Crypto Investors' Behaviour and Performance and the Dot-Com Bubble Compared: This Time it is Different?

1st November 2022

Richard Fairchild, School of Management, University of Bath

Chusu He, School of Management, University of Bath

James Kinsella, School of Management, University of Bath

Neal Hinvest, Department of Psychology, University of Bath

Abstract

Do prices and returns in the financial markets exhibit observable patterns, or are they truly 'random walks', as predicted by the efficient market hypothesis (EMH)? If there are patterns, the natural question becomes, why do we observe such extreme cycles of bubbles (massive over-valuations) followed by the bubble bursting, and extreme crashes (often way below fundamental values)? What is the impact of investor sentiment and emotions? Do these emotions correlate with the time path of the bubble and crash? Can an understanding of this correlation help academics and practitioners to be 'forward-looking', and predict the future time-path of bubbles and crashes: particularly, asking: "is a bubble forming, and when will it burst?" This could be a question relevant to the current crypto-currency market.

In this paper, we develop a seminal theoretical model, cast in an emotional finance framework, that has a first peek at relating investors' conscious and unconscious emotions to stock and crypto market bubbles and crashes. As this is the first model of this kind, we will speculate on whether this model, besides being ex post descriptive, can become ex ante predictive. We also use Elliott Wave Theory to map investor emotions and sentiment to compare the Bitcoin bear market of 2021 and the Dot-Com crash of the early 2000's.

Keywords: cryptocurrencies, emotional finance, market cycle, bubble, prediction

1. Introduction

In recent years, an exciting, innovative new area of investing has arisen, crypto currencies, offering new opportunities for financial market participation. The advent of Bitcoin, Ethereum, Cardano, Vechain, etc. has captured the imagination of investors, both traditional and new, young, and old. Fortunes stand to be made and lost on the strength of these investments. For quite a while, it seemed as though investors could not lose when investing into these currencies. For example, Bitcoin seemed infallible, with massive initial increases in valuations for a long period.

While these increases kept occurring, researchers and analysts questioned whether crypto was indeed in a bubble situation, with valuations way over fundamentals. Now, with the first crashes in some crypto valuations, and some casualties (e.g. crypto firms going bankrupt), the question arises: has the bubble burst, or is this a temporary correction? Will cryptos 'bounce back' in the long-term?

Some commentators have asked: Are there parallels between the crypto-currency markets, and the Dot-Com/High tech bubble of the 1990's? This could prove to be a useful comparison, and this is the approach we take in this paper. We ask the following questions:

1. How similar is the current crypto market to the Dot-Com market of the 1990s? What are the key differences?
2. Is crypto in a bubble situation, about to burst, just as the Dot-Com market of the 1990's? Will crypto bounce back (unlike the Dot-Com bubble, which burst and crashed, never to recover).
3. Do the price patterns of crypto charts mirror the price patterns of 1990's Dot-Com stocks?
4. Are the emotional drivers of crypto prices similar to the emotional drivers of the Dot-Com bubble?

In approaching these questions, we employ the emotional finance framework (Taffler and Tuckett, 2005; Tuckett and Taffler, 2008; Eshraghi and Taffler, 2009, and Belotti, Taffler and Tian, 2010). This is the perfect framework for our analysis. Emotional finance represents a

paradigm shift from behavioural finance. The pioneers of emotional finance (Taffler and Tuckett) developed this approach in order to consider the effect of the time-path of ***un***conscious emotions (love and hate) in a Freudian psycho-analytical framework on price paths (particularly, bubbles and crashes). The focus of emotional finance is on exciting new stocks and financial innovations and has been used to analyse such historic innovations as tulip-mania, the South Sea bubble, 19th century rail-road stocks, 1990s Dot-Com bubble, and the mysterious hedge fund industry. In each case, the stimulus is an exciting new innovation which investors do not really understand but become excited about and fall in love with ("Have to have it"). At this point, the investment seems infallible, without any downside risk. At a certain tipping point, love rapidly turns to hate, and then revulsion and panic. The financial instruments or stocks are quickly dumped, and the price crashes forever.

Thus, it is natural to compare the current crypto market with the 1990's Dot-Com bubble, employing an emotional finance framework. The rest of the paper is organised as follows. In the next section, we outline the development of finance research from standard to behavioural finance, and then to the exciting paradigm shift of emotional finance. Then we consider the nascent and emerging research into the application of behavioural finance to crypto-investing, and particularly the research that looks at the difference in the characteristics of crypto-investors, compared to traditional stock investors.

Section 3 examines the emotional finance framework, and discuss how it can be applied to the Dot-Com bubble. In Section 4, we develop a formal emotional finance model that demonstrates the link between the time-path of unconscious emotions (love and hate) and the time-path of prices, and how these emotions can generate bubbles and crashes. Section 5 employs the emotional finance framework to compare the Dot-Com bubble with the current crypto market. In this analysis, we adopt chart analysis, Elliott Wave Theory, and actual crypto cases. We conclude by discussing the implications of our analysis and providing suggestions for future research.

2. From Standard to Behavioural and Emotional Finance

Traditionally, academic research into financial markets and corporate finance has been based upon the standard economics view (homo economicus) that people are fully rational, self-interested, unemotional, profit/utility-maximising agents, untainted by psychological

biases. This approach resulted in the development of such notable and elegant financial market theories as Markowitz portfolio analysis, CAPM (Sharpe and Lintner), and Fama's Efficient Market Hypothesis. Recently, behavioural finance has arisen, recognising that human beings (for example, investors and corporate managers) are boundedly rational, not completely self-interested, imperfect calculators of expected utility, and above all, subject to psychological biases and emotions.

Behavioural finance arose as a response to real-world anomalies in the financial markets and in investor behaviour that contradicted the tenets of traditional fully rational finance, and brought into question Markowitz Portfolio analysis, and Fama's EMH. In a very recent paradigm shift, emotional finance (Taffler and Tuckett, 2005) examines the effect of investors' unconscious emotions on their behaviour, and market pricing in a Freudian paranoid-schizoid framework. Importantly for our analysis of crypto-currency behaviour, the emotional finance (EF) approach focuses on the trajectory of investor emotions (switching from love to hate) and the relationship of this trajectory to pricing bubbles and crashes in the financial markets. Furthermore, particularly relevant, the EF framework focuses on new mysterious financial instruments that capture the public imagination (such as tulip-mania, 19th century rail-road stocks, 1990's high-tech dot com bubble). A question arises: can the EF framework be applied to crypto currencies? Are we facing the same emotional and psychological trajectory here? Are cryptos currently in a bubble situation?

2.1 Behavioural Finance and Crypto Currencies

Researchers are increasingly analysing the behavioural and psychological factors affecting Bitcoin investors' activity and performance. Indeed, O'Neill (2021) emphasises that investing in Bitcoin resembles a lottery type gamble. He writes:

"The sudden rise of "special purpose acquisitions companies" and cryptocurrencies speaks less to the virtues of these vehicles than to the excesses of the current bull market. In the long term, these assets will mostly fall into the same category as speculative "growth stocks" today."

Corbet et al (2019) conduct a systematic review of the existing literature research into crypto currency. Interestingly, their review reveals an asset class trilemma:

"Cryptocurrency advocates believe that there is evidence to support the asset's continued evolution as a cashless medium of exchange that can potentially change the world of finance as we know it. Opponents to the evolution of cryptocurrencies identify the role of cybercriminality and the unknown destabilising effects on world economies as some of the potential pitfalls of their evolution." Corbet et al's review considers the bubble effects of crypto in relation to market efficiency, and whether the currently unregulated crypto-currency market should be regulated.

Furthermore, an IMF report (Lyer, 2022) that suggests that crypto currencies are becoming more correlated with stocks.

