Mathematical Models and Mental Methods.

By: Osmond Plummer
Professor of Finance

EU Business School, Switzerland
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In the 1950s Markowitz (1952, referenced 1991) published his famous paper on portfolio selection ushering the age of what is known as modern portfolio theory which proposed using diversification via non-correlated assets to provide optimal performing portfolios with minimal risk profiles. In the 1960s Sharpe (1964) & Lintner (1965) (referenced in Markowitz 1991) developed one of the first analytical models for predicting returns on financial assets, the Capital Asset Pricing Model (CAPM). These key events and other work by these economists and others such as Fama & French and a host of other names you will have heard in your economics and finance classes ushered in an era of mathematisation of finance where the application of financial mathematics was used to assist asset managers in portfolio construction.

The end of the cold war combined with an explosion in computer memory and processing power and the increase in the size and importance of the world of Finance in developed economies. This created an environment where the engineers who had been at the forefront of the design in weapons systems were diverted into the Financial Services industry where they worked on what would become, in the end, a different kind of weapon of mass destruction. Financial models became more and more complex relying on huge data sets and the complexity of the models eventually meant that very few people actually understood the formulas and processes that created the outcomes that appeared on the screens in the investment banks.

The demise of (the not ironically named) Long Term Capital Management in 1998 was a warning sign that was not heeded. Extreme leverage combined with mathematical models that ignored market realities combined forces with complex derivatives to create a melt down in that particular fund – which was founded by maths geeks and two Nobel laureates. Instead of a reasoned assessment of the underlying risks of certain strategies the markets headed into a dot-com bubble with its subsequent bust in 2001. Then just 10 years ago, we were in the middle of a severe market melt-down over the sub-prime bubble. What happened to all of these market models and predictive algorithms? Where and why did they go wrong?

In simple terms we can state that the mathematical models are good at assessing risk and especially at using historical risk as a proxy for future returns. What these models fail to address is the other side of risk which is uncertainty. They also fail to address the human nature of markets and the increasingly important area of Behavioural Finance. Montier (2007) states that risk remains the least understood concept in Finance. In short, we are not all rational maximisers of economic profits based on expected utility as is assumed in much of classical economics. We are humans and subject to emotions as well as rational thoughts. By some measures non-quantitative imperatives account for some 80% of market movements.

One such feature of our human nature is loss aversion. Kahneman (2011) provides a good overview of this subject for the interested reader. Whilst economic theory suggests that we should value a profit of $10 in equal measure as we dislike a loss of $10, the fact is that people vary in their reaction to the losses but, on average, humans

feel a loss at about twice the level that they feel a similar level of profit. Again, we see the two sides of risk. One question asks how much risk someone will accept as a concept – the other how much downside you will tolerate in the event that it happens. The answers are often quite different.

The study of Behavioural Finance has shown some areas where we, as humans and as investors, act against our best interest's due to the way in which we think and process new information. In an information-heavy world such as the one in which we are living, it is important to be aware of these biases and seek to work to avoid being trapped into financial self-harming. Our biases (heuristics) fall into some broad categories such as belief biases, information processing biases and emotional biases. This article will briefly consider some belief biases.

Cognitive Dissonance occurs when we receive information that contradicts a previously held belief. This causes similar mental reactions to pain in our physical bodies. Wise investors will, however, seek out alternative opinions and test their assumptions on a regular basis. Cognitive dissonance encourages the opposite behaviour – a selective perception of the situation often backed up by a biased search for information leading to selective decision making. This behaviour can lead to reinforcement of old, poor decisions. The most researched result of this has been the well documented tendency for investors to sell shares that are in profit whist holding onto the losers in the hope that they will come good one day (Kahneman 2011).

Conservatism Bias causes investors to overestimate base returns and under-react to new information. In short investors have a tendency to expect patterns to repeat themselves. In an inversion of the standard disclaimer on mutual fund marketing materials there remains an expectation that past performance is indeed indicative of future performance. Consider the stock analysts' tendency to predict future corporate earnings based on past performance. Whilst that may make sense in some instances, many corporations are multinational businesses in a dynamic commercial environment in which little seems to stay still and even less is constant.

Confirmation Bias occurs when investors selectively seek information that confirms their opinions. It can be expressed as "Show me what I want to see." This manifests itself on the part of both the provider and the receiver of information. Montier (2007) cites the company visit as a classic illustration of this bias. A stock analyst visits a company that s/he follows. The assumption is that they are interested in receiving information that will make them more likely to recommend that investors buy the stock and the company is unlikely to disappoint in this respect, providing a view that is positive in outlook whatever storm clouds lie ahead.

Finally, we look at **Representativeness Bias** through which investors use limited information to predict trends. An example of this type of bias is the gambler's fallacy in which we assume that a run of bad luck (a set of poor dice throws for example) makes good luck more likely. Another very common error that is made in a lot of academic research is the selection of research sample sizes that are too small to representative a population. A common error is an acceptance of the widely reported fact that sample of size of 30 is sufficient to extrapolate to a population at large when this is rarely statistically defensible.

This paper does not seek to identify all types of biases and heuristics that investors face but to illustrate some examples of ways in which human investors frequently fail to act in a manner that would be regarded as

economically rational. This was probably best summed up by Graham (1954) writing at the same time as Markovitz's theory was being published - "The investor's chief problem – and even his worst enemy – is likely to be himself."

References

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