HOW NEUROECONOMICS IN EXPLAINING THE INVESTORS BEHAVIOR

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ABSTRACT

Behavior has a specific term, which is not likely to be limited to the absolute fixity. The term is abstract or conceptual behavior so it can not only be applied to concrete objects and discrete. The hypothesis that connects the brain to the behavior says that the brain is the source of the behavior through the nerve cells or neurons that become a structural and functional unit of behavior. This explanation suggests that there is a link between the behavior of the brain. Multi-complex behavior associated with the working mechanism of the brain that is also multi-complex. Therefore, a variety of investor behavior is a reflection of the multi-complex workings of the brain. Neuroeconomics is a relatively new science as an academic effort to explore the brain nerve when behavior is influenced by psychological biases. Though neuroeconomics is the study of a relatively new, but is a very interesting field of study, especially because it is still minimal reviewed by scientists in the Indonesian economy. This article introduces the concept of neuroeconomics in the role of explaining the behaviors of investors are affected by psychological biases.

Key Word: Behaviour Finance, Neuroeconomics, Psicological Biases

1. Introduction

Behavior has a specific term, which is not likely to be limited to the absolute permanence. The term is abstract or conceptual behavior so it can not only be applied to concrete objects and discrete. Carlson (1994) explains that the silent-even is part of the behavior. Activities regarded as behaviors that would constitute a change inside and outside of himself (the external environment) the relationship between an organism and its environment.

Involves the whole potential internal processes such as associative, cognitive, affective, motivation, experience, learning and memory depend on the good development of the nervous system. Behavior is the most complex phenotype been studied by humans, because the behavior reflect functioning of the whole organism, and because the behavior is dynamic and always changing in answering the environment (Aswin, 1995)

In contrast, an investor's behavior in response to information and decision in the stock market would never be as simple since anything pertaining to human behavior always collided with the potential structure that will always be a black box to the observer. Recent studies show that human behavior is very complex and complicated. Various theories such as the Efficient Markets Hypothesis (EMH), Capital Asset Pricing Models and Arbitrage Pricing Theory have been called in to question. Researchers in finance had been trying to find and explain the anomalous behavior of individuals in financial markets.

For the last 20 years, Scholars' focus has shift to explore and develop behavioral finance. Scholars have developed a more comprehensive model by linking finance and human behavior psychology in financial markets (Shiller, 2002). Behavioral finance attempts to explain and predict the behavior of psychological biases in the market in order to built a more realistic model of economical decision making. This model is contrary to the financial thinking that have been established, which is the behavior of economic agents is not always economically rational. Behavior risk is influenced by psychological biases that always go hand in hand with rational behavior.

One of the subfield in behavioral finance that analyzes the mechanism of the brain when behavior is influenced by psychological biases is neuroeconomics. This study explains how the brain works when economic agents make decisions in financial market. Neuroeconomics is a relatively new science as scholars' effort to explore the brain nerve when behavior is influenced by psychological biases. Attempts were made prove that human behavior is very complex, and the rational behavior was only a small part of the complexity.

Although neuroeconomics is a relatively new study but it is still a very interesting field of study, mostly because how the lack of studies by economic scientists in the Indonesia. This article introduces the concept of neuroeconomics in its role to explain the behaviors of investors who are affected by psychological biases. Some findings from neuroeconomics studies are discussed to provide an understanding of how this study will contribute to the development in science especially in behavioral finance. In addition, some constraints in the development of neuroeconomics in Indonesia are also explained to act as a reflection to the spirit of interdisciplinary science as an effort to develop a comprehensive study.

2. From Behavioral Finance toward Neuroeconomics

The main pillars of success in investment decision making is psychology (Mionel, 2012). Psychology is the science that aims to discover, understand and explain human's personal, nature, behavior and mental processes (Bishop and Trout, 2005). Furthermore, Bishop and Trout (2005) stated that psychology studies how individuals influence each other, how information

affects the individual, and understanding personality characteristics that tend to change from time to time. Mionel (2012) believes that the behavior of economic agents in the financial markets is influenced by personal features (mindset, sense and action), expertise in trading (tactical awareness, tactics and mental) as well as stress management.

