EFFICIENT MARKET HYPOTHESIS EVALUATION USING PSYCHOLOGY AND NEUROECONOMIC PERSPECTIVE: A CRITICAL ANALYSIS

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ABSTRACT

Investment decision-making process involves a relatively complex behavior, and is influenced by several factors. At least there are two fundamental factors that affect the process are internal resources such as age, education, income, investment portfolio and technical factors such as the financial model that represents the relationship between risk and return. Efficient Market Hypothesis assumes investors are rational beings who produce economically rational decisions (Expected Utility Theory). Investors are assumed to be, because the perspective of Expected Utility Theory, placed human beings merely as utility-maximizing individual in a circle and directing the material into homo economicus. Although the idea of the theory of rational behavior based on the Efficient Market Hypothesis has been useful in formulating theories and economic models, in recent decades a number of psychological and behavioral scientists have documented a strong and systematic violations of the basis of rational behavior on the Efficient Market Hypothesis, by questioning the validity of the a descriptive theory of decision making. This article uses two approaches: first psychological form of dual systems theory and the second approach is through the mechanism of brain in neuroeconomic to criticize the assumption of rationality on the Efficient Market Hypothesis. This article is expected to give a new color in the theory of behavioral finance and contribute to improvements in the further development of the Efficient Market Hypothesis

Keyword: Efficient Market Hypothesis, Behavioural Finance, Dual System Theory, Neuroeconomic

1.1 A Brief Review: Efficient Market Hyphotesis

Efficient Market Hypothesis and rational behavior of investors in 1970 became a recognized body of knowledge on traditional financial theory and provide strong empirical support to the Capital Asset Pricing Model, Arbitrage Pricing Theory and Option Pricing Models (Aguila, 2009). However, despite all these achievements, Efficient Market Hypothesis gradually experienced setbacks especially when "anomaly" behaviors were found that opposed the Efficient Market Hypothesis. The assumption that investors behave rationally began to receive criticism from the results of research that show investors turned out to behave non-rationally. Although the idea of the theory of rational behavior based on the Efficient Market Hypothesis has been useful in formulating theories and economic models, in recent decades a number of psychological and behavioral scientists have documented a strong and systematic violations of the basis of rational behavior on the Efficient Market Hypothesis, by questioning its validity as a descriptive theory of decision making. Moreover, Simon Herbert in 1972, wrote the term "bounded rationality", emphasizing the "limits of human ability to adapt optimally or even satisfactorily to a complex environment". Heuristic individual investors are prone to bias, which in turn leads to a number of anomalies in the form of irrational behavior at the market level.

DeBondt and Thaler (1995) describe irrational behavior as the behavior that appears under condition of fear or pressure while avoiding the pain of the previous decision-making errors. While trying to avoid pain, what happen then is an error that is worse than before. Ledoux (1994) explains the irrational behavior comes from the structure of biological and chemical structures of the brain that is connected to the "brain's fight". The mechanism of the human brain does not realize that the fear is actually created by their own and automatically carry out the defense, so the condition of the trauma from the mistakes of the past could generally cause human to be reluctant to learn because of that defensive stance. Ultimately resulting in the inability to respond to feedback and changes, so in the investment decision-making, emotional mechanism are put forward. Emotions such as greed and fear plays a role in the investment decision-making errors. Cognitive biases and heuristics lead investors in analyzing any new information to take a position of overaction or underaction (Abhijeet, 2005)

2.1 Behavior Finance: Opening the Anomaly Door

The main pillar of investment success is psychology (Mionel, 2012). Abhijeet (2005:7) describes the similarity of the Efficient Market Hypothesis to psychological biases as follows:

> *Investors put their money in stock markets to earn returns. They always try to beat the market and make riches by investing in stocks. It is assumed that investors always act in a rational manner. It means they behave in a manner that their returns rationally. The central proposition of finance theories, the Efficient Market Hypothesis (EMH) is based on this very assumption. But it has been observed and even proved that individuals are ruled as much by emotion as by cold logic and selfishness. While the emotions such as greed and fear often play an important role in bad investment decisions, there are other causes like cognitive biases, heuristics (all*

drawn from psychology) that make investors incorrectly analyse new information about an investment and thus overreact or under react.

Psychology is the science that aims to discover, understand and explain the human personality, nature, behavior and mental processes (Bishop and Trout, 2005). Furthermore, Bishop and Trout explain that psychology studies how individuals influence each other, the process of information affects the individual, and understand the personality characteristics that tend to change from time to time. Mionel (2012) believes that investing in the stock market is influenced by the personal features of the investor (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 combining finance and psychology in detecting the behavior of investors. Behavioral Finance seeks to identify and study the psychological phenomenon of "working"human in the financial markets, especially individual investors (Pompian, 2006). Some examples of psychological phenomena is the Prospect Theory, overconfident, anchoring and adjustment and representative. Psychological effect on economic behavior began to be studied in 1950 with findings that show the behavior of individual investors are not always oriented to the utility function. The effects of psychological biases varies the decision so that information categorized as good news is not always responded positively (Burrel, 1951; Bauman, 1967; Slovic 1962,1972; and Slovic and Bauman, 1972 in Asri, 2003).

