Elicitation and Elucidation of Risk Preferences

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Abstract

Motivation. Recent developments have created an increased interest among companies in developing formalized enterprise risk management (ERM) policies. Implicit in such an ERM policy is some statement of acceptable and unacceptable tradeoffs, or risk preferences. Since risk preferences will be a central part of the ERM policy, they should be explicitly determined. This would be accomplished through a process of eliciting and elucidating the risk preferences that management may already have in mind for operating the company.

Method. Several methods in current use are described, including survey and discussion group techniques.

Results. This report describes hypothetical results from applying the methods described in both business and non-business contexts.

Conclusions. Making risk preferences explicit enhances the development of an ERM policy. The elicitation and elucidation of risk preferences is neither simple nor brief. The process requires first that the meaning of risk be agreed upon and not assumed since different executives and professionals often have different definitions of risk. Technical survey techniques can be applied to elicit risk preferences. A number of results in behavioral finance are pertinent to risk preference elicitation.

Keywords. ERM, risk measure, risk preference, conjoint analysis, QFDI, behavioral finance.

1. INTRODUCTION

Interest in risk management has grown dramatically in recent years. This is due to a number of factors, including Sarbanes-Oxley, several high profile insolvencies, a better understanding of the risks that businesses face, and better technology to help us model these risks. For example, an asset-liability manager might do extensive simulations that would not have been feasible ten years ago.

While risk management has meant different things in different environments, we think that a crucial first step for every risk manager is to determine risk preferences. This first step is not a trivial task; it can require a great deal of work for senior management to reach consensus on their company's risk tolerance. The focus of the Working Party's research is eliciting and elucidating the risk preferences of an insurer's senior management.

1.1 Research Context and Objective

"Risk preferences" are risk-laden opportunities that are considered acceptable, or more desirable than other possible choices. They are implicit in nearly all decision-making, yet are generally unknown to the decision-maker, exercising profound influence without being recognized. They are rarely, if ever, made explicit in the decision process.

We suggest that eliciting management's risk preferences and making them explicit serves several worthwhile purposes. First, the company can be operated from a coherent risk management policy, rather than isolated, and potentially conflicting individual judgments about which risks to avoid and at what cost. Furthermore, risk management strategy is an important element of long-term strategic planning, whose documentation might become more formalized as a requirement in the future. Finally, making acceptable tradeoffs explicit is the first step to ensuring they are consistent, transparent, and ultimately implemented in daily decision-making at all levels.

1.2 Outline

We have left aside any direct treatment of where management's risk preferences come from or what should drive them, as well as all aspects of the management-investors relationship. Our goal is not to find <u>the</u> <u>optimal</u> risk preference framework assuming efficient market principles. Instead, the objective is to develop <u>a</u> <u>rational</u> framework that can be used by managers to link corporate risk preferences and decision-making.

The steps to this rational framework involve:

- Defining "risk" unambiguously

- Determining the risk measures to be used

- Assessing the context of the company and managers

- Ascertaining risk preferences

In this paper we will discuss each of these steps, providing an overview of possible steps that a company might take to understand their risk preferences. Rather than prescribe a specific procedure, we will introduce several existing techniques that can be used and will also discuss some key considerations in implementation. We will conclude with a brief overview of corresponding behavioral finance research that should be considered when the task of eliciting risk preferences is undertaken.

The paper is organized as follows:

Section 2 will discuss the initial step of defining risk unambiguously.

Section 3 will discuss the necessity to define the risk measures to be evaluated.

Section 4 provides several approaches to ascertain risk preferences.

Section 5 provides discussion and research in behavioral finance and the natural human biases present when assessing risk.

Section 6 provides a conclusion of the risk preference discussion

Section 7 provides a bibliography for additional reference.

2. DEFINING RISK UNAMBIGUOUSLY

Defining "risk" unambiguously

"Put the CEO, CFO, chief underwriter, and chief actuary in a room and do not let them come out until they agree on something measurable with time frames."

Risk analysis often begins with risk evaluation without first establishing the risk definitions. The failure to first define "risk" and how to measure it can lead to confusion and circular debate about the risk objective. A good initial question is, "What is risk?"

2.1 What is Risk?

Risk is one of those concepts that everyone has an idea about and no two ideas agree, which causes considerable confusion in conversations. As a general starting point, corporate risk can be defined as what makes the executive committee uncomfortable.

Risks and goals are two faces of the same coin, the risks being what will endanger the goals. A few common goals are good profitability, no regulatory problems, good analyst (Best, S&P, etc) ratings, and being well regarded by customers. Some goals reinforce each other, such as strong profitability and maintenance of analysts' ratings. Some goals conflict; a familiar example is wanting both high earnings and stable results.

Identifying corporate goals and considering what can endanger these goals makes it possible to identify specific risks that pertain to corporate goals. Some common examples

are impairment of surplus, excessive variability of earnings, loss of underwriting discipline, or fraud.

