Academic Journal of Engineering and Technology Science
ISSN 2616-5767 Vol.3, Issue 8: 36-44, DOI: 10.25236/AJETS.2020.030804

The impact of information disclosure mode on investors' cognitive process

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ABSTRACT. *Information disclosure is critical for the functioning of an efficient capital market. Since most of the investors in the market are not fully rational, managers have the opportunity to affect investors' decision by strategic news releases. This study conducts a neuroscience experiment with functional magnetic resonance imaging (fMRI) to explore how the human brain processes news when they are presented in different orders. This study provides direct empirical evidence of the link between activity in the human brain and the disclosure of accounting information. We find that when good news and bad news are released in various orders, the stock price would show significant difference. This study may help non-professional investors recognize information manipulation and provide policy makers with reference to policy revision of information disclosure.*

KEYWORDS: *information disclosure, neuroaccounting, fMRI*

1. Introduction

1.1 Problem statement

Information is critical for an efficient capital market. Financial reporting and disclosure are potentially important means for management to communicate firm performance and governance to outside investors. However, since the majority of investors in our country's stock market are nonprofessional investors with bounded rationality, they are easily led into a cognitive trap. And recently, more and more cases showed that listed companies would manipulate investors' behavior by changing the information release mode and order, which is called strategic news releases. Bowen et al.(1992) found out that managers are attempting to influence stakeholder perceptions of the firm's earnings performance. Since some stakeholders are not likely to find it cost-effective to monitor the firm actively, managers have the opportunity to influence the perceptions of relatively uninformed stakeholders through accounting decisions such as the timing of earnings announcements. Tang et al(2005) found that The timing of the first quarter quarterly report disclosure may depend on the combination and balance of the positive or negative effects brought

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by the "good news" or "bad news" disclosed in the previous year's annual report and the first quarter quarterly report. Edmans et al. (2018) found that management may affect the company's share price by accelerating or delaying the release of positive or negative news in a specific period.

Although many literatures grounded in economics and psychology examined the role that information disclosure play in valuation, they didn't give answer to the fundamental question, which is how investors evaluate information when the news are presented in different orders. If researchers want to predict investors' behavior, then it is necessary to measure how modifications of available information disclosure order alter subjects' expectations and subsequent actions. If we can understand how cues from the environment stimulate the reward system, then we can understand how, and why, people are motivated to do many of the things, wise and unwise, rational and irrational, that they do. Therefore, I take a novel, radically different approach from the existing literature by relying on cognitive neuroscience and functional magnetic resonance imaging (fMRI) to explore how the information disclosure order affects investors' decision.

1.2 Statement of the research objectives

This study attempts to understand selected irrational investor behaviors through correlations with findings from fMRI research of the reward system and to provide direct empirical evidence of the link between activity in the human brain and the disclosure of accounting information. And then, this study tries to provide some evidence that the fundamental relationship between information and stock prices can be distorted by a firm's strategic incentives to control its information disclosure mode, which may help non-professional investors recognize information manipulation. Finally, this study provides policy makers with reference to policy revision of information disclosure.

2. Literature Review

2.1 Neuroaccounting

In the accounting field, scholars have begun to consider the ways in which they can incorporate neuroscience into their work, and the paradigm they used often referred to as neuroaccounting. Neuroaccounting is the integration of accounting and neuroscience, which shows great intersection and comprehensiveness and expands the traditional accounting research. Neuroaccounting can enrich research methods and strengthen the conclusions that we can draw, which makes it possible to study the phenomena that traditional accounting can hardly explain. These mehods link the inputs and outputs of human decision making through inferences about the working of the unobservable ‘‘black box’’, the actual cognitive processes. This is a great revolution in accounting and even management research. However, due to the unfamiliarity with the experimental methods of neuroscience, how to correctly

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choose the experimental methods of neuroscience has become a major problem for accounting scholars.