Various behavioral finance studies described above indicate that, financial analysis capabilities to achieve optimal investment decision was not effective enough. Personal qualities of maturity and ability to understand human nature supports investors in determining the vision, perseverance and foresight in developing investment strategies. Investors differ in demographic characteristics such as socioeconomic background, educational level, age and sex so that investment decisions taken by any person are not universal. It is difficult for an investors to use proper investment strategy based on strategy developed by others. This implies that the optimal investment decisions for the investor is not necessarily right for another investor. Therefore, in determining the portfolio design, investors are influenced by many factors including internal quality that is psychological factors. The influence of psychological factors on decision-making is often overlooked by individual investors, and this is hampering the performance of their investments in the stock market (Abhijet, 2010).

The influence of psychological factors that are significant in determining the design of an investor's portfolio, led to the birth of new perspectives in the world of finance, namely Behavioral finance. This new perspective, a financial perspective that seeks to complement traditional financial theory by introducing the principles of psychology and financial to improve decision-making (Olsen, 1998). Behavioural finance is the financial branch of science that studies how psychological factors influence investor behavior and how that behavior affects the price (Subash, 2012; Sewel, 2007; Wigan, 2011) Cognitive and emotional human bias become important in the study of behavioral finance since empirical findings indicate inconsistencies with Efficient Market Hypothesis. The main contribution of behavioral finance is to provide a better understanding of the anomalies in the behavior of investors by integrating psychology and economics (Aguila, 2009). Behavioural finance by Belsky and Gilovich (1999) is also called the behavioral economic that collaborate psychology and economics to explain why and how investors seem irrational and unreasonable about when to invest, save and borrow money. Investors often become "victims" of the investment decisions taken because of potential errors in the use of emotions and denying fundamental performance (Selçuk, 2012). Emotions such as greed and fear and cognitive biases play a role in driving errors that lead to a miss in analyzing new information causing underaction or overaction. Behavioural finance study how mental error caused stocks rated too high or too low (Abhijet, 2010).

1.3 *Neuroeconomic*

Revolutionary changes in science became the focus of controversy in half of the twentieth century. Prior to that time, the progress of science is seen as a cumulative process in which new theory replaces the previous theories or reduce the validity of the previous theory (Fumagalli, 2011). In 1962, Kuhn published “Structure of Scientific Revolutions” which provides an innovative space for the development of non-cumulative science. Inside it, he summed up the old perspective that were being replaced in part or whole with a new perspective from (which may conflict) Khun (1965; 91). The scientific revolution was born of anomalies in scientific research that is felt as increasingly severe, and the emergence of crisis that can not be solved by the perspective of which the research is referenced. Robert J. Shiller in his book “How Human Psychology Drives the Economy and Why It Matters for Global Capitalism” explains that economics is currently in a period of unexpected revolution, namely the use of neuroscience studies from the medical field to be one of the way of enlightenment to address anomalies particularly about how individuals make decisions. Neuroscience is the study of the nervous system including the brain, spinal cord, and network of sensory nerve cells or neurons to understand the thoughts, emotions, human behavior and neurological disorders (Hiner, 2013). Neuroscientists use specialized computer software to examine molecules, nerve cells, tissues, and brain systems and then develop nervous systems on neurological disorders.

Neuroscience tries to solve some of the mysteries associated with answers to questions such as: What exactly is the mind? Why do people feel the emotion? What are the causes of neurological and psychiatric disorders? In connection with the use of neuroscience as one of the way of enlightenment to address anomalies in economics, especially how individuals make decisions, the question arises of how economy, which is considered very different from neuroscience, can work together with it to understand the process of decision making by economic actors under conditions of uncertainty. Traditional financial theory as has been described in the beginning, looks at economic actors as homo economicus, to maximize utility based on the experience of satisfaction felt from consuming something. This view contributes to the development of the theories of finance such as efficient market hypothesis, capital asset pricing model and investment opportunity set. Meanwhile neuroscience sees humans as a more complex being in making their decisions, not just using rational but also irrational potential. This can be explained as follows: First, a large part of the brain works automatically, faster than conscious consideration, it even use a little of awareness (Bargh and Chartrand, 1999; Loeweinstin and O'Donoghue, 2004; Schneider and Shiffrin, 1977). Individuals have little

introspective access to control the workings of the brain that are automated so that the growing process of problem solving is also difficult to control. The resulting decisions has not always follow the normative axiom that every decision-making process must necessarily based on logic (Camerer, 2006). Second, human behavior is strongly influenced by the potential of affective (emotional including lust/passion). This potential is generally designed for humans and animals in which the system is very important for regulating behavior. If this system is damaged or disturbed due to brain injury, stress, neurotransmitter imbalance[1], and other things, even though the cognitive potential is in good health, human behavior can not be controlled (Le Doux, 2004).