A qualitative statement defining risk should be the first step of the process. Discussion of the numbers to be used should come later. For example, "We want our surplus to be large enough to survive a horrible year with ratings intact." Another example is, "We want the probability of insolvency to be acceptably small." The quantifications of "horrible year" and "acceptably small" may provoke considerable discussion and should be only entered into after the qualitative statement is agreed. What is necessary is to first frame qualitative statements so that they *can* be quantified.

Furthermore, there are also often situations where the risk or goal is not quantifiable. For instance, it is difficult to quantify the likelihood and severity of fraud even when the goal is clearly "zero fraud". Similarly, the risk of some previously unknown change in the business environment is always present, exemplified by the emergence of toxic mold claims. In cases such as these, it is better to understand the uncertainty of the measure than to ignore the risk entirely.

Finally, the nature of the businesses themselves will also play a large role in answering the question "what is risk?" For example, it is common among property-casualty ("P&C") insurance actuaries to think of risk in terms of the potential ultimate loss from a block of business. The metric is often net income in some form (such as GAAP net income or return on equity) and the timeframe is usually "ultimate" which can range from a year to several decades, depending on the line of business. While most P&C actuaries are probably aware of other risks (such as balance sheet risk) and the significance of annual timeframes, discussions about risk often implicitly assume that risk is defined entirely in terms of ultimate income.

By contrast, many non-P&C actuaries recognize balance sheet exposure as a main risk, and over a shorter timeframe such as one year. Ultimate profitability remains a central goal, but there is also recognition of the need to remain solvent and to maintain strong writing capacity over the long lifetimes of the products. This perspective arises from the nature of many non-P&C businesses, specifically: longer product timeframes, high renewal rates which require capacity to be available in the future for renewals, and statutory reserve requirements above expected value that utilize capital.

Because of these differences in perspective regarding risk, when P&C actuaries discuss risk management and measurement with Life actuaries, a subtle disconnect can occur. Progress is difficult or impossible until the question "what is risk" is sufficiently discussed and vetted. After doing so, it becomes possible to design and formalize consistent risk policies, methods and tools that can be implemented across an organization.

2.2 Desirable Risk Measures

Desirable measures of risk should be objective, transparent, and appropriate.

An objective measure allows agreement on planning. Whereas "I don't feel good about our GL results" may be correct and valid, saying "We need to get our GL combined below 120" allows acknowledgment of when we have brought matters under control.

A transparent risk measure means that it is a measure that is tractable, and can be allocated to the components that are driving the risk. If one cannot determine which issues are driving a change in the risk measure, the decision-making benefits of having consistent risk measures will not be realized. Furthermore, care should be taken to balance granularity with credibility when this allocation is undertaken.

An appropriate risk measure is one that matches both the business realities and the culture of the firm. It is important for the risk measures to fit well with the corporate culture so that they will gain the necessary acceptance. The good news is that this fit can reduce the number and kind of considerations of risk. The bad news is the same; culture can create blindness toward real business risks or over-concern with risks that do not have significant impact on goals. In general, it is more important to have a risk measure that is approximately correct, but fully accepted, than a perfect risk measure that is not trusted by the key decision-makers.

A "risk measure" is a mathematical formula for measuring risk. Each risk measure implements a particular definition of risk. For example, the measure "90th percentile value-at-risk" is the amount of loss at the 90th percentile. This risk measure implements a particular definition of risk: the maximum amount one expects to lose, over 90% of the modeled possibilities.

"Risk preferences," describe which tradeoffs management is willing to make, in other words which combinations of risks are more acceptable than others. For example, in the

case of ceded reinsurance, management may be willing to accept lower net profitability or even a higher probability of a losing year in exchange for limiting the very worst cases. Risk measures can be used to quantify risk preferences, so that management's risk preferences can be stated in risk management policies and implemented more objectively.

2.3 Context and Other Key Considerations

In order to facilitate the definition of risk and the determination of the appropriate risk measures, the context of the organization must be taken into account. Many issues surrounding the organization and its key managers will affect the ability to develop the consensus. The risk preferences that a company agrees on will reflect these considerations.

For instance, how managers are measured will determine what they do. A company's incentive system is a critical context element that has significant influence on the company's operational risk preferences. Furthermore, metrics and goals typically have time frames associated with them, which is another context element. Time frames for goals and the associated metrics can be designed to be consistent with owners' investment goals, which may vary anywhere between long-term investment and short-term gain.

Other contextual elements of the organization that can influence management's stated risk preferences. Issues such as corporate culture, the financial strength and size of the organization, and the individual manager backgrounds can all influence risk attitudes.

2.3.1 Corporate Culture

The age of the organization matters. A startup company is often confident in its expectation of better-than-average claims experience. This confidence may diminish later with experience.

