



Modeling the Behavior of Individual Investors in the Stock Market Based on the Neuro-Finance Approach

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ABSTRACT

The present study aims to provide a model to explain individual investors' behavior in the stock market using the neuro finance approach. The research was applied and performed qualitatively with the grounded theory technique. Data were collected through semi-structured interviews, and theoretical sampling continued until the saturation of categories. Fifteen depositors were interviewed. Then, the individual investors' behavior was presented based on neurological and psychological factors based on Strauss and Corbin's systematic approach theories in open coding, axial coding, and selective coding steps. Finally, the developed theory's validity was examined. The results showed that the model's core category is the individual investors' behavior. Generally, the causal conditions affecting the investors' behavior fall into two main groups in the same contextual and involved conditions. Neurological and psychological factors, which include 19 categories, are among the essential categories, among which ten categories have the highest weight and importance. These categories include changes in the physical and mental state during the intellectual transaction, emotional behavior, sense of security in the investment climate, sensitivity to news, anxiety, peace and focus, expectations and degree of risk-taking, leisure and holidays, and hours of transactions. The second group is demographic factors, which include five categories, among which two categories have been significant, i.e., individual knowledge and number of years of presence in the stock market. The model solution was the stock exchange organization. Finally, the economic consequences of the investors' behavior were discussed as the model's last part.

Keywords: Individual Investors' Behavior, Neurological and Psychological Factors, Demographic Factors, Grounded Theory.



1. Introduction

Extensive financial research and discovering unusual phenomena and exceptions in stock market realities and, more broadly, in investment decisions, which could not be explained by the conventional models in modern investment theories, dragged her focus to behavioral theories (Roodpashti et al., 2008). Neuro finance aims to understand financial markets by determining some physiological behaviors that affect individuals' exchange behaviors and their consequences. In neuro finance, it is assumed that investors have different psychological and physiological characteristics that affect their ability to make rational decisions and, consequently, their investment performance (Yahyaei & Yaghmaei Alisha, 2015). Financial decisions vary from person to person. These individual differences are reflected in individuals' willingness to take financial risks and their preference for short-term investments (Miendlarzewska et al., 2017).

The standard theories in finance and economics argue that decisions must maximize expectation from the expected value, risk (variance), and probability (nonlinearity). However, these theories are not driven by biological or psychological considerations. Neuro finance examines whether the human brain evaluates only desirability, expected value, risk, and probability. Financial theories predict that individuals will invest a fraction of their wealth in the stock market and acquire a diverse portfolio of corporate stocks. However, empirical evidence shows that the behavior of individual investors does not obey these theories. These deviations are systematic, reflect the moderated truth, and describe the patterns of individual investment (Barber and Odion, 2013). For example, the situation influence is the strongest and most well-known trading pattern among individual investors. That is, people tend to sell stocks with a price increase (winner) after buying, as opposed to stocks with a price reduction (loser) (Frydman & Camerer, 2016).

On the other hand, risk-taking is one of the crucial factors in investors' decisions, which affects how they make decisions when buying and selling stocks. Thus, the reactions of investors are different in a given situation. The concept of personality plays a highlighted role here (Doustar et al., 2014). Behavioral biases are defined as systematic errors in the decision-making and judging process. Behavioral biases are very common in the market. For example, following

each other and without sufficient consideration, investors buy or sell a particular stock, which results in the formation of buying or selling queues as examples of specific behavioral patterns prevailing in the market (Rafiei et al., 2018). Personality types explain the investors' behavior. Some personality types do not have the time or patience to manage cash, some investors react late to the information they receive, and some respond quickly to others. Personality types are the model by which one evaluates the real personality. Ambiguous conditions and cognitive errors rooted in human psychology make investors make mistakes in shaping their expectations and exhibit special behaviors when investing in financial markets (Nazaripour et al., 2018). Critics refer to the lack of a comprehensive theory to explain psychological bias and social influences as a problem in behavioral finance (Baker & Nofsinger, 2005). Therefore, there is a need for a comprehensive theory in this area.

The present study examines the local model to identify the factors affecting the behavior of individual investors in the Tehran Stock Exchange and with a neuro finance approach. Relationships between categories and identified factors are evaluated based on interpretive and naturalistic approaches. In this way, the specific characteristics of the Tehran Stock Exchange are considered in terms of spatial and temporal territory, and finally, the local model is presented and estimated. The researcher seeks to answer the question: How can the behavior of individual investors in the stock market be modeled based on a neuro finance approach?