2.2 Crypto Investors and the Disposition Effect

Delfabbro, King and Williams (2021) analyse the psychology of crypto traders. They focus on the harmful effects of these investors' psychological biases, particularly overspending and compulsive checking. The psychological risk factors that may lead to crypto overtrading that the authors focus on are over-estimations of the role of knowledge or skill, the fear of missing out (FOMO), preoccupation, and anticipated regret. They emphasise the role of education and other protective strategies for these vulnerable investors.

Castro (2019) compares the disposition effect between crypto and stock investors. He finds a stronger disposition effect for stock investors than crypto investors.

In contrast, Schatzmann and Haslhofer (2020) test the disposition effect amongst Bitcoin traders and conclude that they suffer from the same disposition effect: they are as irrational as other traders.

Investors do not operate in a vacuum, isolated from society and the markets. Haryanto, Subroto and Ulpah (2019) consider the combined effect of two behavioural biases, herding and the disposition effect in the crypto markets, focussing on Bitcoin. They employ the Mt.Gox data between 2011 – 2013. Interestingly, they find that the market exhibits a reverse disposition effect in bullish periods and the usual positive disposition effect in bearish periods. Furthermore, they find evidence of crypto- herding in both bearish and bullish periods, with herding increasing in both bullish and bearish periods when the bitcoin price increases and decreases, respectively.

2.3 Crypto Investors and Risk Preferences

Some researchers argue that attitude to risk may be different in crypto-investors, compared to stock investors (references needed): it is often argued that the former are more risk-seeking/less risk-averse. Hackethal et al. (2022) find that crypto-investors tend to pursue more risky security investments after acquiring crypto exposures. Fisch (2019) and Howell et al. (2019) reveal that Initial coin offering (ICO) investments attract investors with a high risk-return profile. Hence, we propose testing for risk attitudes.

2.4 Crypto Investors: Emotions

Research into the effect of emotions specifically in the crypto-currency markets is beginning to emerge. Much of it is conducted by practitioner organisations. For example, the investment analyst organisation "Sentimenti" (2020) employed a deep neural network approach to analyse a million articles, comments and posts mentioning Bitcoin in 2018. They focused on eleven indicators of positive and negative emotions, including arousal (interestingly, in our experiment, we propose to use GSR, which is a measure of unconscious emotion/arousal). Sentimenti found a very strong relationship between emotions about Bitcoin, and Bitcoin prices.

As further motivation for our proposed study of crypto investors' emotions, Sentimenti state:

"For everyone who has even a little interest in the market, the cryptocurrencies are known for their strong emotional connection. Values such as Bitcoin, Ethereum (or others!) don't have a real use so far but are mainly treated as purely speculative assets. And where speculation is concerned, there also are emotions." (Similar discussions on the crypto investors' emotions have been conducted by Daniel Dollop, Rollbit, Reddit, Coindesk and CCN. Interestingly, there is a website dedicated to crypto investing called Crypto Emotions).

In addition to the practitioner interest in crypto investor emotions, rigorous academic research is beginning to emerge. The Independent website reports a study by Daniele Bianchi, an assistant professor of finance at Warwick Business School, who "found that the price patterns of the 14 largest cryptocurrencies reflect past returns of investors, combined with the hype and emotion experienced as they watch the value climb or fall." Furthermore, Bianchi told the Independent:

"There is research showing limited similarities between Bitcoin and gold but looking across the 14 biggest cryptocurrencies the high volatility of their price means that they can hardly be seen as a reliable savings instrument in the short-term, let alone the long or medium term."

Aste (2019) conducts an extremely deep and wide-spread analysis of the relationship between prices and social sentiment in almost 2000 crypto-currencies traded during the first six months of 2018. He finds that prices are significantly correlated with sentiment. Interestingly, he considers both the network effects of emotions across crypto-currencies, and causality. In terms of the network effects, he finds that "The major, most capitalised cryptocurrencies, such as bitcoin, have a central role in the price correlation network but only a marginal role in the sentiment network and in the network describing the interactions between the two." In terms of causality, he finds that, "both prices cause sentiment and sentiment cause prices across currencies."

2.5 Differences in the Characteristics of Crypto Currencies versus Stocks

Finally, in addition to the differences in crypto-investor characteristics, the very nature of crypto-currencies themselves, compared with stocks, may drive differences in investor behaviour. It is argued that a) since crypto currencies do not have an underlying fundamental/intrinsic valuation model, they may contain more ambiguity than stocks, and b) they may be more volatile, and subject to greater bubbles, crashes and overbuying and overselling than traditional stocks. Indeed, Fry (2020) argues that crypto currencies behave more like a speculative asset than a genuine currency. He employs a Cauchy distribution in his modelling of cryptocurrency price paths, in order to reflect this ambiguity and excessive volatility. Using this distribution, he demonstrates that liquidity risk can generate heavy tails in crypto-currency prices Furthermore, his model demonstrates that the lack of economic clarity may cause crypto-currency prices to collapse completely: he supports this by comparing theoretically derived price paths graphs with actual pictures of crypto-currency price movements.

Fry's (2020) analysis is useful for us in our experiment. We interpret his "lack of economic clarity" as Knightian uncertainty and the behavioural factor of ambiguity. Indeed, in our trading game, the participants are given no ex-ante information about the characteristics of the price paths: they are not given any information on the mean or variance/volatility of these paths. In other words, they do not know any underlying distribution.

3 The Emotional Finance Framework

Do prices and returns in the financial markets exhibit observable patterns, or are they truly 'random walks', as predicted by the efficient market hypothesis (EMH)? What is the impact of investor sentiment and emotions? The emotional finance (EF) framework, a paradigm shift springing from behavioural finance, which was introduced and developed by Tuckett and Taffler (2008), considers a trajectory/time-path of investors' unconscious emotions, and examines how this emotional trajectory may cause extreme bubbles and crashes to form. Sheila Dow (2010) critiques the EF framework a) for being purely conceptual, with no formal modelling, and b) for being ex post, retrospective, looking back at various financial market bubbles and crashes throughout history, without having the ability to be forward-looking/predictive.

Motivated by Dow's critique, in this paper, we begin by developing a seminal theoretical model, cast in an emotional finance framework, that has a first peek at relating investors' conscious and unconscious emotions to stock market bubbles and crashes. As this will be the first model of this kind, we will speculate on whether this model, besides being ex post descriptive, can become ex ante predictive. We will then examine how this framework can be applied retrospectively to the Dot-Com bubble, and then whether the emotional finance framework can be applied in a forward-looking, predictive manner, to the current situation in the crypto markets.

3.1 Emotions and Sentiment in the Financial Markets

The early work in behavioural finance focussed on psychological and cognitive biases, with little attention paid to the effect of investor emotions. The initial behavioural finance research into emotions in the financial markets focussed on *conscious* emotions: emotions that investors are aware of and can anticipate.

The BF analysis of emotions focuses on two main questions. First, do emotions enhance or detract from investors' decision-making and performance? Second, what is the relationship between emotions/investor sentiment, and stock market prices and returns? Our model focuses on the latter.

In the behavioural finance arena, theoretical models exist examining the relationship between investor cognitive biases, emotions/sentiment, and the stock market. Barberis et al

(1998) considers a stock market where prices truly follow a random walk, but where investors look for patterns, and imperfectly update their beliefs upon observing recent price moves, to falsely believe that markets are trending, or mean-reverting. Investors in the model suffer from two biases: representativeness and conservatism.

Daniel et al (1998) develop a theoretical analysis in which investor overconfidence and self-attribution bias drives stock market bubbles and crashes.

Baker and Wurgler (2007; 2008) were the first to focus on investor sentiment and stock market prices and returns. They first developed a theoretical analysis to demonstrate a correlation between investor sentiment and market pricing/returns, and then tested this empirically.

Shiller (1984) argued that stock investing is a social activity, and that investors tend to observe each other, and follow the crowd. This is important for our model, as we consider a snow-balling effect, with emotions, and the stock price bubble, building and accelerating over time.

3.2 Emotional Finance and Unconscious Emotions

Emotional finance (EF) represents a paradigm shift from behavioural finance (BF). Whereas BF focuses on investors' cognitive biases and *conscious* emotions, EF focuses on the effects of investors' *un*conscious, infantile emotions on the time-path of stock prices.

