Modeling an Uncertain Future

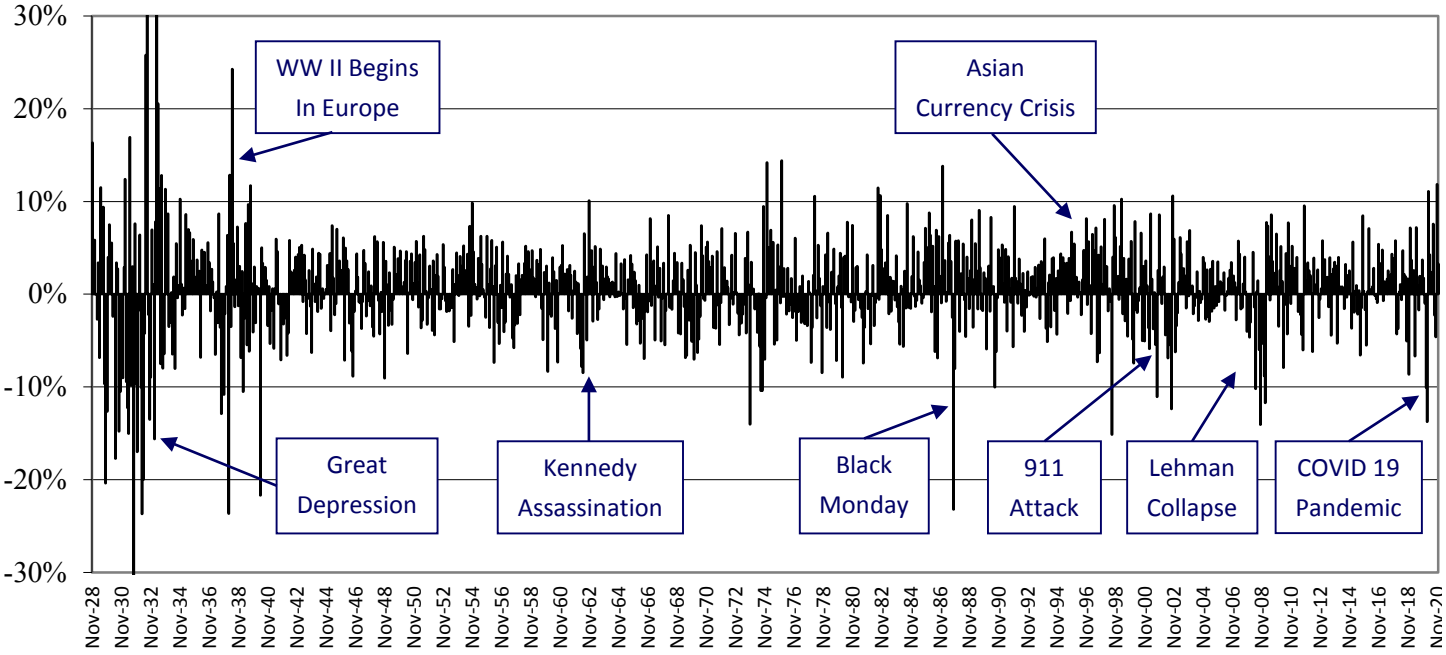
Market volatility this past year, including the enormous drop in value at the start of the pandemic, has reminded us of how uncertain the future is. This can be daunting when considering big decisions like buying a house, sending children to college, or determining when to retire.

In this article, we share how Sharper Granite advisors use sophisticated tools to model these decisions and project potential outcomes with confidence. These customizable tools were built in-house to provide high-fidelity models of our clients' financial lives. They allow us to consider total assets (including those outside of our management) and how various market and economic scenarios may influence life goals. We can even use these tools to evaluate the impact of key financial decisions, such as when to retire.

As we look under the hood of Sharper Granite modeling technology, it is important to remember that our process is built on sophisticated modeling principals and statistical processes. High-fidelity modeling begins with three key factors:

1) Range of Price Movements: This is the real-life distribution of possible daily price movements for various investment classes, including stocks and bonds. (e.g., How extreme might stock or real estate prices travel, and how often do they visit these extremes?) Recent volatility of market prices based on news events is significant, but not unusual. As history shows, stock market investors should be prepared for significant volatility.