Theoretical foundations

Traditionally, financial decision-making is based on maximizing profits and wealth, and it usually stems from the perceived expectation of goods and money. In contrast, biology and psychology argue that profit maximization is only one aspect of the goal. Cognitive limitations may prevent individuals from maximizing expectations (Miendlarzewska et al., 2017). Since the human brain has evolved over millions of years to survive in natural environments (rather than financial markets), humans often conflict with financial decisions. Evolutionary stress has created two fundamental tendencies in humans: acceptance and avoidance (Knutson & Greer, 2008). Tendencies are associated with positive and negative emotional states, often referred to as rewards and punishments (Alcaro

& Panksepp, 2011). Despite their contrasting effects on individuals' behavior, the two mechanisms interact with separate but largely neural pathways (Bromberg-Martin et al., 2010). Examining financial decisions using a neural perspective can reveal such (possibly incorrect) assumptions, explain confusing financial phenomena, and bring awareness to future financial models. It may also explain individual differences in financial decisions, why some people take risks and others do not, and why people's preferences may change over time (Miendlarzewska et al., 2017).

In recent years, many studies have been conducted on the application of neuroscience in finance, and it is rapidly evolving and challenging financial markets and investments (Tseng, 2006). Meanwhile, Neuro finance seeks to respond to decision-makers' behavior through neuroscience tools (Ascher et al., 2018: 3). Neuro finance emphasizes that a set of factors underlies economic decisions. Individuals enter into "baptismal interaction" through reflection and discussion (Ardalan, 2017). From the neoclassical perspective, the human brain behaves like a black box. That is, it receives information and turns it into action as if it is a computer that enforces specific rules blindly (Preuschhoff et al., 2008: 2).

Financial success in similar environments varies significantly from person to person, and only a handful of investors consistently overcome the market. Accurate understanding and evaluation of these biological differences help predict the investors' behavior and performance (Miendlarzewska et al., 2017: 4). Genetic studies have examined whether investors are prone to certain behaviors or the investment behaviors are significantly shaped by environmental conditions. Findings show that individual opinions in financial decisions are somewhat inherited (Cesarni et al., 2010).

Numerous researchers have collected neural economy data directly from financial market traders. Lo and Rapin (2002) adopted metrics for the scientific study of the relationship between psychological and physiological factors from 10 traders during actual daily trading. They found that "contrary to popular belief that emotions have no place in rational decision-making processes, the physiological variables associated with the automated nervous system are highly correlated with financial market events, even in highly experienced professional traders." Coates and Herbert sampled real-time steroid endogenous

secretion in a group of male traders in London. They reported that a trader's testosterone level predicts their profitability during the day under test conditions early in the morning. They also found that the trader's cortisol secretion increased with changes in his trading results and market fluctuations. When stress increases, people's health is affected. Health is a multidimensional concept and is associated with a state of complete physical, mental and social well-being (Haji Baba & Nasrollahi, 2020). This hormonal evidence is combined with our understanding of neural imaging data. Testosterone may increase dopamine secretion. Increasing the activity of the nucleus accumbens in fMRI tests enhances financial risk-taking during neural interactions (Roodpashti, 2012). The importance of this issue becomes apparent when the investors' behavior in the stock market influences the way decisions are made, the allocation of monetary resources, pricing, and the evaluation of companies' returns. Ambiguous conditions and cognitive errors, rooted in human psychology, cause investors to make mistakes in shaping their expectations and show particular behaviors when investing in financial markets (Dadras et al., 2018).