Behavioral finance provide a different approach in the realm of financial theory by elaborating financial and psychology in detecting the behavior of investors in financial markets. Behavioral finance attempts to identify and study the psychological phenomenon of human beings who "work" in the financial markets (Pompian, 2006). Psychological effect on investors' behavior was studied in 1950 with findings that show the behavior of investors is not always oriented to utility function. The effects of psychological biases color decisions so information that is categorized as good news is not always being responded positively. Some examples of the behavior described in behavioral finance is overconfidence, anchoring and adjustment, representative, etc.

DeBondt and Thaler (1995) describe irrational behavior especially emotional as behavior that appears under conditions of fear or pressure while avoiding the pain of the previous decision-making errors. While trying to avoid pain what happen is an error that is much worse than before. Ledoux (1994) explain that irrational behavior comes from biological and chemical structures of the brain that is connected to the "brain's fight".

The mechanism of human brain does not realize that the fear it was actually created by themselves and automatically would go in defense, so when an individual is in trauma by the mistakes of the past, they are generally reluctant to learn because they are being defensive. In the end, the result is an inability to respond to feedback and changes that when it comes to investment decision, the emotional mechanism was put forward. Emotions such as greed and fear play a role in the investment decision-making errors. Cognitive biases and heuristics lead investors to falsely analyzing any new information that they take an overreaction or undereaction reaction (Abhijeet, 2005).

The development of sub recent studies of behavioral finance, which discusses in detail how brain system's work, that is associated with the behavior of economic agents in making economic decisions is referred to as neuroeconomics. Camerer (2005) explains that neuroeconomics is a subfield of Behavioral Finance (see also Pompian, 2006). This science is still relatively new and a synergy between psychology, neuroscience, and economics to find a better model of the decisions, interactions, risks and benefits.

3. Neuroeconomics: Elaboration Interdisciplinary Theory

Neuroeconomics is a study related to microbiological mechanism on brain rational and irrational areas function in generating economic behavior. This study uses neurotechnology to analyze the financial markets through the observation and understanding of behavior of economic agents in the financial markets. The main goal of neuroeconomics is to get a better understanding of economic agents' behavior in the market by identifying psychology biases that affect the trading behavior and the outcome of such behavior associated with the working mechanism of the brain.

Neuroeconomics assumes that investors have a psychological differences that affects the ability to produce a rational decisions, build a portfolio design, analyzing market information and decision making. It is suspected that psychology give a very significant impact on behavior in economic decision making in financial markets. The behavior in responding to informations and decisions of economic agents in the financial markets could never be simplified in respect that any given human behavior will collide with the potential structure that will always be a black box (black box) to the observer. Exploring how brain's neural networks works when behavior reflects a certain psychological biases, provide a great opportunity to open investor's behavior that was still a 'black box' until now.

Neuroeconomics as an interdisciplinary approach uses methods that have been utilized by neuroscientists to analyze the workings of the brain such as measuring the movement of a single cell, study damages to the brain (decreased brain performance), and brain imaging technology. Most depictions of the brain involves experiment that comparing each participants when carrying out two different tasks. Areas of the brain that are active at certain tasks will be clearly defined. The result would show brain areas can collaborate and compete with each other in decision making. Logothetis et al. (2001) explains that there are three methods used to describe the working brain mechanism, namely Electro-encephalogram (EEG), Positron Emission Topography (ERP), and Functional Magnetic Resonance Imaging (fMRI).

EEG is a method of using electrodes placed on the scalp to measure the stimulus in form of events and response to the events through electrical activities. Positron Emission Topography (ERP) is done by measuring blood flow in the brain as a proxy for neural activities that causes an increase in blood flow. Increased blood flow in the brain showed a response to an event.

