Monte Carlo Simulations

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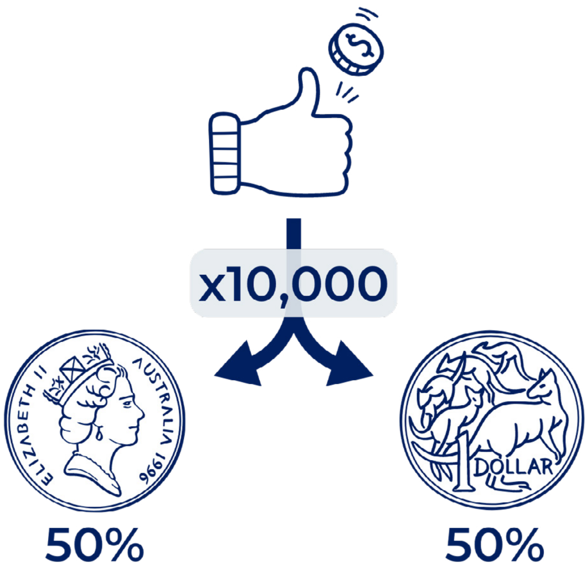
Confrontning Uncertainty

"Uncertainty is a fact of life in valuation, and nothing is gained by denying its existence. Simulations offer you an opportunity to look uncertainty in the face, make your best judgments and examine the outcomes. Ironically, being more open about how wrong you can be in your value judgments will make you feel more comfortable about dealing with uncertainty, not less."

– Aswath Damodaran,
"DCF Myth 3.2: If you don't look, it's not there!"

A Monte Carlo simulation (MCS) is one of many types of financial simulations and is Qube's approach of choice when dealing with the uncertainty inherent in investment valuations. If we define a simulation as a single instanced depiction of reality and its resulting phenomenon, then a MCS would be a large sampling of repeated instances and its resulting phenomenon.



For example, tossing a coin and having it come up as heads would be a simulation on the probability of a coin toss. If we tossed the coin 10,000 times and summarized these results, we would probably find a 50/50 split between heads and tails. In repeating the simulation 10,000 times, we have **clarified the uncertainty,** inherent in a coin flip, by **observing** that there is a 50% probability of the coin coming up as a head or a tail.

Contrast this approach with a simpler but less accurate calculation: dividing 1 possible outcome from 2 potential outcomes. The approach using multiple, repeated instances—along with the resulting probability distribution—define a Monte Carlo simulation.

Historical Applications and Challenges

The MCS approach to understanding uncertainty is not new. It was first developed and used for the Manhattan Project during World War II to solve key problems that were too complex for conventional mathematical methods. While the MCS approach was successful in guiding the design of a working atomic bomb, trying to replicate these methods in a setting without the limitless budget of wartime America proved challenging.

The largest problem is the **computational power** necessary to replicate thousands, if not millions, of possible combinations. The value of the MCS approach increases as more combinations are tested in the model.

The second problem, relevant to investment valuation, is **access to timely, accurate and reliable data.** Historically, this data was (and still is) jealously guarded for competitive advantage purposes. Even now, easy access to publicly available, financially related information can cost you upwards of **$35,000 CAD per year[1].**

Technology has progressed a long way since World War II. With faster computers being produced, the MCS approach has seen increasing adoption in applications such as:

- computational physics,
- microelectronics engineering,
- search & rescue,
- artificial intelligence,
- and of course, investment valuations.

Nowadays, the confluence of better technology and more readily available financial data means that even the public can feasibly build their own Monte Carlo simulation into their investment valuation models.

Cost of capital is the minimum return required to justify any of a company's projects or ventures.

At Qube, our valuation model of choice is the Discounted Cash Flow (DCF). Under this model, we have several key inputs that determine the intrinsic value of a company: the company's current cost of capital, future revenues, operating margins, and reinvestment costs. In a normal DCF model, we would use our best estimates for these inputs, and the result would be our best estimate of the company's intrinsic value.