Recently, neuro finance has been the focus of many studies and is considered a new way for management and accounting researchers to analyze the factors influencing financial decisions (Ascher et al., 2018). Neuro finance is a relatively new field of research to understand financial decisions by combining the insights of psychology and neuroscience with financial theories. Neuro finance deals with how to evaluate information about financial options that are uncertain, time-limited, risky, and strategic. It also describes how emotions, psychological biases, stress, and individual differences (personality, heredity, gender, and neuroanatomy) affect financial decisions (Miendlarzewska et al., 2017). Cognitive and emotional biases influence individual decisions. Therefore, it is vital to understand the origin of these biases and tendencies. The subject of neuro finance is an emerging field of neural economics and explains the relationship between human brain activity and financial behaviors (Srivastava et al., 2019). Srivastava et al. (2019) used neural imaging techniques of brain regions to understand the existing processes. The main point is to focus on the effect of brain function on financial decisions and how it acts in dangerous situations. One

of the main objectives of the Ascher et al. (2018) study is to develop a systematic evaluation conducted by Mousnad et al. (2014). By searching for neuro finance articles, this study examined the main ideas, methods, processes, and topics related to financial decisions. Ardalan (2017) has developed neuro finance implications according to the efficient markets hypothesis. He believes that neuro finance informs thinking puts pressure on people's minds. This means that thinking is a relatively efficient, biological, and neurologically expensive cognitive process. This article shows that people balance the costs and benefits of thinking about financial decisions and ultimately inefficient financial markets. Miendlarzewska et al. (2017) addressed how the brain processes financial information and comes to a definite conclusion. Finally, by combining the studies conducted, he tries to explain the failure of classical financial theories. Frydman and Camerer (2016) argued that financial decisions are one of the most important life-shaping decisions that people make. They review facts about financial decisions and examine the kind of cognitive and neural processes that influence decision making. They conclude that many household decisions violate sound financial principles due to cognitive limitations and moderate levels of financial literacy.

According to the results of Nazaripour et al. (2016), there is a significant relationship between the personality type of investors and their behavior in the capital market. This means that risk-averse and reputable investors tend to invest in financial products of the first and second types. In contrast, cautious and ethical investors tend to invest in the third, fourth, and fifth types of financial products. Finally, individual investors are inclined to invest in all five types of financial products. Mir Alavi et al. (2019) show that all factors except "overconfidence" affect investment. The extent of this effect varies for relative profit and loss, inclination, conservatism, mass behavior, Representation intuition, ownership, and regret aversion. Accordingly, "relative profit and loss" has the most impact, and "regret aversion" has the least impact on the investment of financial assets in the stock exchange, which will directly impact the stock price index. Also, the grasshopper optimization algorithm has been used to select the best samples, train the neural network, and improve the results. The results show that the proposed model operated with a lower prediction error than other models. Khajavi and

Fattahi Nafchi (2013) have shown that the human brain is like a black box that records all the moments of that event, and the recorded features can be processed to prevent mistakes. Awareness can lead to an optimal choice in investors' decisions in different decision-making conditions.

Methodology

This research is applied because it seeks to model individual investors' behavior in the stock market and provides reliable guidelines based on the neuro finance approach. On the other hand, this research also has a developmental orientation considering the increase in knowledge resulting from the presentation of a native model for the Iranian stock market and the study of the effects of psychology and neuroscience variables. The applied data in the present study are obtained from two different sources. The first is secondary data obtained from books, articles, and documents. Preliminary data are also obtained from a semi-structured interview. Therefore, from this perspective, the present study is considered as a field and library research. The qualitative research method is based on grounded theory (grounded theory) and a localization approach. Considering that no other neuro finance study has modeled individual investors' behavior in Tehran Stock Exchange, the researcher intends to discover investors' features and behavioral characteristics in making financial decisions by applying the grounded theory. The statistical population of the present study is managers, university professors, and experts in the field of financial sciences and psychology who have sufficient experience in trading in the stock market. In the present study, the statistical sampling continued until the categories were achieved by 15 specialists, university professors, and real investors in the country's stock market. In the grounded theory, data collection continues until the research is saturated, i.e., when the new data collected is no different from the data previously collected and is precisely the same. In other words, when the research reaches a point of decline in data collection, one could make sure that the research has reached the required adequacy. In the present study, the theoretical sampling method was used to determine the number of statistical samples, and the number of investors continued until the saturation of categories. After extracting the open codes in each interview and comparing them with the new ones, the researcher found that all the codes were

duplicated in the fifteenth interview and terminated the interview. This study used the grounded theory. In this approach, theories have been developed using a set of data. Accordingly, this theory explains a process, an action, or an interaction on a large scale. The theory resulting from implementing such a research method is a process theory. Using common data collection methods, the researcher has identified categories, themes, and the relationship between these categories and has proposed a theory to explain a process.

