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Providing a mathematical framework to deduce the dynamics of the pricing behavior of investors through heterogeneous bias

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ABSTRACT

Since investors' behavioral bias is a relatively vague concept, its accurate definition and measurement are extremely challenging. Furthermore, the common asset pricing models do not take into account the effect of behavioral biases in portfolio assessment. However, the dawn of behavioral finance undermined all the foundations of rational finance yet it did not result in an independent paradigm for explaining the inefficiencies. This concept also led to this major question among the investment advisers: How the advice about buying, maintaining or selling an investment shall be offered based on theories or the immeasurable behavioral biases? Attempts to quantify the biases and use them in the mathematical models became the subject of behavioral finance. Noise is one of the difficulties in finding the dynamism factors of financial market behavior. The chance events that occur round the globe are constantly changing the values but extraction of these chance events from the possible definite forces is difficult. Therefore, this study is an attempt to propose a mathematical model for measuring biases and its application to behavioral optimization in portfolio selection.

Keywords:

pricing dynamics, behavioral finance, behavioral biases, heterogeneous rational finance.

1. Introduction

Classical finance has formed based on the description of rules that determine the behavior of the investor. One of the conflicts between classical finance and behavioral finance is rooted in the rational human concept. In the behavioral finance, the "normal" human is opposed to the "rational human" in neoclassical economics. According to this approach, the rationality assumption is incapable of explaining the investors' behavior because it is not realistic (Zhason et al., 2018). Another criticism that came from behavioral finance about classical finance is directly linked to Fama's efficient market hypothesis (EMH), especially the stock market anomalies. The evidence of market inefficiency includes the fundamental anomaly (i.e. the anomalies associated with the fundamental performance assessment of a stock), technical anomaly (i.e. the lack of conformity between the technical analyses and the EMH hypothesis), and calendar anomaly (which reflects the different effects of time on the stock return and price). The most important one of them is known as the January Effect (Arora and Marwaha, 2014). Therefore, the views of the pioneers of behavioral finance, such as Shiller, Vernon Smith, David Porter, Don Balenovich, Vladimira Ilieva, and Ahmet Dura along with the results of studies by Jeff Madura and Ray Sturm and others contradict the efficient market hypothesis based on their evidence. Another criticism about the efficient market hypothesis is the notion of bubbles in the financial markets because bubbles will be nonexistent if the market is efficient. In this regard, Fama believes that extraordinary phenomena in the financial markets occur due to the investors' under-reaction or overreaction. Secondly, abnormal phenomena are ruled out either overtime or following an improvement in the research methodology. However, Fama's reasons for rejecting the bubble phenomenon in markets did not convince the advocates of behavioral finance (Burton et al., 2013). As regards the first reason, it is worth mentioning that this argument reflects a misconception about the psychological fundamentals of behavioral finance because there is no psychological principle that suggests people always under-react or over-react. Furthermore, the fact that primary hypotheses in studies are generally rejected or confirmed through subsequent research is an essential part of scientific and research studies in scientific fields. Absolute reliance on the deterioration of extraordinary phenomena overtime does not prove that markets function absolutely rationally. Even if the markets act extremely irrationally, the gradual elimination of extraordinary phenomena can still be expected (Zhu and Niu, 2016).

2. Research Theoretical Foundations

The efficient market hypothesis (EMH) was the prevailing hypothesis in the global scientific and academic financial economics circles from the 1970s to the 1980s. The efficient market hypothesis forms one of the foundations of modern financial theories but it is highly controversial and debatable. At the time, financial models explored the relationship between asset prices and macroeconomic variables using the rational expectations theory to integrate financial and economic sciences into a single theory. However, there was empirical evidence such as market exceptions, which could not be explained by the conventional efficient market hypotheses. Examples are the detection of behavioral anomalies in the stock market and patterns that were not in line with the modern financial theory and events such as the stock market bubble in the United States in the 1920s before the Great Depression and the dot-com bubble in the late 1990s, which was caused by the speculation activities that followed the technological developments. Other stock market bubbles include the bubbles in the 1880s and the early 1890s in Brazil, the Nifty Fifty bubble in the early 1970s, and the Japanese bubble in the late 1980s. As a result, a huge gap opened up between the world of finance and the days of its high stability and validity (Shiller, 2002)