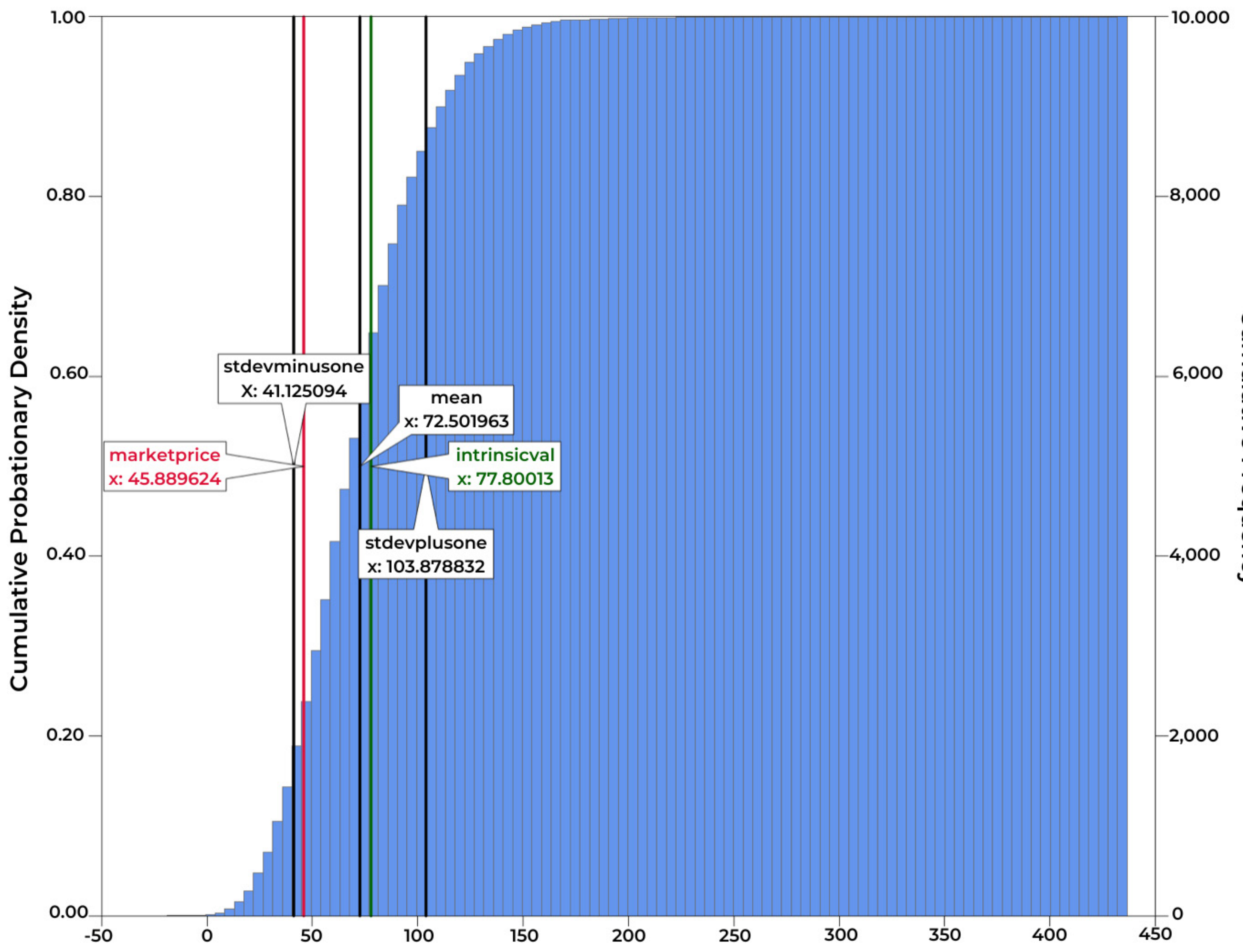
[1] Qube's approximate cost for a Bloomberg Information Terminal subscription.

The implicit assumption in every investment valuation is that both our inputs and our subsequent outputs are estimates; however, by providing only a single value for each input, the DCF model fails to explicitly convey the level of uncertainty in the output of the model. **A company that is 50% undervalued is a lot less exciting if we realize that there is likely only a 20% probability that this scenario is accurate.**

To solve this problem, rather than trying to come up with a mathematical formula to calculate the probability of our outcomes, we can instead use a Monte Carlo simulation to observe these outcomes, as we did by tossing a coin 10,000 times.

A Monte Carlo in Action

For example, consider the company Kroger, an American retail giant. Below is a representation of an MCS output for Kroger's intrinsic value.



Qube's analysts ran 10,000 simulations of our DCF model when valuing Kroger. For each material input in the determination of the company's intrinsic value, we set a **range of possibilities,** and this range represents the boundaries of our uncertainty for that input.

One material input in the determination of Kroger's intrinsic value is operating margins. Our best estimate for future margins was 2.35%, which we used in our base case DCF model. Through our research, we felt it was also plausible—though not as likely—that margins could decline to as low as 1.4% or increase to as high as 3.3%, depending on the company's future failures or successes in certain endeavors (like grocery delivery). By using ranges instead of a set value for our variables, our intrinsic value outputs will also be within a range, with some values being more likely to occur than other values.

In our Kroger MCS, our outputs had the following characteristics:

- 50% of the 10,000 simulations had intrinsic values above and below $69.26 USD/share.
- Approximately 68% of our 10,000 simulations had intrinsic values between $41.13 USD/share and $103.88 USD/share.
- The average intrinsic value across 10,000 simulations was $72.50 USD/share.

When we initially laid out our base case scenario, Kroger was calculated to have an intrinsic value of $77.80 USD/share. At its then price of $45.89 USD/share, we estimated that Kroger was undervalued by approximately 70%.

With a Monte Carlo simulation, we explicitly laid out the uncertainty around our $77.80 USD/share intrinsic value. Statistically, we are reasonably close to our average simulated values, and the number is well within the boundary of most of our simulated results.

Additionally, if we take our results from 10,000 simulations and compare it to the price of $45.89 USD/share, we find that almost 80% of the simulated values lie above this price. If we think about these 10,000 simulations as 10,000 possible future timelines, then almost 80% of these timelines show Kroger as undervalued. These are respectable odds!

In Conclusion...

"First, the only certainty is that there is no certainty. Second, every decision as a consequence is a matter of weighing probabilities. Third, despite uncertainty we must decide, and we must act. And lastly, we need to judge decisions not only on the results, but how those decisions were made."

– Robert Rubin, 70th United States Secretary of the Treasury

We believe that the Monte Carlo simulation is a tool that can be used to enhance the accuracy of Qube's decision-making. It allows us to view a point estimate in terms of probability, which provides a better perspective of risk.

If we discover that we are pitching a 90th percentile story, for instance, this may indicate that the quantitative analysis was supported by an overly optimistic narrative. In other words, it could help prevent a convincing narrative from leading to incorrect decisions.

This approach is crucial in forcing everyone involved in the analysis and resulting decision to explicitly recognize the uncertainty inherent in forecasting and to think probabilistically.

Again, a Monte Carlo simulation is only part of how we value companies for our Kaleo portfolios. To learn more about our carefully crafted process, read about our in-house research. You can also reach out to our team by email or calling us at (780) 463-2688.

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