Human behavior according to Camerer *et al*. (2005), requires a neuron fluid produced by the interaction between cognitive and affective systems. Yet it is a common assumption that behavior is a product of cognitive systems, although various empirical studies show that humans are influenced by the work of the two systems. Sometimes the two systems will collaborate but not rarely also the system would be used as mutually exclusive or competing with each other. The above description gives a strong reason why the findings of neuroscience, the underlying theories and research methods used in neuroscience is very useful to develop an understanding of financial theory, especially in complex decision-making behavior. Therefore, at this time neurologist, psychologist and finance expert are working together to develop what is referred to as nerueconomic (Camerer, 2006).

As described above, neuroscientists and economists work together to investigate how the brain works to influence the behavior of individuals using biological approaches. The study shows how biological mechanisms become the base in the process of individual emotional, interpersonal interactions, understanding the mind and developing strategies in order to take a decision. Neuroeconomic is one of the studies that are being developed to better understand the decision-making behavior. This is a reflection of how this synergy makes an important contribution to the exploration of science.

Neuroeconomic is a study in how the brain processes in making decisions. McCabe (2003) describe neuroeconomic as an interdisciplinary research programs with the goal of building a biological model of decision making. Similar explanations proposed by Glimcher and Rustichini (2004, p.447) of neuroeconomic as an attempt to combine economics, psychology and neuroscience into one integrated disciplines with the aim to enhance the theory of human behavior. Camerer et al. (2009), defines neuroeconomic as part of the behavioral finance studying financial behavior by using the facts about brain activity. Most of the techniques involve neuroeconomic brain activity so it is easily to perceive that neuroeconomic only develop map of the parts of the brain and their respective duties. But in reality, neruoeconomic gives instructions from a different perspective which it radically change the understanding of how economic actors work specifically in making a decision. Camerer et al. (2007, 5), propose neuroeconomic as follows: "Neuroeconomic use knowledge about brain mechanisms to inform economic theory, opening up the "black box" of the brain."

1.3.1 Dual System Theories: Reflections on Coginitif and Affective Collaboration and Competition

One important concept in neuroeconomic is what is referred to as thinking system in decision-making which is governed by the interaction between two different systems. Two of these systems have a variety of terms (terminology) but refers to the same concept. Schneider and Shiffrin and Schneider (1977) refer to such systems as Automatic and Controlled Processes, Epstein (1994) mentions such 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) called system 1 and system 2, Lieberman (2003) mentions such systems as impulsive and reflective systems and Frank et al. (2009), referred to them as deliberative and automatic systems.

Automatic and Controlled Processes system described by Camerer et. al. (2005: 16), in Table 1 Two Dimensions Of Neural Functioning as following:

TABLE 1
TWO DIMENSIONS OF NEURAL FUNCTIONING

	Cognitive	Affective
Controlled Processes ▪ serial ▪ effortful ▪ evoked deliberately ▪ good introspective access	I	II
Automatic Processes ▪ parallel ▪ effortless ▪ reflexive ▪ no introspective access	III	IV

Table 1. Two Dimensions Of Brain Function (Camerrer et al., 2005; 16)

[1] Neurotransmitters are one of a class of chemicals that carry messages between neurons. Neurons (pathway) is a particular type of cell that is specialized to store and transmit information

Controlled processes that lies in the first two lines have a serial or sequential nature, using step by step, slowly, relatively flexible, controllable, and effortful work pattern. This system uses the maximum cognitive potential that is considered more representative of potential cognitive (Camerer et al., 2005). Moreover this system has the potential to be used intentionally or knowingly accessed when economic agents met with a challenge or threat (Hastie, 1984). The second system allows one to analyze, synthesize, evaluate and develop hypotheses (Capelleti, 2009). When economic agents the tools to solve quantitative economic analysis, expert programmers build dynamic programming or design and an individual is faced to choose a new car or buy a used car, then the work is dominated by controlled processes (Camerer et al., 2005)

Automatic system is the opposite of controlled processes where operations have parallel properties, below the threshold of consciousness, effortless, and able to work multiple tasks at the same time (multitasking) (Camerer et al. (2005). This is also explained by Lovric et al. (2008; 7) as follows:

> *Controlled processes are serial (step-by-step), evoked deliberately, they cause the subjective feeling of effort, and are accessible by introspection. Automatic processes operate in parallel, they are relatively effortless, and are inaccessible to consciousness*

Furthermore, Kahneman (2003) describes the characteristics of an automatic system as working fast, automatic, effortles, reflex, appears as a habit, is difficult to be controlled and modified. Automatic system is minimal in using cognitive potential, largely innate instincts and tend to be emotional and is considered more representative to affective potential. Frank et al. (2009), defines automatic system as a mechanical system that integrates past experience to strengthen the results of an action. Parallel processes provide redundant facilities which the brain automatically categorize and store data. For example, a box containing investment management course files, intermediate accounting course files, clothes files, and other foods files. Positive consequences of "facility" is to reduce the vulnerability of the brain to injury. When neurons are progressively destroyed in certain areas, the impact is not sudden but gradual (Scheffer et al ., 2009). This was also stated by Rumelhart and James (1986) as follows :

> *Parallelism also provides redundancy that decreases the brain's vulnerability to injury. When neurons are progressively destroyed in a region, the consequences are typically gradual rather than sudden*

Work characteristics of the automatic system as mentioned above, takes place below the threshold of consciousness that make it difficult to examine the potential outcome of this action. For example, when controlled processes assess the actions outcome of automatic system of face reflection "pretty" or "cynical", then try to prove whether the facial expressions express the substance of the action, the judgment is often wrong. It turns out that facial expression only produces falsehood (Wilson et al., 2000).