Taffler and Tuckett use Freud's (1911, 1916) theory of the phantastic object in order to explain investor behaviour around stock market bubbles and crashes. As Tuckett and Taffler (2012, p. 83) Note, "Everyday financial markets generate emotions…. Investment activity inevitably engages feelings and creates emotional conflict."

Emotional finance represents a considerable step forward in research into financial market behavior because it provides a unified framework for considering the evolution and trajectory of stock market bubbles and crashes through investors' phantasies and unconscious emotions. The initial impetus is a mysterious, magical innovation (Taffler and Tuckett 2005), such as tulips (tulip mania), mysterious investments (South-sea Bubble and twenty-first century hedge funds), and internet stocks (the late 1990s internet bubble). This creates an exciting new investment as a "phantastic object", which is:

“a mental representation of something (or someone) which in an imagined scene fulfils the protagonist’s deepest desires to have exactly what she wants, when she wants it.” Tuckett and Taffler 2008.

Furthermore, investors form these deep-seated phantasies in their childhood, such that the ‘shiny’ new investment evokes emotions similar to those experienced as a child with a favourite toy:

“Infantile feelings and phantasies leave, as it were, their imprints on the mind, imprints that do not fade away but get stored up, remain active, and exert a continuous and powerful influence on the emotional and intellectual life of the individual.” (Klein, 1975).

In the EF framework, when faced with an exciting and mysterious new investment opportunity, such as high-tech stocks in the 1990s, or today’s crypto currencies, an emotional trajectory is set in motion. First, investors enter the paranoid-schizoid (PS) phase where they view these investments as infallible and certain to succeed. A mental ‘splitting’ process occur, where the pain (i.e., the risk associated with the investment) is split from the pleasure (i.e., the excitement of the investment), and the risk is buried deep in the unconscious. Investors thus ‘fall in love’ with these investments and value them for their qualities, such as excitement, over and above their financial rewards.

Furthermore, at this stage, experts’ views, such as financial analysts, academics, and even the press, are sacrosanct. Therefore, in the PS phase, mass-buying of the stocks occurs and creates an irrational bubble. Because investors have fallen in love with the phantastic object and value it much beyond its financial rewards, they are willing to pay ‘silly money’ for their investments, way above fundamental values. However, at a critical ‘tipping-point’, nagging doubts emerge. On entering the depressive (D) phase, reality (the painful risk) floods the conscious, and investors are overwhelmed with feelings of hate for the investment. In the D phase, they now revile those whom they viewed as experts in the PS phase. Thus, investors look for scapegoats and blame these experts. Panic occurs and results in mass-selling. Therefore, the bubble bursts and the market crashes.

Emotional finance provides a framework that can explain consistently repeated episodes in history where financial markets have rapidly inflated towards an irrationally high peak

("boom"), followed by a sudden very rapid massive fall (the bubble bursting and the market crashing).

Tuckett and Taffler (2008) apply the framework to the internet dotcom bubble, which occurred between 1995 and 2000. In the 18 months between October 1, 1998, and March 9, 2000, the Dow Jones Internet Index multiplied six times. In the next month, it halved in value and by the end of 2002 stood at only 8 percent of its high.

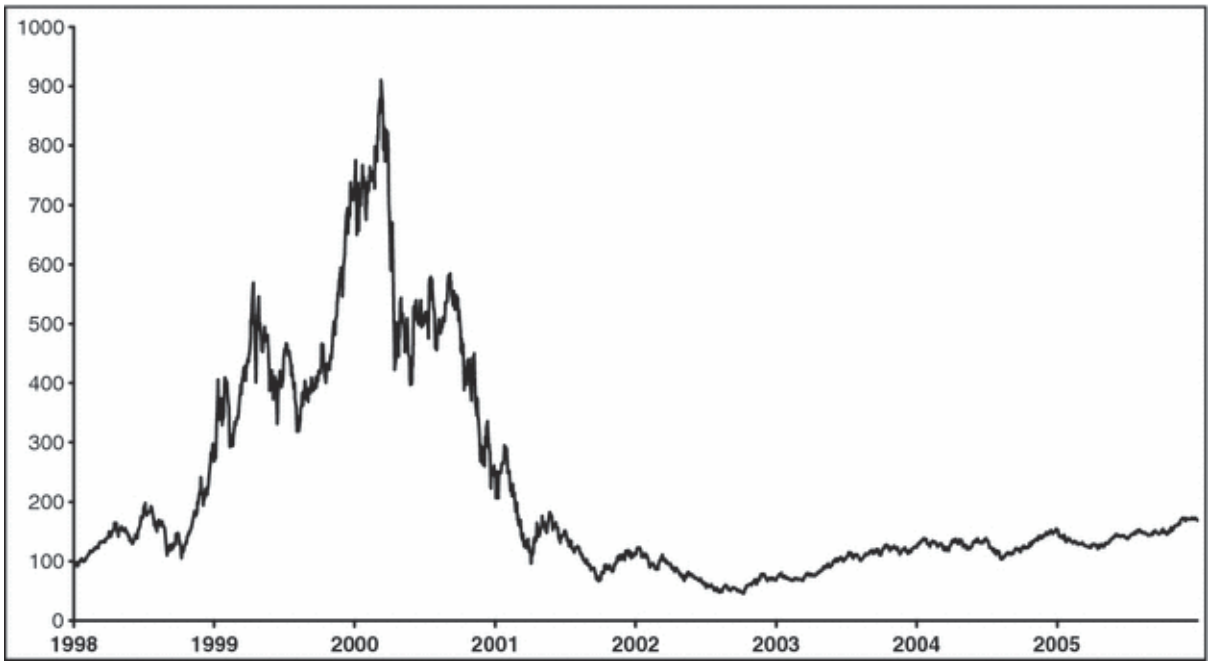


Figure 1 Dow Jones Internet Index (January 1998 = 100)

(Reproduced from Taffler and Tuckett 2008)

Bellotti, Taffler, and Tian (2010), who examine the Chinese stock market bubble, find that between June 2005 and 14 October 2007, when the market peaked, the Chinese stock market increased five-fold and then fell dramatically, losing 70 percent of its value over the following year. In the hedge fund bubble, hedge fund assets under management grew at the rate of 25 percent per year from 1990 to June 2008, peaking at almost $2 trillion. In the following six months, assets under management collapsed by almost a third. According to Eshraghi and Taffler (2009), investors may have viewed hedge funds as phantastic objects and viewed such funds as infallible and immensely valuable. Upon reflection, investors feel cheated and the once dominant feeling of desire for the phantastic object turns to anger and blame.

Taffler (2017) provides further practical EF examples, including the 2008 financial crisis, and gambling.

In a very recent break-through paper, Taffler, Wang and Li (2017) begin to demonstrate that we may be able to analyse the emotional finance framework using empirical techniques. Focussing on the Chinese stock market bubbles of 2008 and 2014, they employ content analysis of media coverage, looking at various words relating to emotionality and EF. Using this data, they employ VAR time-series techniques to demonstrate that the movements in the Chinese stock market mirrors the investors' emotional trajectory. They appeal to Kindelberger's 5 phase emotional trajectory.

3.3 Dow's Critique of Emotional Finance

As Dow (2010) notes, Taffler and Tuckett's (2005) emotional finance approach does not attempt to model behavior in any deterministic way. If investors hold knowledge with uncertainty, they will switch from euphoric market behavior to panic as the potential of the bubble breaking gains force and the structure of the financial system becomes more fragile. Yet, investors cannot predict the nature and timing of events that provoke the onset of panic. Tuckett and Taffler's (2008) framework provides a good ex post analysis of bubbles and crashes that can be used to 'fit' any episode in history. However, as Dow (2010) maintains, it is not a forward-looking framework that can be used to predict the exact trajectory and timing of emotions and financial market behavior. This observation motivates our model in the next section.

