The Solution for Unstable Bubble Assets: Reflection from an Islamic Finance Perspective

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Abstract
In the fast-paced world of technology, there exist popular investment instruments that have no intrinsic value (non-asset-based). As a result, their prices are highly volatile and prone to bubbles. However, from an Islamic perspective, investment vehicles must have a fundamental value (asset-based) to ensure price stability. This research aims to compare the behaviour of asset prices between non-asset-based and asset-based types by utilizing a system dynamics model. Furthermore, this study investigates the impact of two types of market sentiment: relatively stable good market and very good market sentiment, follows by very bad market sentiment. The findings of this study suggest that non-asset-based asset prices tend to bubble in response to good market sentiment and then rapidly decline when significant bad market sentiment arises. In contrast, asset-based assets tend to have more stable prices because investors have benchmarks and do not rely solely on intuition. This research highlights the importance of the fundamental value or asset base in investment instruments, as required by Islamic finance. However, asset-based assets can also be prone to high volatility when irrational investors dominate, and speculation prevails. In such cases, government intervention or regulation may be necessary to mitigate risks and stabilise the market.

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1. Introduction

As the world becomes increasingly digitalized, technology development has brought about major innovations across every sector, including finance. One of the most significant advancements in this sector is the rise of cryptocurrency assets. Białkowski (2020) notes that cryptocurrencies have proliferated and emerged as popular assets in the twenty-first century's global financial markets. However, these new types of assets lack a real asset basis, making it difficult to determine their fundamental value (Kallinterakis and Wang, 2019). As a result, the fundamental driver of the price behavior of such assets is often driven by investor perception, investor sentiment, and the news (Flori, 2019), particularly as research indicates that cryptocurrency investors' primary motivations are social influence and public sentiment (Almeida and Gonçalves, 2023).

According to Almeida and Gonçalves (2023), irrational investors who rely on market sentiment when making investment decisions control the cryptocurrency ('crypto') market. Therefore, they are susceptible to psychological biases that can lead to very volatile price movements (Pelster et al., 2019) and even bubbles (Cretarola and Figà-Talamanca, 2020). Recent examination of investors' experiences with cryptocurrency shows that almost every crypto price drops dramatically; some crypto prices have dropped by as much as 99%, while there has even been cryptocurrency exchange collapses in one single night (Jalan and Matkovskyy, 2023). These incidents highlight the need for investment instruments to have a clear asset value.

For a long time, Islamic finance has emphasised the important of fundamental values, stating that investment instruments should be based on assets to ensure stability and protect investors. According to Islamic financial principles, investment instruments must be backed by real businesses and tangible assets, and have a direct connection to the real economy (Hassan, 2019). Islamic financial principles also prohibit the charging of interest (riba) and unethical and immoral business (including ecological concerns), require economic reward to be based on profits or fees, and prohibit any speculation, uncertainty, or gambling (Billah, 2019). These instruments are more likely to exhibit stable prices (Hassan and Aliyu, 2017) and provide enhanced consumer protection during times of crisis (Aziz, 2019). Therefore, this study explores the price behaviour of non-asset-based and asset-based investment instruments using a system dynamics model approach, then conducting simulations under different market sentiment conditions.

System dynamics is an interdisciplinary approach to addressing complex problems across various fields (Sterman, 2000). It employs mathematical modeling, computer simulation, and experimental research to investigate the behaviour of complex systems over time (Ruth and Hannon, 2012). The capacity of system dynamics to simulate and analyse the behavior of systems under diverse conditions is a key advantage, enabling researchers to identify patterns and trends and assess the efficacy of various policies and strategies (Cosenz, 2017). Modeling and simulation research in the field of Islamic finance is scarce, creating a gap in the literature. This study aims to fill this research gap and contribute to the existing body of knowledge in this field. It extends the investigation by examining the impact of the proportion of irrational and rational investors on the model's behavior. To the best of our knowledge, prior research has yet to explore a system dynamics model that incorporates both asset-based and non-asset-based types of asset prices while analyzing the implications of investor-type proportion.

Furthermore, the research found that non-asset-based asset prices exhibit a tendency to inflate into bubbles following positive news before experiencing a rapid decline when significant negative news emerges. Asset-based investment instruments are more stable and better equipped to withstand speculation that can cause price surges. Nevertheless, asset-based prices can experience significant volatility when irrational investors are prevalent, resulting in speculation. In this case, it may be necessary for the government to intervene to manage risks and bring stability to the market.

The paper is structured as follows. Section 1 introduces the research background, while Section 2 provides a literature review, including an explanation of the methodology and a review of relevant concept. Section 3 details the methodology used, including the model’s idea and its mathematical representation. Section 4 presents simulation results under various scenarios and discusses the empirical behavior of asset prices. Finally, Section 5 provides conclusions, limitations, and policy recommendations.

2. Literature Review

2.1. System Dynamics

System dynamics is an interdisciplinary approach developed to deal with complex problems in various fields (Sterman, 2000). This field uses a combination of mathematical modeling, computer simulation, and experimental research to understand the behavior of complex systems over time (Ruth and Hannon, 2012). It is particularly useful for understanding systems with feedback loops, stocks and flows, and causal relationships (Cavana *et al.*, 2021). System dynamics models have been applied in various fields, such as management (Sánchez-García *et al.*, 2022), economics (Hartwig, 2022), public policy (Xiao et *al.*, 2023), environmental science (Porcelli *et al.*, 2023), engineering (Jang *et al.*, 2021), and many others.

In economics, system dynamics is used to study the behavior of markets, including the effects of government policies (sun *et al.*, 2020). In finance, models of system dynamics can analyze investment allocation (Huang *et al.*, 2023) and portfolio management. The strength of system dynamics lies in its ability to simulate and analyse the behavior of systems under different conditions, allowing researchers to identify patterns and trends and evaluate the effectiveness of different strategies and policies (Cosenz, 2017). It provides a powerful tool for decision-makers to understand the complexity of the systems they are dealing with and to make informed decisions based on evidence, scientific analysis, and real-world data (Cosenz *et al.*, 2020).