The next section of Table 1 illustrates the cognitive and affective processes. Affective is the reflection of emotion, feeling and mood potentials (Reber, 1995; 15). Affective express emotions, anxiety signs of heart shown to others. Dettmer (2006) suggested that affective contains behaviors that emphasize aspects such as feelings and emotions such as interests, attitudes, appreciation, passion and adaptive way. Affective component can be observed from the reaction of the body, such as sweating, trembling, and paling. This component is a function of the activity of the autonomic nervous system, the body prepares to take action when deemed necessary (Gerrig and Zimbardo, 2002: 251). Individual behavior or thinking should fulfill some criteria to be classified as affective potential which is that behavior involves feelings and emotions and the behaviors are unique (Anderson and Anderson, 1982). Camerer et al., (2005) not only expands the understanding of affective emotions such as anger, fear and jealousy but also the impulse from hunger, thirst, sexual desire, nausea and other psychological symptoms.

Cognitive is the potential to learn, observe, reasoning, judgment, imagine, think, and speak (Schueler, 1997). This potential is related to the ability to think, including memorization, understanding, analysis, synthesis, evaluation, and application. Sandberg and Bostom (2009) defines cognitive as a process of information organizing including choosing, observing, perceiving, understanding, maintaining information memory and using the information for a specific purpose. Cognitive is the existence of mind capacity to process information systems. Brandimonte et al. (2006), explains that cognitive is not only a process, rather it is a mental process that transforms internal and external inputs to be reduced, collaborated, elaborated, stored, and used. This process involves a variety of mental functions such as perception, focus, coding, memory, reasoning for planning, problem solving and execute actions. In addition, cognitive process is also used for empirical investigation that led to scientific investigation through the methods of the natural sciences .

Furthermore in Table 1, Camerer et al. (2005), describes how cognitive and affective potential is divided into four quadrants in the capacity of controled systems and automatic systems. Quadrant I illustrates controled process of cognitive potential in which this quadrant is fully responsible when the thinking process is rational and logical involving quantitative models, physics, computational, mathematical and others. Quadrant II depicts controled process but still involves the affective potential in which this quadrant is responsible when conscious thought processes involving past emotional experiences to stimulate or bring back the same emotion today, but under control. For example, people thinking about past events related to happiness or achievement with the aim of stimulating that emotions to be more encouraged in work. Quadrant III illustrates the automatic process but still involves cognitive potential, for example moving the hand to take a drink of water when thirsty or a football player who swung his feet to dribble. Quadrant IV illustrates the automatic process with the affective potential in which this quadrant take full responsibility when thought processes is below conscious or uncontrolled. For example, a person will instinctively jump and scream when startled.

1.3.2 Finding Instructions From the Brain

Scientists from East and West for centuries were struck by the relationship between cognitive and affective in the human brain. Mechanism of the brain action that is full of mystery, stole a lot of attention to be studied and analyzed, though until the 21st

century, it is still able to explore less than 10% of the actual working mechanism of the brain. What is presented in this study is a small part of that 10% due to only focusing on a few aspects related to the four research propositions.

For decades, scientists separates brain functions and parts into two independent parts namely affective brain (brain affective) and cognitive brain (cognitive brain). Over time, various research and development on the knowledge of brain function and connectivity that is distinguished independently become increasingly problematic.

There are at least three reasons which suggest that independent differenciation is not worth to maintain (see Ledoux, 1995; Churbetta and Shulman, 2002; Pessoa, 2008; Frank et al., 2009), namely, first, it turned out that regions or areas of the brain that has been determined as affective function was also involved in cognitive function. Second, the area or areas of the brain that are designated as cognitive function are also involved in affective functions. Third, cognitive and affective circuits in touch and work in an integrated manner. Therefore, no system is completely separate for cognitive and affective. The system is very complex, rich in interactions between tissues that compose and is dynamic over time. Recent developments revealed stronger evidence that suggest cognitive and affective not only interact with each other in the brain but are also integrated, in which that together they contribute to the behavior.

This system can not be approached by dividing it into the small parts (modular) that are independent and then used in different systems to drive on several different functions. This system has the majority of its own function but interrelated and are not able to work independently. Interactions can include collaboration but also mutually exclusive (competition).