Functional Magnetic Resonance Imaging (fMRI) according to Camerer (2006) is the current approach in measuring brain activities when responding to an event. fMRI works by tracking blood flow to the brain using magnetic changes of blood's oksigensai[1] properties. Simultaneously, the tool will record the neural processes when subjected to magnetic changes when responding to an event. Egidi and Nusbaum (2012) refers fMRI as localizer tasks that have the ability to identify areas of the brain when it responds to certain types of stimuli or psychological processes such as specific physiological response to a specific event.

Neuroeconomics limitation lies in its method to identify the behavior, both behavior dominated by cognitive or affective potential as well as the collaboration potential between the two. This limitation is related to the degree of difficulty when it is

[1] To address the need of **oxygen** in the body

only done by economists without collaborating with neuroscientists. Perhaps this condition does not become a significant obstacle for those scientists who are in developed countries with adequate facilities.

It is different when the research is conducted in developing countries which do not have high technology and access to collaborate among scientists with divergent scientific specialties. Therefore, the study and research of neuroeconomics is still limited in developed countries. But neuroeconomics perspective in identifying potential work structure of the human brain gives a new color to the development of financial theory, particularly in behavior of economic decision-making that is more comprehensive and waiting to be explored further.

4. Collaboration and Competition Two Brain Systems

One of the important concept in neuroeconomics is referred to as the working potential of the brain in decision making. This potential interacted between two different systems. These two such systems have a variety of terms (terminology) but refers to the same concept. Shiffrin and Schneider (1977) refer to such systems as Automatic and Controlled Processes, Epstein (1994) describes these two systems as rational and experiential systems, Sloman (1996) associative and rule-based systems, Evans and Over (1996) implicit and explicit systems, Metcalfe and Mischel (1999) hot and cool systems, Stanovich (2000) and Kahneman (2003) refer to it as System 1 and System 2, Lieberman (2003) refer to these two systems as Impulsive and reflective systems, and Frank et al. (2009) referred to it as deliberative and automatic system.

Deliberative system in this case represents a cognitive or rational potential while reflective system represents an affective or irrational (emotional) potential. This illustrates that behavior of an individual in making economic decisions are influenced by rational and emotional. Bavel et. al (2012) describes the characteristics of an affective (reflective system) which is always growing or evolving, automatic, fast processed and requires minimal cognitive resources. This system serves as a habit, in which there are emotions and intuitions that are programmed by an innate instinct which makes it difficult to control.

Contradictory with cognitive (deliberative system), characteristics of this system is that it is slow, it can be controlled, analytical, and demanding cognitive potential to the fullest. Deliberative system potential allows one to evaluate, analyze, and synthesize to make a decision. Kiviniemi et al (2007) suggested decision-making in neuroeconomics perspective is an associative process between rational and irrational. Concrete behaviors, activity of choosing, predict the most appropriate action for the future is an interrelation of cognitive and affective responses (Deyreh, 2012; Kiviniemi and Bevin, 2008; Wrase et al., 2007).

Both systems that have been describedabove sometimes works in collaboration and often competing. Collaboration does not indicate independence but an intact relationship. Reflecting the same thinking portion that led to a balanced behavioral patterns between rational and emotional. While competition, shows the fact that there are two different systems in the brain that encourage behavior toward the opposite direction, competing for power to control the other.

Emotional is not always beneficial and or detrimental to a decision. The influence of both negative and positive emotions depends on situations in the market. Excessive negative emotions cause behavior to be contaminated by psychological biases so much that it becomes irrational. In contrast, positive emotions strengthen the activation of deliberative system that the it creates harmony between the rational and the emotional behavior. In his study, Damasio et al. (1996) states that individuals with minimal cognitive but lack affective ability will have trouble making decisions and often lead to poor decisions. However, when affective occupies too much portions and reduces cognitive, the more wrong decisions will be made. Therefore, it is essentially required to collaborate or harmonize between the two systems to produce a correct decision.

