Risk Decision of Corporate Internet Financial Reporting Based on Brain Evoked Potential Testing Technology

Lingyan Ou [1,2*]

ABSTRACT

Corporate decision makers will weigh and balance before making any decisions at different points in time. Different time and process of decision-making will lead to different degrees of risk to the financial status of the company. According to different inter-temporal decision-making financial risks, corporate decision makers will show different behavioral responses and neural changes. Based on the brain evoked potential testing technology, this study tests the behavioral performance and brain mechanism responses of the subjects under the frameworks of financial risk and zero financial risk, and explores the brain evoked potential and brain network mechanism of inter-temporal decision-making on financial risks. The experimental results show that subjects are more willing to choose the options that are nearer in time and smaller in number under the framework of risk conditions. Under the two frame conditions, the decision type has significant main effect, while the electrode has no main effect, and there is no interaction effect between the decision type and the electrode. The degree distribution, clustering coefficient and shortest path length under the two frame conditions are different, that is, the function and efficiency of brain network are different. Analysis of the key nodes by degree distribution also shows that the brain mechanism is different under the two conditions.

Key Words: Intertemporal Decision Making, Risk, Brain Evoked Potential Testing Technology, Brain Network Mechanism, Corporate Internet Financial Reporting

DOI Number: 10.14704/nq.2018.16.5.1397 **NeuroQuantology 2018; 16(5):594-600**

Introduction

Companies often face decision making about events that occur at different time points, and their decision-making behavior does not involve merely the events happening at the current moment (Pavão *et al.*, 2017). In most cases, the decision-maker needs to compare and weigh the outcomes that their decisions may bring at different points in time (Sgouras *et al.*, 2017). The decision-making process in which people weigh the options at different time points to make decisions and choices is called inter-temporal decision-making (Solorzano-Margain *et al.*, 2013). There are various risks in various degrees when the corporate is carrying out various financial activities, the most common ones of which include the investment and financing risks and business risks (Poledna *et al.*, 2017). The research on the corporate inter-temporal settlement involves many subjects, such as psychology, economics, behavior, brain neurology and so on(Papenbrock & Schwendner, 2015; Groth & Muntermann, 2011). The control of corporate financial risk can effectively avoid its occurrence. At present, the economic models for intertemporal settlement of corporate networks include discount utility

Corresponding author: Lingyan Ou
Address: [1]School of Accounting, Fujian Jiangxia University, Fuzhou 350108, China; [2]Finance & Accounting Research Centre, Fujian Province Philosophy Social Science Research Base, Fuzhou 350000, China
e-mail ✉ 22087335@qq.com
Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.
Received: 8 April 2018; **Accepted:** 7 May 2018

model, hyperbolic discount models, and quasi-hyperbolic discount models. The established studies have found that immediate effects, dynamic inconsistencies, magnitude effects, and symbolic effects are consistent with the anomalies of discount utility model assumptions (Nagurneya, 2006).

Economists have proposed a psychology theory of intertemporal decision-making based on financial risk management theory, which holds that the psychological mechanism of intertemporal decision-making can be explained in the perspectives of cognitive emotion theory, construction level theory and evolutionary psychology (Wessel, 2016). The rapid development and application of brain evoked potential testing technology have led to the increasing use of brain imaging technology for the researches of intertemporal decision-making. In recent years, a number of neural processing models have been proposed for neural loop systems that represent subjective values in network inter-temporal decision-making, including single-system neural processing models, dual-system neural processing models, and multi-network mechanism neural models (Dastkhan and Gharneh, 2018; Xia *et al*., 2017; Zaccone *et al*., 2017). The financial risks caused by an enterprise's inter-temporal decision-making are affected by the attributes of the decision-making object, the traits of the decision-maker, and the decision-making context. The traits of the decision-maker are related to his personality, age, and emotional state (Zahedi *et al*., 2017; Ishizaki *et al*., 2010). Based on the brain evoked potential testing technique, this article analyzes electroencephalogram of the subjects to study the brain evoked potential and the brain network mechanism of the inter-temporal decision-making on the financial risk.

Basic Connotation, Cause Analysis and Early Warning Research Design

Basic Connotation of network intertemporal decision-making

The rapid development of the innovative economy has witnessed lack of core technologies and innovation capabilities, the incomplete industrial chain system, the serious regional convergence, and poor reliability of products in the companies. As a result, many enterprises in the period of development and expansion, are often affected by many factors such as their environment, which leads to the deviation of the operation of the enterprise financial system from the expected objective, resulting in significant economic losses (Cruz *et al*., 2006). Intertemporal decision is common for an enterprise, some of which may lead to a reduction in the financial operating results of the enterprise, or poor financial management. As far as China's high-end equipment manufacturing industry is concerned, China's products are less competitive in the international market, thus high-cost production will not necessarily bring about the expected benefits. The reasons for poor financial performance are largely reflected in decision-makers' decisions (Miocinovic *et al*., 2017). Figure 1 shows the flow chart for constructing early warning model for intertemporal decision-making on financial risk, including such steps as analysis of the model index variables of the study sample according to the research object, model selection based on risk early warning theory, setting of the corresponding model parameters, construction of an early warning model for intertemporal decision-making on financial risk, application of the model to Intertemporal decision-making of the enterprise.

