1928 looking to invest in stocks would have been just as likely to invest in the Austrian stock market as the U.S. stock market and would have had far less success with his investment over the rest of the century. This view is backed up by a study of

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[39] On a simple average basis, the premium is even larger and exceeds 6%.

[40] Mehra, Rajnish, and Edward C.Prescott, 1985, The Equity Premium: A Puzzle' *Journal Monetary Economics* 15 (1985), pp. 145–61. Using a constant relative risk aversion utility function and plausible risk aversion coefficients, they demonstrate the equity risk premiums should be much lower (less than 1%).

seventeen equity markets over the twentieth century, which concluded that the historical risk premium is closer to 4% than the 6% cited by Mehra and Prescott.[41] However, even the lower risk premium would still be too high, if we assumed reasonable risk aversion coefficients.

- Disaster Insurance: A variation on the statistical artifact theme, albeit with a theoretical twist, is that the observed risk in an equity market does not fully capture the potential risk, which includes rare but disastrous events that reduce consumption and wealth substantially. Thus, the fact that there has not been a catastrophic drop in U.S. equity markets in the last 50 years cannot be taken to imply that the probability of such an occurrence is zero.[42] In effect, forward looking risk premiums incorporate the likelihood of these low probability, high impact events, whereas the historical risk premium does not.

- Taxes: One possible explanation for the high equity returns in the period after the Second World War is that taxes on equity income declined during that period. McGrattan and Prescott, for instance, provide a hypothetical illustration where a drop in the tax rate on dividends from 50% to 0% over 40 years would cause equity prices to rise about 1.8% more than the growth rate in GDP; adding the dividend yield to this expected price appreciation generates returns similar to the observed returns.[43] In reality, though, the drop in marginal tax rates was much smaller and cannot explain the surge in equity risk premiums.

- Preference for stable wealth and consumption: There are some who argue that the equity risk premium puzzle stems from its dependence upon conventional expected utility theory to derive premiums. In particular, the constant relative risk aversion function used by Mehra and Prescott in their paper implies that if an investor is risk averse to variation in consumption across different states of nature at a point in time, he or she will also be equally risk averse to consumption variation across time. The counter argument is that individuals will choose a lower and more stable level of

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[41] Dimson, E., P. March and M. Staunton, 2002, *Triumph of the Optimists*, Princeton University Prsss.

[42] To those who argue that this will never happen in a mature equity market, we offer the example of the Nikkei which dropped from 40,000 in the late eighties to less than 10,000 a decade later. Investors who bought stocks at the peak will probably not live to see capital gains on their investments.

wealth and consumption that they can sustain over the long term over a higher level of wealth that varies widely from period to period.[44] One reason may be that individuals become used to maintaining past consumption levels and that even small changes in consumption can cause big changes in marginal utility.[45] Investing in stocks works against this preference by creating more instability in wealth over periods, adding to wealth in good periods and taking away from it in bad periods. In more intuitive terms, your investment in stocks will tend to do well when the economy in doing well and badly during recessions, when you may very well find yourself out of a job. To compensate, you will demand a larger premium for investing in equities.

- <u>Myopic Loss Aversion</u>: Earlier in this chapter we introduced the notion of myopic loss aversion, where the loss aversion already embedded in individuals becomes more pronounced as the frequency of their monitoring increases. If investors bring myopic risk aversion into investing, the equity risk premiums they will demand will be much higher than those obtained from conventional expected utility theory. The paper that we cited earlier by Benartzi and Thaler yields estimates of the risk premium very close to historical levels using a one-year time horizon for investors with plausible loss aversion characteristics (of about 2, which is backed up by the experimental research).

The bottom line is that observed equity risk premiums cannot be explained using conventional expected utility theory. Here again, the behavioral quirks that we observed in both experiments and surveys may help in explaining how people price risky assets and why the prices change over time.

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[43] McGrattan, E.R., and E.C. Prescott. 2001. "Taxes, Regulations, and Asset Prices." Working Paper No. 610, Federal Reserve Bank of Minneapolis.

