

# Option Valuation by Simulation

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## Outline

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- **What is Simulation?**
- **Why Simulate to Obtain Value?**
- **General Procedure**
- **Examples**
  - **Antamina Mine**

## What is Simulation?

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- **Simulation is a procedure to replicate the consequences of a probabilistic process**
- **Procedure consists of**
  - **Sampling a process (Ex: the distribution of the quality of ore in a mine), to...**
  - **Obtain a value of a parameter (Ex: ore quality)**
  - **Calculating the consequences of that factor (Ex: the profit from that mine)**
  - **Repeating 1000's of times, to get probability distribution of consequence (Ex: of profits)**

## Use of Simulation is New

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- **Recent software makes simulation feasible**
- **1000's of repetitions in seconds**
  - **Crystal Ball and other packages**
- **Often, model of consequences simple, for example, spreadsheet modeling profits**
- **See example to follow**

## How is Option Value Calculated?

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- **Step 1: Get distribution of consequences (Ex: profitability of Mine) and expected NPV**
- **Step 2: Assume option exercised only in favorable circumstances, thus drop unprofitable outcomes from distribution => a revised NPV**
- **Step 3: Value of Option is difference**

## Why Simulate Option Value ?

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- **To explore options on actual distributions**
- **Binomial Options Analysis**
  - Presumes known ‘random’ variation (Ex: stock or commodity prices) -- OK for traded assets
- **Decision Analysis**
  - Can use known variations, but can be “messy”, especially if we want to combine distributions
- **Simulation is a middle way**

## Requirements for Simulation

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- **A Model of Behavior of System**
  - Ex: Profit for Mine as function of: ore quality, quantity; cost of mining; value of metal
- **Distributions for Key parameters**
  - Best estimates (Ex: ore quantity, quality)
  - Engineering Calculations (Ex: Process Cost)
  - Market Data (Ex: variation of metal price)
- **See Example to follow**

## Use of Simulation for Option Valuation

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- **Both types of real options**
  - “on” projects, where technology is a “black box”
  - “in” projects, which involve options designed into project
- **Antamina Example**
  - Option on development of mine, that depends strictly on contract with Government
  - Option created by changing nature of project (Ex: building port facilities to enable expedited development if that path chosen)