Results

There are three stages of coding in the systematic grounded theory (Creswell & Clark, 2007).

Step One - Open Coding

In this type of coding, events, actions, and interactions are compared to examine similarities and differences and label the concepts.

Step Two - Axial Coding

This step aims to establish the relationship between the concepts generated in the open coding step. Here, by examining the concepts and placing close ones in a class, an axial category is extracted and provided in Table (1).

According to Strauss and Corbin's model, the extracted categories should be divided into four sections: conditional (causal, contextual, intervening), main category, strategies (interactions), and consequences.

Table 1: Final extracted categories

Axial coding	
Neurological and psychological factors	Changes in physical and mental states when during the transaction
	Trusting the experience
	Beliefs and intellectual cognitions
	Attitude
	Psychological illness as the threshold of trust in the stock market
	Emotional behavior
	Perceived security of investment space
	Genetics and intelligence
	Sensitivity to news and information
	Discipline
	Anxiety
	Peace and focus
	Avarice
	Fear
	Expectations
	Risk taking
	Weather conditions
	Location
Recreation and holidays	
Personal life satisfaction	
Trading hours	
Demographic factors	Knowledge
	Number of years of presence in the stock market
	Financial ability
	Gender
Investor's behavior	Age
	Individual investor's behavior
Intervening conditions	Parallel markets
	Overseas factors
Underlying conditions	Cultural factors
	Political factors

Axial coding	
	Economic factors
	Social factors
Strategy	Stock Exchange Policies
Consequences	Economic consequences of investor's behavior

Table 2: Weight and significance of components

Factors	Components	Weight and significance of each component	Factors	Components	Weight and significance of each component
Neurological and psychological factors	Changes in physical and mental states when during the transaction	17	Demographic factors	Knowledge	14
	Trusting the experience	5		Number of years of presence in the stock market	11
	Beliefs and intellectual cognitions	6		Financial ability	4
	Attitude	6		Gender	2
	Psychological illness as the threshold of trust in the stock market	5		Age	3
	Emotional behavior	13			
	Perceived security of investment space	11			
	Genetics and intelligence	8			
	Sensitivity to news and information	18			
	Discipline	4			
	Anxiety	14			
	Peace and focus	35			
	Avarice	4			
	Fear	10			
	Expectations	11			
	Risk taking	19			
	Weather conditions	8			
	Location	3			
	Recreation and holidays	27			
	Personal life satisfaction	13			
Trading hours	17				

Step 3 - Selective coding

Then, the major categories are related to each other in a paradigm model (contextual model) around the core category. The model formally describes and analyzes the category. This process is called combining the core

category, refining, and finalizing the resulting structures. The model can be drawn as a formal model or diagram while including the semantic and conceptual factors.