2.1.1. Reinforcing Loops

Reinforcing loops, also known as positive feedback loops, are an essential concept in system dynamics and have been extensively studied in various fields. These loops refer to a self-reinforcing process in which an increase in one variable leads to an increase in another variable, further reinforcing the original trend. Therefore, the loop amplifies the original effect (Sterman, 2000). Positive reinforcing loops can have beneficial and detrimental effects on the system's behavior: they can lead to rapid growth and expansion, creating virtuous success circles, or they can lead to runaway growth or unsustainable outcomes, such as environmental degradation or social inequality. Negative reinforcing loops, on the other hand, can lead to decline and collapse, such as in the case of a company losing market share, a population facing resource depletion, or an asset price bubble emerging and leading to a recession and crash (Cavana *et al.*, 2021; Miao and Wang, 2018).

2.1.2. Balancing Loops

Balancing loops, also called negative feedback loops, play a crucial role in system dynamics, as they provide self-correcting mechanisms that help stabilise and regulate complex systems over time. According to Sterman (2000), these loops exhibit a pattern whereby an increase in one variable causes a decrease in another variable, leading to a decrease in the original variable. This process creates a loop that ultimately stabilises the trend. Balancing loops are essential in system dynamics, as they can help create sustainable and resilient systems that can adapt to changing conditions and achieve long-term goals. Balancing loops can help maintain stability and prevent runaway growth or decline and can be used to optimize system performance over time. Balancing loops is a crucial and complementary concept in system dynamics that helps promote stability, resilience, and sustainability in complex systems (Cavana *et al.*, 2021).

2.1.3. Previous Research on System Dynamics in Economics and Finance

Du *et al.* (2010) attempted to model an economic dynamical system and control the potential chaos. The term ‘control’ here refers to directing or regulating a system's behaviour toward a desired outcome. This study demonstrates that the system can be effectively controlled by setting boundaries for the variables. Additionally, the implementation of control enhances system performance. Furthermore, Du *et al.* (2010) argue that economic actors, policymakers, stakeholders, and others unconsciously implement this control system. Uehara *et al.* (2016) aim to integrate economics and system dynamics to understand ecological-economic systems better. By incorporating economic concepts such as markets and prices, this study successfully captures the complex behaviour within a complex system. With this understanding, the study reveals that ecological-economic systems are susceptible to price adjustment times. The simulation demonstrates that the model's behaviour varies significantly based on the extent of price adjustment times. Sverdrup and Ragnarsdottir (2016) endeavour to model the behaviour of the platinum group metal system, including supply, demand, and market prices. The system dynamics model successfully replicates the historical data and market prices from 1900 to 2014. This study extends the simulation until 2400 and provides valuable insights for policymaking.

Furthermore, driven by the oscillation behaviour of real estate prices, Özbaş *et al.* (2014) endeavoured to model, simulate, and analyse this phenomenon using system dynamics. The study assumed a balance between supply and demand while acknowledging an unavoidable delay in the construction process of new buildings. After successfully capturing the price behaviour, two policies were implemented. It was, firstly, reducing construction time and considering ongoing projects when initiating new ones. These two policies successfully contributed to more stable price behaviour. Moving on, Dong *et al.* (2016) aimed to construct a system dynamics model to understand financing structures. The researchers reviewed the literature concerning financing structures to comprehend the problematic behaviour. Subsequently, the model's robustness was assessed by comparing its behaviour with real-world data. The study then conducted simulations and analyses under various assumptions, providing insights into improving the financing structure. Trideria and Ardi (2020) employed system dynamics to model the dynamic behaviour of an Indonesian startup company, investigating the company's strategies to support its survival in a highly competitive market. Possible approaches to stimulating corporate growth were simulated in this study and two significant findings emerged. Firstly, companies must identify the dominant factors or strategies contributing to immediate growth. Secondly, companies must achieve profitability as quickly as possible and establish a reinforcing loop within the system to ensure sustainability.

2.2. Asset Price

According to Billah (2019), there are two main types of assets: physical assets, such as real estate and gold, and financial assets, such as stocks, bonds, and mutual funds. For investment purposes, the investor often uses financial assets because they offer greater liquidity than physical assets. Investors can sell financial assets in the secondary market, where investor interaction determines the asset prices. The price forms from a secondary market activity called ‘market price’, which is determined by supply and demand (Sun *et al.*, 2016). However, market prices of financial assets such as stocks and bonds often have gaps with their true values. According to Hördahl and Packer (2007), the true value of financial assets is commonly called ‘fundamental value’ or ‘intrinsic value’.

Asset prices are critical aspects of financial markets, influencing the behaviour of investors, traders, and other market participants. Understanding the factors that drive changes in asset prices is essential for making informed investment decisions and managing risk. Economic indicators such as inflation, interest rates, and GDP growth can significantly impact asset prices (Šimáková *et al.*, 2019). For example, lower interest rates can stimulate demand for stocks and other investments, potentially leading to higher asset prices (Gu *et al.*, 2021). Geopolitical events like wars, political instability, and natural disasters can also affect asset prices. These events can create uncertainty and volatility in financial markets, leading investors to reassess their investment strategies and potentially driving prices up or down. In addition to these external factors, market sentiment and investor behaviour can also play a role in asset price movements (Berardi, 2020).

2.2.1. Non-asset-based

The motivation to analyse non-asset-based assets in this study is because of the emergence of cryptocurrency and non-fungible tokens (NFTs) as alternative financial investments. Cryptocurrency attempts to mimic the concept of fiat money as a digital currency but lacks intrinsic value compared to fiat money (Abubakar *et al.*, 2019). Muhammad (2017) even stated that cryptocurrency has no intrinsic value. Furthermore, cryptocurrency exists only in digital form, and governments and companies do not control its transactions. The uncertainty surrounding the fundamentals of cryptocurrency leads to dispersed beliefs among investors, resulting in high trading and speculative bubbles (Almeida and Gonçalves, 2023). Berardi (2020) asserts that increasing uncertainty increases the influence of psychological attitudes in investors' decision-making. Therefore, Gurdgiev and O'Loughlin (2020) suggests that cryptocurrency prices are driven by sentiment and that there are indications of herding behavior and bias. Herding occurs during normal, bullish, and high volatility periods (Shrotryia and Kalra, 2021).

