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Maths, human nature and investment banking: Are we economists or human beings?

Are mathematical algorithms enough to base investment decisions on? And to what extent does human nature get in the way? **Osy Plummer** looks back on the rise of mathematical algorithms in finance and economics, and explores the relationship between rational actions and emotional impulses.

Advances in technology and particularly in the field of artificial intelligence have led to the automation of many of the traditional elements of financial services – matching surplus funds with needs, those who need protection with those who have an appetite for risk and, of course, in simplification and automation of payment systems. As a result, technology has turned its attention to the selection of investments.

> *"For more than three decades macroeconomics has gone backwards. The field is dominated by a tight-knit congregation unified by deference to authority, not facts and propped up by dubious mathematical models."*
>
> Paul Romer,
> The trouble with macroeconomics, 2016[1]

Market models and predictive algorithms

In the 1950s, Harry M Markowitz published his famous paper on portfolio selection, ushering in the age of what is known as 'modern portfolio theory'. This proposed using diversification via non-correlated assets to provide optimal performing portfolios with minimal risk profiles.

In the 1960s, William Sharpe (1964) and John Lintner (1965) developed one of the first analytical models for predicting returns on financial assets – the 'capital asset pricing model' (CAPM).[2] These key events – and other work by these economists and others such as Fama and 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 in the pursuit of optimal returns.

The Cold War ended at a time when there was an explosion in computer memory and processing power, and the increase in the size and importance of the world of finance in developed economies. Engineers who had been at the forefront of the design in weapons systems for the feared military confrontation went into the financial services industry where the pay was somewhat better. There 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. The complexity of the models eventually meant that very few people actually understood the formulas and processes that created the outcomes appearing on the screens of 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 limitations, joined forces with complex derivatives to create a meltdown in that particular fund – which was founded by maths geeks and two Nobel laureates. Instead of dwelling on 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 ten years ago, we were in the middle of a severe market meltdown over the sub-prime bubble. What happened to all of these market models and predictive algorithms? Where and why did they go wrong?

1 Romer, P. (2016) The trouble with marcoeconomics [pdf]. Available at https://ccl.yale.edu/sites/default/files/files/The%20Trouble%20with%20Macroeconomics.pdf [Accessed 15 May 2019]

2 University of Freiburg (2010–11) The Sharpe–Lintner CAPM [pdf]. Available at https://www.empiwifo.uni-freiburg.de/lehre-teaching-1/winter-term-10-11/materialien-portfolio-analysis/capm_model.pdf

The other side of risk

In simple terms we can state that mathematical models are good at assessing risk (normally calculated as the standard deviation of historical returns or a similar measure of volatility) 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 states that risk remains the least understood concept in finance, not least because it is about so much more than just processing market data.[3]

In short, we are not all rational maximisers of economic profits based on expected utility as is assumed in much of classical economic theory. We are humans and subject to emotional impulses as well as rational thoughts. The upshot of this is that, by some measures, non-quantitative imperatives account for some 80 per cent of market movements.[4]

One such feature of our human nature is **loss aversion**. Kahneman (2011) provides a good overview of this subject.[5] 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, whilst people vary in their reaction to the losses, 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 demonstrated a number of areas where we – as humans and as investors – act against our best interests due to the way we think and process new information. In an information heavy world such as ours, it is important for investors 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. Let's briefly consider some of the most commonly seen biases.

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 whilst holding onto the losers in the hope that they will come good one day.[6]

Conservatism bias causes investors to overestimate base returns and underreact 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 where 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 suggests the stock analyst's company visit as a classic illustration of this bias.[7] A stock analyst visits a company that he or she 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.

Representativeness bias happens when investors use limited information to represent the larger universe 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 represent a population. A common error is a surprisingly widespread acceptance of the 'fact' that a sample size of 30 is sufficient to extrapolate data to a population at large when this is in fact rarely statistically defensible.