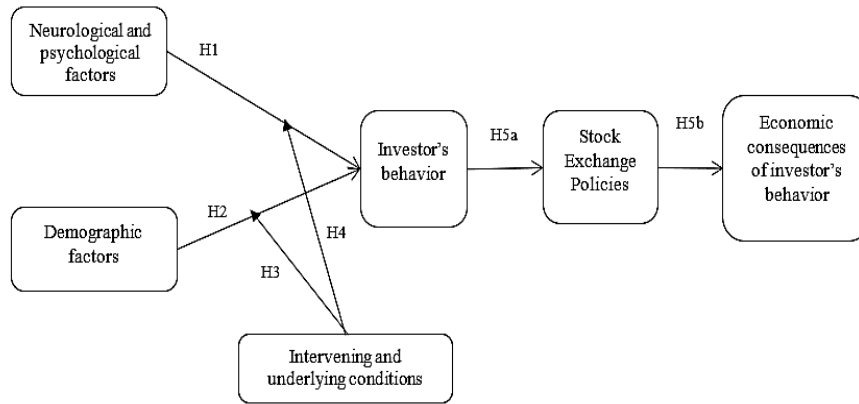


Figure 1: Paradigm model

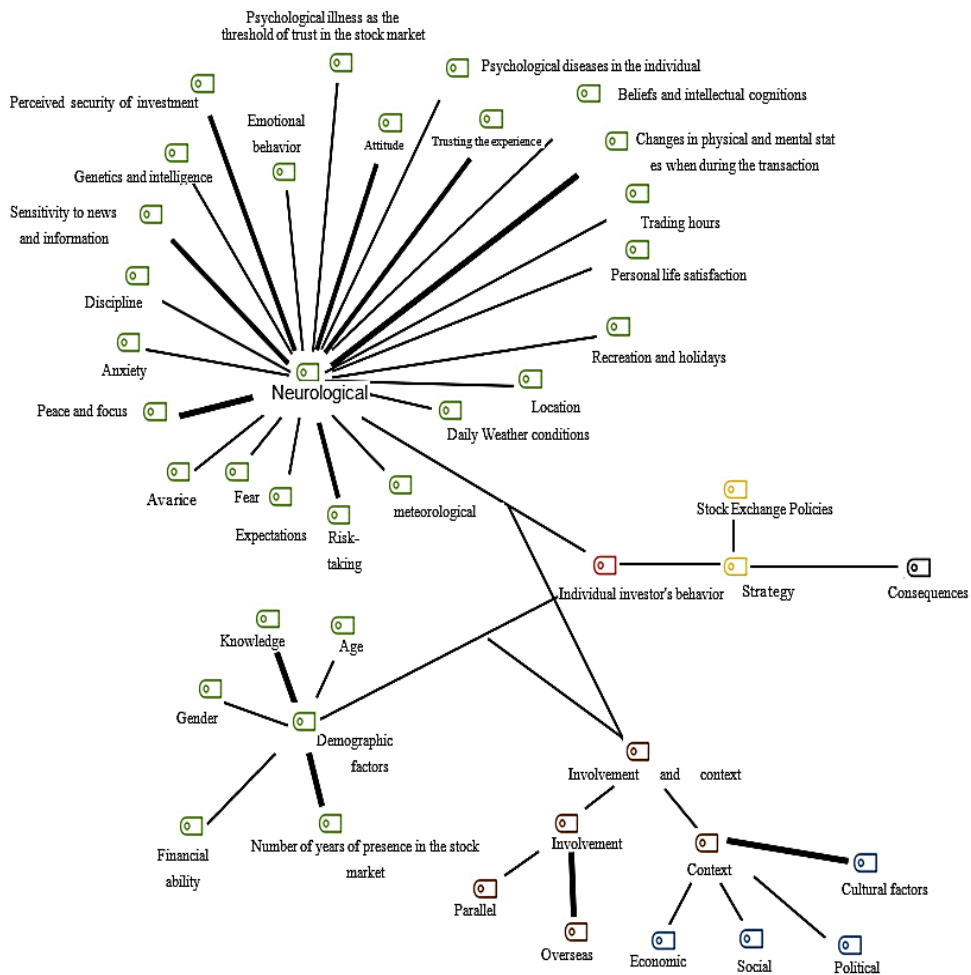


Figure 2: The final model

According to the obtained model, five main hypotheses are formulated:

H1: Neurological and psychological factors significantly affect the individual investors' behavior according to the intervening and underlying conditions.

H2: Demographic factors significantly affect the individual investors' behavior according to the intervening and underlying conditions.

H3: The intervening and underlying conditions mediate the relationship between neurological and psychological factors and the individual investors' behavior.

H4: The intervening and underlying conditions play a mediating role in the relationship between demographic factors and the individual investors' behavior.

H5: The individual investors' behavior according to the stock exchange policies has a significant impact on the economic consequences of the stock market.

Validation of Theory

After formulating a theory, the grounded theorists validate the process by comparing it with existing processes found in the specialized background (Danaei Fard and Emami, 2007). For this purpose, the

theoretical foundations for each of the components are presented after presenting the final model:

Thus, several studies have been conducted on the interviews' concepts on all categories, which indicates the categories' validity. In all studies, individual investors' behavior is influenced by the dependent variable and other independent variables. According to the theoretical foundations of the present subject, neurological and psychological factors have had the highest repetition in previous studies. This concept includes changing physical and physical states during the transaction, trust in experience, beliefs and intellectual cognitions, attitudes, psychological illnesses, threshold confidence level, emotional behavior, sense of security in the investment environment, genetics and intelligence, news sensitivity, personal discipline, anxiety, peace and focus, avarice, expectations, and degree of risk-taking, weather conditions, location, recreation and vacation, personal life satisfaction, and trading hours. Therefore, it has strong theoretical foundations. Following the last category, the demographic factors have a higher weight. This variable includes the categories of individual knowledge, number of years of presence in the stock market, financial ability, gender, and age.