3. Principles of Classical Finance

Statman, M. (1999) believes "classical finance is a knowledge set based on the Modigliani-Miller arbitrage principles, the fundamentals of Markowitz' portfolio theory, Sharpe-Lintner-Black the capital asset pricing theory, and Black–Scholes–Merton option pricing theory". The classical finance articulated the explanation framework for the complicated real world in an attempt to picture a computational vision. Classical finance is based on a set of simplifying assumptions and the concept of economically-wise human is hidden in the foundations of this approach, which states humans always make rational decisions

(Ftiti et al., 2016). Classical finance has formed based on the description of beliefs dictating the investor's behavior. According to the classical finance theorists, the classical finance theory is based on fundamental notions and basic principles such as the absolute personal interest, absolute rationality, and Fama's efficient market hypothesis. The occurrence of several important events in the 1930s and 1950s formed the basis for the behavioral economics. The development of "laboratory economics" also undermined the underlying assumptions about the "economic human". Kahneman and Tversky conducted studies on decision-making under uncertainty conditions to clarify the occurrence, causes, and effects of human errors in economic rationality and proposed the "prospect theory" (Thorsten et al., 2016).

4. Behavioral Finance

The Violation of the Classical Finance Principles and Biases

There are two paths in research that question the stronger form of the efficient market hypothesis. One of them explains that even when all enterprises behave rationally, there are various constraints and frictions that may lead to misevaluation (e.g. behavioral biases or incorrect pricing). As a result, fundamental values and market values diverge within a specific period of time. Factors that can lead to such anomalies include the information and transaction costs of information asymmetry, incomplete interbank markets, short sale restrictions, and relative wealth issues. These factors can set the scene for arbitrage and misevaluation (Tavoosi et al., 2018). The second issue related to the efficient market hypothesis is rooted in the behavioral finance issues. In behavioral finance, the efficient market hypothesis is unrealistic from the behavioral point of view. Studies on behavioral finance showed how psychological forces affect investors' decisions and lead to the inefficient behavior of financial markets (Rahnama Rudposhti et al., 2012). Theoretical models indicate that alignment of rational traders with people suffering from cognitive or psychological deficiencies leads to incorrect pricing and systematic errors. Behavioral finance is among the new concepts introduced by some financial scholars in the past two decades that quickly garnered the attention of professors, experts and students in this field around the globe. Consequently, the discussions led to the formation of an independent discipline in the field of financial science (Nikoomaram et al., 2012). The assumption about investors' "rationality", as a simple model of human behavior, is one of the main bases of classical finance and it has influenced almost all of the classical finance theories such as the portfolio theory, capital labor market, capital asset pricing model (CAPM), the agency theory, and its subsets. According to behavioral finance, this assumption cannot explain the behavior of investors because it is not realistic. In some cases, various factors cause irrational behavior and influence their decisions. This group of factors has paved the way for the entrance of behavioral sciences into the field of finance. Financial-behavioral research determines how individuals collect, interpret, and process information (Danaee Fard and Kazemi, 2010). This scientific field strongly stresses cognitive and emotional biases. To wit, human beings do not behave rationally due to their preferences (emotional biases) and cognitive errors (cognitive biases) (Farlin, 2006). Therefore, the behavioral science is designed to explain the market anomalies and other activities that cannot be based on the efficient market hypothesis. Fundamental principles of behavioral finance include psychological factors or behavioral biases that influence investors, limit or distort their information, and may lead to wrong decisions and outcomes in spite of the information accuracy (Anke et al., 2018). This notion is further discussed in this manuscript. In behavioral finance, the sophisticated dimensions and the human brain activities are analyzed precisely but it has been challenged by the uncertainty of economic decisions. The most important human attributes (i.e. fear, anger, greed, selflessness, etc.) considerably influence our investment decisions. Intelligence, greed (in a specific situation), reason (the long-term consequences of actions), and emotions (finding a reason for our actions) are all interconnected, and prediction based on limited and short-sighted rules is difficult (Khan et al., 2016). Behavioral finance challenges the classical finance theories, especially the efficient market hypothesis on the macro level. On the micro level, behavioral finance seeks to demonstrate how investors' behavior in reality is not in line with the rationality requirement in neoclassical economics. "Irrational" behavior is not the opposite of "rationality" in the behavioral finance literature. Rather, irrational behavior is a behavior that does not fully comply with the predefined rationality