Hindsight bias is the last of the belief biases which this paper will address. When you read of the 'clearly unsustainable bubble in the US housing market in 2006–07' you are reading something written with hindsight bias – 'I knew it all along'. It is in most people's nature to remember their successes (often further gilded than they were) and selectively forget their failures. We assign good

3 Montier, J. (2007) Behavioural investing: a practitioners guide to applying behavioural finance. Chichester: Wiley.

4 Baker, K. & Nofsinger, R. (2010) Behavioral Finance: Investors, Corporations and Markets. Chichester: Wiley.

5 Kahneman, D. (2011) Thinking fast and slow. London: Penguin

6 Kahneman, D. (2011) Thinking fast and slow. London: Penguin.

7 Montier, J. (2007) Behavioural investing: a practitioners guide to applying behavioural finance. Chichester: Wiley.

outcomes to our skill as investors and poor outcomes to bad luck. As noted in Pompian.[8] it is human nature to look at the events of history and see them as all but inevitable in the context of what happened, rather than reflecting on the uncertainty and unpredictability of the future – even back then.

Information biases

Anchoring takes place when someone is asked to estimate a number that they have little ability to assess objectively and little time to consider with an appropriate analysis. Given ten seconds to estimate the total number of registered paediatricians in sub-Saharan Africa, most of us couldn't come up with a number that had any basis for reliability. Had you first been asked whether there were more or less than ten million such medical experts in the region, you would have made a choice based on some rule of thumb. If then asked to estimate the exact number of paediatricians in sub-Saharan Africa, most responders would cite an estimate in the region of ten million as this was the number previously mentioned and this 'lens' has distorted their view.

The consequence of anchoring is that, when faced with uncertainty, it is human nature not to verge very far from the 'expert' predictions. For one example of the consequences of this, I would refer readers to a chart of the share price of Snap – parent of the messaging app Snapchat – since its IPO in March 2017 at $17 per share. Over the next two days, the share price increased by some 44 per cent but then fell over the next few trading days to below the $17 mark. Since then, the company's share price has never been above the IPO price and, at the time of writing, was barely above $6.

Framing describes the human reaction to the way a question is asked rather then the decision that is required of the responder. In many instances it is possible to ask the same question in more than one way. When faced with two questions about fertiliser usage – one suggesting that 75 per cent of the crop will survive the drought with fertiliser, and the other than 25 per cent of the crop will die despite use of the same fertiliser – a significant difference in responses has been demonstrated, despite the fact that the questions are essentially the same.[9] In summary, optimistically framed questions tend to produce positive responses and negatively framed questions produce negative responses.[10]

Availability bias is when recent or well documented events are assumed to be more likely to occur in the future than older events or those that attract less media attention. Another bias that has a similar provenance is called the **recency bias**. The most frequently cited example of this is that more people take out hurricane insurance after experiencing a hurricane, even though these events rarely repeat themselves in the same place and the same manner.

These biases are related to the way we process information on the nature of risk related events. The events of September 2001 had a huge effect on the public perception of the risk of flying even thought the events of that day did not significantly affect the statistical risk of flying. Investors flee markets as they plummet and remain on the sidelines out of a greater perception of risk even when an oversold market may represent a significantly profitable investment opportunity.

I referred to loss aversion earlier in this article. A similar and related emotional bias is **regret aversion bias**. Regret aversion includes the desire not to miss out on gains, as well as the desire not to be caught by a market downturn. A well-known example of this is attributed to Chuck Prince, speaking as Chief Executive Officer (CEO) of CitiGroup as the US mortgage market started to show signs of stress. He said, "When the music stops in terms of liquidity, things will be complicated. But as long as the music is playing, you've got to get up and dance. We're still dancing."[11]

Regret aversion makes investors apprehensive about investing in markets that may be oversold and stay invested in markets that rational analysis suggests are overbought. It may also prevent investors from taking a profit on a position due to the fear of losing out on future gains. The bias can work towards errors of commission when actions that are unwise are taken, or errors of omission when actions warranted by events are not taken in a timely manner.