The tenure of the current management matters. A new CEO, or management team, brought in to "fix things" is likely either to take risks previously avoided or to drop all the perceived risky elements of the prior regime, going to one extreme or the other.

The way compensation is structured can create a short-term view in management, or a divisional rather than a corporate view. Whether the company is organized in a centralized, or de-centralized reporting structure will also influence these views.

2.3.2 Size of firm, financial strength and ownership structure

A financially strong company could be willing to take a risk of a larger loss in the short term because its management may feel that the potential reward is worth the risk, given that the company will be solvent and operational in any case.

At a certain level of market share, firms become more risk tolerant, feeling they are too big to fail. Alternatively, they may assume because of their success that they know all the situations and answers. This can lead to risk tolerance because of ignorance of changes in their environment. On the other hand, a company with a track record of good returns may become more risk averse in the hope of maintaining the gains previously achieved.

A financially weak company, with perceived risk of going out of business, will be willing to take more risks. For example, they may decrease current costs by running up the retentions on their reinsurance, gambling on not being hit. If it works, they may continue to do so. *This used to be known as Russian roulette.*

A closely held company's management can be expected to make decisions that reflect the owners' particular risk preferences. An otherwise identical company that is broadly held by the public would probably be managed with a different approach to risk. The term "context" as used here refers to the environment in which risk-return tradeoffs are evaluated, two key considerations being capital structure and financial condition.

2.3.3 Individual Manager Background

The time element of the person's career matters. A person new to the organization is more willing to run risks than a person longer at the organization. A person near retirement who wants to go out quietly and not have anything bad happen will be very risk averse short term, but may also be quite risk tolerant regarding hazards that will not manifest for several years.

The experiences of the manager matters. A manager with a sales background may tend to focus on top-line issues, while one with a financial background may focus on financial issues. Similarly, a manager with a life insurance background may tend to focus on asset market risk and changes in policyholder persistency, while a manager with P&C experience may focus more on natural catastrophe risk and reserve risk.

3. ASCERTAINING RISK MEASURES

Interviewing is the prime method. This should be done with individuals separately, and then reconciled in a group. The interviewer needs to keep in mind the pitfalls of interview methods and of the particular corporate culture.

Nigel Taylor [5] has mentioned a number of sources of bias in interviews, especially around the framing of questions. These biases come up in all phases of risk analysis. Some of the important effects are

- Decisions are often made by adjusting from an existing position (anchoring)

- People are risk averse when facing gains but become risk seeking when facing losses (prospect theory)

- The frequency with which something is monitored can impact the decision (myopic loss aversion)

- People have a tendency to ignore underlying probability distributions

- Almost everybody is overconfident

On the last note, a problem is how to make possible bad scenarios real enough to be considered. The best way is for them to have actually happened, and questioning done after the event may give quite different answers compared to before the event. This can be due to a change of perception of the risk or a change of risk tolerance.

The interviewer should understand the corporate culture because it may be necessary to suggest areas of concern, if only to have them listed for prioritization. For completeness we need to get the cards on the table, going out far enough so that we are reasonably sure that nothing important has been left out.

For risk measures to be both useful and used, group reconciliation is usually necessary. Whether the organization elects a single person to make a decision or builds consensus on how to measure risk, it is critical to the success of determining organizational risk preferences. Without consensus, the independent utility functions for each decision maker will pose conflicting views of risk preference. While each individual possesses a unique and independent utility function, the determination of the corporate utility is necessary in evaluating the tradeoffs the organization is willing to exchange. The composition of the

group will depend on the corporate structure, and in the end it may only be advisory to a single decision-maker.

Formal techniques, such as the Delphi method, can be used to reach either consensus or at least understanding of why there are outliers. The Delphi technique begins with a few simple questions to gather general feedback. From the initial responses, additional questions are presented and elaboration of the original responses is solicited. The process continues until no new ideas or suggestions are proposed. At this point each participant provides a ranking of the proposed ideas and concepts. Scores are tallied and results are shared with the participants of the process.

As with any tool, abuses and misuses can be identified. While the tool could be used to impose a preset agenda upon the participants, the intent is to produce a solution by which the majority of respondents needs are met. More details on the Delphi Technique can be found in the suggested readings in the bibliography.

Another tool used to build consensus and determine preferences is the quality functional deployment, or QFD, approach [4]. This tool is commonly used in "six sigma" process improvement efforts. The method begins with identifying:

- all possible alternatives,

- key variables, and

- the trade-offs being evaluated.

For each of the preference variables, a weight is assigned to reflect the importance of that variable to the decision makers. Then scores are assigned to each variable's possibilities using a high / medium / low system such as high = 5, medium = 3, and low = 1. The score for an alternative is the weighted total of its scores on each of the variables. Alternatives with higher scores are more preferable. The main challenge with this approach is agreement on the weight assigned to each criteria and the scoring system to use.