characteristics or deviates from them. The emergence of phenomena such as the price bubbles in the stock market, over-fluctuation of stock prices, and overreaction (under-reaction) of investors to new information is opposed to the efficient market hypothesis (Thorsten et al., 2016).

Behavioral Bias

Bias could be defined as the tendency to defend and advocate a theory or theorem without assessing its truth or falseness by overlooking and rejecting the rational alternative viewpoints. Bias unconsciously influences the person's judgments and typically leads to misunderstanding and conflicts. People may suffer bias in any aspect of their investment (Toma, 2015). Bias refers to unilateralism, the lack of an impartial viewpoint, or the lack of openness in making rational decisions. In other words, bias is the act of wrongly repeating or insisting on thinking, assessing, recalling, or other cognitive processes and it shows the pattern of standard deviations in judgments. Hence, inferences might be irrational due to bias (Tiwari et al., 2018). Bias is a model that distorts one's judgment and reasons, thereby causing irrational conclusions about other people and situations. The "subjective social reality" of humans forms through the observation of the inputs. The formation of an individual's "social reality" dictates their behavior in society rather than their objective inputs. Therefore, cognitive bias may eventually lead to perceptual distortion, misjudgment, irrational interpretation, or what is commonly known as irrationality. Bias may be manifested in different forms and it is linked to discoveries, prejudgments, and intuition, which can result in a systematic deviation from a good judgment or a rationality standard. These concepts are often analyzed in psychology and behavioral economics (Thorsten et al., 2016). The origin of some of the heterogeneous behaviors can be cognitive errors, which are the rules of mental accounting.

Bernoulli Error Behaviors

Bernoulli error behaviors were inspired by Bernoulli's article (1638), where he put forward the utility theory. Utility mainly means joy. The question raised by Bernoulli was: How do people make high-risk decisions? Bernoulli assessed the possible consequences with regard to their utility. He believed investors calculate within the framework of their financial condition and try to estimate their return if their investment is fruitful, if it is fruitless, or if it is insured or not (Charles Cadogan, 2018).

Bernoulli's utility theory has an error and the occurrence of this error is surprising in some respects. According Bernoulli, one's financial condition is the amount of money earned by the person and the priorities are equal whether the initial capital is one million dollars, half a million dollars, or two million dollars. However, it should be noted that no investor thinks like this as he/she also thinks about his/her own profit and loss in his/her financial condition (Chen et al., 2018). In fact, this factor is highly insignificant but it was revealed that it is a fundamental factor that causes fundamental differences. This is because if people do not think like this and if people think within the framework of their loss and profit rather than their financial condition, none of the mathematical analyses based on this image of people can be correct. The correction of Bernoulli's error affected the theories of Richard Thaler's, who used it to found behavioral economics and strongly challenge the rational model. Richard Thaler referred to the dominance of the rational model over economics and its continued dominance in the future. Behavioral economics explores it, corrects its assumptions, and makes it a psychologically rational concept (Charles Cadogan, 2018).

Random Error Behavior

This error results from the dispersion in the absence of systematic errors around a relatively uniform actual market value. In other words, the probabilities of positivity or negativity of this error are equal. Random errors are defined as errors whose positivity or negativity probabilities are equal. Hence, it seems the mean value of these figures is a good estimate of the actual quantity value, while it also grows closer to the actual value with an increase in the number of measurements. If the measurement errors are only random errors, the range of the results of consecutive measurements around the given actual quantity increases. As stated, the mean of the figures is a good estimate of the actual given quantity value in the presence of random errors (Tuyon et al., 2016).