4 Our formal Emotional Finance Model

We outline a model which aims to provide a formal emotional finance framework for financial market bubbles and crashes and aims to be predictive. Our focus is on a financial market where a phantastic new, novel ground-breaking financial investment opportunity arises (for example, South Sea bubble, tulip mania, US Railroad stocks, hi-tech Dot-Com bubble of the 1990's, hedge funds, and now AI and crypto currencies, such as bit coin). Our model captures the idea, following Taffler and Tuckett's conceptual EF framework, is that, when this new investment opportunity arises, all investors "go mad" together: everybody falls in love with these investments. For a period of time (the paranoid-schizoid stage), the 'pain' associated with these investments (the risk of failure) is split out and buried deep in the

unconscious. The 'pleasure' aspect remains in the conscious, and these investments are viewed as infallible.

During the PS phase, love for the investment builds and escalates. At the same time, this growing euphoria causes an extreme bubble to form in the market valuations of these investments. However, a tipping point exists where "reality intrudes": investors begin to realise that these stocks are extremely overvalued, and the 'depressive' phase begins.

In contrast to Taffler and Tuckett's framework, where the reality (the pain, the risk, the overvaluation) floods out of the unconscious into the conscious, and investors immediately panic, we introduce a psychological 'go-between': the sub-conscious. The information dwells in the sub-conscious for a period, before fully flooding the conscious.

We model this formally as follows. The PS (unconscious hate) phase, in which all investors are in love with the stocks covers the time period $t \in \{t_0, t_1\}$. The "sub-consciously aware" phase exists in the period $\{t_1, t_2\}$. The depressive phase, in which reality floods the investors' consciousness, is when $t > t_2$.

In the PS (unconscious hate) phase, investor emotions evolve as follows:

$$E_t = Lt^{\alpha}.$$

In the "sub-consciously aware" phase, each investor places some weighting on love and hate, as follows:

$$E_t = \beta Lt^{\alpha} + (1-\beta)Ht^{\gamma}.$$

In the third and final depressive phase, when reality floods the consciousness, and investors switch completely from love to hate, investor emotions become:

$$E_t = Ht^{\gamma}$$

Where $\alpha, \gamma \geq 1,\ L > 0\ and\ H < 0.$

When $\alpha = \gamma = 1$, love and hate evolve in a linear fashion over time in their relevant time periods: That is, in the first period, $E_t = Lt$. In the second period, $E_t = \beta Lt + (1-\beta)Ht$. In the third period, $E_t = Ht$.

When $\alpha, \gamma > 1$, love and hate evolve at an increasing rate over time ('snow-ball' effect: positive in the case of love, and negative in the case of hate). For example, when $\alpha = \gamma = 2$, love and hate evolve in a quadratic fashion over time in their relevant time periods: That is, in the first period, $E_t = Lt^2$. In the second period, $E_t = \beta Lt^2 + (1-\beta)Ht^2$. In the third period, $E_t = Ht^2$. In our numerical examples, we focus on both linear and quadratic effects.

Furthermore, β represents the extent of the effect of the subconscious on the investors' mindset in the second, subconscious phase. When $\beta = 1$, the subconscious reality/hate has no effect on the conscious love: effectively, the subconscious is irrelevant. The subconscious phase effectively does not exist, and love continues to grow. The depressive phase is delayed and begins at the start of the third phase.

As β decreases, the sub-conscious reality/hate has an increasing effect on the conscious. In effect, the reality/hate begins to 'leak out' through the sub-conscious. When $\beta = 0.5$, the subconscious hate impinges equally on the conscious love. When $\beta = 0$, the subconscious hate immediately dominates and eliminates the conscious love: we effectively have the Taffler and Tuckett case: no subconscious phase: once reality and hate leave the unconscious, they flood the conscious. In our numerical examples, we focus on two cases: $\beta = 1$, and $\beta = 0.5$.

We next need to consider how investor emotions translate into financial market prices. We work with the following pricing equation:

$$P_t = FV + \mu E_t$$

We note that FV refers to the fundamental value of the financial instrument: the "phantastic new object". In the second term, E_t refers to investor emotions at time t, which evolve as in equations (1) – (3). The μ term reflects the strength of the effect of investor emotions on the stock price P_t.

Note that, in our model, we assume that fundamental value FV is fixed, and the only movements in the stock price (diverging from fundamental value) are due to the time path of investor emotions (love and hate). In the case of "normal" stocks (for example, the dot.com stocks of the 1990s), the fundamental value can be found by considering using the DCF approach: that is, discounting the expected future cashflows of the company stocks in question, to provide the present value. In the case of the focus of our analysis, crypto-currencies, such as Bitcoin, there is much debate on what the fundamental value would be. What are the future expected cashflows from owning a unit of Bitcoin?

Biais et al (2022) provide a model that considers "equilibrium Bitcoin pricing". In their model, the fundamental value of the cryptocurrency is its stream of net transactional benefits, which depends on its future prices. Due to "sunspots", there are multiple equilibria and extrinsic volatility. In contrast, in our model, we fix the fundamental value, and the volatility in Bitcoin prices around the fundamental value comes from the volatility of emotions in an emotional finance framework.

Numerical examples

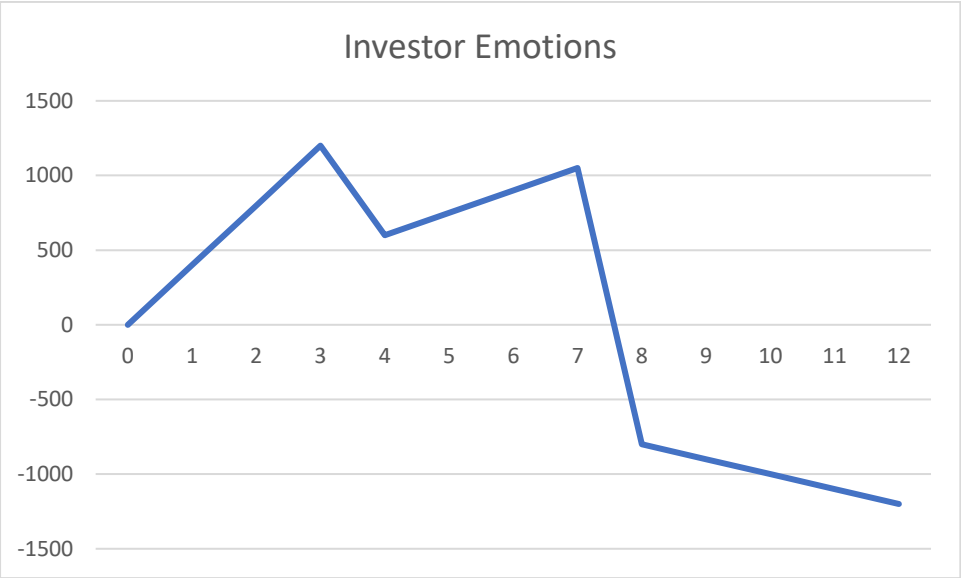
We consider the following numerical examples. $t \in [0,12]$; $L = 400; H = -100$. $FV = 12{,}000$.