1.3.3 Brain Regions That Correlate With Cognitive and Affective

Prefrontal cortex (PFC) is the front part of the brain's frontal lobes (the front of the large hemispheres) located in front of the motor and premotor areas. PFC is associated with the region that controls motoric and chemical response and receive signals from all sensory areas of the brain that controls the body (Mengarelli, 2012). It has a strategic location, has extensive anatomical connections ability with the posterior regions of the cortex and subortikal (lower brain).

This brain region is involved in cognitive behavioral abilities, expressing personality, decision-making and moderators of social behavior. Working like an orchestra between thoughts and actions in accordance with internal goals. Common psychological terms for functions carried out by the prefrontal cortex area are executive, top-down or motoric system function. This function relates to the ability to distinguish between conflicting thoughts, determine good and bad, better and best, same and different, future consequences of what is done now, working to achieve the goal set, predict the results of an action and social control (the ability to suppress action to be accepted by the public).

Dorsolateral prefrontal cortex (DLPFC) is a region in the prefrontal cortex of the human brain that experiences a very long period of growth and maturation because it lasts until the human reaches adulthood. DLPFC is not an anatomical structures but one functional area which is located in the middle of the front part gyrus (figure 9.1). An important function of the DLPFC is executive functions such as working memory, cognitive flexibility, planning, obstacles and abstract reasoning. However, the DLPFC is not exclusively responsible for executive function.

All complex mental activity requires additional cortical and subcortical circuits to connect DLPFC with other parts of the cortex. Even so, DLPFC is one of the highest cortical areas involved in motoric planning, organization and regulation. Having a large number of connections, makes DLPFC more ideal for processing information needed to perform top-down control of the low-level sensory processes of the brain.

Furthermore, the DLPFC is connected with the high degree of sensory and motoric on limbic structures through Orbifrontal Cortex (Fuster, 2001). DLPFC is connected with the orbitofrontal cortex and other brain areas such as the thalamus, dorsal nucleus (part of the basal ganglia), hippocampus, and occipital. Consistently, neuroscience studies provide evidence that DLPFC is responsible for monitoring and selecting the information that is relevant with the purpose (Wagner et al., 2001) and to extract information about the rules throughout its life experiences to drive action (Miller, 2000). Not less important is the ability of the anterior DLPFC of problem solving and difficult tasks reasoning (Kroger et al., 2002).

Orbitofrontal cortex (OFC) is a region in the prefrontal cortex in the frontal lobe that is involved in decision making and have a relationship with the cognitive part of the brain that play a role in affective functions. Human OFC is one of the least understood areas of the human brain, is involved in the sensory integration and have a connection with affective function in decision-making (Kringelbach, 2005).

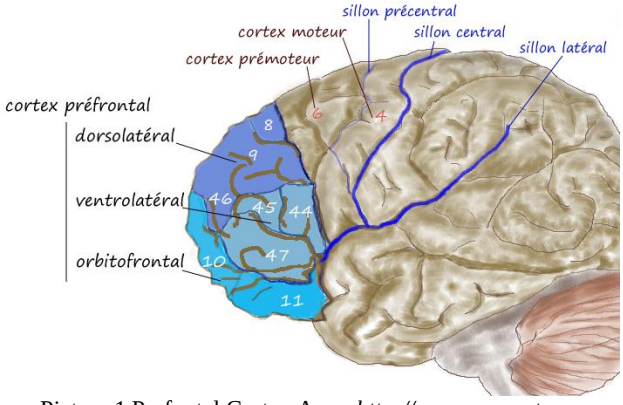
Research conducted by Schoenbaum et al. (2011), suggests that the orbitofrontal cortex together with the amygdala learns and connects any information that represent emotional. According to Schoenbaum, neurons in the OFC detect changes in the value of reward, studying the stimulation caused by changes in the value and change the response of the stimuli. This area has an important function in signaling the expected profit, the punishment of an action, remembering certain details, comparing between reward and punishment which is important to the learning process. Signals from Blood Oxygen Level-Dependent (BOLD) in the OFC are sensitive to the value of an outcome, integrating information about probability, size and time related reward and or punishment, furthermore assess emotional response.

Ventromedial prefrontal cortex (vmPFC) is part of the prefrontal cortex, located at the bottom of the frontal lobe which is involved in processing risk and fear, inhibit emotional responses and decision-making process. The difference between the OFC

and vmPFC function has not been clearly defined, but studies have shown that vmPFC is more superior in terms of social and affective functions. Neural network in vmPFC grows rapidly during adolescence and adulthood that plays a role in the regulation of affective and decreased levels of cortisol[1] at the time of decision-making.

Perbedaan fungsi antara OFC dan vmPFC belum ditetapkan secara tegas, namun penelitian menunjukkan bahwa vmPFC lebih unggul terkait dengan fungsi sosial dan afektif. Jaringan syaraf pada vmPFC berkembang pesat selama masa remaja dan dewasa yang berperan dalam regulasi afektif dan penurunan tingkat kortisol[2] pada saat mengambil keputusan.