The classical asset pricing models that are based on the normal assumption can generate random errors. In an efficient market, investors make rational decisions on the uniform and normal distribution of

errors cause the balanced prices of financial assets. This error is one of the investment errors caused by a unique and unrepeatable error. The accidental error associated with news is limited to a particular situation or event. This unsystematic error is also known as the error that can be eliminated within a specific period without/with delays. This error can be reduced by improving optimal and accurate learning. In a portfolio with an effective rational diversity, random error is insignificant and could be neglected. Basically, the random error in such portfolios can only be analyzed as the systematic error risk (Charles and Cadogan, 2018).

Systematic Error Behaviors

The conventional neoclassical hypotheses, which form the foundation of the asset pricing models, revolve around rationality. The priorities of fully rational investors comply with the expected utility. Interestingly, the expected utility model consists of two components: a set of possible beliefs and a utility function. In the conventional models, rational investors efficiently utilize information, and thus their beliefs are based on the use of optimal statistical procedures. In the conventional asset pricing models, utility functions are concave functions of wealth levels, and this concavity reflects the investors' risk aversion (Greenwood et al., 2014). The first note to the conventional pricing theorists is linked to the behavioral characteristics of the model inputs. The advocates of behavioral finance assume psychological phenomena prevent most investors from being fully rational. Besides, it is assumed investors are partially rational. The partially rational investors do not demonstrate the same forms of risk aversion and they even act as risk-seekers in some cases. In addition, partially rational investors do not rely on the optimal statistical procedures. Rather, they rely on exploratory processes that turn their beliefs into biases. Similar to the utility functions, the functional arguments used by the partially rational investors are mainly based on a change of wealth as compared to the final wealth. As a result, these investors voice their priorities regarding the final condition of their assets. As proven in the following, investors make systematic errors (Charles, 2016). The second type of error in financial studies is the systematic error, which has a known direction or pattern unlike random error. This error also has a predictable pattern. This type of error always leads to overvaluation or undervaluation based on the notion of error, which refers to the distance between the expected value and the actual value of a given variable. Hence, not only the direction of this error is predictable but also the mean of errors is a non-zero value. This type of error is called a bias in behavioral finance research methodology (Charles, 2016). Concerning the effect of the existing systematic errors, they result in a deviation from the actual average value. The detection and correction of systematic errors are relatively difficult in general and they can be detected when a quantity is calculated through several iterations. However, it is relatively easy to work with random errors and correctly calculate the quantity because if there are large random errors in the investment, they will be observed as large values in the final error. Moreover, an undetected systematic error may lead to a seemingly valid result with a small estimated error, which is actually a grave mistake. In fact, systematic errors have to be detected and eliminated one by one. However, there is not a general rule for this process and the knowledge is obtained through extensive experience. In mathematical sciences, bias or systematic error exists. The amount of error and its size and sign (positive or negative) are determined by the magnitude of the bias source. The systematic error in the analysis of the particular causes of an error is constant, repetitive, and unilateral. In other words, repeated errors occur under similar conditions (Hai et al., 2018). Psychologists have concluded that when economic agents use their mental beliefs, they are exposed to some systematic errors. As stated, behavioral patterns mitigate the effect of these biases and increase market efficiency. In this regard, Kahneman and Tversky used Allais experiments set, and the results revealed that humans make decisions under erroneous conditions that do not comply with the prediction of rational decisions. In addition, they do not make random errors and are interested in repeating systematic errors or biases. Kahneman and Tversky's observations also indicated the increase in the importance of systematic errors based on the prospect theory during the study period and the observations confirmed the validity of the proposed model (Allais, 1953). Kahneman and Tversky stated that the value function is asymmetric in relation to the utility curve (under erroneous conditions). They believed decision makers are increasingly experiencing fewer errors per unit return but instead

they accept more errors to avoid a unit loss. In other words, "losses seem larger than profits from afar". Kahneman and Tversky's prospect theory offers a suitable framework for describing the detection of investors' systematic errors. However, it was the basis of Simon's experience. Fama's approach is basically different from that of Kahneman and Tversky, Simon, and other behaviorist scientists. Instead of stressing people's rational behavior (or other types of behavior) in decision making, he is interested in determining whether the market is efficient at all. He articulates his viewpoint as follows: "The lack of conformity of the investors' errors alone cannot represent the market inefficiency unless there are investors who can use the available information to make better assessments against the market (in which case ... its effect is hidden in market prices) (Charles and Cadogan, 2018).