[44] Epstein, L.G., and S.E. Zin. 1991. "Substitution, Risk Aversion, and the Temporal Behavior of Consumption and Asset Returns: An Empirical Analysis." *Journal of Political Economy*, vol. 99, no. 2 (April):263–286.

[45] Constantinides, G.M. 1990. "Habit Formation: A Resolution of the Equity Premium Puzzle." *Journal of Political Economy*, vol. 98, no. 3 (June):519–543.

Beyond Equities

The approach that we used to estimate the equity risk premium and, by extension, get a measure of risk aversion can be generalized to look at any asset class or even individual assets. By looking at how investors price risky assets, we can get a sense of how investors assess risk and the price they charge for bearing it.

For instance, we could look at how investors price bonds with default risk, relative to riskfree bonds, to gauge their attitudes toward risk. If investors are risk neutral, the prices and interest rates on bonds should reflect the likelihood of default and the expected cost to the bondholder of such default; risk averse investors will attach a bigger discount to the bond price for the same default risk. Studies of default spreads on corporate bonds yields results that are consistent not only with the proposition that bond investors are risk averse, but also with changing risk aversion over time.[46]

We could also look at the pricing of options to measure investor risk aversion. For instance, we can back out the risk neutral probabilities of future stock prices changes from option prices today.[47] Comparing these probabilities with the actual returns can tell us about the risk aversion of option investors. A study that estimated risk aversion coefficients using options on the S&P 500 index, in conjunction with actual returns on the index, concluded that they were well behaved prior to the 1987 stock market crash – risk aversion coefficients were positive and decreased with wealth – but that they changed dramatically after the crash, becoming negative in some cases and increasing with wealth.[48] An examination of options on the FTSE 100 and S&P 500 options from 1992 to 2001 concluded that risk aversion coefficients were consistent across utility functions and markets, but that they tended to decline with forecast horizon and increase during periods of low market volatility.[49]

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[46] Wu, C. and C. Yu, 1996, Risk Aversion and the yield of corporate debt, Journal of Banking and Finance, v20, 267-281.

[47] The risk neutral probability can be written as a function of the subjective (and conventional) probability estimate and a risk aversion coefficient.
Risk neutral probability = Subjective probability * Risk aversion coefficient

[48] Jackwerth, J.C.,2000, Recovering Risk Aversion from Option Prices and Realized Returns, The Review of Financial Studies, v13, 433-451.

[49] Bliss, R.R. and N. Panigirtzoglou, 2001, Recovering Risk Aversion from Options, Working Paper, Federal Reserve Bank of Chicago.

In summary, studies of other risky asset markets confirm the findings in equity markets that investors are risk averse, in the aggregate, and that this risk aversion changes over time.

The Limitations of Market Prices

While markets are large, ongoing experiments, they are also complicated and isolating risk aversion can be difficult to do. Unlike a controlled experiment, where all subjects are faced with the same risky choices, investors in markets tend to have different information about and views on the assets that they are pricing. Thus, we have to make simplifying assumptions to back out measures of the risk premium. With the equity risk premium, for instance, we used a two-stage dividend discount model and analyst estimates of growth to compute the equity risk premium. Any errors we make in model specification and inputs to the model will spill over into our risk premium estimates.

Notwithstanding these limitations, market prices offer valuable clues about changes in risk aversion over time. In summary, they indicate that expected utility models fall short in explaining how individuals price risky assets and that there are significant shifts in the risk aversion of populations over time.

Evidence from Horse Tracks, Gambling and Game Shows

Some of the most anomalous evidence on risk aversion comes from studies of how individuals behave when at the race traces and in casinos, and in recent years, on game shows. In many ways, explaining why humans gamble has been a challenge to economists, since the expected returns (at least based upon probabilities) are negative and the risk is often substantial. Risk averse investors with well behaved utility functions would not be gamblers but this section presents evidence that risk seeking is not unusual.