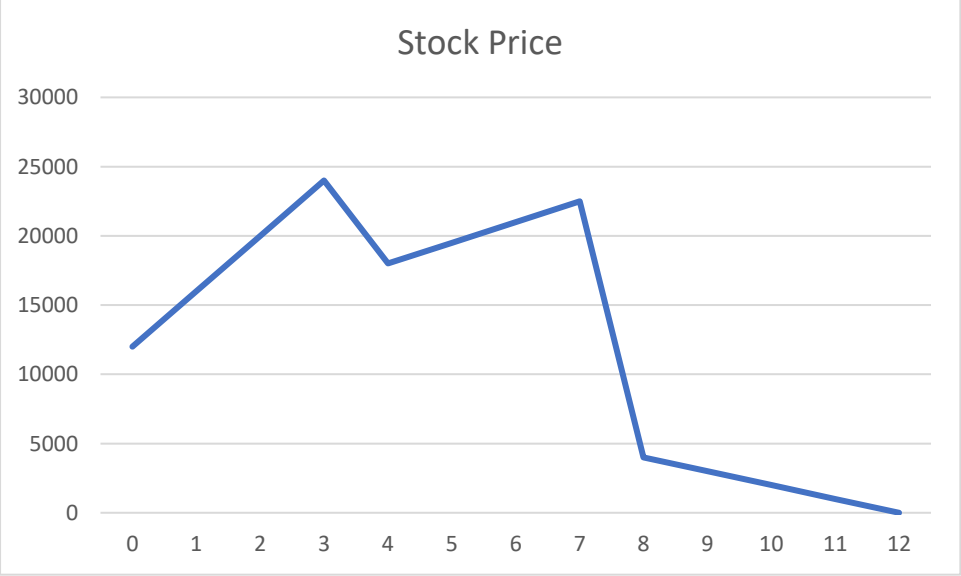
Thus, we focus on asymmetric love and hate: love is stronger than hate.

We focus on the case where the time period is segmented equally between the initial unconscious phase (for periods 1 to 4), then the subconscious phase (for periods 5 to 8), and then the final depressive phase, where reality/hate floods the consciousness, for periods 9 to 12. In terms of the subconscious weightings in the second phase, we focus on two cases: $\beta = 0.5$; and $\beta = 1$.

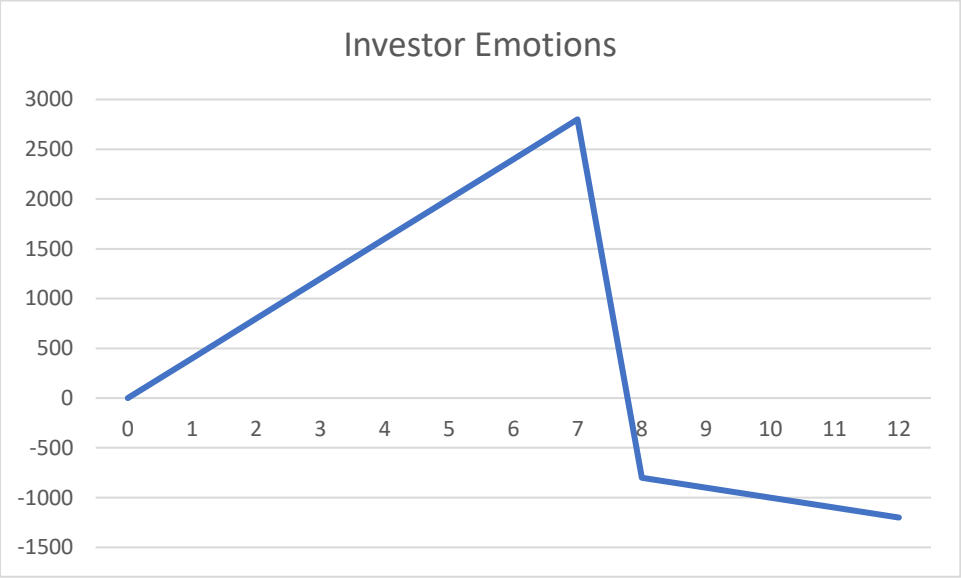
Given these parameters, we consider two cases for the evolution of love and hate: the "linear evolution" case ($\alpha = \gamma = 1$): and snowballing love with linear hate ($\alpha = 2; \gamma = 1$).

Linear Case: $\alpha = \gamma = 1; \beta = 0.5$.

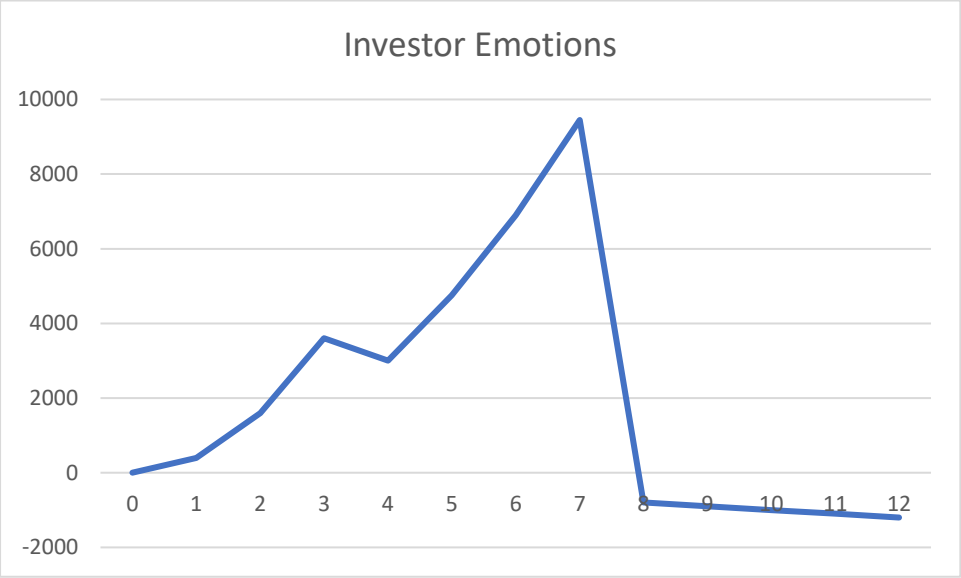




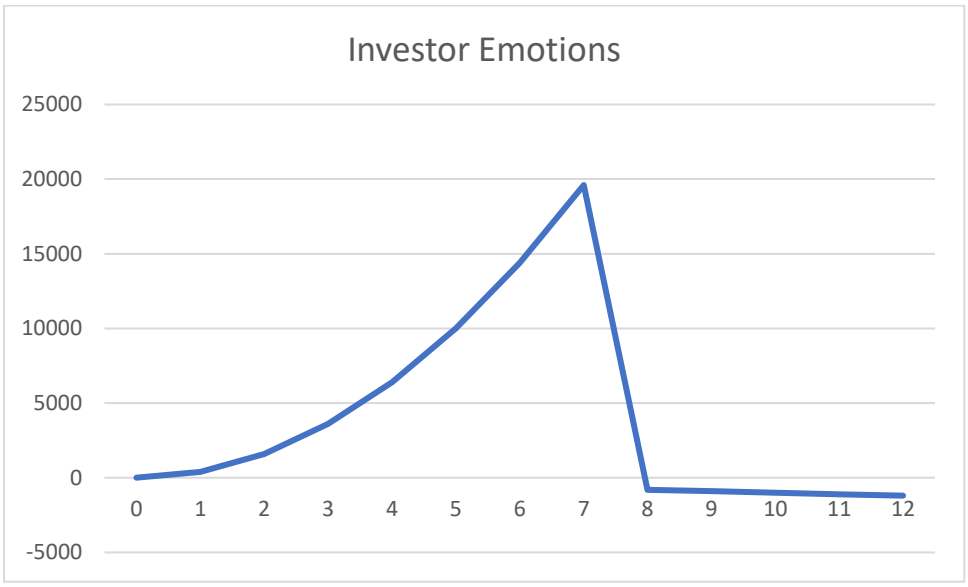
Linear Case: $\alpha = \gamma = 1; \beta = 1$



Snowballing love: linear hate $(\alpha = 2; \gamma = 1).\ \beta = 0.5.$



Snowballing love: linear hate $(\alpha = 2; \gamma = 1).\ \beta = 1$



Thus, our formal theoretical model, and all of these cases/graphs capture the time path of emotions embodied in Taffler and Tuckett's emotional finance conceptual framework: the

initial and growing love for the "infallible/phantastic" stock in the PS phase, with the hate/risk buried deep in the unconscious. Then, at a critical point in time, the reality intrudes (the "depressive phase"), with the hate flooding out of the unconscious, and flooding the conscious.