Inferring the Investors' Behavioral Pricing Dynamic by Heterogeneous Biases

A regression model based on the following arbitrage is used to infer the behavioral pricing dynamic from unexpected fluctuations.

(1)

$$E(R) = f(F_i / \Omega_t)$$

$$E(R)=\eta+\beta_i \sum_{i>0,t=0}^{i,t=n} (F_{it} / \Omega_t)$$

$$n = 1, 2, \ldots.$$

In this model, E (R) denotes the expected stock return based on the stock fundamental factors and η is the constant values vector. Besides, B represents the coefficient matrix of the determining factors, F stands for the research determining variables in the information content Ω_t, and ε shows the unexpected fluctuations. Generally, regression suits the estimation of the market model parameters. In addition, the rational models are efficient markets considering the assumptions and there is no trace of behavioral bias. For the i-th participation during the event, estimators use the market model parameters to obtain the estimation equation 1 (McKinali, 1997 and Bagato Romano, 2002). Since one of the considerable notable applications of the rational expectations notion is in the efficient markets theory and asset pricing, the related observation series follows the random walk model (the random effect) if the current value of a variable (e.g. stock prices) is the best possible prediction of its future values. In the stock price efficient market theory, the rational expectations notion is utilized to conclude that stock price variations follow the random walk model when the effect of discount and dividends is properly removed from them. The chain of the reasons for this conclusion is as follows: To predict the prices, the investors analyze all information sources (see Information and Prices), including patterns detectable in the previous price variations. In the efficient market hypothesis, economic decision-makers reexamine their expectations based on the previous period errors in accordance with the rational expectations. In other words,

(2)

$$R-E(R)=\lambda(R_{t-1}-E(R)_{t-1}) \qquad 0<\lambda<1$$

E(R) denotes expectations associated with R at time t-1. In this equation, λ is a constant. According to this equation, people may make errors systematically. In other words, they may overestimate (or underestimate) R changes for several consecutive periods. In the adaptive expectations hypothesis, which is expressed via equation 2, E (R) moves asymptotically to a new level R. In other words, variable R is underestimated for several consecutive periods. Besides, in the rational expectations theory of classical finance, people do not make systematic errors. Therefore,

(3) $$R=E(R)+\varepsilon_t$$

Where ε_t is not the systematic prediction error and R is predicted accurately. The only cause of the expectations error, $\varepsilon_t = E(R)-R$, is the economic content shocks, while a shock is defined as an unpredictable accident. In this theory, predictions are unbiased, which suggests the mean prediction error, ε_t, is always zero. Based on the classical finance rationality theory, investors always predict the variable in the best possible way. Therefore, equation 4 is minimized as follows

(4) $$MinE\left[(R-E(R))^2/\Omega_{t-1}\right]$$

Where Ω_{t-1} is the total time t-1. In other words, people minimize the mean squared error based on the available information. It could also be indicated that

the mentioned minimization problem has the following result.

$$E(R)=E\left[R^2/\Omega_{t-1}\right] \quad (5)$$

Hence, the best prediction of variable R is the mean of this variable that is dependent on the time information t-1. In addition, the predictions are always unbiased in this case because

$$\varepsilon_t = E(R)-R \Rightarrow E(R)-E\left[R/\Omega_{t-1}\right] \quad (6)$$

We obtain the expected value of the two sides of equation 6 on the condition of time t-1 information considering that the mean X_t, which is conditional on time t-1 information, is known and its mean equals its value. Therefore,

$$E(R)-E\left[R/\Omega_{t-1}\right] = E(R)-E\left[R/\Omega_{t-1}\right] - E(R)-E\left[R/\Omega_{t-1}\right] \Rightarrow E\left[R/\Omega_{t-1}\right]-E\left[R/\Omega_{t-1}\right]=0 \quad (7)$$