2.2.2. Asset-based

In this research, the concept of asset-based investment is broad, ranging from real asset values serving as a basis to real businesses that benefit the real economy. The reflection of an asset-based investment instrument in this research is stock or equity. Compared to cryptocurrency, in Islamic finance, fiat money must be backed by a real asset, such as metal. This principle also applies to investment activities, with Billa (2019) noting that business activities must link to tangible assets and contribute to the real economy (Hassan, 2019). Therefore, all tangible assets, financial performance, benefits, and prospects can be classified as the bases of assets used to calculate the fundamental or intrinsic value. This asset basis serves as an essential benchmark for investors when making investment decisions. As Rupande *et. al*, (2019) stated, rational investor conditions suggest that the price will move if any fundamental factors change.

2.3 Islamic Finance

Islamic finance is a financial system rooted in the principles of shariah (Islamic law). The key characteristics of Islamic finance are the prohibition of interest (riba), a mandate to avoid unethical or immoral business practices (including ecological issues), the requirement for economic rewards to be profit or fee-based, and the prohibition of speculation, uncertainty, and gambling (Billah, 2019).

In the context of investment instruments, Islamic finance scholars have built and classified investment instruments based on their activities. All instrument types share the same underlying similarities: their business and activities are based on real assets and these activities bring benefits, linking all financial activities to the real economy (Hassan, 2019) and using proper contracts that benefit all parties (Aziz *et al.*, 2009). Therefore, Islamic finance instruments can provide better consumer protection during times of crisis (Aziz, 2019) and offer a more stable and less ambiguous financial system (Hassan and Aliyu, 2017).

3. Methodology

This paper investigates asset price behaviour of asset-based and non-asset-based investment instruments. We use a system dynamics model to simulate behaviour. In order to provide the big picture of the model, this paper draws a causal diagram of the model, representing the relationships between variables in a system. Then, we use mathematical expressions to express the model's detailed characteristics. Specifically, we employ a difference equation to depict the dynamics through the use of discrete time, providing a realistic description of the system dynamic, compared to the differential equation which expresses the system through continuous time.

3.1. Non-asset based Model

3.1.1. Casual Diagram

Figure 1 shows a causal diagram for the non-asset-based model. It provides a simplified overview of the model, which shows that the expected return positively drives changes in asset price. In this research, the expected return assumed will drag the price to the investor's expectation since it will influence the supply and demand. As stated by (Sun *et al.*, 2016), supply and demand are the determinant factors of asset price, but investor sentiment positively influences the expected return. Since a non-asset-based investment has no asset basis, it can be assumed that there is no fundamental value. As a result, investor sentiment depends solely on market sentiment and return value. In other words, if the market sentiment is positive, the investor expects prices to rise, and vice versa. If the previous return was positive, the investor expects a similar return in the future. As a result, this type of investor, in this study, is categorized as an irrational investor.

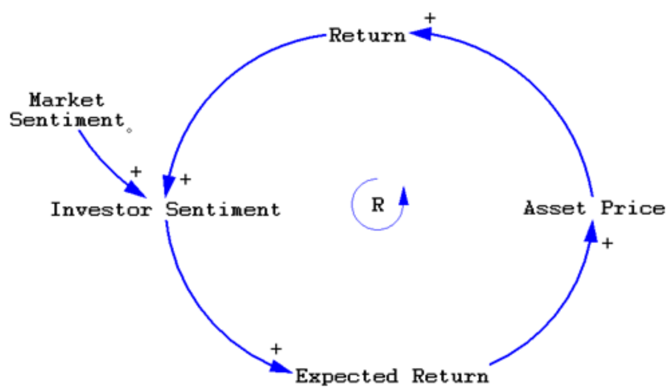

Figure 1. Non Asset-Based asset price model

The behaviour of the aforementioned model is described by a reinforcing loop, because all of the relationships between the variables are positive. This type of loop is a circular process that amplifies and reinforces an initial change, leading the system to persist in that direction. Miao and Wang's (2018) research suggests that a reinforcing loop can lead to the emergence of an asset price bubble, although it can lead to a collapse or crash (Cavana *et al.*, 2021).

3.1.2. Mathematical Model

This section presents the mathematical model for the non-asset-based asset price model. To express the asset price dynamics, we utilise a difference equation, which we discussed previously. We begin our discussion with our primary objective being to explain the asset price, followed by providing a sequential description of the other variables. We aim to make this discussion accessible to all readers, including those unfamiliar with mathematical expressions. For a clearer understanding of the model explanation, refer to the causal diagram in Figure 1. Additionally, we will use non-mathematics-friendly notation in this model.

Let us define asset price and expected returns at time t as $A_p(t)$ and $E_r(t)$, respectively. Here, we define asset price as a level price, which is not a percentage return, and expected return as the expected percentage increase in the asset price, defined as a growth rate in a system dynamic. Based on this definition, we can write the dynamics in equation (1), which explains that the asset price at time $t+1$ equals the asset price at time t plus the increase based on the expected return at time t. The asset price must satisfy the conditionA $A_p(t) > 50$, which is the minimum price required for this instrument in the financial market.

$$A_p(t+1) = [1 + E_r(t+1)] \cdot A_p(t) \tag{1}$$

We assume that the expected return at time t in this model is equivalent to the investor sentiment at time t, denoted by $I_s(t)$. Although in reality, the expected return driving the price may not be precisely the same as investor sentiment, and there may be other factors or variables affecting it. However, we maintain this assumption to simplify the model and comprehend the behaviour of asset prices. This relationship can be expressed as equation (2).

$$E_r(t) = I_s(t) \tag{2}$$

Furthermore, investor sentiment at time t can be considered as a combination of both rational and irrational investor sentiments, denoted as $R_i(t)$ and $I_i(t)$

respectively. In this model, for the sake of simplicity, we assume that investor sentiment is simply the sum of both rational and irrational investor sentiments. However, since non-asset-based investments have no fundamental value, the $R_i(t)$ value is assumed to be zero. Hence, equation (3) can be used to express the investor sentiment equation.

$$I_s(t) = I_i(t) \tag{3}$$

The irrational investor sentiment at time t is influenced by market sentiment and previous returns. Market sentiment includes various subjective factors such as news, perspectives on asset performance, prospects, and other non-standard measures. Components include news sentiment, macroeconomic indicators, and management, among other things. However, this research does not specifically discuss how to calculate market sentiment, and it is assumed to be a given value, as shown in Figure 3. in the market sentiment scenario section below.