Our innovation is to add a middle phase, where the hate "seeps out" into the sub-conscious. We then consider two cases: a) where this has no effect on the overall emotion: investors still exclusively focus on the love of the stock, and b) where the subconscious hate impinges on investors' love for the stock.

Furthermore, in our modelling attempt, we have included an equation linking emotions with stock pricing. We have modelled this as contemporaneous: that is, the level of love and/or hate to have an immediate effect on stock price in the current period. Thus, we observe in the graphs that when the emotions switch from love to hate, the stock price immediately crashes. Also, we have modelled the strength of the effect of love and hate on the stock price through μ in our equation. In our numerical example, we have considered the case where $\mu = 10$.

5 Emotional Finance: Comparison of Dot-Com and Crypto

Thus far, we have developed an emotional finance framework, demonstrating a link between the time path of the unconscious emotions of love and hate, and the time path of stock prices. Our formal analysis demonstrates how this tipping of love into hate (in the Freudian psycho-analytical framework) can result in the forming of huge stock market bubbles, followed by sudden massive crashes. We suggest that our formal mathematical framework can be used to look back, and explain, in a descriptive manner, major episodes of bubbles and crashes in history, including the Dot-Com/ high-tech bubble of the 1990s. Indeed, the graphs that come out of our theoretical analysis mirror the graph of the Dot-Com crash.

Following Sheila Dow's critique, we now consider whether we can apply this framework in a forward-looking predictive manner, looking at the current crypto market. We ask: Do the current pricing patterns mirror those of the Dot-Com bubble, thus suggesting that crypto currencies are in a bubble, and are in danger of the bubble bursting and crashing? Are crypto investors' (time path of) emotions, like that of the 1990s dot com crash, with emotions swinging wildly, form extreme love to utmost hate?

To address the first question, we will look at episodes of pricing that have happened already in different cryptos, focusing on Bitcoin as the market leader. We compare Bitcoin with the Dot-Com pricing chart, and particularly, we employ Elliott Wave Theory.

For the second question, we compare the price charts with the fear-greed index in cryptos to examine the correlation between emotions and price. We also note that the characteristics of crypto investors is different from standard investors, which may have an effect here. Furthermore, we note that the characteristics of the market are unique, with lower volumes, and a mix of dominant institutions and retail investors, which may result in strategic game-playing. Finally, of interest, there are many different types of crypto currencies, whereas Dot-Com was more homogeneous. Thus, there appear to be asynchronous bubbles and crashes across different currencies.

5.1 Crypto cases: Emotional Finance and Elliott Wave Theory

This section provides practical applications of the Emotional Finance framework through the innovations of Elliott Wave Theory (EWT), a technical analysis tool used to map emotions through price action. For the sake of focus, we shall focus on two wave formations within the Elliott Wave Theory paradigm: The five-wave motive move and the three-wave corrective move. Both structures in question define narrative, volume, social mood and facilitate price action expectations. Within Crypto, the wider market (altcoins) is significantly driven by the price action of Bitcoin. Our first chart will demonstrate the five-wave motive move and three wave corrective structure of Bitcoin. We shall then explain the emotional rationale for each wave respectively and touch upon the ongoing game between retail investors and institutional investors. To finish, we shall examine the fear and greed index and compare the most recent Bitcoin crash to the Dot-Com bubble.

Figure 2: Bitcoin Bear Market 2021: A 3-3-5 Corrective Structure.

First, we begin by dissecting the most recent Bitcoin bear market. Within EWT there are several types of corrective structures that take shape in the form of WXY corrections and ABC corrections. These movements are against the larger trend and do not alter the macro trend. During the beginning of corrective movements institutions begin taking profits, causing slight downward pressure on price. Retail investors then see this pullback in price action as an opportunity and buy more, which is demonstrated by Bitcoins retest of its all-time-high just prior to the significant corrective phase beginning. During the corrective phase institutions begin distributing their holdings to retail investors, who still believe that the 'bull run' is ongoing (Wave W macro).

During wave X, denial begins to set in. Retail investors begin moving out of their positions and larger holders termed as 'whales' begin accumulating. Retail investors have bought high and sold low, transferring wealth from retail investors to institutional investors. As price action begins to become more positive and institutions finish accumulating, retail investors begin becoming more optimistic and willing to purchase Bitcoin. As such, institutions begin taking profits and distribute their Bitcoin to retail. The cycle repeats.

Interestingly, during this cyclical observation, individuals who utilise high degrees of leverage to underpin positions become liquidated. For example, at the low of wave W, retail

investors are apathetic, heavily in loss and despondent. The love they had for Bitcoin dissipates and becomes shallow, turning to a cacophony of hatred and despair. The retail investors who are now chasing losses begin to increase their risk tolerance in hopes of recovering some of the lost funds. Due to the unregulated nature of the Crypto space, institutions begin manipulating price action by placing large 'ghost' orders that they have no desire to fill. The price gradually moves up (or down) until individuals margins evaporate (Wave A), closing their positions and generating pockets of liquidity for institutions to accumulate further (wave B), before pushing the price up higher into the final wave C.

Finally, Bitcoin resumes the corrective nature to the downside (wave Y). Wave Y is interesting as it can be complex and manifest in several different corrective structures. Be it a 3-3-3 wave structure or a 3-3-5 wave structure. In the chart above, Bitcoin is demonstrating a 3-3-5 macro correction that is currently ongoing and would suggest lower lows are to follow. From the emotional finance perspective. This wave is increasingly potent for retail investors. Institutions begin distributing Bitcoin to retail investors, causing a shift in narrative from negative to positive. People begin feeling 'happy' and 'enjoy' their portfolio once again. This step is necessary to create the sufficient force required to tip individuals from love to hate and encourage the sale of their assets at a steep loss (discount) to institutions, who subsequently buy.

From the chart above, we project the Bitcoin bottom to occur around $16k -$16.5k based on the typical expectation of a wave five to the downside (1-1.236 of wave 4). The main takeaway from the unregulated nature of crypto is that a consistent game is afoot between retail investors and institutional investors, transferring information, wealth, and assets. Normally from retail investors to institutional investors.

Next, we analyse a five-wave motive move (bull run) for Bitcoin, explaining the emotional implications of each wave.

Figure 3: Bitcoin Bull run 2019: A 5-3-5-3-5 Motive Move

The difference between a motive move and a corrective move is the formation of a trend. A five-wave motive move demonstrates and combines corrective moves into an impulsive structure (1.618 of wave 1/2) that depicts emotional price path movements. In terms of a Crypto bull market, a five-wave motive move runs from the previous bear market low to the new all-time-high (in Bitcoin's case).

All five-wave motive moves begin life as an ABC, a three-wave structure. To evolve into a five-wave motive move, the C wave of an ABC must equate to 1.618 of wave A/B. Interestingly, wave three is termed as the institutional wave, driven by institutions who purchase the discounts on offer within the B wave (wave 2).

Waves 1 and 2 are the most difficult to spot within a five-wave structure. Holistically, the entire motive move structure is depicted as a 5-3-5-3-5 as opposed to the corrective moves 3-3-3-3 or 3-3-5 structure.

Wave 1 begins after the previous bear market comes to an end, reaching a lower low. Many retail investors have panic sold their assets and institutions and savvy retail investors now begin purchasing assets at a steep discount when compared to all-time-high. It is difficult to ascertain the discount received as there are no fundamental valuation methods in crypto, only what someone is willing to pay. The narrative is still negative in wave 1 with many calling for another lower low and perpetuating the 'going to zero' narrative. In the meantime, retail

investors begin opening further short positions as the price appreciates, leading to further losses as positions get liquidated quickly on high leverage margin.

During wave 2, retail investors begin to become more positive, their hatred softens and their desire to return to Crypto increases. Institutions begin taking profits and distributing their discounted tokens to retail investors at a hefty profit. An increase in volume to the downside begins to push price down as this activity commences. During this phase, a three-wave corrective structure is witnesses with investors monitoring Fibonacci retracement tool zones to underpin their decision-making process (much like a self-fulfilling prophecy). Ultimately, retail investors who have bought the top again become despondent expecting new lower low and begin to sell their assets at a loss, again. This is a rationale for the depth and severity of wave 2. It also offers investors a second chance to accumulate at discounted prices.