Table 3: Number of studies conducted in related categories

Final categories	Proof	Number of studies
Neurological and psychological factors	Srivastava, 2019	26
	Ascher et al, 2018	
	Miendlarzewska et al, 2017	
	Ardalan, 2017	
	Sagar and Janardhanam, 2017	
	Frydman and Camerer, 2016	
	Bakar and Chui Yi, 2016	
	Jagongo and Mutswenje, 2014	
	Rocha et al, 2013	
	Alcaro and Panksepp, 2011	
	Cesarni et al, 2010	
	Baker and Nofsinger, 2005	
	Nazari Pourohmkaran, 2020	
	Ghorbani Bojabdi & Shahverdiani, 2020	
	Mir Alawi et al., 2019	
	Yaqubi and Saeedi, 2018	
	Dadras et al., 2018	
	Hajiroudi et al., 2018	
	Gorjizadeh and Khan Mohammadi, 2017	
	Ebrahimi et al., 2017	
Samiei et al., 2015		
Darabi et al., 2015		
Rahnama Roudposhti and Taj Miriahi, 2014		
Khajavi & Fattahi Nafchi, 2013		

Final categories	Proof	Number of studies
	Vakilifard et al., 2013	
Neurological and psychological factors	Miendlarzewska et al., 2017 Tauni et al., 2017 Buccioli & Zarri, 2017 Bakar and Chui Yi, 2016 Barber and Odean, 2013 Lo and Rapin, 2002 Yaqubi and Saedi, 2018 Dadras et al., 2018 Gorjizadeh and Khan Mohammadi, 2017	9

Conclusions, Discussions, and Suggestions

The results show that the individual investors' behavior is the axial category of the model. The causal conditions affecting the investors' behavior are in two main groups in the same contextual and involved conditions. Neurological and psychological factors are among the most important factors, including 19 categories, out of which ten categories with the highest weight and importance have been identified. These categories include changes in the physical and mental state during the intellectual transaction, emotional behavior, sense of security in the investment climate, sensitivity to news, anxiety, peace and focus, expectations and degree of risk-taking, leisure and holidays, and hours of transactions. Many studies have listed the factors affecting shareholder behavior. The second group is demographic factors, which include five categories. Among these, two categories have been significant. These categories are individual knowledge and years of presence in the stock exchange. The policies of the stock exchange organization were determined, and finally, the economic consequences of investors' behavior were explained as the last part of the model.

The results emphasize that a set of factors underlies economic decisions. Investors have different psychological and physiological characteristics that affect their ability to make rational decisions and, consequently, their investment performance. That's why financial decisions vary from person to person. Different types of investors in the stock market are very important because different types of investors react and behave differently when deciding to invest. The role of individual investor behavior is significant in an inefficient stock market. This is because the market is faced with a large number of individual investors and certain low reporting standards.

Therefore, technical analysis or fundamental analysis alone cannot confirm the success of investor decisions. The decision-making process of individual investors is much more complex than before. Measuring one's psychological mood is one of the most difficult issues when making financial decisions. The present study focuses on the psychological factors that guide stakeholder behavior and decision-making and uses behavioral economics and cognitive psychology insights. Instead of looking at absolute results (expected utility), this approach assumes that investors think based on expectation over a reference point (such as current wealth).

Moreover, the ambiguous conditions and cognitive errors rooted in human psychology and the external environment cause investors to make mistakes in shaping their expectations, and as a result, present particular behaviors when investing in financial markets. In this regard, the school or financial view of behavior emerged from the combination of psychology and finance, stating that psychology plays a role in financial decision-making and cognitive errors and deviations affect investment theories. According to the results, it is suggested:

The results of this study show the way to the best possible choice in financial advice to an investor. Therefore, it is suggested to consider 19 categories of neurological and psychological factors and five demographic factors for operating in financial markets and trading or advising individual investors to make the best choice in trading. These factors focus on the behaviors of individuals' financial decisions and try to analyze and express the financial decisions of decision-makers. It was also found that the intervening and underlying conditions play a mediating role. Therefore, it is vital to consider the cultural, political, economic, and social factors and the part of parallel markets, especially the foreign exchange market, to optimize financial decisions.

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