Dow Jones Industrial Average Monthly Percent Change 1929 – 2020 [1]



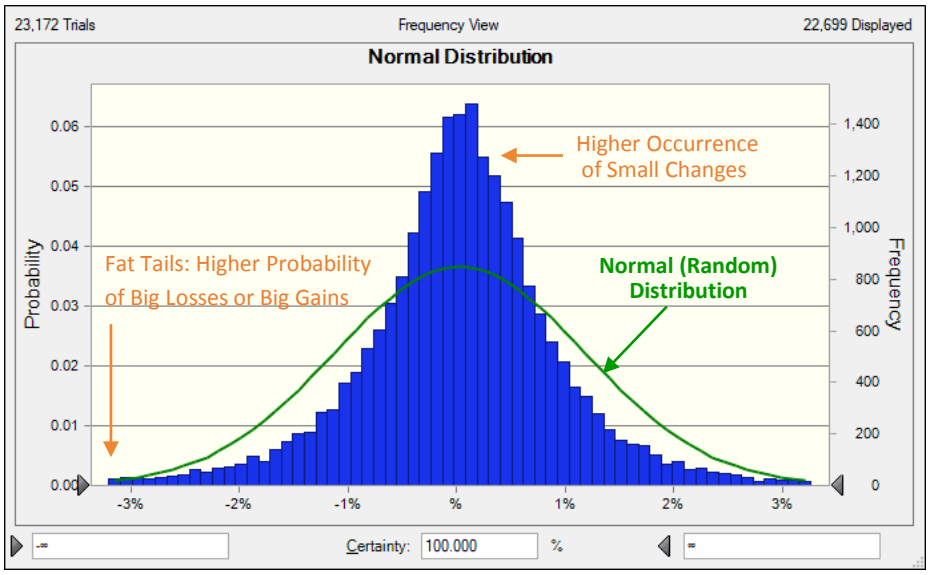
While most financial planning software products use Normal Distributions to model price distributions, actual price movements are not quite random and so do not fall along a bell-shaped Normal Distribution curve. If we observe daily stock price changes, when compared to the Normal Distribution, differences emerge between randomness and reality. For example, history shows more small changes, as well as more large changes, than we would expect if stock returns were random.

Stock prices have exhibited off-normal characteristics consistently since measurements began. From 1928 to 2020, based on a Normal Distribution there should have been seven daily swings of more than 4.5%; in fact, there were 201. Swings of 7% or more should appear once every 300,000 years; in fact, we saw 46 such days in the last 93 years.[1]

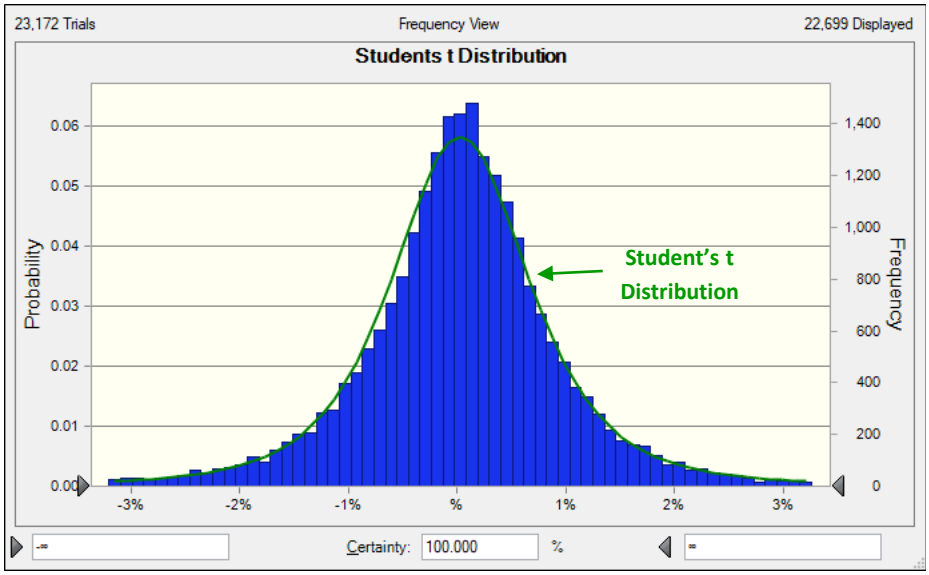
Fortunately, other mathematical tools have been developed which more accurately model price movements of stocks, bonds, real estate, and inflation. The French mathematician, Benoit Mandelbrot, studying natural events from Nile River flood history to Bristlecone tree rings, developed other useful distributions that are applicable to market returns.[2] Specifically, for stocks, we find price movements follow more closely to "Logistic" or "Student's t" distributions. The plot of actual daily stock price changes is shown again in the second chart with a Student's t Distribution. It clearly proves a much better fit with reality than the Normal Distribution.