Furthermore, this model assumes that the irrational investor expects at least the same return as the previous period. To account for biased psychology, we have incorporated an assumption that when the return value of the two previous periods and the market sentiment have the same value, the irrational investor sentiment will increase by C_{Bp}. In this paper, we have assumed a value of 20% for C_{Bp}. This assumption is in line with the findings of Burton and Shah (2013), who noted that psychological investor biases can occur when news appears to be relevant to price movements. Therefore, equation (4) is expressed as follows.

$$I_i(t) = \big((1 + C_{Bp} \cdot B_p(t)\big)(M_s(t-1) + r(t-1)) \tag{4}$$

Where $M_s(t)$ is the market sentiment at time t, and $r(t)$ is the return of asset price at the time (t). Then, $B_p(t)$ is the bias psychology, while C_{Bp} is the coefficient increase in percent if the bias psychology occurs. Then return of the asset price at time t can be calculated in equation (5). While equation (6) shows the condition for piecewise function for $B_p(t)$. Equation (6) shows that if the return at time $t-1, t-2$, and the market sentiment time at time t have the same positive or negative sign, then the bias will occur, represented by coefficient one.

$$r(t) = \frac{A_p(t) - A_p(t-1)}{A_p(t-1)} \tag{5}$$

$$B_p(t) = \begin{cases} 1, & r(t-1), r(t-1), M_s(t) > 0 \\ 1, & r(t-1), r(t-1), M_s(t) \le 0 \\ 0, & Others \end{cases} \quad (6)$$

So far, if all of the above model descriptions are combined, a complete model is obtained, which can be seen in equation (7). Since it contains quadratic variables and multiplication between variables, it is categorised as a non-linear system. Also, since it contains two periods of time, namely $t+1$, t, $t-1$ form time $t+1$ function, it is categorised as a second-order difference equation. Therefore, this system can create a complex behavior that can be analyzed further in the simulation result section. However, we do not analyse the equation (7) structure further because it is beyond our discussion.

$$A_p(t+1) = \left[1 + \left((1 + C_{Bp} \cdot B_p(t) \right) \left(M_s(t-1) + \frac{A_p(t) - A_p(t-1)}{A_p(t-1)} \right) \right] \cdot A_p(t) \quad (7)$$

3.2. Asset-Based Model

3.2.1. Casual Diagram

Figure 2 depicts the model for the asset price with asset-based characteristics. The model is similar to the non-asset-based model. However, the asset-based model also includes a balancing loop. Since the asset-based asset has an asset base as a benchmark, therefore, its fundamental or intrinsic value can be calculated. However, we were not concerned about calculating the asset's fundamental value in this paper, so the fundamental value is given only for illustration in the simulation.

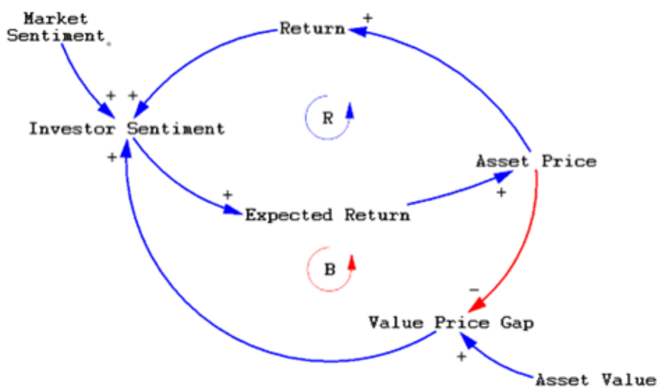

Figure 2. Asset-Based Asset Price model

Furthermore, the balancing loop in the asset-based model comes from the gap between asset price and its asset's fundamental value, represented as the value price gap in Figure 2. The value price gap is the difference between the asset value (fundamental value) and the asset price. Consequently, an increase in asset price negatively affects the value price gap. If the asset price increases, the gap between asset values decreases. A positive value price gap indicates that the asset price is lower than its value, which is a positive sentiment for rational investors. Otherwise, a negative gap indicates that the asset price is higher than its value, representing a negative sentiment. This value price gap positively impacts investor sentiment from a rational investor perspective.

3.2.2. Mathematical Model

In this section, structurally, we use the same mathematical model as the non-asset-based case, but in this case, there is the presence of rational investors. Therefore, let us rewrite equation (3) as equation (8). The equation of irrational investor $\left(I_i(t)\right)$ is the same as equation (4). Then the only difference is only in the equation for the rational investor, denoted as $I_r(t)$, represented in equation (9). The $A_v(t)$ represent asset value at time t, while $A_p(t)$ represent the asset price at time t. In equation (9), we used the asset value at time $t-3$, to reflect the reality that financial reports are published quarterly, therefore, there is a delay of at least one quarter. This implies that for time t, we can use the value from $t-3$.

$$I_s(t) = I_i(t) + I_r(t) \tag{8}$$

So far, if all of the above model descriptions are combined, a complete model is obtained, which can be seen in equation (10). It gives a more complex equation than the non-asset-based model. However, we do not analyse the equation (10) structure further because it is beyond our discussion.

$$I_r(t) = \frac{A_v(t-3) - A_p(t-1)}{A_v(t-3)} \tag{9}$$

$$A_p(t+1) = \left\{1 + \left(1 + C_{Bp} \cdot B_p(t+1)\right)\left(M_s(t) + \frac{A_p(t) - A_p(t-1)}{A_p(t-1)}\right) + \frac{A_v(t-3) - A_p(t-1)}{A_v(t-3)}\right\} \cdot A_p(t) \tag{10}$$