4. ASCERTAINING RISK PREFERENCES

A common approach to analyzing the tradeoffs in risk amongst several alternatives is to examine the tradeoffs present in the expected outcomes of the results. Traditional tradeoff models generally select a single measure for reward such as the mean net income, return on

capital, etc. and compare the result to a single risk measure such as standard deviation of the outcome, TVaR, or some other measure of risk. This makes an analysis of risk-return trade-offs tractable through the use of efficient frontiers or other frameworks.

Using one dimension for return and one for risk brings simplicity but is incomplete. For example, there are multiple variables capturing different goals of the company, including capital, premium, and underwriting income. Each variable's outcome has some degree of importance, which can vary depending upon the scenario. For instance, capital volume becomes more important in scenarios where it becomes very low.

Evaluating each variable separately or together in a composite formula misses the interaction effects among the variables and their varying degrees of importance when faced with decisions having numerous alternatives. When making decisions to act upon a suggested strategy, we are attempting to assess the expected results and the risk of adverse results associated with that strategy across all key variables. One method to achieve this understanding of risk preferences is conjoint analysis.

Conjoint analysis is a marketing research tool used to elicit preferences from potential purchasers of product or services based upon the underlying characteristics of those products and services. Eliciting risk preferences is concerned with determining the acceptable tradeoffs among various business risks, analogous to the tradeoffs people face in evaluating which products and services to purchase. As such, conjoint analysis is a potentially useful method for the risk application. Risk utility curves can be constructed utilizing the conjoint analysis approach, modifying the method to elicit risk preferences rather than purchasing preferences.

Conjoint analysis is based on a model that uses the following considerations:

- Context: Company characteristics that are not expected to be changed

- Attributes: Company characteristics that are expected to be influenced by company strategy

- Levels: Measurement system for attributes.

Defining too many attributes and levels to measure upon will increase the number of questions needed to ask the survey respondents to stabilize the model. Fewer questions can be selected sacrificing the predictability of the model. In the construction of a conjoint

analysis, multiple attributes with various levels are identified. The decision makers must evaluate tradeoffs among the attributes. The levels of each attribute are selected based upon the expected outcomes of the risk measures.

In order to explain the utility and preferences of multiple decision makers with multiple variables to consider, let's examine the purchase of a vehicle. The first step in the process is to establish the context of the decision maker. Assume we have two purchasers, a young family of four and a recent college grad, both interested in purchasing a vehicle. They both require transportation, but the utility and preference of each is significantly different given the current financial position and the immediate seating needs, or the context of the user.

To further develop our example, let's assume the purchasers are making the decision to purchase the vehicle based upon the attributes of seating capacity, gas mileage, and cost as an oversimplification. For each of the attributes, we must determine the number of levels within each attribute we wish to evaluate, and for our example assume we have the following table.

	Attributes		
Levels	Seating Capacity	Gas Mileage	Cost
1	2	15 mpg	$15,000
2	4	21 mpg	$25,000
3	6	29 mpg	$35,000

In order to elicit the preference of each purchaser, we need to evaluate the trade-offs and the associated utility of each of the attributes. The survey was constructed in a fashion such that the decision maker selects between numerous tradeoffs. For example, consider these choices:

Choice	Option A		Option B
1	4 Seats, 29 mpg	or	6 Seats, 21 mpg
2	2 Seats, $15000	or	4 Seats, $35000
3	2 Seats, 21 mpg	or	4 Seats, 15 mpg
4	15 mpg, $15000	or	29 mpg, $25000

The family of four might choose Option B for Choices 1, 2, and 3, selecting the need for more seating capacity over gas mileage and cost, while choosing Option A for choice number 4, choosing cost over gas mileage. The recent college grad might likely choose Option A for choices 1, 2, 3, and 4, selecting the lowest cost option regardless of seating capacity. Both parties are interested in maximizing seating capacity, maximizing gas mileage, and minimizing cost. The final decision is dependent upon the interaction of these three attributes (capacity, gas mileage and cost) and the weights placed on the attributes.

To illustrate the interaction, a survey was constructed providing a tradeoff between each attribute, such that no one choice provided a tradeoff along a single attribute, i.e. the combination of 4 seats, 29 mpg versus 4 seats, 15 mpg would not be a valid tradeoff as it is only a tradeoff with respect to gas mileage.

The constructed survey resulted in 54 individual tradeoffs, and 36 possible responses for each attribute. The construction of the survey was such that an equal number of responses for each attribute were collected, eliminating the need for normalization. The survey was completed using the rationale described above for both the family of four and the recent college grad, and produced the following results.

Family of Four   **Recent College Grad**

Response Rate

Levels	Attributes				Levels	Attributes		
	Seating Capacity	Gas Mileage	Cost			Seating Capacity	Gas Mileage	Cost
1	0	11	20		1	12	6	24
2	17	11	12		2	12	12	12
3	19	14	4		3	12	18	0
Minimum	0	11	4		Minimum	12	6	0

The responses rate provides a count of the number of times a specific attribute and level combination was selected. In order to determine the true utility of a specific attribute and level, the difference between the response rate and the minimum value in each column is taken to determine the relative trade off.