The methods for measuring the neural activity in the brain can be divided into two categories, brain imaging and electroencephalogram, which vary in terms of temporal resolution, the precision of time measurement, and spatial resolution, the precision of physical location within the brain. Brain imaging techniques include fMRI, MRI and PET, while electroencephalogram techniques include EEG, MEG and ERP. Among them, fMRI and EEG are the most widely used methods.

fMRI can observe neural BOLD signal changes during complex cognitive and emotional task, and it is non-invasive and involves no inherent health risk even for multiple or repeated sessions. Another prevalent method is EEG, which captures the synchronous firing of neurons in the brain and recorded by an electronic amplifier. Compared with fMRI, EEG is more portable and costs less. ERP is an experimental paradigm designed on the basis of EEG. The data obtained from the EEG experiment can be analyzed to form the distribution of ERP brain topography and analyze the components of ERP.

fMRI is mainly used to study investor's response to earning information(Barton, Berns and Brooks, 2014), investor's trading intuition (Bonner, Clor-Proell and Koonce, 2014), corporate performance incentive and other investor behavior(Hidetoshi, Masatoshi and Yoshinori, 2016) and other investors' decision-making behavior.EEG is mainly used to study stock market trading decision-making (Vieito, da Rocha and Rocha, 2015), financial misreporting behavior(Eskenazi, Hartmann and Rietdijk, 2016) , continuous operation decision-making(Carvalho et al., 2017) and other company and market related issues.

For general research issues, all three methods, fMRI, EEG and ERP, may be applicable, but in consideration of the type of research issues and the advantages and disadvantages of the three neuroscientific experimental methods, we can generally summarize the optimal experimental methods for different research issues. For example, when using experimental methods to study risk management problems, participants should be placed under the pressure of choice to induce activity in various areas of the brain, which is in line with the basic concept of ERP operation. Compared with the high cost of fMRI, evoked potentials analysis like EEG and ERP are better way to solve risk management-related problems.

2.2 Information disclosure

Healy and Palepu (2001) generalize the motivation of management voluntary disclosure into six hypotheses. First of all, the hypothesis of capital market transaction. Voluntary disclosure is conducive to reducing the degree of information asymmetry between internal management and external investors, so as to reduce the cost of capital. Secondly, the hypothesis of control competition. In order to prevent management from losing control due to poor market performance, managers would like to disclose more information to avoid the company's value being underestimated by the market. Thirdly, the hypothesis of stock compensation plan. The

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compensation of the management includes the compensation plan based on the stock price, such as stock options, etc., which will encourage the management to disclose information to the market to improve the performance of the stock market and maximize their own compensation. Danines et al. (2018) found that before the management incentive option was granted, the management of some listed companies would gradually reduce the stock price of the company by accelerating the publication of negative information, and then reduce the exercise price of the option to improve the value of the management incentive option. Fourthly, the manager's ability letter hypothesis. The management has the motivation to transmit their own ability letter to the market through the disclosure of voluntary information. Fifthly, the hypothesis of specialized cost. in order to avoid the weakening of the competitiveness of the company, the management has the motivation to carry out selective information disclosure. Last but not least, the hypothesis of litigation cost. The litigation risk (litigation cost) faced by the management has an important impact on voluntary disclosure. The increase of litigation risk may make the company improve the level of voluntary disclosure, especially the level of bad news disclosure. Skinner's (1997) research shows that early disclosure of bad news can reduce the possibility of later prosecution. Influenced by LLSV (1997,1998,2000) and its leading "law and finance" research, the litigation cost hypothesis has been continuously concerned by foreign scholars in recent years, but the relevant research conclusions are quite different. Field et al. (2005), Wynn (2008), Levy et al. (2017), Naughton et al. (2019) shows that litigation risk is positively correlated with voluntary disclosure level. However, Rogers et al. (2009) and Bourveau et al. (2017) concluded that on the contrary, the increase of litigation risk reduced the level of voluntary disclosure.

Although laws and regulations have strictly restricted the information disclosure behavior of listed companies, the company's management still has a certain degree of decision-making power for the information disclosure of listed companies, and the management can strategically adjust the content of information disclosure and choose the time of disclosure within the scope of laws and regulations. Scholars at home and abroad have proved through various empirical studies that the strategic information disclosure of the company's management will have a significant impact on the company's stock price, and the strategic information disclosure often occurs in the period of specific events such as the company's merger and acquisition, senior management's reduction of holdings.