Wave 3 is often coined as the institutional wave, often the largest and most explosive wave, and can never be the shortest wave in a five-wave motive move. Institutions accumulate discounted assets as retail investors sell-off their holdings as they begin to cut their losses and leave the space. Retail investors view the second wave corrective move as a precursor to the infamous Crypto capitulation event. Wave 3 typically sees significant increases in volume after institutions finish accumulating their chosen assets. The end of wave 3 is marked by institutions proactively beginning to offload their assets as retail becomes intrigued by the space once more. A battle of rationality and cascade ensues.

Wave 4 is another corrective three-wave structure enforced by institutional distribution. If a Fibonacci retracement tool exhibits wave 3 lengthening to more than 1.618 of wave 1/2 then retail investors will hold to try and maximise gain. Greed begins to kick in. Price within wave 4 needs to drop low enough to entice retail investors to purchase assets, often wave 4 retraces around 38% of wave 3. Additionally, wave 4 cannot cross the high of wave 1 as this would invalidate the larger impulsive structure.

Wave 5 is the last of the motive move. Wave 5 is often the most unpredictable of all of the waves as it is driven purely by retail speculation and emotion. Retail investors begin purchasing assets during wave 4 as institutions begin distributing their holdings. Often retail investors are stuck holding their positions during this wave as their emotion inclines the

production and belief of irrational price targets that are never met. Retail investors often facilitate institutional distribution as they 'keep buying the dip' in anticipation that every crypto bull run produces a new all-time-high.

Alternative.me (2022) compile a fear and greed index that utilises emotions and sentiments from several different sources. This metric captures a holistic snapshot of investors feelings daily and links emotions with price action. It is claimed that the metric is representative of the whole crypto market, although it is unclear how 'whales' who manipulate price action are configured within this data.

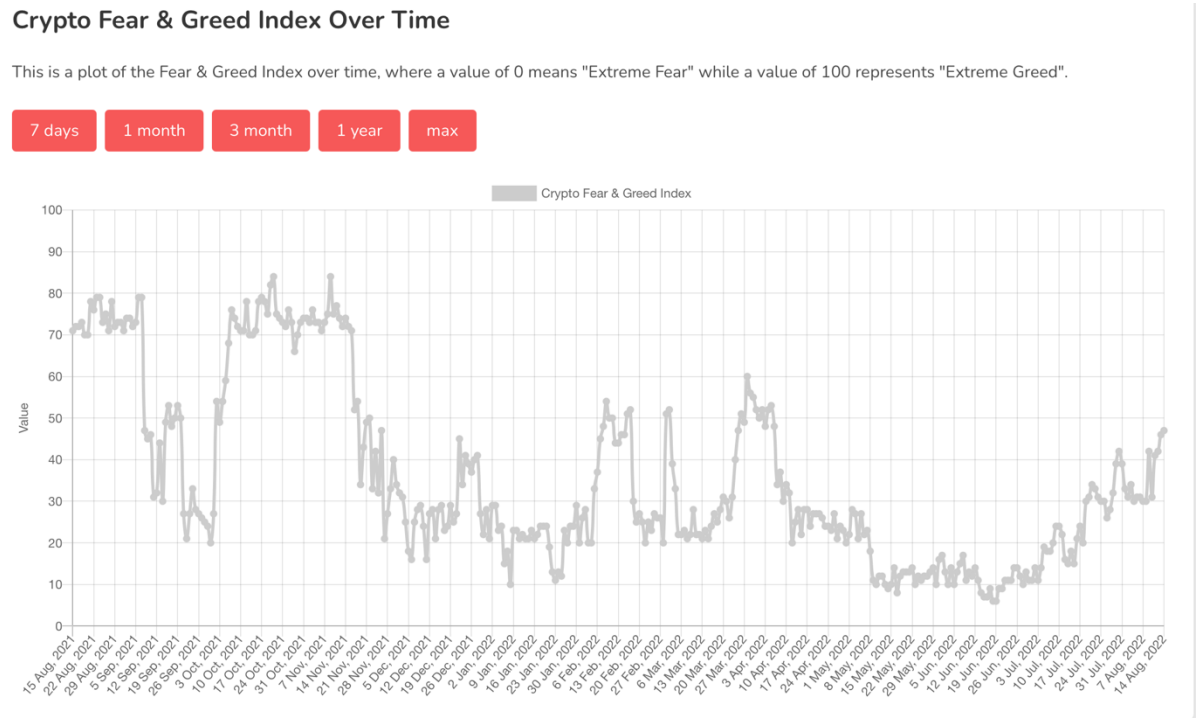


Figure 4: Crypto Fear & Greed Index: Bitcoin.

(Data source: Alrternative.me)

The fear and greed index typically correlates with price momentum in the market. When prices appreciate, investors become greedier and when prices go down investors become more fearful. Due to the lack of regulation in the Crypto space and the known price manipulation events, the fear and greed index should almost be inverted, and is for institutional investors. It is often that on the macro scale the fear and greed index hold strong

positive correlation price. Although, due to the larger institutional players entering the market and the lack of volume within the market, the fear and greed index may briefly decouple.

5.2 Dot-Com Bubble & Bitcoin: A Brief Comparison

Throughout the lifespan of Bitcoin there have been several drawdowns of over 80%. The coin, which was created on the back of the tumultuous conditions generated by the 2008 Financial Crisis holds much resemblance to the Dot-Com bubble of the 1990's. During the 1990's businesses simply changing their name to '.com' skyrocketed in value with fundamental value and all methodologies defined to produce a stock value becoming worthless. Many firms in the city saw huge profits and proclaimed that the parabolic upside was to continue for many years to come. A lovely example of cognitive dissonance, fear, and later, denial.

Figure 5: Comparison Between Dot-Com Bubble (March 27th 2000 – October 7th 2002) and Bitcoin Bear Market (2021-Present)

Our first observation when comparing both price charts is the relative similarity between the corrective structures. A significant period of higher highs and higher lows erode resistance to the downside. A period of denial demonstrates investors emotional resilience. Using EWT, this period of significant sideways ranging demonstrates the distribution and accumulation periods of institutional investors quite well, with a subsequent period of markdown following.

Interestingly, as assets are distributed from institutional to retail investors, the gradient of each markdown period steepens as retail investors turn from love to hate at an arguable quicker rate. Generating further downside pressure that generates significant emotional and informational cascade (Alsharman & Fairchild, 2019).

The general narrative in the Crypto space is that this bear market is just like any other. Bear market retracement has diminished with each passing bear market; Returns have too. However, there is no actual way to value a Crypto in fundamental terms, the price is purely what the buyer is willing to pay for an asset and what the seller is willing to sell the asset for. A key driver of any prolonged action is emotional synchronicity. Emotional stimuli require sufficient velocity and potency to override stimuli from new information to solidify a stance or decision-making process. In the case of the Dot-com bubble emotional stimuli dictated a greater fool scramble with investor exiting toward the door in the hopes another unsuspecting investor would take their place.

Finally, the fractal similarities between both Bitcoin and the Dot-Com bubble are clear to see. Comparatively, both fractals represent an exciting time for the assets. However, a significant difference between both the Dot-Com bubble and Bitcoin is the lack of regulation within the wider Crypto market. Investors can use underhanded tactical psychology to facilitate mapped transfers of wealth from retail investors to institutional investors. Perhaps a goal of corrective moves within a bear market are like fishing in a stream, dangling just the right bait and waiting for the unsuspecting fish to bite.

5.3 Will the Bitcoin Bubble Burst?

Thus far, we have developed a theoretical/mathematical model that formalises Taffler, Eshraghi and Tuckett's emotional finance framework. Our model examines a time-path of emotions, switching from love to hate at a crucial tipping point. Our model then relates this time path of emotions to the time-path of asset prices, in order to explain how the prices of phantastic new objects in the financial markets (for example, tulips, hedge funds, dot.com stocks, and now crypto-currencies, such as Bitcoin) can form into a massive bubble, which can then burst so dramatically.