Family of Four   **Recent College Grad**

Utility

Levels	Attributes				Levels	Attributes		
	Seating Capacity	Gas Mileage	Cost			Seating Capacity	Gas Mileage	Cost
1	0	0	16		1	0	0	24
2	17	0	8		2	0	6	12
3	19	3	0		3	0	12	0

As can be seen from the results, the family of four prefers vehicles with higher seating capacity, and lower cost, but are indifferent with respect to gas mileage. On the other hand, the recent college grad is indifferent with respect to seating capacity and is looking for the lowest cost, highest gas mileage option. The method can be easily modified to elicit risk preferences by replacing seating capacity, gas mileage, and cost with risk elements such as immediate loss recognition in property losses, delayed loss recognition in liability losses, and net retentions or limits.

The approach provides a basic approach in the application of conjoint analysis. There are more sophisticated approaches and techniques available to perform advanced statistical analysis of the survey responses. The specific application and use of the analysis should be selected based upon the needs of each user.

As with the car-purchasing example, the current context of a company must be considered in the determination of the company's risk preference:

i)   Stock company vs. mutual company

ii)   Life vs. P&C

iii)   Start-up vs. mature

iv)   Primary vs. reinsurer

v)   Global vs. domestic

When evaluating the tradeoffs, the context of the company and the current position will play a large role in the preference of specific risk attributes. In addition, utilizing an approach evaluating the inter-relationship of multiple attributes provides information useful in determining the trade-offs decision makers are willing to make.

The above approach has been simplified to demonstrate a technique capable of eliciting the preference and utility of the decision makers. Various other advanced approaches and techniques using multi attribute decision analysis could also prove useful in the development of risk utility functions such as:

- MAUT - Multi Attribute Utility Theory is the construction of utility curve constructed as a weighted average across multiple attribute dimensions. The Schaefer paper provides a quick overview of the tool with some rules for application.

- QFD – Quality Functional Deployment is a structured methodology to identify and translate customer needs and wants into technical requirements and measurable features and characteristics. It assigns weights to how well the requirement meets each need. This site provides step-by-step instructions for implementing QFD. A simple application using the car-buying example follows. Suppose six cars are available on the market with the following characteristics.

	Attributes		
Car	Seating Capacity	Gas Mileage	Cost
1	2	15 mpg	$15,000
2	4	21 mpg	$25,000
3	6	29 mpg	$35,000
4	2	21 mpg	$35,000
5	4	15 mpg	$15,000
6	6	21 mpg	$25,000

Each attribute has three values, affecting the car's desirability. In this example, assume that both the family and the college grad want to spend as little as possible on the car and prefer higher mileage, all else being equal. The family needs a lot of seating capacity, while the college grad would prefer a sportier 2-seater. For this example, assume that the most desirable value for each attribute receives a score of "9", the next best receives a "5" and the least desirable receives a "1". For instance, car 1 costs only $15,000 and gets a "9" on price, while car 3 costs $35,000 and gets a "1" on price. The score for a car's seating capacity depends on whether the family or the college grad is doing the scoring.

QFD's for the family of four and the college grad would lead to different "best choice" candidates, reflecting the family's and the college grad's different preferences:

Family of Four

	Car					
Need	1	2	3	4	5	6
Price	9	5	1	1	9	5
Seats	1	5	9	1	5	9
Mpg	9	5	1	5	9	5
Total	19	15	11	7	23	19

Recent College Grad

	Car					
Need	1	2	3	4	5	6
Price	9	5	1	1	9	5
Seats	9	5	1	9	5	1
Mpg	9	5	1	5	9	5
Total	27	15	3	15	23	11

There are many alternative approaches and methods of which include:

- SMART - Simple Multi-Attribute Ranking Technique

- AHP - Analytic Hierarchy Process compares all possible combinations of each pair of attributes and assigns weights to each pair-wise comparison. This site provides an overview and example of AHP.

- WORA - Weighting determined based upon Ordinal Rankings of Alternatives

While no one method is clearly superior to another in all applications, incorporating multiple attributes and using simultaneous evaluation provides a useful approach in determining tradeoffs.

Through all of the analysis, the outcomes are normative, not definitive. In other words, the approach is intended to provide an approximation of the preference of the decision maker that allows for testing hypotheses regarding future decisions. However, as noted in the construction of the survey, we must be careful to weigh the impact of emotions and current context and how these influence the decisions made.

5. BEHAVIORAL FINANCE RESEARCH

In the previous sections, we have advocated the use of surveys to elicit risk preferences. These surveys can be a valuable exercise, but it is important to understand their limits.