3. Hypothesis

Traditional finance theory assumes that financial markets are efficient and that market participants make rational decisions based on the best available information. However, recent research has revealed the evidence of irrational investor decision-making. Investor biases such as overconfidence, narrow framing, optimism, and misattribution have been modelled as the primary biases affecting financial market efficiency. Several studies have directly identified affective factors as the likely causes of large anomalies in financial prices, and managers would change the

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disclosure order or strategically time the release of the news to affect investors' emotion and behaviors. Bowen et al. (1992) believed that the management influences the judgment of investors through accounting decisions such as the timing of earnings announcements. Givoly and Palmon (1992) pointed out that management has corresponding incentive to manipulate the time of information disclosure, and the bad news is often accompanied by a longer delay. Edmans et al(2014) showed that CEOs strategically time the release of corporate news to coincide with months in which their equity vests. Also, managers would strategically release good news like charitable donation to reduce the negative impact of negative news on the enterprise (Freeman, 1984; Godfrey, 2005); or use the good news as an afterthought fire-fighting strategy to disperse the public's attention to the negative events of the enterprise and restore the image and reputation of the enterprise (Koehn and Ueng, 2010).

Therefore, we have the reason to believe that the different combination of the good news and the bad news can have totally different outcome, like people would react differently between the situation where a good man did something bad and a bad guy did something good. According to the anchoring effect, when people make decisions, they tend to over rely on the first impression or the first information they get, and investors are more sensitive to the bad news. So we assume that when the information is totally identical, disclosing bad news first will produce less belief revision when the good news released. Our first hypothesis is:

H1: Subjects would give a lower stock price valuation when they are told the bad news on the company first.

The human brain has more than 100 billion neurons, each connecting to anywhere from one to about 10,000 other neurons. Each neuron transfers information to another neuron by releasing chemicals like dopamine, serotonin, and glutamate that bind to receptors in the receiving neuron; the latter aggregates information from different sender neurons and relays it further downstream. Active neurons demand energy, leading to an increase in blood flow to the region of activation. fMRI relies on differences in the magnetic susceptibility of oxygenated and deoxygenated blood. Changes in oxygen concentration due to neural activity lead to a change in the blood oxygen level-dependent (BOLD) signal that we capture in the fMRI scanner. Increased neural activity leads to positive BOLD changes, while decreased activity leads to negative BOLD changes.

We assume that the shock of the different news would be processed initially in the ventral striatum, where the reward system lies(Montague et al. 1996; Schultz et al. 1997; Niv 2009). The brain's reward system underlies the fundamental neural processes of goal evaluation, preference formation, positive motivation, and choice behavior. Neurons in this region become more active when an individual learns that his estimates of the value of the events are too low, which will happen when subjects learned the good news after the bad one; and the region will become less active when he learns that his estimates are too high, corresponding to the bad news after the good one. The more active the neurons become, the higher the BOLD signal will be. And the absolute value of the bold signal can elaborate that investors react in

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distinct ways when the information is presented in different orders. Our second hypothesis is:

H2: The absolute value of BOLD signals in the ventral striatum is lower when they are told the bad news on the company first.

4. Methods

This study is a neuroscience experiment with fMRI. Since the tasks that the subjects need to complete require a basic knowledge of accounting and investing, we choose the students in the school of management as our subjects. Also, the subjects should have no psychiatric/neurological disorders or other characteristics that might preclude them from safely undergoing fMRI scanning. The experiment consists of three steps. First, the experimenter will provide some information about a company, subjects will be asked to value the stock of the company as the base line. Secondly, the subjects will be separated into two groups. The first group would be given the good news first, such as good financial performance and then the bad news, like poor financial performance or law suit. On the contrary, the second group will be given bad news first. The information is identical, only the order is different. Subjects will be asked to value the price again based on the information given.

In the meantime, we will scan subjects' brains with fMRI during the valuation process. The three images below are from a MRI scan of the human brain. The first image shows a frontal or coronal view of the brain (the face of the person is to the front, facing the reader), the second image shows a side or sagittal view (the face is to the right), and the third image is a horizontal or axial view (the face is to the top of the image). The areas highlighted in stripes show the ventral striatum, the region in the brain that we predict will process investors' reactions to the news.