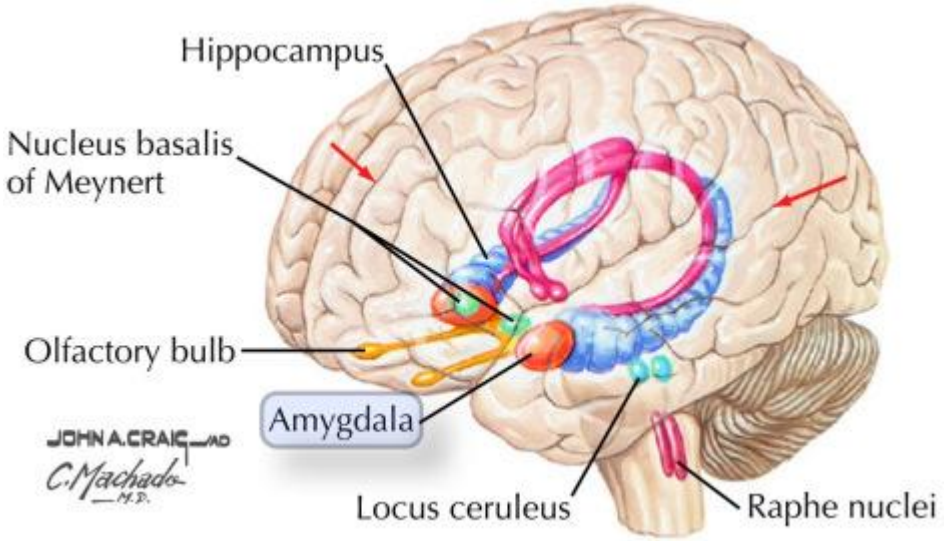
This is further corroborated by the findings of Bechara et al. (2000), that a person who suffered injuries in the vmPFC are likely to experience severe disruption in personal and social decision-making, difficulty in selecting uncertain option because of risk factors, mistakes learning disorder and taking wrong decisions repeatedly. Regions of the prefrontal cortex can be described as follows:



Picture 1 Prefontal Cortex Area. *http://www.psypost.org*

The amygdala is an area which has a complex structure, is involved in a large number of affective ability, especially to process signals of emotion, emotional conditioning and consolidation of emotional memories. Amygdala as in most regions of the brain, does not stand alone but rather consists of several different sub-areas and differentiated by function and histological criteria.

One function of the amygdala is the ability to recognize and learn about dangers. Study of neuroscience indicate that amygdala is actively responding to the induction of both positive and negative emotional condition of fear. When someone is having a dysfunction in this brain region, it will cause the blunting of emotional abilities and not having fear (Feistein et al., 2011). The amygdala can be described as follows:



Gambar 2 *Amygdala. http://teddybrain.wordpress.com*

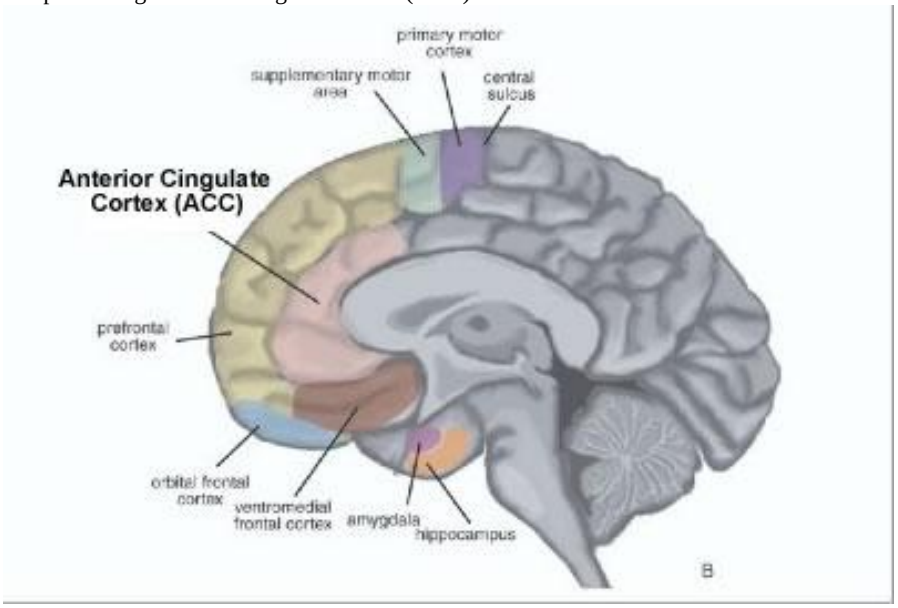
Anterior cingulate cortex (ACC) is an area that is crucially involved in two, namely affective and cognitive ability. From a functional standpoint, this area has two sub-areas: the front part of the anterior cingulate cortex or referred as rostral is specific for the affective processes and the middle or the dorsal part is specific for the cognitive process.

In other words, rostral is connected with the amygdala and orbitofrontal cortex, whereas the dorsal is connected with the dorsolateral prefrontal corticex. ACC is a brain region that is very unique because of its capability of detecting and monitoring

[2] Hormon produced by the adrenal glands. This hormone is involved in stress response and increases blood pressure and blood sugar levels

errors, then evaluate the error rate and then indicates the most appropriate form of action to be done. The error here is caused by a conflict between the affective and cognitive.