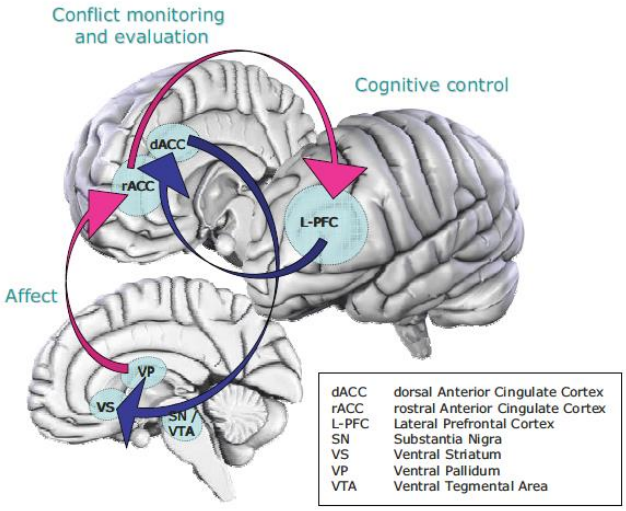
5. Some Neuroeconomics Study Regarding Psychological Biases

Neuroeconomics gives an important emphasis on the emotional potential as one of the fagents that affect quality of decision making. The difficulty of quantitatively measuring emotional causes negligible of this aspect's influence in the development of traditional financial theories. Even emotional aspects seems to be reduced with the assumption that economic agents' behavior are rational. In reality, working mechanism of the brain showed that economic agents do not always behave rationally.

Emotional potential (affective) or reflective systems in the brain's network structure share nerves with rational potential (cognitive) or deliberative system. However, brain mapping indicates that the emotional and rational potential components involves several different neural (You and Zhou, 2007). Sporns (2004) states that connectivity of rational and irrational (emotional) brain area are presented in just a few synapses (the gap between two nerve cells) that spread like a stream of water from one area to another. Each synaptics illustrates the brain as a small world full of nodes and small nodes projection.

Deliberative system's ability to perform analysis, evaluation, market information synthesis, build economic planning, problem solving and decision-making involves dorsolateral prefrontal cortex area (DLPC) which is in prefrontal cortex, anterior cingulate cortex (ACC) and the posterior parietal cortex (Miller and Cohen, 2001). While reflective system ability to produce emotional potential involved sub-cortical areas especially the amygdala and the nucleus accumbens. However, recent studies show that brain areas that represent rational and emotional potential is not working independently but dependently. This is evident from the prefrontal cortex region which is justified as purely rational potential turns out to have several sub-areas that connect with the emotional brain areas such as orbitofrontal cortex (OFC) and ventromedial prefrontal cortex (vmPFC) which is suspected to have connections with the amygdala (Fuster, 2001; see also Kringelbach and Berridge, 2009)). This can be seen in Figure 1 as follows:

Picture 1 Cognitive (Rational) and Affective (Irrational/Emotional) Area Interconnections



Source: Kringelbach and Berridge (2009:144)

Working mechanisms of the brain that are interconnected is shown in several studies of behavioral finance such as ultimatum game, loss aversion, representative bias and so forth. Sanfey (2003) conducted a study related to the working mechanism of the brain in an experimental test of ultimatum game. This game is one of a behavioral theories that was developed from an assumption that economic agents are selfish individuals. Experiment design is conducted by dividing participants into two role, namely the porposers (offering money) and responders (recipient of the money).

Financial theory assumption states that porposers will offer a smaller amount of money to responders. The offer will certainly be accepted by responders instead of not getting any amount of money at all. However, result shows that most porposers are not selfish, they turns out offer larger amount of money. In addition, study shows that majority of responders chose not to accept any money from selfish porposers that offer smaller amounts of money. Emotional aspects are involved in decision-making process in both porposers and respondent which indicates that economic agents are not always rational.