Human biases in evaluating risk have to be anticipated when designing methods to elicit risk preferences. Results from risk surveys often appear to contradict one another, even when the questions pose simple scenarios to the same people. The discussion below gives a brief introduction to the vast literature in behavioral finance, and is intended to give the reader a sense of the field. Most of the examples are taken from Bazerman [1] or Kahneman, Slovic and Tversky [3], both of which provide comprehensive introductions to the subject.

5.1 Framing

Taylor's paper [5] provides a number of experimental results from behavioral finance and explains their implications for actuarial work. The paper also discusses methods to mitigate effects from biases and errors. As an added bonus, the paper is easy to read and written in an entertaining style.

One example from the paper deals with how questions are framed. In an experiment conducted by Slovic, Fischhoff and Lichtenstein, people were presented with two options:

Option 1: A 100% chance of losing $50

Option 2: A 25% chance of losing $200, and a 75% chance of no loss

About 80% of subjects chose option 2, which is consistent with the usual finding that people exhibit risk-seeking behavior when confronted with choices among losses.

The experiment was repeated with option 1 re-worded but having the same result:

Option 1: An insurance premium of $50 to avoid a 25% chance of losing $200

Option 2: A 25% chance of losing $200, and a 75% chance of no loss

Here, 65% of subjects chose option 1. Quoting Taylor, "When a sure loss is presented as an insurance premium most people become risk-averse rather than risk-seeking."

Sensitivity to framing means that the questions used to elicit risk preferences from a company's management have to be carefully designed and examined to know whether framing biases might be present. One possible way to deal with this is to use a several questions that frame a particular risk preference in a variety of contexts, and evaluate the entire group of responses.

5.2 Insensitivity to Sample Size and Conjunction Fallacy

Kahneman and Tversky [3] have published many papers that chronicle the surprising results consistently obtained from relatively simple behavioral experiments involving risk and judgment. For example, in one experiment subjects were given a description of a man and told that he was drawn from a group of 70% engineers and 30% lawyers. The description used generic phrases such as "high ability" and "well liked"; this description was specifically designed to give no information regarding the man's occupation.

Subjects generally estimated the probability of "engineer" to be 50%, even though the correct probability with no additional information is the a priori probability, 70%. Subjects also estimated the probability at 50% when told that the man was drawn from a group of 30% engineers and 70% lawyers. The a priori probabilities, which were the most important information, were disregarded in the presence of rich, descriptive details even when those details were statistically neutral.

The underlying model of reasoning often used is "heuristics," which are decision-making short cuts that allow people a simple way of dealing with a complex world. Examples of heuristics are:

- "never play for an inside straight" from poker

- "only spend 35% of your income on housing" from mortgage lending

The heuristics model contrasts with models of rational behavior, or bounded rational behavior, which is rational behavior with limited information and resources. The model of heuristics is perhaps more descriptive of actual human reasoning, while the rational behavior models represent more internally consistent, idealized decision-making.

All of these models are discussed in Bazerman [1] which offers a comprehensive overview of many behavioral finance issues pertinent to eliciting risk preferences.

Another recent contribution to the literature [2] discusses elicitation of probability distributions in light of the necessary behavioral context. This paper also has a comprehensive bibliography, providing guidance to the pertinent literature on behavioral finance.

The above example shows the "representativeness" heuristic, the fact that people will tend to judge probability based on descriptive factors and will discard other relevant data when descriptive data is available.

Insensitivity to prior probabilities is only one of several flaws produced by the representativeness heuristic. Others include insensitivity to sample size (judging an unusual outcome to be equally likely for small and large populations), conjunction fallacy (misestimation of compound probabilities) and the illusion of validity (overconfidence in a prediction when factors that limit predictability are present). Examples of two of these are:

Insensitivity to Sample Size

A town is served by two hospitals, one with 45 births per day, and the other with 15. For a period of 1 year, each hospital recorded the days in which more than 60% of the babies born were boys. Which hospital do you think recorded more such days? (a) The larger hospital; (b) The smaller hospital; (c) About the same (that is within 5% of each other).

Bazerman indicates that most people choose (c), not recognizing the fact that it is more likely for a smaller sample to exceed 60% than for a larger sample. .

Conjunction Fallacy

Linda is 31 years old, single, outspoken, bright, and deeply concerned with issues of social justice and discrimination. Rank the following in order of probability: (a) Linda is a teacher in an elementary school; (b) Linda is active in the Feminist movement;(c) Linda is a psychiatric social worker; (d) Linda is a bank teller; (e) Linda is an actuary; (f) Linda is a bank teller who is active in the feminist movement.

People tend to rank (f) as more likely than (d) even though (f) is a subset of (d).

Biases based on representative characteristics may be stronger in group settings.