Horse Tracks and Gambling

Gambling is big business. At horse tracks, casinos and sports events, individuals bet huge amounts of money each year. While some may contest the notion, there can be no denying that gambling is a market like any other, where individual make their preferences clear by what they do. Over the last few decades, the data from gambling

events has been examined closely by economists, trying to understand how individuals behave when confronted with risky choices.

In a survey article, Hausch, Ziemba and Rubinstein examined the evidence from studies of horse track betting and found that there were strong and stable biases in their findings. First, they found that people <u>paid too little for favorites</u> and <u>too much for long shots</u>[50]. In particular, one study that they quote computed rates of returns from betting on horses in different categories, and concluded that bettors could expect to make positive returns by betting on favorites (9.2%) but very negative returns (-23.7%) by betting on long odds.[51] Second, they noted that bettors tended to bet <u>more on longer odds horses as they lost money</u>, often in a desperate attempt to recover from past losses.

This long shot bias is now clearly established in the literature and there have been many attempts to explain it. One argument challenges the conventional view (and the evidence from experimental studies and surveys) that human beings are risk averse. Instead, it posits that gamblers are risk lovers and are therefore drawn to the higher risk in long shot bets.[52] The other arguments are consistent with risk aversion, but require assumptions about behavioral quirks or preferences and include the following:

- The long shot bias can be explained if individuals underestimate large probabilities and overestimate small probabilities, behavior inconsistent with rational, value maximizing individuals but entirely feasible if we accept psychological studies of human behavior.[53]

- Another argument is that betting on long shots is more exciting and that excitement itself generates utility for individuals.[54]

- There are some who argue that the preference for long shots comes not from risk loving behavior on the part of bettors but from a preference for very large positive

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[50] Hausch, D.B., W.T. Ziemba and M. Rubinstein, 1981, Efficiency of the Market for Racetrack Betting, Management Science

[51] Snyder, W.W., "Horse Racing: Testing the Efficient Markets Model," *Journal of Finance* 33 (1978) pp. 1109-1118.

[52] Quandt, R. (1986), "Betting and Equilibrium", Quarterly Journal of Economics, 101, 201-207.

[53] Griffith, R. (1949), "Odds Adjustment by American Horses Race Bettors",American Journal of Psychology, 62, 290-294.

[54] Thaler, R. and W. Ziemba (1988), "Anomalies—Parimutuel Betting Markets: Racetracks and Lotteries", Journal of Economic Perspectives, 2, 161- 174.

payoffs, i.e. indvidiuals attach additional utility to very large payoffs, even when the probabilities of receiving them are very small.[55]

Researchers have also used data from racetrack betting to fit utility functions to bettors. Wietzman looked at betting in 12000 races between 1954 and 1963 and generated utility functions that are consistent with risk loving rather than risk averse individuals.[56] While a few other researchers back up this conclusion, Jullien and Salane argue that gamblers are risk averse and that their seeming risk seeking behavior can be attributed to incorrect assessments of the probabilities of success and failure.[57] Extending the analysis from horse tracks to other gambling venues – casino gambling and lotteries, for instance – studies find similar results. Gamblers willingly enter into gambles where the expected returns from playing are negative and exhibit a bias towards gambles with low probabilities of winning but big payoffs (the long shot bias).

Game Shows

The final set of studies that we will reference are relatively recent and they mine data obtained from how contestants behave on game shows, especially when there is no skill involved and substantial amounts of money at stake.

- A study examined how contestants behaved in "Card Sharks", a game show where contestants are asked to bet in a bonus round on whether the next card in the deck is higher or lower than the card that they had open in front of them. The study found evidence that contestants behave in risk averse ways, but a significant subset of decisions deviate from what you would expect with a rational, utility maximizing individual.[58] In contrast, another study finds that contestants reveal more risk

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[55] Golec, J. and M. Tamarkin, 1998, Bettors Love Skewness, Not Risk, at the Horse Track, Journal of Political Economy 106, 205-225. A study of lottery game players by Garrett and Sobel backs up this view; Garret, T.A, and R.S. Sobel, 2004, Gamblers Favor Skewness, Not Risk: Further Evidence from United States' Lottery Games, Working Paper.