Following Dow's critique, we have argued that our mathematical framework formalises, ex post, bubble/crash episodes in history. What characterises historical episodes such as tulip

mania, and the dot.com crash, is that the bubble builds up over a period of time, due to excitement, passion, love. Then at a critical tipping point in time, reality intrudes and hatred floods investors' consciousness. The bubble bursts, the market crashes forever, and the phantastic object disappears without a trace (as happened in the case of tulips and dot.com stocks).

Now, the situation appears to be different in the case of crypto-currencies in general, and Bitcoin in particular. Casual analysis of the trajectory of Bitcoin prices (and emotions in the greed-fear index) suggests a constantly repeating pattern of bubbles, crashes, and then new bubbles. It is thus, essential (in future analysis) to develop a model that reflects this repeating pattern. Why is it that the Dot.com stock bubble burst without trace in the 1990s, while the Bitcoin bubble and crash recur.

An element that a future model would have to capture is the game played by institutions, exploiting the dramatic swings in Bitcoin prices and investor emotions. The question would then emerge: will this repeating pattern continue indefinitely? If not, what would be the tipping point that causes crypto-currencies to crash for good?

5.4 Delving Deeper into a Crypto Investor's Psyche.

We conclude by considering a startling and very dramatic case that emphasises the psychological biases, emotions, and fervour behind crypto investing for one particular crypto investor. This is the case of a computer engineer who accidentally threw away £140 million pounds' worth of Bitcoin in 2013.[1] He had bought the Bitcoin for next to nothing in 2009. When he was clearing out his house, he threw away an old computer, and forgot that he had the Bitcoins stored on there.

Now his lost investment has rocketed in value to £140 million (a demonstration of the massive rise in the price of Bitcoin since 2009: is this a bubble?). We can imagine his emotional roller-coaster on discovering this. He has repeatedly asked Newport County Council whether

[1] Recorded in the article "I'll spend £10m to get my Bitcoin back from tip, IT worker tells council" available from https://www.msn.com/en-gb/money/other/i-ll-spend-10m-to-get-my-bitcoin-back-from-tip-it-worker-tells-council/ar-AA10dvQY

he can dig up the land-fill site to try to find his computer: they have refused permission. Nevertheless, he has now raised £10m funds, with Venture Capital involvement, to invest in robot dogs and AI to try to dig and find his computer. The Council have still refused. It is a risky investment (by him and the venture capitalists) as a) they are very unlikely to find the computer, and b) if they do find it, if it is broken (highly likely under tons of landfill), the data will be lost anyway.

Such is the excitement and clamour around Bitcoin! Furthermore, it would be ironic if he found his haul, and then Bitcoin crashed towards zero!

6 Conclusion

We have developed a theoretical/mathematical model of financial market bubbles and crashes in a Taffler/Tuckett emotional finance framework. Our modelling approach formalises the effect of the trajectory of investor emotions (love turning to hate at a crucial tipping point) on the time path of financial prices. The emotional finance framework focuses on "phantastic new investments". In this study, our focus is on crypto currencies in general, and Bitcoin in particular.

Our modelling efforts have been motivated by Sheila Dow's critique that the emotional finance framework is merely a) descriptive with no formal rigorous modelling, and b) is only backward looking, providing ex post descriptions of historic episodes of financial market bubbles and crashes, such as tulip mania, the South Sea Bubble, 19th century rail-road stocks, and the 1990s Dot.com Bubble, with no predictive power.

To address this critique, we developed (to the best of our knowledge) the first formal emotional finance model that relates the time path of investors' psychoanalytical emotions to the time path of a bubble and a crash. We then use it to (ex post) compare the Dot.com Bubble of the 1990s, with the current Bit-coin price and emotions path. Showing similarities between the Dot.com and Bitcoin paths, we then asked whether our model could become a predictive tool for the future. Only time will tell!

References

Alsharman, M., & Fairchild, R. J. (2019). When Love and Hate Collide: A Network Analysis of emotional contagion in Financial Markets. Available at SSRN 3821539.

Aste, T. (2019). Cryptocurrency market structure: connecting emotions and economics. Digital Finance, 1(1), 5-21.

Baker, M. and Wurgler, J. (2008). “Investor Sentiment and the Cross-section of Stock Returns.” Journal of Finance vol 61, number 4. 1645-1680.

Baker, M., and Wurgler, J. (2007). “Investor Sentiment in the Stock Market.” Journal of Economic Perspectives vol 21, number 2. 129-151.

Barberis, N., Shleifer, A. and Vishny. R. (1998). “A Model of Investor Sentiment.” Journal of Financial Economics 49 307-343.

Bellotti, X. A., Taffler, R., & Tian, L. (2010). Understanding the chinese stockmarket bubble: The role of emotion. SSRN Working Paper

Biais, B., Bisiere, C., Bouvard, M., Casamatta, C., & Menkveld, A. J. (2022). Equilibrium bitcoin pricing. Journal of Finance, forthcoming.

Daniel, K., Hirshleifer, D., and Subrahmanyam. (1998). “Investor Psychology and Security Market Under- and Overreactions.” Journal of Finance vol 52, no 6. 1839-1885.

Eshraghi, A, and Taffler, R. (2009). “Hedge Funds and Unconscious fantasy.” Online Working Paper.

Fisch, C. (2019). Initial coin offerings (ICOs) to finance new ventures. Journal of Business Venturing, 34(1), 1-22.

Hackethal, A., Hanspal, T., Lammer, D. M., & Rink, K. (2022). The characteristics and portfolio behavior of bitcoin investors: Evidence from indirect cryptocurrency investments. Review of Finance, 26(4), 855-898.

Howell, S. T., Niessner, M., & Yermack, D. (2020). Initial coin offerings: Financing growth with cryptocurrency token sales. The Review of Financial Studies, 33(9), 3925-3974.

Iyer, T. (2022). Cryptic connections: spillovers between crypto and equity markets. International Monetary Fund.

Klein, M. (1975). Love, Guilt and Reparation and Other Works: 1921–1945

Freud, S. (1911). ''Formulations regarding two principals of mental functioning'' The Standard Edition of the Complete Psychological Works of Sigmund Freud

Freud, S. (1916). ''Introductory lectures on psychoanalysis'' The Standard Edition of the complete Psychological Works of Sigmund Freud

Sentimenti (2020). Sentiment or emotions on the crypto stock market? Sentimenti. https://sentimenti.com/blog/sentiment-or-emotions-on-the-crypto-stock-market/

Dow, S. (2010). "The Psychology of Financial Markets: Keynes, Minsky and Emotional Finance," Chapter, in: Dimitri B. Papadimitriou & L. Randall Wray (ed.), The Elgar Companion to Hyman Minsky, chapter 13, Edward Elgar Publishing.

Shiller, R. J. (1984). Stock Prices and Social Dynamics. Brookings Papers on Economic Activity, 1984(2), 457–510.

Taffler, R. (2017). “Emotional Finance: Investment and the Unconscious.” European Journal of Finance.

Taffler, R., Wang, C., and Li, L. (2017). “Asset Pricing Bubbles and Investor Emotions: An Empirical Analysis of the 2014-2016 Chinese Stock Market Bubble.” Online Working Paper.

Tuckett, D. and Taffler, R. (2005). “A Psychoanalytical Interpretation of Dot.Com Stock Valuations.” SSRN Working Paper.

Tuckett, D. and Taffler, R. (2008). “Phantastic Objects and the Financial Market’s Sense of Reality: a Psychoanalytical Contribution to the Understanding of Stock Market Instability.” International Journal of Psychoanalysis 89: 389-412.

Tuckett, D., & Taffler, R. (2012). Fund management: An emotional finance perspective. CFA Institute Research Foundation.