

## WHEN UNCERTAINTY IS BENEFICIAL: INTERESTING IMPLICATIONS FOR THE HYDROCARBON DISCOVERY PROCESS

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Consider a basin with remaining undiscovered fields, in which both field sizes and their number are uncertain. Assuming that the probability of finding a field is increasing in its size, we show that the expected size of the *first* remaining field discovered, which is of particular importance, is *increasing* in the variability of field sizes, and results from a simulation model of exploration illustrate this trend for the first several fields discovered. We also provide simple bounds on the expected size of the first field discovered. It seems that more information (less variability) leads to less value—something unexpected. We explore and explain this seemingly counterintuitive result.

Suppose that the probability of selecting an item from a set is increasing in the item's size. A case in point is the hydrocarbon discovery process, where it has been observed that the probability of discovering a particular field within a basin is increasing in the field's size (e.g., Arps and Roberts 1958, Barouch and Kaufman 1976, Power and Fuller 1991). This is akin to other common observations, like finding a grownup's socks in the wash before the baby's or quarters in your pockets before the pennies. How would then the expected size of an item selected (first) of those remaining be influenced by the variability of sizes? We prove that even for a population with a fixed mean the expected size of the item selected is *increasing* in the variability. Thus the more uncertain the sizes of remaining fields, the larger the expected size of the field found first. This observation has a seemingly counterintuitive implication for hydrocarbon exploration, since it seems to imply that improved geological knowledge of a certain type, i.e. which reduces field size uncertainty and leaves mean field size unchanged, will reduce the expected size of the first field found. Loosely speaking, it seems that *more information leads to less value*—something rather

unexpected if we are accustomed to prefer less variability, e.g., in financial decisions. In this paper, we explore and explain this seemingly counterintuitive result.

We also derive simple upper and lower bounds on the expected size of the next field found.

The expected size of the first, or first few, remaining fields discovered in a basin is particularly important because although all, or most, of the economically viable fields will eventually be discovered with enough exploratory effort, discounting of potential values of discoveries makes the early ones of greatest interest. Faced with a choice between drilling expensive exploratory wells in one basin or another, a company's decision may depend on the expected sizes of the first few discoveries in the basins. The actual size(s) of the first field(s) discovered may not follow this pattern but the observation that their expected size(s) do is informative for planning purposes.

### THE MODEL

Let  $X_1, X_2, \dots$  be identically distributed nonnegative random variables, and let  $N$  be a positive integer-valued random variable, independent of the  $X_i$ 's. In the context of

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