[56] Weitzman, M. (1965), "Utility Analysis and Group Behavior: An Empirical Study", Journal of Political Economy, 73, 18-26.

[57] Jullien, B. and B. Salanie, 2005, Empirical Evidence on the Preferences of Racetrack Bettors, chapter in Efficiency of Sports and Lottery Markets, Edited by D. Hausch and W. Ziemba,

[58] Gertner, R. (1993). `Game Shows and Economic Behavior: ``Risk-taking'' on ``Card Sharks''', Quarterly Journal of Economics, vol. 108, no. 2, pp. 507±21.

neutrality than aversion when they wager their winnings in Final Jeopardy, and that they make more "rational" decisions when their problems are simpler.[59]

- In a study of the popular game show "Deal or No Deal", Post, Baltussen and Van den Assem examine how contestants behaved when asked to make choices in 53 episodes from Australia and the Netherlands. In the show, twenty-six models each hold a briefcase that contains a sum of money (varying from one cent to $1 million in the U.S. game). The contestant picks one briefcase as her own and then begins to open the other 25, each time, by process of elimination, revealing a little more about what his own case might hold. At the end, the contestant can also trade her briefcase for the last unopened one. Thus, contestants are offered numerous opportunities where they can either take a fixed sum (the suitcase that is open) or an uncertain gamble (the unopened suitcase). Since both the fixed sum and the gamble change with each attempt, we are observing certainty equivalents in action. The researchers find evidence of overall risk aversion but they also note that there are big differences across contestants, with some even exhibiting risk seeking behavior. Finally, they back up some of the "behavioral quirks" we noted earlier when talking about experimental studies, with evidence that contestant risk aversion is dependent upon prior outcomes (with failure making contestants more risk averse) and for the break even effect (where risk aversion decreases following earlier losses and a chance to recoup these losses).[60]

- Tenorio and Cason examined the spin or no spin segment of The Price is Right, a long running game show.[61] In this segment, three contestants spin a wheel with 20 uniform partitions numbered from 5 to 100 (in fives). They are allowed up to two spins and the sum of the scores of the two spins is computed. The contestant who scores closes to 100 points, <u>without going over</u>, wins and moves on to the next round and a chance to win big prizes. Scoring exactly 100 points earns a bonus for the

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[59] Metrick, A. (1995). `A Natural experiment in ``Jeopardy!''', American Economic Review, vol. 58, pp. 240-53. In Final Jeopardy, the three contestants on the show decide how much of the money winnings they have accumulated over the show they want to best of the final question, with the recognition that only the top money winner will win.

[60] Post, T., G. .Baltussent and M. Van den Assem, 2006, Deal or No Deal, Working paper, Erasmus University.

contestant. The key component examined in this paper is whether the contestant chooses to use the second spin, since spinning again increases the point total but also increases the chance of going over 100 points. This study finds that contestants were more likely to make "irrational" decisions when faced with complicated scenarios than with simple ones, suggesting that risk aversion is tied to computational ability and decision biases.

- Lingo is a word guessing game on Dutch TV, where two couples play each other and the one that guesses the most words moves on to the final, which is composed of five rounds. At the end of each round, each couple is offered a chance to take home what they have won so far or go on to the next round; if they survive, they double their winnings but they risk losing it all if they lose. The odds of winning decrease with each round. A study of this game show found that while contestants were risk averse, they tended to be overestimate the probability of winning by as much as 15%.[62] A study of contestants on *Who wants to be a Millionaire?* In the UK backs up this finding. In fact, the researchers contend that contestant behavior on this show is consistent with logarithmic utility functions, a throwback to Daniel Bernoulli's solution to the St. Petersburg paradox.[63]

In summary, game shows offer us a chance to observe how individuals behave when the stakes are large (relative to the small amounts offered in experimental studies) and decisions have to be made quickly. The consensus finding from these studies is that contestants on game shows are risk averse but not always rational, over estimating their probabilities of success in some cases and behaving in unpredictable (and not always sensible) ways in complicated scenarios.

