The Clifton Group
Investment Management Company

Shortfalls of Traditional Financial Risk Models

Introduction

On October 19th, 1987 the Dow Jones Industrial Average (DJIA) dropped by 508 points, nearly 23%. Two days later, the DJIA rebounded, gaining more than 10 percentage points. On October 15th, 2008, the DJIA fell over 773 points, or 7.87%. Considering the average daily fluctuations for this index are less than 1%, these large moves represent the atypical rather than the norm. However, it is these large jumps – the outlying and seemingly unpredictable – which account for the majority of financial movement.

The significance of these "low-probability, high-impact"[1] movements is irrefutable; for instance, if the 40 highest percentage return days were removed from the S&P 500 Index's 14,000+ day history, the market level would drop from over 1200 to 288 points. Similarly, disregarding the S&P 500's lowest 40 percentage days raises the index to 11,550 points.[2]

Unfortunately, there are many more recent examples of arguably unappreciated risk leading to negative outcomes. "The crumbling of Lehman and buyout of Merrill came only one week after the government committed up to $200 billion to shore up home-loan giants Fannie Mae and Freddie Mac. And it came six months after investment bank Bear Stearns Cos., the first big Wall Street victim of the housing crisis, was acquired by JPMorgan Chase & Co. with federal assistance."[3]

Although these extreme movements cannot be ignored, traditional risk models are based on Gaussian, or normal, distributions that assume large moves are unpredictable with negligible effect. Consequently, their validity is questionable. New and more applicable models are necessary to accurately represent risk in our capital markets, especially as complex financial instruments become more prevalent.

Problems with Traditional Risk Models

The traditional financial risk model is a normally distributed bell curve. Bell curves are useful for modeling many statistical trends of large, random populations; however, we believe their application has been mistakenly extrapolated into the world's financial realm.

Normal distributions are founded on certain assumptions: events occur independently, extremes are very rare, and outliers[4] have minimal effect on expected outcomes. All these assumptions – the assumptions in which the distribution's effectiveness is founded on – are violated when applied to the financial markets.

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[1] Mauzy, Stephen. ***"Risk Runs Roughshod and Conventional Financial Models Fail to Keep Pace."*** Certified Financial Analysts Institute. May/June 2008.
[2] Bogle, John. ***"Black Monday and Black Swans."*** Financial Analysts Journal. Volume 64. 2008.
[3] Los Angeles Times, September 15, 2008.
[4] Statistically, an outlier is an observation that is significantly distant from the rest of the observations.

Economic history shows that extremes do exist more than predicted, their effects are significant, and they appear connected, occurring in groups. For instance, in August of 1998 the DJIA experienced three large declines of 3.5%, 4.4%, and 6.8 percent.[5] According to standard risk models, the probability of these three *independent* movements occurring in one month was 0.000000001%[6]. More recently, between September 29, 2008 and October 22, 2008, the DJIA experienced the following declines: 7.0%, 5.1%, 7.3%, 7.9%, and 5.7%.[7] These highly volatile periods highlight the inappropriateness of normal distributions with its significant outliers and statistical anomaly suggesting dependent events.

While the existence of large deviations with significant market impact is obvious, proving that risk is a dependent, predictable event is more difficult. However, in 1976, economist Stephen Ross developed the Arbitrage Pricing Theory (APT) which strengthened this view. Ross's theory proposed that an asset's pricing was dependent on external macro-economic risk variables and thus, could be modeled. In the model, an asset's price was not random, but calculable based on its specific relationship (beta) to macro-economic risk factors. As the APT became more widely accepted in asset pricing, the idea of market risk as an independent, random event was further challenged. If asset prices were predictable, so was market risk.

In 1992, economist Hyman Minsky developed a market risk theory titled the "Financial Instability Hypothesis". In his hypothesis, Minsky refuted the traditional view that markets are 'equilibrium seeking' (or normally distributed) systems and unpredictable. Instead, Minsky theorized that market risk is related to external variables, specifically market stability. The risk associated with market stability is counterintuitive. While its seems that market stability would decrease financial risk, the hypothesis argues that consistency allows "investors to extrapolate stability into the distant future"[8] and thus engage in riskier financial behavior. In his paper, Minsky traces this progression from stable hedge units, to more risky speculative units, and finally to the very risky 'Ponzi' unit. Eventually, Minsky theorized, markets based on 'Ponzi' fail. Today's mortgage crisis reflects the eventual financial breakdown where borrowers assumed real estate would continue to appreciate but were caught by devaluations after defaults started to occur.[9] Part of the problem is that risk models fail to capture the vulnerability introduced by operating and financial leverage that grows in consistent, stable times.

Additionally, globalization – specifically through technology and communication – exacerbates the movement toward instability[10]. Today, investors operate with more homogeneity because of increased access to the same information resulting in similar trading patterns and risk positions. As a result, synchronized traders contribute to market instability because their actions are no longer random.