3.3. Market Sentiment Scenario

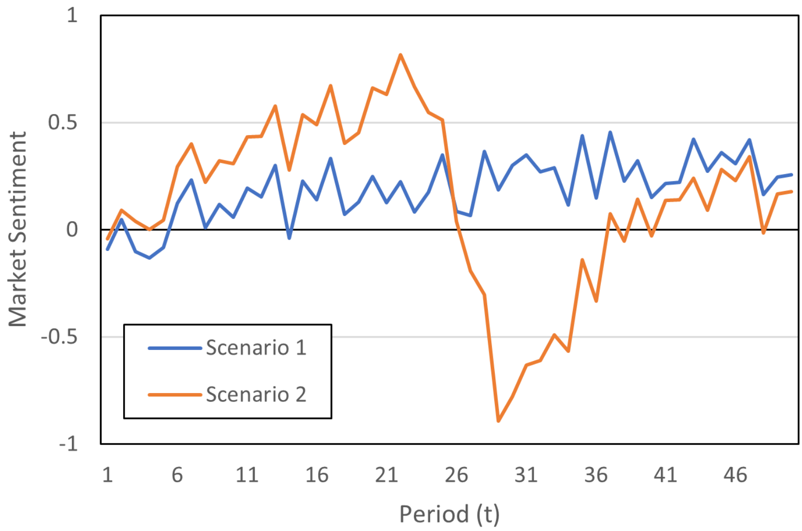

Figure 3. Market Sentiment Scenario

As previously mentioned, determining the fundamental value of non-asset-based investments is challenging because they lack a real asset basis (Kallinterakis and Wang, 2019). As a result, the price movement of these assets is highly sensitive to investor sentiment (Flori, 2019). Therefore, two market sentiment scenarios have been defined since this research aims to investigate the behaviour difference between non-asset-based and asset-based asset prices in response to market sentiment. These scenarios are illustrated in Figure 3. Scenario 1 represents a condition of relatively good market sentiment, with a moderate and slow increase. Otherwise, scenario 2 depicts a more extreme case, where the market sentiment is very positive and increases significantly in the initial investment period, before the sentiment turns very negative in the middle prior to gradually improving and becoming optimistic again. Then, random noise was applied to these news scenarios to reflect the unpredictability of market sentiment in reality.

3.4. Fundamental Value

Since this study aims to compare the behaviour of non-asset-based and asset-based asset prices, it is crucial to determine the real asset value to achieve this. The real asset value is also known as the intrinsic value or fundamental value, and we can use various methods to calculate it. Hördahl and Packer (2007) recommend using the stochastic discount of the expected asset value one year ahead, which can be based on the asset's financial performance or prospects. However, the methodology and proxy of asset value are not discussed, and the asset value is given in this research.

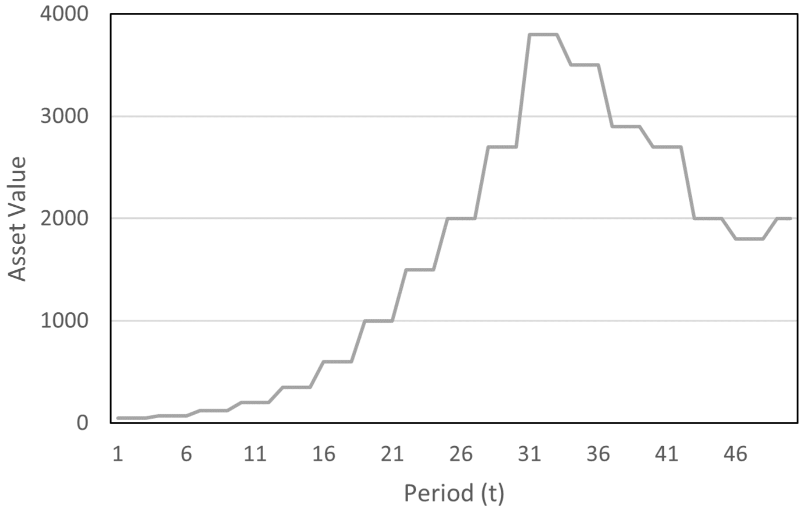

Figure 4. Fundamental Value of the Asset

The asset value used for simulation purposes is illustrated in Figure 4, which is created in quarterly periods, as commonly seen in enterprise financial reports or macroeconomic indicators. The simulation assumes that the asset value starts at the bottom of its price, gradually increases to its peak, and then decreases. The use of quarterly periods and the defined behavior of the asset value aim to provide more realistic results.

3.5. Data

In the final section, this study examines the actual behaviour of large and small capitalised stocks, as well as stable cryptocurrencies with high capitalisation and new ones with relatively small capitalization. Bank Central Asia (BBCA) and Elnusa (ELSA) will be used as proxies for large and small capitalized stocks, respectively. BBCA has a valuation of around 1,077 trillion Indonesian rupiah (72.3 billion USD), while ELSA has a valuation of around 2.93 trillion rupiah (196 million USD). The cryptocurrencies Bitcoin and Terra Luna Classic are also analysed, with Bitcoin having a peak valuation of 14,000 trillion rupiah (1000 trillion USD) and Terra Luna Classic reaching only 14 billion rupiah at its peak (1 billion USD). The reason for considering stocks with high market capitalisation and low capitalisation is rooted in research findings (Diebold and Yilmaz, 2008; Duttilo et al., 2021), which indicate that stocks with higher capitalissation tend to exhibit lower volatility compared to those with lower capitalisation. By including both types of stocks, the aim is to capture varying proportions of irrational and rational investor behaviour.

Furthermore, the chosen data period for analysis spans from 2018 to 2023encompassing both positive and negative sentiments that had a notable impact on the stock and cryptocurrency markets. In the stock market, negative sentiment stemmed from the COVID-19 pandemic, while positive sentiment emerged from a substantial price surge because of a steep decline, accompanied by a doubling of investors in Indonesia (Nagib and Husodo, 2022). Meanwhile, the cryptocurrency market experienced significant positive or negative influences due to decisions made by the US Federal Reserve Board during the period (Almeida and Gonçalves, 2023).

Lastly, the price data for all assets were obtained from Yahoo Finance, while the fundamental value representation of stocks, namely net income, were obtained from TradingViews with annual timeframe. Then, the net income data was interpolated.

4. Result and Discussion

4.1. Simulation Results

This section covers the behaviour analysis of the model created after the simulation. The simulation is carried out by computing a variable's value at time t based on the variable's value at $t-1$. The simulation involves several cases based on the proportion of rational and irrational investors. Rational investors make decisions based on the price value gap, while irrational investors base their decisions on market sentiment and previous return value. The simulation is divided into two sections: one for the non-asset-based case and the other for the asset-based case, with the latter representing Islamic finance wisdom.