Propositions about Risk Aversion

As you can see, the evidence about risk aversion comes from a variety of different sources and there are both common findings and differences across the different

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[61] Tenorio and Cason,

[62] Beetsma, R. and P. Schotman, 2001. Measuring Risk Attitudes in a Natural Experiment: Data from the TelevisionGame Show *Lingo, Economic Journal, October 2001*

[63] Hartley, R., G. Lanot and I. Walker, 2005, Who Really Wants to be a Millionaire: Estimates of Risk Aversion from Game Show Data, Working Paper, University of Warwick.

approaches. We can look at all of the evidence and summarize what we see as the emerging consensus on risk aversion:

1. <u>Individuals are generally risk averse, and are more so when the stakes are large than when they are small</u>. Though there are some differences across the studies, the evidence does support the view that individuals are willing to invest larger amounts in risky assets (decreasing absolute risk aversion) as they get wealthier. However, the evidence is mixed on relative risk aversion, with support for increasing, constant and decreasing relative risk aversion in different settings.

2. <u>There are big differences in risk aversion across the population and signifcant differences across sub-groups</u>. Women tend to be more risk averse than men and older people are more risk averse than younger people. More significantly, there are significant differences in risk aversion within homogeneous groups, with some individuals exhibiting risk aversion and a sizeable minority seeking out risk. This may help explain why studies that have focused on gambling find that a significant percentage (albeit not a majority) of gamblers exhibit risk loving behavior. It seems reasonable to believe that risk seekers are more likely to be drawn to gambling.

3. While the evidence of risk aversion in individuals may make believers in expected utility theory happy, the other evidence that has accumulated about systematic quirks in individual risk taking will not. In particular, the evidence indicates that

   - Individuals are <u>far more affected by losses than equivalent gains</u> (loss aversion), and this behavior is made worse by frequent monitoring (myopia).
   - The choices that people make (and the risk aversion they manifest) when presented with risky choices or gambles can <u>depend upon how the choice is presented</u> (framing).
   - Individuals tend to be much more willing to take risks with what they consider "found money" than with money that they have earned (house money effect).
   - There are two scenarios where risk aversion seems to decrease and even be replaced by risk seeking. One is when individuals are offered the chance of making an extremely large sum with a very small probability of success (long shot bias). The other is when individuals who have lost money are presented with choices that allow them to make their money back (break even effect).

- When faced with risky choices, whether in experiments or game shows, individuals often make mistakes in assessing the probabilities of outcomes, over estimating the likelihood of success,, and this problem gets worse as the choices become more complex.

In summary, the notion of a representative individual, whose utility function and risk aversion coefficient can stand in for the entire population, is difficult to hold on to, given both the diversity in risk aversion across individuals and the anomalies (at least from the perspective of the perfectly rational utility seeker) that remain so difficult to explain.

Conclusion

Investors hate risk and love it. They show clear evidence of both risk aversion and of risk seeking. In this chapter, we examine the basis for these contradictory statements by looking at the evidence on risk aversion in the population, acquired through a number of approaches – experiments, surveys, financial market prices and from observing gamblers. Summing up the evidence, investors are generally risk averse but some are much more so than others; in fact, a few are risk neutral or even risk loving. Some of the differences in risk aversion can be attributed to systematic factors such as age, sex and income, but a significant portion is random.

The interesting twist in the findings is that there are clear patterns in risk taking that are not consistent with the rational utility maximizer in classical economics. The ways we act when faced with risky choices seem to be affected by whether we face gains or losses and how the choices are framed. While it is tempting to label this behavior as anomalous, it occurs far too often and in such a wide cross section of the population that it should be considered the norm rather than the exception. Consequently, how we measure and manage risk has to take into account these behavioral quirks.