Overall, a normal distributions' assumptions are violated when applied to the capital markets. More modern theories have demonstrated that

[5] Mauzy
[6] Mauzy
[7] Source: www.djindexes.com
[8] Mauzy
[9] McCulley, Paul A. ***"The Liquidity Conundrum."*** CFA Institute Conference Proceedings Quarterly, March 2008.
[10] Mauzy

pricing and risk are predictable, implying the existence of more appropriate models.

Advancements in Risk Models

As the shortcomings of traditional models become more obvious, new theories have been developed to try to more accurately model financial risk. Yale University Professor Benoit Mandelbrot has proposed a more modern risk model involving fractal systems.

Fractal systems are mathematic models based on repeating patterns where growth is logarithmic, or power-based. The strength of fractal systems in modeling financial risk are the more realistic assumptions that large deviations are plausible, carry the most significant impact, and are predictable because "volatility breeds volatility."[11] This conclusion is not necessarily inconsistent with Minsky (as described earlier). One could argue that stability over a medium or long time frame breeds riskier behavior that, eventually, leads to a fractal model where the short-term risk patterns (e.g. daily volatility) are logarithmic.

Mandelbrot's model treats risk as dependent on history. For instance, "the likelihood of a daily or weekly drop exceeding 20% can be predicted from the frequency of drops exceeding 10%, and that the same ration applies to a 10% vs. a 5% drop."[12] On the whole, extreme risks are calculable quantities because they are dependent on previous market movement. Although fractal systems are more accurate (based on empirical evidence)[13], normal distributions still dominate market risk models.

Related to fractal systems are investor behavioral models. Often, investors behave irrationally. They "trade based upon considerations that are not inherently related to fundamentals."[14] Irrational trading behavior can distort real investment choices and pricing and work against price mean reversion. It can result in outcomes that differ significantly than those predicted by traditional risk models.

Hedge Funds and Derivatives

The increase in assets controlled by hedge funds and financial markets participants' use of derivatives pose different obstacles for modeling risk, yet both emphasize the need for modern, more accurate, and standardized models.

First, hedge fund volatility makes Gaussian distributions inappropriate for modeling risk. Instead of a bell curve, hedge fund risk has greater than normal measures of kurtosis - sometimes called 'fat tail' risk – where extreme deviations have larger probability. Fat tail risk is difficult to accurately measure as hedge fund "returns tend to be overstated because of survivorship bias, reporting and data problems…and illiquidity associated with particular positions undertaken."[15] Leverage undertaken by hedge funds also contributes to fat tail risk by increasing the probability of extreme returns when compared to a normal distribution.

[11] Mandelbrot, Benoit and Nassim Nicholas Taleb. ***"How the Finance Gurus Get Risk All Wrong."*** Fortune, 2005.
[12] Mandelbrot

[13] Mandelbrot
[14] Hirshleifer, Subrahmanyam, and Titman. ***"Feedback and the Success of Irrational Investors."*** Journal of Financial Economics, August, 2006.
[15] Statement of the Financial Economists Roundtable. "***Hedge Funds***." November 3, 2005.

Additionally, hedge funds have systemic risk, which cannot be modeled by fat tails. Systemic risk occurs when one party's transaction failure initiates failure in counterparties.[16] A hedge fund's systemic risk is relatively invisible to outsiders as counterparties and transactions are not observable.

In attempts to improve risk models for hedge funds, log-normal distributions are sometimes employed. Log-normal distributions take a normal distribution and skew it using an additional variable. While these distributions may be a slight improvement over traditional models, they are one-tailed – while hedge funds have two fat tails - and have the same assumptions. The lack of appropriate standardized risk models leads many economists to suggest minimal investment in hedge funds until improvements are available.[17]

Finally, the increase in newer, more complex financial tools like derivatives demands the need for standardized, comprehensive financial risk models. Derivatives add confounding variables like leverage, complexity, and illiquidity when measuring risk because outcomes are derived from underlying assets. AIG utilized internally developed risk models that "harnessed mounds of historical data…but didn't attempt to measure the risk of future collateral calls or write-downs, which have devastated AIG's finances." [18]

Conclusion

The inadequacies of traditional models have made the need for newer, more standardized, and more accurate risk tools obvious. Risk models have progressed with time; however, the financial world currently still relies on normal distributions and the resulting risk assessments too often without recognizing the model's meaningful shortcomings.

The cost of poor models lies in the real world financial implications. For instance, a normal distribution would not have been able to predict the recent collapse of Bear Stearns, Fannie Mae and Freddie Mac, Lehman, Merrill, and AIG. Rather, the model would suggest that the entities' share prices would seek equilibrium or, arguably, that only one of the entities would have failed in the time period. As a result, investors were unaware of the true risk and were blind-sided by events that were not possible according to the common model.

Until the risk models most often utilized today are replaced by more comprehensive and accurate models, we believe financial markets participants will continue to misunderstand their true exposures. A combination approach using traditional models, improved models that recognize non-normal distributions and the risks introduced by certain financial instruments, as well as forward looking methods including scenario analysis is the best technique for thoughtful consideration of risk.

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[16] Statement of the Financial Economists Roundtable

[17] Statement of the Financial Economists Roundtable

[18] The Wall Street Journal: ***"AIG's Risk Models Failed."*** November 3, 2008.

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