Sanfey (2003) explains that working mechanism of the brain in ultimatum game is a collaboration and competition between areas of the brain that are responsible for deliberative or rational potential and reflective or emotional system. Through neuroimaging it is known that there are two areas of the brain that are active when participants are faced with an unfair offer, namely the dorsolateral prefrontal cortex (DLPFC) which represents the rational potential and anterior cingulate cortex (ACC) which represents the emotional potential. If ACC activation is greater than DLPFC responders tend to reject less or unfair amount of bid, contrary when participant experience a greater DLPFC activation, they tend to accept the offer instead of not get a any money at all.

Loss aversion is an excessive fear when dealing with losses. This behavior is often found in investors inside an unhealthy market situation. They are more focused on avoiding loss than attempting to make profit. Barberis and Xiong (2009) explains that loss aversion causes investors to experience dispotition effect, which refers to withstanding prolonged stocks that perform poorly (losser), or selling stocks that are performing well (winner) too quickly. This behavior reflects excessive emotional that there would be inconsistent view of profits and losses.

Loss aversion also stimulates investors to inconsistently see the profits and losses. In stable conditions, investors do not like risk and would prefer an investment with a certain rate of returncompared to an uncertain returns. Therefore, there is a linear relationship between risk and return. However this does not apply when experiencing loss aversion, investors would risk averse when they saw gains and risk-seeking when looking at a loss.

James (2010), in his study found out that when investors experience loss aversion, an area in the brain particular amygdala becomes very active. Amygdala's activity dominates the working mechanism of the brain which then weakens the deliberative system areas, especially prefrontal cortex. Amygdala is an area which has a structure complexity and is involved in a large number of reflective system's ability to process the signal of a particular emotion, conditioning emotion and consolidation of emotional memories. Amygdala is as in most areas of the brain, does not stand alone but is composed of several different sub-areas and is differentiated by function and histological criteria.

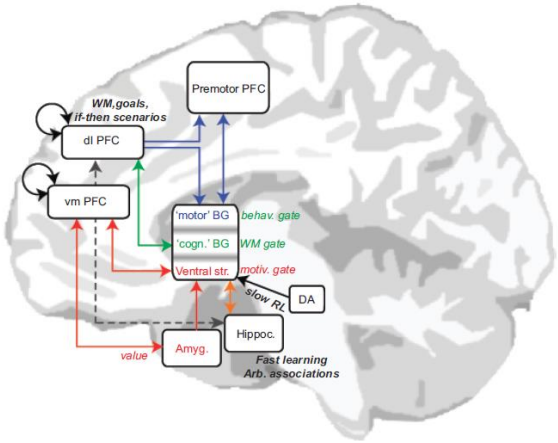
One of amygdala's function is the ability to recognize and learn about dangers. The study of neuroscience indicates that amygdala is actively responding to emotional induction of both positive and negative from a state of fear. Feistein et al. (2011) stated that when a person is experiencing dysfunction in these brain regions it would blunt the emotional abilities and they will have no fear. De Martino et al. (2009) conducted a study to analyze the effects of an injured amygdale on behavior. Studies show that injuries to the amygdala causes a decrease in the ability to receive information on the analysis of the rational brain areas. When the information illustrates that there will be an adverse situation, amygdala does not respond optimally. This causes no fear and emotional responses which is shown through fMRI results that illustrates the slow blood flow in the amygdala area.

Representativenes behavior is one of the thing that are studied in depth in behavioral finance. Representativenes is an individual behavior to categorize a new situation or phenomenon based on previous experience patterns (perceptual mapping), although in reality, the new phenomenon is different. Economic agents deceive themselves (self-deception) in response to information resulting bias investment decisions. Empirical study results of Nikoomaram et.al (2011) shows investors' behavior in making investment decisions are based on the perception that they built, the historical price trends and events of the past is a picture of price that will occur in the future. Although new information differentiate from historical events and trends patterns, investors perceive it as the same.