4.1.1. Simulation Results

The simulation for the non-asset-based model initially examines the behavior of only 10% of irrational investors. As there is no fundamental asset value for non-asset-based models, rational investors lack guidance in decision-making. Therefore, in the non-asset-based simulation, the rational investor does nothing. They simply hold the asset from the beginning because they believe in the asset's project (such as in the case of cryptocurrency and NFTs). After all, it is the only guide for rational investors.

Figure 5a illustrates the price behavior of the non-asset-based model when the proportion of irrational investors is only 10%. Scenarios 1 and 2 correspond to different news scenarios. In scenario 1, the price exhibits a slow and steady exponential increase, as the market sentiment remains relatively stable with some noise. In contrast, scenario 2 displays more significant price fluctuations. Initially, the price increases more significantly than scenario 1 due to the relatively more positive news. However, the market sentiment takes a significant downturn, resulting in a sharp decline in price for scenario 2. The price then recovers as the news sentiment improves again. Overall, the price behaviour of scenarios 1 and 2 are relatively the same, despite scenario 2 has fluctuation. It was because the proportion of irrational investors is only 10%.

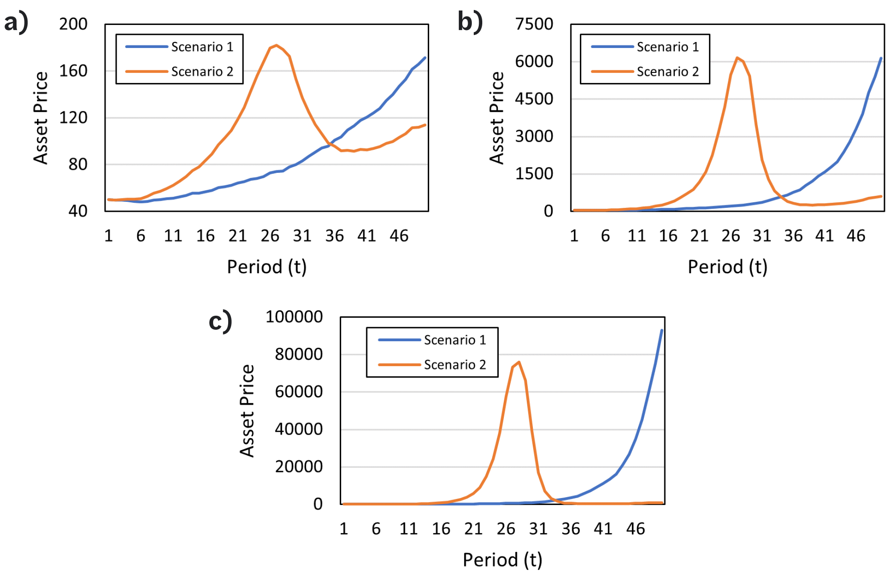

Figure 5. Asset price behavior for non-asset-based case with 10% irrational investor (a), 30% of irrational investor (b), and 40% irrational investor (c).

We extend our discussion to the non-asset-based model simulation with a 30% proportion of irrational investors. As depicted in Figure 5b, scenario 1 exhibits a significant increase in price due to the relatively positive market sentiment. Since the model, on average, yields a positive return, irrational investors expect to achieve at least the same return as before. This results in a primarily positive investor sentiment, which also drives the expected return to be mostly positive. Consequently, the compounding effects lead to an exponential growth in price. Otherwise, scenario 2 exhibits a more significant price increase than scenario 1 due to the initial positive market sentiment. However, a sharp price decline occurs because the market sentiment takes a significant downturn in the middle of the simulation. This extreme decline occurs due to the enforcing effect and the psychological bias. This model assumes that the irrational investor expects the same return as the previous period. It worsens the sentiment and holds back returns when the news improves.

Moreover, when the proportion of the irrational increases to 40%, for the scenario 1 and 2, the price will be significantly higher – up to ten times – than in the previous case. In addition, for scenario 2, the price will significantly drop and experience difficulties in returning to previous highs (see Figure 5c).

4.1.2 Asset-based

Compared to the non-asset-based model with 30% irrational investors, the asset-based model exhibits more stable price behaviour. As seen in Figure 6a, both scenario 1 and scenario 2 show that the price behaviour is not far from the asset value. In scenario 1, even if the news is consistently positive, if the price increases beyond the asset value, the rational investors will pull the price back towards the asset value. In scenario 2, if the asset receives negative news but the asset value is higher than its price, the rational investors will push the price up towards the asset value.

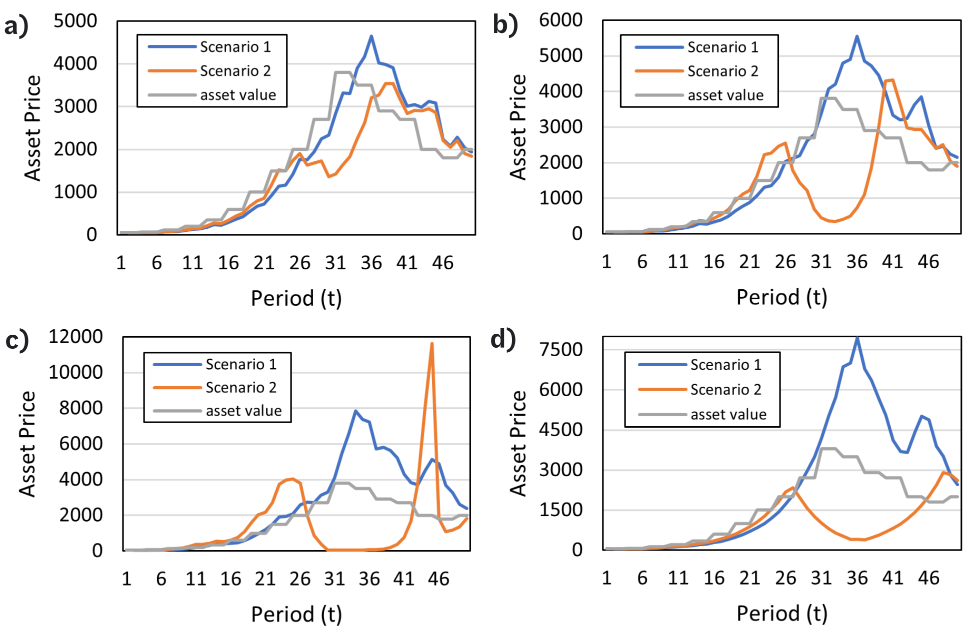

Figure 6. Asset price behavior for asset-based case with 30% irrational investor (a), 50% of irrational investor (b), 70% irrational investor (c), and 70% irrational investor with auto rejection policy.