In addition, in these classical finance theories, prediction errors have to be independent of each other. In other words,

$$E(\varepsilon_t\,\varepsilon_{t-i} \mid \Omega_{t-i})=0 \qquad i=1,2,\ldots,\infty \quad (8)$$

However, people's rationality rarely forms in the black or white area from the behavioral finance point of view. Rather, real modeling takes place within a gray spectrum. When the "behavioral finance" was introduced to the capital market actors, understanding the effect of the investor's psychological dimensions on the investment outcomes led to new insights into the investors' analyses. This study explores the second error. In this model, if the heterogeneous errors are significant, the E(R) return prediction will be asymmetric. Therefore, the company's shareholders expectations have systematic errors and the market arbitrage fails to solve the wrong pricing problem. The positive and negative shocks also do not have equal effects and the behavior of the company's shareholders is biased. These behavioral biases lead to misevaluation and investors' errors in behavioral finance are defined as follows.

$$R-E(R) \neq \lambda(R_{t-1}-E(R)_{t-1}) \quad 0<\lambda<1 \quad (9)$$

In this case, the prediction error variance, $\mathrm{var}(\varepsilon_t)$, is undamped because as long as information serves as the prediction content, the prediction error, ε_t, is not always asymptotic towards zero. Based on the behavioral finance expectations theory, decision makers do not always have the best predictions of variable R and it is biased based on investors' decisions in the market. Therefore, equation 4 is not minimized:

$$\left[(R-E(R))^2 / \Omega_{t-1}\right] \simeq \infty \quad (10)$$

In addition, there is a correlation between the errors in this case.

$$E\left(\varepsilon_t\varepsilon_{t-j} \mid \Lambda_{t-j}\right)\neq 0 \qquad j=1,2,\ldots,\infty \quad (11)$$

Considering this argument and Kahneman and Tversky's theories (2002), people's bias in behavioral finance theories suggests that investors' past performance leads to the formation of a type of mental classification biased expectations about the future expectations. According to one of the behavioral biases, people and investors perform specific classifications in their minds to predict the future events based on the past performance of the companies and discover similarities between the companies' performances. Therefore, in modeling the behavioral finance utility function, it is assumed that people do not carry out predictions based on a subset of the previous period information, $\Lambda_{t-1}(\subset \Omega_{t-1})$. Besides, E(R) does not move asymptotically to a new level R. In this case, the predictions are biased and result in misevaluation through behavioral biases if the return of share i during time t is undervalued or overvalued due to the traders' actions. This study focuses on the second error.

$$E\left((R-E(R))^2 \mid \Omega_{t-1}\right)\neq 0 \quad (12)$$

$$h_t = E\left(\varepsilon_t \mid \Omega_{t-1}\right) \sim i:i:d(0,h_t)$$

$$\left(h_t\right)=C+\sum_{j=1}^{q}\beta_j h_{t-j}+\sum_{k=1}^{p}\alpha_k \varepsilon_{t-k}^2 +\gamma_k \varepsilon_{t-k}^2 I_{t-k}+\eta_k \varepsilon_{t-k}^2 \psi_{t-k}$$

If α_k is significant based on the aforementioned model, the null hypothesis of every model is that valuation bias exists. Hence, both models are not undervalued or overvalued. Moreover, if γ_k is significant for negative shocks, the model is asymmetric, which means the effect of an equivalent negative shock is greater and there is a negative behavioral bias. In other words, the investors' behavioral biases are undervalued and the behavior of the company's shareholders has a negative bias. Consequently, stock returns have a lower value than the returns that only reflect the economic value if traders' actions lead to the undervaluation of the returns.

$$(13)\quad I_{t-k} = \begin{cases} 1 & \varepsilon_{t-k} < 0 \\ 0 & els > 0 \end{cases}$$

Besides, for positive shocks with constraints

$$(14)\quad \psi_{t-k} = \begin{cases} 1 & \varepsilon_{t-k} > 0 \\ 0 & els < 0 \end{cases}$$

If η_k is significant, the model is positive and asymmetric, which means the positive shock effect is larger and there is a positive behavioral bias. In other words, the investors' behavioral bias is overvalued and the behavior of the company's shareholders is positively biased. Consequently, stock returns are more valuable than returns that only reflect the economic value if traders' actions lead to the overvaluation of the returns.