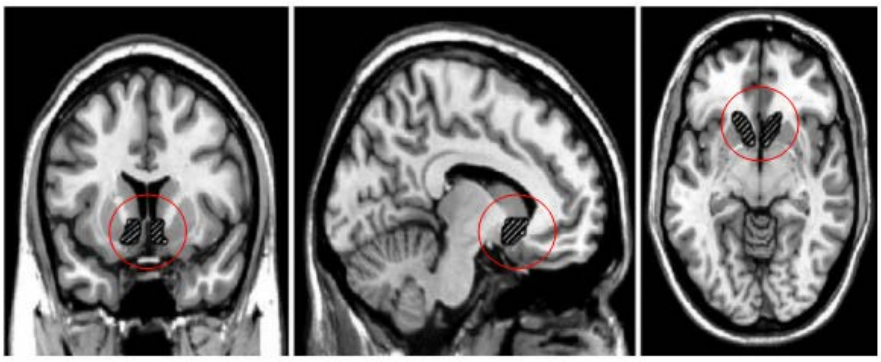

Figure. 1 A MRI scan of the human brain

ISSN 2616-5767 Vol.3, Issue 8: 36-44, DOI: 10.25236/AJETS.2020.030804

5. Expected Results

5.1 The study of stock price valuation

The second group, who is given bad news first, would give a lower stock price valuation. Figure 2 shows the experiment process and results. Subjects will be asked to value the price three times, based on the information given. If subjects are fully rational, the final price should show no significant difference, but sadly they are not. Therefore the second group gave a lower price.

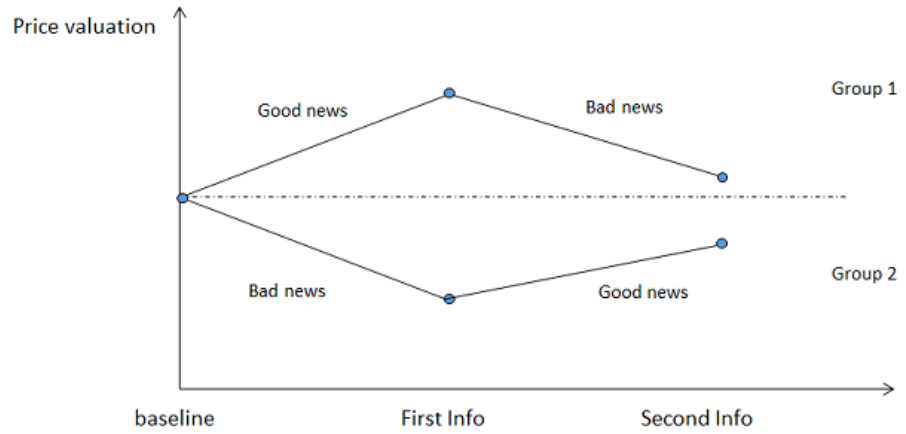

Figure. 2 The experiment process and results

5.2 The study of the absolute value of BOLD signals

The absolute value of BOLD signals in the ventral striatum is lower when they are told the bad news on the company first. When subjects learned the good news after the bad one, neurons in the reward system became more active; and the region became less active when subjects learns that their estimates were too high, corresponding to the bad news after the good one. The more active the neurons become, the higher the BOLD signal will be. And the absolute value of the bold signal can elaborate that investors react in distinct ways when the information is presented in different orders.

6. Discussion

With the advancement of technology, the brain-based tools are increasingly accessible through neuroscience avenues, scholars of the neuroeconomics and social neuroscience fields have fruitfully integrated neuroscience to form new research paradigms. This study take a different approach from the existing literature on the

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information content of information manipulation by relying on the tools of cognitive neuroscience to explore how the human brain processes news when they are presented in different orders. We assume that releasing the bad news first may cause a worse market reaction, since irrational investors value first impression more than update information. This study also reveals the neuroscience behind the information manipulation and cast new light on the relation between the human brain and irrational financial decision-making.

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