However, as the proportion of irrational investors increases to 50%, the price behaviour becomes much more volatile. Figure 6b illustrates that when bad news hits, the price drops significantly, but then the rational investors drag it back up as the price-value gap widens. The impact of psychological biases becomes even more apparent when the proportion of irrational investors increases to 70% (Figure 6c). Despite the asset price falling to its lowest point due to negative news sentiment, the price subsequently surges as sentiment gradually improves. However, the significant increase in price widens the price-value gap, leading to another price drop.

In the scenario with 70% irrational investors, the asset price is highly susceptible to news sentiment and very volatile. This behaviour is typical of assets with small capitalisation in the capital market, making government intervention necessary. Figure 6d illustrates the efficacy of government intervention, specifically auto-rejection, where the price cannot increase or decrease by more than 20%. This approach can effectively manage the problem in scenario 2, as depicted in Figure 6c.

4.2 Empirical Price Behaviour

In this section, we will provide real examples of the movement of stock and cryptocurrency prices. Stocks are a representation of asset-based investments because they have clear company basis and financial & company performance, so their fundamental value can be calculated. Meanwhile, cryptocurrency is a representation of non-asset-based investment instruments, lacking clear fundamental value.

Figure 7 shows the movement of two stock prices. The first stock is Bank Central Asia (BBCA) stock, followed by Elnusa (ELSA) stock. BBCA stock represents a company with a very large market capitalisation, valued around 1,077 trillion Indonesian rupiah (72.3 billion USD). As a result, its movements not significantly influenced by sentiment alone. BBCA stock represents a condition where rational investors are more dominant than irrational investors. On the other hand, ELSA is a stock with a small market capitalisation, around 2.93 trillion rupiah (196 million USD), and is usually still influenced by news and other sentiment factors. Therefore, ELSA stock represents a condition where the proportion between irrational investors and retail investors is equal or even more dominated by irrational investors. Moreover, the grey line represents the fundamental value of the company, which is approximated by its net income. Then, there are red and green lines indicating negative and positive market sentiments, respectively. In Figure 7, on the Indonesian stock market, there emerged a negative sentiment when the first COVID-19 case was identified. However, a few months later, the stock market sentiment became positive due to the increasing number of investors and surging stock prices.

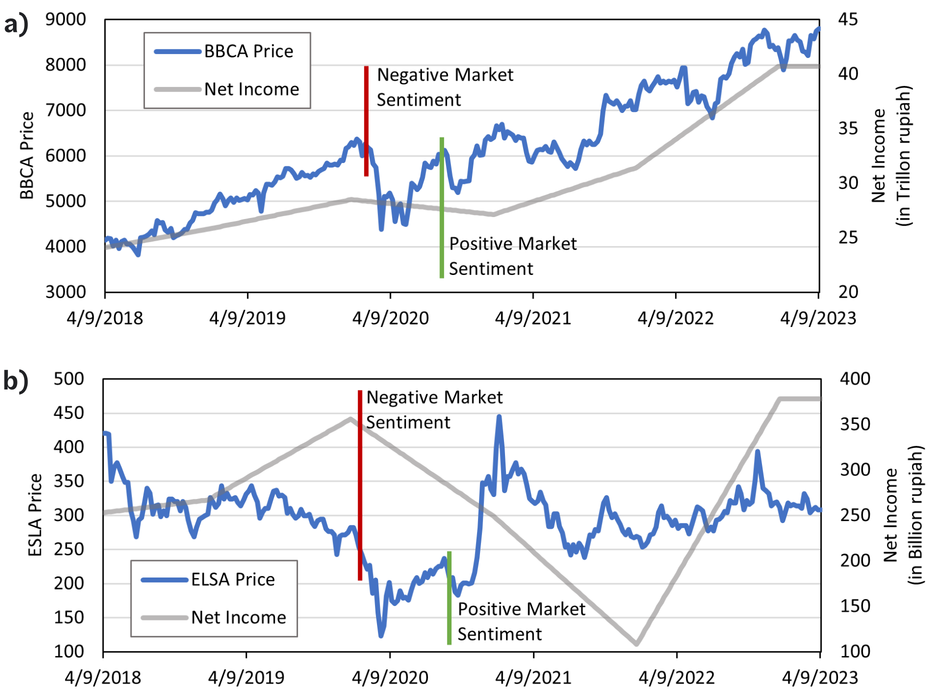

Figure 7. The stock price and net income (fundamental value representation) of BBCA (a) and ELSA (b).

Figure 7 illustrates that both BBCA and ELSA have similar stock price movements to movements in their fundamental values. However, BBCA's stock price fluctuation is relatively smaller compared to ELSA's. In Figure 7a, BBCA's stock price increased by approximately 107% from its lowest point to its highest point, while in Figure 7b, ELSA's stock price increased by around 265% from its lowest point to its highest point. Upon closer observation, BBCA's stock behavior aligns with the asset-based model when rational investors make up 70% of the market (refer to Figure 6a). The stock price moves around its fundamental value with minor fluctuations due to market sentiment. On the other hand, ELSA's stock behaves similarly to the asset-based model when rational investors constitute 50% of the market (see Figure 6b). Market sentiment significantly impacts asset price, causing fluctuations to deviate considerably from their fundamental value. Furthermore, it should be noted that ELSA's stock is still classified as a medium capitalisation stock in Indonesia. Stocks with lower capitalisation will give more fluctuating stock price movements, representing a more dominant irrational investor condition as shown in Figure 6c.