5. Conclusions and Suggestions

The Bias usually affects a person's decision without realizing it. It should be noted that bias can affect any trader with any level of experience, but such biases include most newcomers and inexperienced traders. With a correct understanding of the market, he realized such biases and controlled them, preventing the loss of capital or reducing profits and increasing losses. The price is never fixed and does not move in a straight line, it is the behavior of traders to move in which direction. The superiority of different biases, different investment periods, and different price perspectives is at stake, and it is the task of an analyst to behave, in fact the analyst is a behaviorist who makes the trader a person of perfect rationality and It is characterized by profit-seeking, but it should be noted that in different situations, traders are not so dominant that they engage in rational behavior, which in turn leads to various biases.

The dynamics of behavioral price of investors through heterogeneous biases for a wide range of practical problems in the financial field uses a systematic priority for skewness and payments to elaborate behavioral explanations for the paradox of bowman and the stock premium puzzle . sp / a theory has incorporated the dynamics of hope and fear into a completely behavioral portfolio design theory . Because investors do not play a perfectly rational game of optimization in optimizing human reactions. The spectrum, from game theory to evolutionary psychology, has shown that economic decisions and their consequences, despite the reach of classical and neoclassical approaches, are largely dependent on psychological, social, mental, and emotional factors. Therefore, the key to solving sustainable and long-term problems in economic and financial affairs is in the hands of behavioral considerations. Market defects such as bubbles and crashes, mass behavior, and the stock puzzle are just some of the phenomena whose primary reasons stem from the perceptible mysteries of human perception and behavior. In dissident economics and the broader contexts of behavioral economics, a separate branch of behavioral finance has emerged. Finance is recognized as a separate branch of economics that uses an arsenal full of mathematical learning for risk management issues. Statistical taxation is so specialized. Therefore, mathematics can help economists in analyzing, explaining and predicting economic problems. Likewise, if behavioral taxation is to live up to its commitment to the superiority of its unique critique and provide a more comprehensive account of financial markets, ethicists must use the purely mathematical tools known to all other branches of finance. In a world that praises Eugene Fama's performance hypotheses and avoids Robert Schiller's warnings in the face of unreasonable abundance, progress relies a little on the commitment of Lars Peter Hansen. Theory and experience are inseparable allies for today and will always be united and inseparable.

An increasing number of researchers, actors, and regulators believe that repeated financial crises and definite evidence of market anomalies can only be explained through behavioral finance concepts.

Behavioral finance concepts have managed to detect the investor's irrationality. In other words, investors are influenced by cognitive psychological factors, emotions, and irrational factors at the time of selecting a portfolio and behavioral bias is one of these important factors. In behavioral finance, it is assumed people are not absolutely rational and they may exhibit irrational behavior in making decisions. Behavioral finance seeks to stimulate creativity and involve the other data classes in the testable hypotheses. Moreover, neuroeconomic research serves to understand and explain the dimensions of human behavior, which are excluded from the classical economic models. Our understanding of the human decision-making process also increased with the technological development, thereby increasing our computational power. In this regard, portfolio selection based on the assessment of the stock behavioral biases is introduced as a useful means of further understanding human behavior and improving future predictions. In the modern behavioral finance studies, financial markets are analyzed using technological and quantitative methods to observe and understand people's trading behaviors in the market. This research presents the assessment of behavioral biases based on the available data from the assessment of investors' behavioral reactions to emotions, which could be used to explain price variations in the stock market. Finally, the assessment of the designed market behavioral biases effectively reflects the overall market condition regarding the investors' biases in the Iranian market condition.

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