Heuristics can be beneficial when used correctly. The danger with heuristics is when they are used in inappropriate situations. Three general heuristics that create potential for systematic error are:

- The Availability Heuristic – Vivid, emotional events are more easily remembered than bland, vague events. This will lead to an over-estimation of the likelihood of events that can be easily recalled when compared to equally likely events that are not as easy to remember.

- The Representative Heuristic – When making a judgment about individuals, people tend to look for traits that correspond with previously formed stereotypes. This becomes problematic when individuals rely on a representative heuristic strategy even when information is insufficient and/or when better information exists to base a decision upon.

- Anchoring and Adjustment – People make assessments by starting from an initial value and adjusting to yield a final decision. In ambiguous situations, trivial issues may become the anchor from which further analysis develops.

5.3 Biases Due to Anchoring and Adjustment

Whenever we try to estimate likelihoods, we tend to seek out an initial anchor, which often weighs strongly in our decision making process. Our experience teaches us that starting from somewhere is easier than starting from nowhere, but we frequently over-rely on these anchors and fail to question their validity to the problem to which they are being applied. Many times we fail to even recognize that these anchors affect our final decision.

5.3.1 Conjunctive and Disjunctive Events Bias

Which event is more likely: (a) drawing a red marble from a bag of 50% red, 50% white marbles; (b) Drawing a red marble 7 times in a row with replacement, from a bag containing 90% red, 10% white marbles; (c) Drawing at least 1 red marble in 7 tries, with replacement, from a bag containing 90% red, 10% white marbles?

This example should be a piece of cake for actuaries; however, most people incorrectly order the likelihood b-a-c, not c-a-b because of anchoring. They feel b remains "close" to 90%, and c remains close to 10%. The impact of this bias is that in a complex system, when several items can cause failure, people tend to concentrate on the small probability of each individual item causing a failure, and miss the cumulative effect that the probability at least one component will fail can become quite large. Executives' attitudes about risk could be affected similarly.

5.3.2 Hindsight and the Curse of Knowledge

After finding out the results of an uncertain event, people tend to over-estimate the degree to which they would have predicted the correct outcome. For instance:

You are an avid football fan, and you are watching a critical game with your team behind 35-31. With 3 seconds left, and the ball on the opponent's 3-yard line, a pass play into the corner of the end zone is called. When the play fails, you shout, **"I knew it was a bad play."**

5.4 Actuaries Demonstrate Many of These Biases

Surveys were conducted with a number of actuarial students sitting for fellowship exams. Surprisingly, these students demonstrated common biases in their risk preferences: overconfidence, representativeness, and regret as discussed below. The survey questions are slightly modified versions of questions from Bazerman [1].

5.4.1 Framing

Two groups of actuarial students were randomly selected and each person was given either Version 1 or Version 2 of the questions shown below.

In both versions, the student was offered two choices. One choice had a guaranteed outcome (the risk averse choice). The other choice (the risky choice) had two possible outcomes giving the same expected value as the guaranteed outcome.

The possible outcomes (and their probabilities) are the same in both versions. The only difference is how the questions are framed. In one version, the guaranteed outcome is presented as an option to purchase "insurance" to avoid a possible bad event. The other version presents the same choice as an option to gamble and hope for a better outcome.

The questions and the summary of the selected responses were as follows:

Elicitation and Elucidation of Risk Preferences

Version 1	Version 2
Question 1	Question 1
In addition to your initial wealth, you are given $1,000 and then have to choose from among the following choices:	In addition to your initial wealth, you are given $2,000 and then have to choose from among the following choices:
A) Receive $1,000 with probability p=.5 or receive$0 with probability p=.5.	A) Lose $1,000 with probability p=.5 or lose $0 with probability p=.5.
B) Receive $500 with probability p=1.	B) Lose $500 with probability p=1
Results: *A: 25*	*Results:* *A: 60*
B: 72	*B: 35*
Question 2	Question 2
Imagine you have just learned that the sole supplier of a crucial component is going to raise prices.	Imagine you have just learned that the sole supplier of a crucial component is going to raise prices. The price increase will cost the company an additional $6,000,000 in supply costs.
Two alternative plans have been formulated to counter the effect of the price increase. The anticipated consequences of these plans are as follows:	Two alternative plans have been formulated to counter the effect of the price increase with savings in other parts of the company. The anticipated consequences of these two plans are as follows:
Plan A) If this plan is adopted, the company's costs will increase by $4,000,000.	Plan A) If this plan is adopted, the company will save $2,000,000 in operating expenses.
Plan B) If this plan is adopted, there is a 1/3 probability that there will be no cost increases, and a 2/3 probability that the company's costs will increase by $6,000,000.	Plan B) If this plan is adopted, there is a 1/3 probability that the company will save $6,000,000 in operating expenses, and a 2/3 probability that no savings will be achieved.
Results: *A: 36*	*Results:* *A: 84*
B: 61	*B: 12*

Note that Question 1 leads to the same overall outcomes in Version 1 and Version 2: $1,500 guaranteed or equal probability of either $2,000 or $1,000. However, when the question was framed in terms of gains (Version 1), students overwhelmingly chose the Risk Averse choice. When the essentially identical problem was framed in terms of losses (Version 2), the majority selected the Risky choice.