Overconfidence is rife in the financial services sector, especially in asset management. James Montier reported that 75 per cent of fund and investment managers in his research sample believed they are better than average (whilst many of them fail to regularly outperform their benchmark).[12]

One experimental illustration of this comes from a confidence interval test in which participants are asked not to estimate a figure, but a range within which they would be 90 per cent confident of locating the correct answer. As an illustration, a question could request estimates of the age of death of Martin Luther King. A response of between 20 and 100 would be correct but our nature as humans

8 Pompian, M. (2012) Behavioural Finance and Wealth Management. Chichester: Wiley.

9 Kahneman, D. (2011) Thinking fast and slow. London: Penguin.

10 Pompian, M. (2012) Behavioural Finance and Wealth Management. Chichester: Wiley.

11 Nakamoto, M. & Whighton, D. (2007) Citigroup chief stays bullish on buy-outs. Financial Times [online] 9 July 2007. Available at: https://www.ft.com/content/80e2987a-2e50-11dc-821c-0000779fd2ac [Accessed: 17 May 2019].

12 Montier, J. (2007) Behavioural investing: a practitioners guide to applying behavioural finance. Chichester: Wiley.

is to estimate a much narrower range and to attribute 90 per cent confidence to that range. When conducting this experiment, the author has noticed that the most common age range suggested is 40–60 years, which is not correct. Similar results have been demonstrated in research when estimating future prices of various financial assets as reported in Pompian.[13]

A further important investor bias is referred to as the endowment bias. Essentially the **endowment bias** suggests that individuals value what they own more highly than what they do not own. This has been demonstrated by Thaler[14] and Khanemen[15] (2011) and replicated in a number of studies. This fact creates a negative effect for investors. An investor owns a financial asset for the simple reason that they hope to gain financial benefit from ownership. With an investment in shares, this benefit is mostly derived from expected, or hoped for, future capital appreciation of the share price. In other words, the investor believes that the asset is worth more than the market value of the investment. Implicit in this bias, therefore, is a statement that the investor and the market disagree as to the value of the asset in question. When combined with overconfidence, endowment bias can cause an expensive foray into an investment with an outcome that is less than optimal. In short, caveat emptor.

The final bias to be addressed in this article is **self-control** or, more accurately, the lack of this in many retail investors. Investing, at a base level for the average retail investor, is a process by which we seek to create a sufficient pool of assets to allow us to live out our retirement in relative financial comfort. In this respect self-control pits the desire for instant gratification against the unknown future benefits of delayed consumption. However, most people prefer a higher standard of living to a lower one and a consistent lifestyle to a diet of feast and famine. Shefrin & Thaler, as referenced in Pompier, provide a behavioural guide to retirement planning which argues that individuals are poor at planning and need to have some sort of future financial planning enforced on them for their own good.[16] This insight led to recommendations for opt-out pension schemes where employees had to elect not to be included rather than be included only by request which vastly increased the uptake of some sort of long-term savings for many people.[17] (Thaler & Sunstein, 2009).

This paper does not seek to identify all the types of biases and heuristics that investors face but to illustrate some examples of how human investors frequently fail to act in an economically rational manner. This was best summed up by Graham writing around the same time that Markovitz's theory was first being promulgated. In 1954 he wrote, "The investor's chief problem – and even his worst enemy – is likely to be himself."[18]

13 Pompian, M. (2012) Behavioural Finance and Wealth Management. Chichester: Wiley.

14 Thaler, R. (2016) Misbehaving. London: Penguin.

15 Kahneman, D. (2011) Thinking fast and slow. London: Penguin.

16 Pompian, M. (2012) Behavioural Finance and Wealth Management. Chichester: Wiley.

17 Thaler, R. & Sunstein, C. (2009) Nudge: Improving Decisions About Health, Wealth and Happiness. London: Penguin.

18 Graham, B. (1954) The intelligent investor. New York: Harper & Brothers.