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Modeling the Economic Impact of Cognitive Biases on Oil and Gas Decisions

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Abstract

Cognitive biases have long been known to impact decisions taken under conditions of uncertainty [1, 2]. Previous demonstrations of these biases, however, have focused on their impact on a single, typically technical, parameter judgment rather than examining their potential impact on economics when applied to all of the judgments involved in a complex Oil and Gas (O&G) decision such as reservoir characterization. Herein, we model the impact of three individual biases – *overconfidence* [2], bias resulting from the *trust* heuristic [3] and *availability* [4] - to measure their effect on economic outcome as represented by NPV.

All three biases are shown to have marked effects on the estimated value of a project, not just its uncertainty. Overconfidence at the levels people commonly demonstrate shown to result in a \$259 million dollar mistake in calculating NPV in our modeled decision – making a project with a negative NPV seem to have a positive NPV. Availability bias, as modeled herein, similarly acts to increase the *apparent* NPV of a project – making a project actually likely to result in a \$55 million dollar loss seem to have an NPV of up to \$329 million.

The trust heuristic differs slightly in that its use, rather than actively causing bias, prevents the use of techniques that reduce overconfidence. The model shows that incorporating the views of five experts rather than accepting the values provided by the best of the five reduces overconfidence by 10%, even when agreement between the experts is high. Referring this back to our overconfidence model results, we note that this equates to a difference of up to \$125 million in the mean NPV of the project.

On the basis of our findings, we argue that industry personnel be educated in the psychological limitations affecting decision making as awareness of their existence is the first step in reducing their effect [5]. Further, the inclusion of such material in petroleum engineering and geosciences

curricula would be an effective way of ensuring that knowledge of cognitive biases spreads across the industry [6].

Introduction

Cognitive biases are unconscious errors in judgments and decisions (in particular those made under conditions of uncertainty) that arise from the inherent structure and functioning of the brain's cognitive architecture [1]. These errors affect the majority of subjective judgments of probability and value and are potentially multiplicative – with the same biases able to affect multiple parameters and thus have an impact that increases with the complexity of calculations made using those parameters.

The effect of specific cognitive biases such as overconfidence [7] on judgments made by oil and gas personnel has been repeatedly demonstrated over the last three decades – both on general knowledge questions and questions more closely related to the personnel's field of expertise [see, e.g., 2, 8]. The impact that such biases can have on the complex decisions undertaken in the oil and gas industry, however, has not yet been assessed.

Part of the reason for this, no doubt, is the perceived difference in scale between the simple judgments that biases operate on and large exploration and development decisions. This difference is, however, largely illusory as the largest industry decisions are, at their base, dependent on the judgments of individuals and are, thus, vulnerable to any biases that affect those individuals.

Of course, this is not to ignore the fact that many industry decisions are made by teams but evidence from recent work [3] suggests that, in many cases, the “team” decision is actually based largely on the judgment of the most trusted member of that team. Additionally, while it is well known that having a team of experts can produce more accurate responses [9], if this is not done in a carefully controlled manner it can lead to consensus decisions that are actually more biased than individual judgments [10]. Thus arguments based upon the biases displayed by individuals are not necessarily avoided by invoking group decision making.

One area of oil and gas decisions that seems particularly vulnerable to biases is the choice of distributions for the input parameters that go into simple volumetrics calculations. That is, such parameters as average porosity, net-to-gross and formation volume factor. Given the high degree of subjectivity in assessing these distributions, and the difficulty of calibrating the assessments, they are extremely susceptible to cognitive bias.