A similar result occurred with Question 2. In both cases, the outcomes are the same in Version 1 and Version 2: extra costs of $4 million guaranteed or a 1/3 probability of no extra costs and a 2/3 probability of $6 million extra costs. However, when the question was framed in terms of *gains* (Version 2), the overwhelming majority selected the Risk Averse choice. When framed as a *loss* (Version 1), the majority selected the Risky choice.

More interestingly, the majority of the students who received Version 1 chose the Risk Averse choice for Question 1 but the Risky choice for Question 2. Similarly, the majority of the students who received Version 2 chose the Risky choice for Question 1 but the Risk Averse choice for Question 2. Thus, the same students chose differently, depending on the presentation. These students showed a preference not to gamble when it was presented as a possible gain. They showed a preference to gamble when the risk-averse choice was presented as insurance.

Taken together, these results demonstrate the results obtained in numerous studies. Attitudes towards risk can change in different situations and can be influenced solely by the way choices are framed (or the way choices are *interpreted*).

5.4.2 Overconfidence

Another experiment tested whether these actuaries demonstrated overconfidence. Eighty actuarial students were given the following two questions:

1. Listed below are two uncertain quantities. Write down your *best estimate* of these quantities without looking up any information on these quantities.

Wal-Mart's 1999 Revenue: _____

Plastic Waste Generated in the U.S. in 1993, in tons: _____

2. Listed below are the two uncertain quantities from the previous question. Put an upper and lower bound around your estimate, so that you are 95% confident that your range surrounds the actual quantity.

	Lower	Upper
Wal-Mart's 1999 Revenue:	_____	_____
Plastic Waste Generated in the U.S. in 1993, in tons:	_____	_____

Of the answers given, only 23 of the eighty confidence intervals were wide enough to include the actual Wal-Mart revenue ($166.8 billion) and only 25 of the eighty confidence intervals were wide enough to include the actual amount of waste (19.3 million tons). These figures include those results where the confidence interval could be argued to have been too wide (e.g. "0 to 100 trillion").

These results are consistent with other published results of overconfidence when making estimates with substantial uncertainty.

5.4.3 Representativeness

Eighty actuarial students were also given the following question:

Linda is 31 years old, single, outspoken, and very bright. She majored in philosophy. As a student, she was deeply concerned with issues of discrimination and social justice and she participated in antinuclear demonstrations.

Rank order the following eight descriptions in terms of the probability (likelihood) that they describe Linda:

a. Linda is a teacher in an elementary school.

b. Linda works in a bookstore and takes yoga classes.

c. Linda is active in the feminist movement.

d. Linda is a psychiatric social worker.

e. Linda is a member of the League of Women Voters

f. Linda is a bank teller.

g. Linda is an insurance salesperson.

h. Linda is a bank teller who is active in the feminist movement.

Highest Probability -----------------------------Lowest Probability

_____   _____   _____   _____   _____   _____   _____   _____

Notice that choice *h* – "Linda is a bank teller who is active in the feminist movement" is a subset of choice *f* – "Linda is a bank teller". However, because the description of Linda is representative of a person who might be active in the feminist movement, people tend to rank *h* higher than *f*. Of the eighty responses (from experienced actuaries), 52 made this error.

5.4.4 Regret

Eighty actuarial students were given the following question (79 responded):

You are out of town at a business meeting that runs late. As soon as you can break away, you head to the airport to catch the last flight home. If you miss the flight, which is scheduled to leave at 8:30 PM, you will have to stay overnight and miss an important meeting the next day. You run into traffic and do not get to the airport until 8:52 PM. You run to the gate, arriving there at 8:57 PM. When you arrive, either:

(A)   You find out that the plane left on schedule at 8:30 PM, or

(B)   You see the plane depart, having left the gate at 8:55 PM.

Which is more upsetting (circle one)?   A   B   Neither

Of the eighty responses, 60 felt that *B* was more upsetting, 16 were indifferent and 3 felt that *A* was more upsetting. Perhaps there are things that matter to people when making decisions under uncertainty that are not usually captured in economists' models of utility, such as regret avoidance. Or perhaps, the lesson is that when we do experience "regret", we need to be careful how we evaluate our decisions. If we had no reinsurance last year in Florida, and the wind blew, we felt a lot of "regret". We shouldn't let this regret encourage us to pay too much for reinsurance this year.

6. CONCLUSION

Our intent in this report is to raise awareness of the benefits of formally eliciting risk preferences for a company. This effort can lead to a mutually agreed upon framework to evaluate potential strategies. Introductions to techniques and references are provided for interested readers to use in pursuing the subject further.

7. REFERENCES

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