Frank et al. (2009) conducted a neuroeconomics study related to neural network that works, when there is an alternative choice of the correct gain estimation and bias estimation because of past experiences. Research procedures conditioned information information that provides negative signal on current situation, which is different from the perceptual mapping the participants themselves. The results shows that at a neurobiological level, perceptual mapping predictions based on current situation that is different from the what the mind construct from past experience, is the work of dopamine signal in subcortical regions (from affective area's position).

The dopamine signal modifies the "synaptic plasticity"[2] in amygdala that the experience in individuals' life fused stronger to form perceptual mapping. Furthermore, using a sensory signal sent to PFC and overwhelm it to weaken the cognitive system (rational). In the end, the entire process is reflected in the behavior that tends to make the experience of the past as a benchmark or the basis to act. This can be explained in Figure 13.3 as follows:

Picture 2 Perceptual Mapping Process Affects Decision Making



Source: Frank *et al.* (2009:75)

Currently there are many similar studies to understand other behaviors that are affected by psychological biases on the study of Behavioral Finance. For example, Dalton and Ghosal (2014) detected biological processes of the brain on toverconfidence behavior, Frydman (2012) identified the brain microbiologic in investors' regret behavior in financial markets, and Mohr and Heekeren (2012) analyzed working mechanism of the brain in middle-aged investors, Brocas and Carillo (2014) analyzed the brain nerves of investors in the dual system theory.

Most uses Positron Emission Tomography (PET) and functional magnetic resonance imaging (fMRI) that shows participants brain's image sequences when asked to perform a specific task. By comparing the blood flow to various parts of the brain before, during and after performing certain tasks would discover brain area that has the highest activity. This technology provides a revolutionary spirit of knowledge on a variety of psychological and financial studies by providing a more comprehensive understanding related to cognitive processes and behavioral patterns.

Finale

Traditional financial theories assumptions state that economic agents' behavior are rational. Behavioral models and theories are built based on that assumption, such as Capital Asset Pricing Model, Arbitage Pricing Theory, Option Pricing Model, etc. However, psychological research and related financial assessment and decision-making has shown plenty of evidence that in fact, this model can not provide a satisfagenty explanation of the behavior of financial agents especially investors in financial markets. The study result was supported by neuroscience in areas of the brain and were found that economic behavior is not the product of one process, but an interaction of the different sub-systems.

Two such systems are reflective system that represent affective or irrational potential (emotional) and deliberative system that represents a cognitive or rational potential. Brain areas that are the core or center of the reflective system are subcortical areas

[2] Neurons process form a synapses (relationship) or physical and chemical connection between neurons

such as the amygdala, nucleus accumbens, and the hypothalamus. Meanwhile, brain areas that represents deliberative system potential is cortical areas such as the prefrontal cortex (PFC), which is divided to several sub anatomy such as dorsolateral prefrontal cortex (DLPC), orbitofrontal cortex (OFC) and ventromedial prefrontal cortex (vmPFC).

Although these systems appear to collaborate, sometimes they often compete with one another to produce different behaviors of the same information. This is then used as a basis reassessment of traditional financial models which have just appreciate one process which is economic behavior will always be rational. To produce rational behavior takes positive information input to generate positive emotional. This situation will increase deliberative system brain areas' activity so that blood flows overwhelm and weaken the amygdala, nucleus accumbens, and hypothalamus which are areas of the reflective system.

In contrast, the irrational behavior product is produced from the weakness of cognitive areas or deliberative such as dorsolateral prefrontal cortex (DLPC), orbitofrontal cortex (OFC) and ventromedial prefrontal cortex (vmPFC) due to increased activity of amygdala, nucleus accumbens and hypothalamus region. This is what is referred as the working mechanism of competition between two systems. The question is whether a behavior could reflect one hundred percent rational and vice versa? Then the answer is that it is not possible because the two areas of the brain work interdependent from each other so rational and irrational colors will always remain there.

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