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## Modeling the Economic Impact of Individual and Corporate Risk Attitude

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### Abstract

Walls' work [1, 2], based around Expected Utility Theory [3], has highlighted the relationship between corporate risk tolerance and value; and others have commented on the loss of value resulting from companies behaving in a non-risk-neutral manner (i.e. not using expected value (EV) to make decisions) [4].

Prospect Theory [5], however, extends Utility Theory [3] to describe decisions individuals actually make under uncertainty. Key features include: diminishing utility of returns, resulting in risk aversion for gains and risk seeking for losses; use of "decision weights" rather than probabilities; and asymmetry between losses and gains, with people weighting losses more heavily. All three effects impact on a person's risk tolerance (i.e., how risk averse or risk seeking they are).

We present four studies highlighting the impact of Prospect Theory on decision value and, particularly, changes in decision value resulting from differences between individual and company risk tolerances. Study one shows losses resulting from risk aversion due to diminishing returns, discussing and comparing individual and corporate risk tolerances; the second highlights the impact of using decision weights; and the third the effect of loss/gain asymmetry. The fourth study is not directly based on Prospect Theory but rather shows the effect of the chance of ruin [6] on risk tolerance.

Results indicate that the Prospect Theory effects cause changes in risk tolerance resulting in lost value compared to risk neutral decisions and that this is strongest when the probability of success is low. Any difference between individual and corporate risk tolerances also impacts on value. The results of the fourth study, conversely, show why it can benefit an individual or (less often) a company to be risk averse, as this is demonstrated to reduce the chance of ruin and thus can increase EV in the long run.

Finally, we discuss the implications of these findings for corporate and individual decision makers, arguing that the corporate risk tolerances observed by Walls [1, 2] are, in fact, aggregated individual risk tolerances which should be compared to *ideal* corporate risk tolerances calculated using the chance of ruin for a company with a particular portfolio of investments.

### Introduction

In the oil and gas industry, where decisions regarding uncertain options are regularly made, it is necessary to understand the way in which people make decision under uncertainty in order to determine: firstly, whether these decisions differ from rational behavior; and, secondly, how this impacts on the economic outcomes for the individuals and companies involved. By now, many in the oil and gas industry will be familiar with the concept of risk attitude as described in the psychological and management literature (see, e.g., [7]). At its simplest, risk attitude divides peoples reactions when making decisions under uncertainty into three categories: risk neutral, when people are indifferent between a certain and uncertain option with equal expected value (EV); risk seeking, when people prefer the uncertain to the certain option despite equal EV; and risk averse, where the certain option is preferred despite the equal EV. As such, risk attitudes other than risk neutrality are deviations from rational theories of decision making [3], which prescribe that decisions should be made on the basis of EVs.

Prospect Theory [5], first introduced to the industry in 2003 [4], is, by comparison, a descriptive theory of decision making – that is, it describes the manner in which people actually make decisions rather than dictating how decisions should be made. As such, it attempts to explain the way in which people evaluate and decide between options so as to explain observed patterns of choice and preference. Risk attitude is thus one of the occurrences that Prospect Theory sets out to explain.

Starting with the primary observation that people tend to be risk seeking when dealing with losses and risk averse when dealing with gains, Prospect Theory argues that this results from the diminishing utility of money, first described by Bernoulli [8] in the 1700s, which holds that the subjective (and, to some extent, objective) utility of money does not increase in a linear fashion. Rather, the utility of money is monotonically increasing and concave such that having twice as much money is judged less than twice as useful. This causes risk aversion in decisions made under uncertainty as the *utility* of a 50% chance of \$100