Etkin (2006) suggests that there is separation of the functions of the ACC in which the dorsal that is to detect emotional conflict and ventral together with the ventromedial prefrontal cortex and the amygdala are involved in the regulation of emotional conflict. Dorsal ACC is active when revaluating through top-down control activities by means of consciously or intentionally modulating emotional processing. Anterior cingulate cortex (ACC) can be described as follows:



Gambar 3 *Anterior Cingulate Cortex* (ACC).*http://www.sutherlandsurvey.com*

1.4 Efficient Market Hypothesis Reflection

Behavior has a unique term, in which it does not have the possibility to be limited to the absolute determination. The term behavior is abstract or conceptual in which it cannot only be applied to the concrete and discrete objects. Carlson (1994) explained that even silence is part of a behavior. Activity is said as a behavior if it leads to changes inside and outside of itself (the external environment) in relation between the organism with its environment. It involves all internal potential such as associative, cognitive, affective, motivation, experience, learning and memory processes that depends on the development of a good nervous system. Behavior is the most complex phenotype[3] that is ever learned by humans, because behavior reflects the functioning of the whole organism, and because behavior is dynamic and ever-changing in answering its environment (Aswin, 1995)

McGaugh et al. (1966) state that behavior is encoded in the neurochemical gene through micro control system in the brain. Such systems allegedly formed from the interaction of genes, therefore, it can be said that the behavior evolves. Micro control system itself determines how a person behaves. This system forms centers in the brain such as the analysis center, the synthesis centers, the love centers, and so on.

Hypothesis of the brain connection with behavioral argue that the brain is the source of the behavior through nervous cells or neurons that become structural and functional unit of behavior (Kolb and Wishaw, 1985). This explanation suggests that there is a link between behavior and the brain. Multi-complex behaviors are associated with the working mechanisms of the brain that are also. Therefore, a variety of investor behavior is a reflection of the workings of the multi-complex brain.

Kolb and Wishaw (2001) explains that the growth of human along with its brain is in line with the development of behavior. A newborn baby's brain weight approximately 400 grams and develop to 850 grams at the age of 11 months. At the age of 3 years, the brain weight becomes 1100 grams and then it becomes 1450 grams as an adult. This suggests that the development of increasingly complex behaviors are associated with the size or weight of the brain. However, after a human reach 75 year, brain lost about 100 grams of its weight, causing a decrease in the ability of elderly human.

By sex, Ashwini (1995) explains that the female brain is smaller (not that much lighter) than the male brain. This does not mean that women are less intelligent than men. Women's right and left brain hemisphere is more symmetrical than men's brain especially in the area of language which is the planum temporale (Hughdal, 2005). Therefore, the women are superior in language while men excel in spatial. Allegedly, because this spatial superiority, men are superior in music and chess.

[3] Characteristics (both structural, biochemical, physiological, and behavioral) that can be observed from an organism that is governed by the type of genes and environments and the interactions of both.

Kolb and Wishaw (2001) explains that although brain size may be important , but it is not necessarily able to answer the behavior or human nature, especially when associated with other mammals such as dolphins. Although the dolphin's brain is bigger relative to its size than humans, but it is certain that the behavior of dolphins is not like humans both in complexity and structure. Carlson (2010) stated that the small brain is more beneficial in some ways comparable to a large brain. For example, freshwater turtles can behave in such way that it can survive in the water for more than 1 week compared to the dolphins which have higher intelligence but are only able to survive no more than 5 minutes. It turns out that turtle which is considered as the most stupid creatures over 200 million years, still have some achievements on the other things. This suggests the chain that lead to human beings is not always the best for all animals because each path provides advantages and limitations .

Various studies on the brain mechanisms show that many behavioral centers in the brain have been mapped in detail. Scientists conduct exploration in the various regions of the brain using brain mapping to study the area of human behavior. Carlson (2010; 43) describes how much information is processed in the nervous system in the brain as follows:

> *Information received through the senses is processed by various systems of neurons in the brain. Some systems store the information in the form of memory; other systems control behaviour. Some systems operate automatically and unconsciously, while others are conscious and require effort*.

The more complex nervous systems that are active, the more complex the behaviors that are shown. Illustration of the brain in the form of figures illustrate how increasingly complicated and complex the structure, organizations and functions of the brain to produce behavior. Neurobiology experts use terminology from social and language of everyday communication to explain the relationship between brain and behavior.

Aswin (1995) for example, explains that life takes place because all actions are "controlled" by the "instructions" given by the communication of information in the form of code. Kolb and Wishaw (2001) explains that the brain is an information network which is very broad, rich, complex and organized, it is was always awake when sleeping to actively monitor, process and control every activity of the body and behavior, physical and non-physical.