By determining the true array of possibilities, we can accurately model potential price movements, including the extreme behavior that occurs during so-called "black swan" economic events.

Dow Jones Daily Price Change Frequency 1928 – 2020 vs. Normal Distribution [1]



Dow Jones Daily Price Change Frequency 1928 – 2020 vs. Student's t- Distribution [1]



2) Correlations: Because investment classes such as stocks, bonds, and real estate affect each other, along with inflation and other economic variables, another key model component relates how these factors move relative to one another. For example, when interest rates go up, bonds generally decline, and real estate is also usually impacted. In order to build well-diversified portfolios and to model real world possibilities within our projections, Sharper Granite studies the correlations of over 50 different investment classes to better understand their association.

3) Memory: Finally, in constructing a portfolio projection model, the presence of any momentum effects, or memory, should be included. The idea of memory applying to economics and investments was developed in 1965 – 1966 by Professors Irma Adelman at Johns Hopkins and Clive Granger at the University of Nottingham, England, who eventually won a Nobel Prize in 2003.[3,4] They proved that some investment class prices could resonate for very long, perhaps infinite, cycles while other investment class prices held virtually no memory.

As it turns out, stock returns each year have virtually no relationship to stock returns the following year. But year-to-year inflation readings are significantly related. During portfolio construction Sharper Granite factors this inflation "stickiness" when determining how to hedge portfolio inflation and model realistic nest egg projections.

In addition to sophisticated modeling principles and advanced statistics, which are not commonly found in most planning software, we also customize assumptions or model inputs. A model is only as good as its assumptions, or you could have "garbage in and garbage out." Our tools allow us to alter expectations for equities, real estate, long-term bonds, short-term bonds, cash, and even inflation.

Flexibility in our inputs also allows for easy adjustment of asset allocations to show, for example, how a safer portfolio would behave. Similarly, we can adjust income to account for changes in work, inheritances, one-time contributions, Social Security, and portfolio generated income. Each of these may be changed at any point in life.

Taxes are modeled specifically for each client. We model federal and state taxes, portfolio-generated taxes (cap gains and income), FICA, Social Security effects, as well as any unique deductions. We can use previous year tax returns to model a client's tax situation. Additionally, we model tax rate changes as clients move through different retirement stages.

Expenses are the final model input. Here, we adapt the model with expected life changes. We model an increasing base spend (inflation cost of living adjustment – COLA) to enable a consistent lifestyle throughout retirement. We model different types of expenses (ongoing costs or one-time purchases) and break them out individually to show how they affect the projection. Large U.S. banks have unique insight into how Americans adjust spending over time. We leverage this research from JP Morgan Chase to estimate spending changes in specific areas such healthcare throughout retirement.

In summary, many "canned" savings calculators exist, but they use simple Normal distributions, single-line outputs and lack the ability to customize around unique individual situations. Building price range probabilities, correlations, and memory into our modeling process gives clients improved accuracy when making investment and financial planning decisions. This, along with the ability to fully customize client scenarios, allows us to deliver robust projection models for our clients.

After building these client-specific models, we use Oracle's Crystal Ball simulation software to generate thousands of realistic financial lives. From these simulations, we provide a more accurate picture of possibilities beyond a most-likely case, allowing clients to make better informed decisions.

Notes and Acknowledgements:

1. Sharper Granite Research. "Modeling an Uncertain Future: Part II: Price Correlations and Memory," *Summer 2010 Letter on the Economy with updated data for 2020*
2. *The Misbehavior of Markets*, Benoit Mandelbrot, 2006
3. "Long Cycles – Fact or Artifact?" *American Economic Review*, Irma Adelman, Johns Hopkins, 1965
4. "The Typical Spectral Shape of an Economic Variable," *Econometrica*, Clive Granger, University of Nottingham, 1966