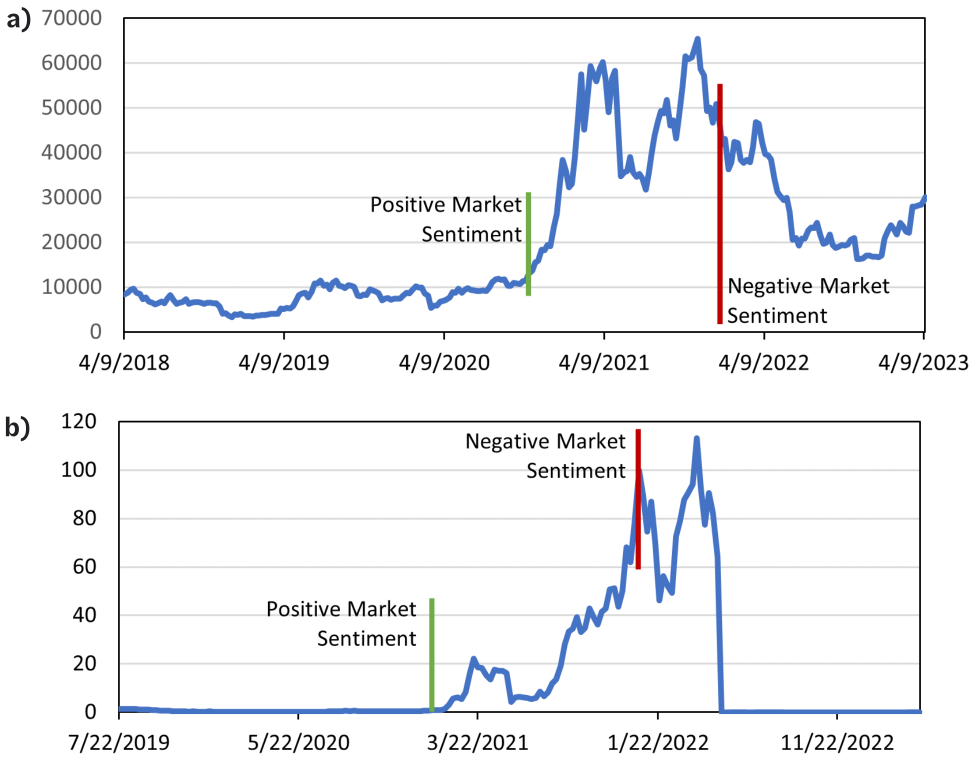

Figure 8. The cryptocurrency price of BTC-USD (a) and LUNC-USD (b)

Figure 8 displays the movement of two cryptocurrencies: Bitcoin in US Dollars (BTC-USD) and Terra Luna Classic in US Dollars (LUNC-USD). Being the first cryptocurrency and having the largest market capitalisation, Bitcoin represents the movement of non-asset-based asset prices with a relatively lower level of irrational investors. In contrast, Terra Luna Classic is a new cryptocurrency with a significantly smaller market capitalisation than Bitcoin, thus representing the movement of non-asset-based asset prices with a relatively higher level of irrational investors. In Figure 8, the red and green lines indicate negative and positive market sentiments, respectively. These sentiments are related to the US Federal Reserve Board's decisions, which impact all traded cryptocurrency assets.

Figure 8 depicts the movement of cryptocurrency assets, which follows a pattern similar to the non-asset-based model (refer to Figure 5). Specifically, Figure 8a illustrates the movement of bitcoin, which shares similarities with the non-asset-based model when irrational investors make up 10% of the market. As positive market sentiment increased, the price of Bitcoin surged by 650%, with the highest price being approximately 1,900% greater than the lowest price. When negative sentiment emerged, the price dropped by about 73%, but it eventually started to recover. On the other hand, Figure 8b displays the movement of Terra Luna Classic, which aligns with the non-asset-based model when irrational investors constitute 40% of the market. The price of Terra Luna Classic surged by 868,000% from 0.13 USD to 113 USD. However, when negative sentiment pervaded the crypto market, the value of Terra Luna Classic plummeted by 99.99% from 113 USD to 0.0001 USD in a short span of time.

5. Conclusion

5.1 Conclusion

The objective of this study was to develop a model for asset price formation structure for two distinct types of assets: non-asset-based and asset-based. These asset types differ significantly in their fundamental value. Non-asset-based assets, such as cryptocurrencies, lack intrinsic value, resulting in high price volatility and the risk of speculative bubbles. In contrast, asset-based assets meet the requirements of Islamic finance for investment assets to have an intrinsic asset base, leading to more stable prices. The dynamic model used in this study captures the basic idea of how asset prices form based on investor sentiment and analyses the influence of two distinct market sentiments on asset prices.

The study reveals that non-asset-based investments are prone to bubble during periods of positive news and experience rapid declines during negative news. On the other hand, asset-based assets show more price stability, as investors rely on benchmarks in addition to sentiment. The study emphasises the significance of fundamental value in Islamic finance, but also cautions that assets with fundamental value can still experience wild fluctuations if irrational investors dominate, which increases the risk. Thus, in such cases, government intervention may be necessary.

5.2 Limitation

In order to investigate the behaviour of the structure of asset price movement for non-asset-based and asset-based assets, this research makes certain limitations. Firstly, the value of market sentiment and the fundamental value of asset-based assets are assumed to be given. This assumption is made to avoid unnecessary complexity in the discussion, as measuring market sentiment and fundamental value can be a complicated task. This limitation is expected to provide a more focused discussion of the results. Further, this study succeeds to illustrate the price behaviour according to the behaviour of market sentiment and fundamental value movement. Secondly, this study presents only four empirical data as representative examples of the model's behaviour, as displaying a large amount of data would be inefficient due to the need to showcase price behaviour.

5.3. Policy Recommendation

Living in an era that is highly innovative and technologically disruptive, the rise of financial instruments that lack fundamental value is inevitable. As demonstrated by the simulation results above, these assets exhibit wild fluctuations and are prone to bubbles. Therefore, it is crucial for practitioners and regulators to devise a method for calculating their fundamental value that is universally accepted. Fundamental value can serve as a rational benchmark for investment decisions, rather than relying solely on intuition or gut feelings. Furthermore, even assets with fundamental value can still experience fluctuations, risks, and bubbles if irrational investors outweigh the rational ones. Hence, regulators must address this issue to curb abnormal price behavior.

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