Azevedo et al. (2009) explains that the communications network that are vast and complex are formed by millions of nerve cells interconnected with one another. The brain is estimated to have more than 10 billion nerve cells (neuron) and has 10 times as many supporting cells. These organs receive, process and send information in the form of a coding system that has its own characteristics and is different from the artifacts of communication such as telephone, television and computer. Until now, the system node and code is still mysterious and yet to be revealed. Furthermore, Kolb and Wishaw (2001) explains that the brain receives and analyzes information using electrical leap where electrical signals are identical for all the nerve cells in the form of different symbols with which it described to the outside world. Neurons are interconnected with each other to change complex code information into electrical impulses and produce simple concepts.

Kissin (1986) in his book titled "Conscious And Unconscious Programs in the Brain", explains that in order to figure out how brain programs in producing patterns of behavior is to analyze the nerve cells in making combinations formed from the letters of the brain alphabet. As explained in the previous section that, the brain contains nerve cells. These cell conceptually are in the form of letters of the alphabet version of the brain.

The combination of these letters form words, sentences, paragraphs, chapters and books to put together a program that produces a pattern of behavior. That is, if the words and sentences is assembled correctly will generate events in the environment both internally and externally and also generate certain commands. Therefore it can be said that, the brain is a control organ that is always active in selecting and sorting of the many alternative behavior through communication channels between programs. This suggests that nerve cells that are huge in numbers, are varied because no one cells are similar, related to each other on a large scale, multi-complex and intricate patterns have resulted in a complex behavior.

Society for Neuroscience in 2013 published a very interesting article related to facts about the brain. The official publication explains that the most complex organism on earth contains more genetic information and ekstragenetik. Map of the human genome[4] has been successfully created and deliver stunning results which is that the more complex a tissue or organ, the more number of active genes is required. Dr. James Watson map all the genes in human DNA which was launched in 1990 in the Human Genome Project. It turns out that the brain is the organ with the most active genes containing as many as 3,195 genes. The brain record a complete human evolution during its course of life and there are no adaptive behavioral changes that are not influenced by the working mechanism of the brain.

Finally, to further strengthen the complexity of human behavior which dwarfed the thoughts that place the investors behavior of as rational is to study the explanation Carl Sagan (1978) in his book entitled "The Dragon of Eden : Speculation On The Evolution of Human Intelligence" which won the Pulitzer Prize Winner award. Carl Sagan explained that, in addition to the uniqueness and diversity of behavior, to define the complexity of the organism is also based on the information content of the minimum genetic material. To find information on the genetic material is through the DNA inside the organism chromosomes. Heredity[5] language is written in the alphabet consisting of four letters. Language of the genetic information of human life is determined by four different nukleotid[6]. The human brain is an amazing and extraordinary library of life. There are approximately 5 billion nukleotid pairs inside the chromosomal DNA molecules in the brain. Information content of a message

[4] Overall genetic information possessed a cell or organism
[5] Inheritance from parent to offspring character biologically through a gene (DNA)
[6] Molecules that form an important part of the DNA

in unit is called bits. If the genetic code is written only with two letters then the number of bits in a DNA molecule is equal to two times the number of nukleotid pairs.

However, since there are four kinds of nukleotid then one chromosome contains 20 billion bits of information. Sagan (1978) in his study have converted 20 billion bits of information in a number of books that can be generated. The results illustrate that, if the information is written in a book printed in the language of modern humans, it would be approximately equal to 500 million words, or 2 million or 4 thousand page volumes. A very large library in a small and light organ. This is explained by Sagan (1987:15) as follows:

> *...therefore twenty billion bits are the equivalent of about three billion letters (2 X 1010/6 = 3 X 109). If there are approximately six letters in an average word, the information content of a human chromosome corresponds to about five hundred million words (3 X 109/6 = 5 X 108). If there are about three hundred words on an ordinary page of printed type, this corresponds to about two million pages (5 X 108/3 X 102 X 108). If a typical book contains five hundred such pages, the information content of a single human chromosome corresponds to some four thousand volumes (2 x 108/5 x 102 = 4 x 103). It is clear, then, that the sequence of rungs on our DNA ladders represents an enormous library of information.*

Sagan Explanation's (1978) above shows that the content of information in the brain is very complex and therefore we can not imagine how complex the variation of the resulting behavior. Even Sagan compares the content of the information content of the brain with the information contained in the Viking spacecraft which is aimed at making a trip to the planet Mars expedition. Viking aircraft only a have few million bits for the instructions programmed in the computer. It is equal to the amount of genetic information that is contained by a single bacterium.

Conclusion

The above description shows that human behavior in this case investors can not be seen from one point of view only. Investor behavior that is rational is only a small particle part of the complex investors behavior. In fact, the four propositions on this research is also still a small particle in the vast, complex and complicated expanse behavior of investors. But at least, this study provides some color in the investor behavior that is not only rational but also irrational and the collaboration between the rational and irrational. Behavior that is not only generated by cognitive but also affective and collaboration between cognitive and affective. Behavior that is not only dominated by the work of the DLPFC, ACC, OFC and vmPFC but also amydala and hypothalamus and as well as the collaboration of the six areas of the brain regions above as well as other areas that still has not been mentioned in this study and that may also still be a mystery to date.

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