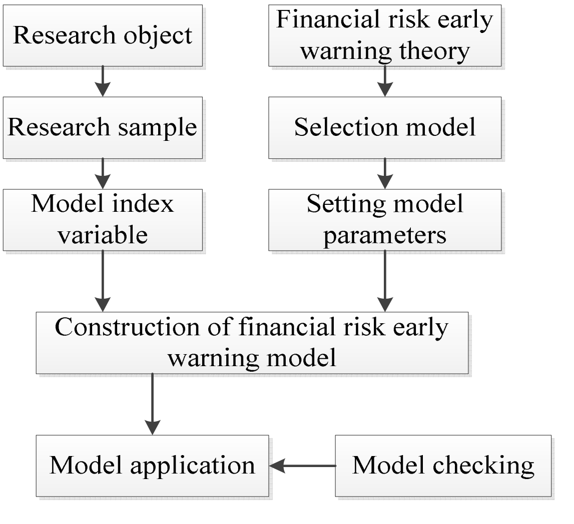

Figure 1. Flow chart of early warning construction for intertemporal financial risk decision-making

Cause analysis and the basic characteristics

There are many factors that cause financial risks for companies, such as the adverse effects of exchange rate fluctuations, declining demand caused by weakening macroeconomic conditions, competition of foreign products, the impact of national fiscal and tax policies, and internal management levels (Pascual Leone *et al*., 2011). The basic characteristics of financial risk of network intertemporal decision-making show in

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poor account receivable management capabilities, unreasonable capital structure, insufficient cash flow, high corporate investment and financing risks, and unsatisfactory profitability (Guo *et al*., 2014; Hashem and Giudici, 2016). The capital chain is a guarantee for the normal operation of an enterprise, and the amount of capital flow is also an important factor affecting the inter-temporal decision-making. With a long period of recovery of the company's product transaction payment, and a high proportion of receivable account, many accounts receivable develop into a large amount of bad debts cumulatively, affecting the cash inflow of business activities. With high-end manufacturing companies as the majority, there are many uncertainties and instabilities in those companies' operating activities. The financial risks they face continue to increase, and decision makers' mistakes in intertemporal decision-making can also cause huge financial risks, threatening their survival and development.

Network Intertemporal Decision-making Behavior

Methods

The enterprise's intertemporal decisions are related to its financial benefits and losses. Under the backgrounds of financial zero risk decision-making and financial risk decision-making, this article studies the subjects' differences in their selection of the options that are nearer in time and smaller in with number and that of the options that are farther in time and larger in number and analyzes the differences in decision-making behaviors of the subjects in the two decision-making contexts. The experiment recruits 22 enterprise management decision-makers by payment, all with certain experience in corporate leadership decision-making, all of whom are right-handed. The experimental program is written by E-prime 2.0 software, and the experimental stimulus materials are pictures in JPEG format. The pictures include 44 with zero risk framework and 44 with risk framework and each picture is repeated twice during the experiment. Subjects are not disturbed by external factors during the testing process and are informed in advance of the corresponding experimental procedures, objectives, and precautions. The left side of the display area shows the options that are nearer in time and smaller in distance, and the right side of the display area shows the options that are farther in time and larger in number. The subjects use a single factor in-test design and they are subjected to the tests under two frameworks.

Results

Under the two frameworks, the proportion of the subjects selecting the options that are nearer in time and smaller in number are 51.55% and 69.40 % respectively, both of which are higher than 50%. That is, more subjects select options on the left side of the display area. After t-test analysis of the samples, it is found that compared with the zero-risk framework, the subjects are more willing to choose the options that are nearer in time and smaller in number under the risk framework. In other words, enterprise decision makers will make decisions on recent earnings or losses and will not make decisions that affect future financial results. Figure 2 shows the reaction time of the subjects under the two framework conditions and the reaction time for zero-risk framework and risk framework is 2,181.11ms and 2,658.51ms, respectively. After the t-test on the test samples, the difference is found to be significant, and the reaction time is much shorter under zero-risk framework. In a summary, in contrast to the profit framework conditions, subjects are more willing to choose the options that are near in time and smaller in number under the loss framework, and they are not inclined to postpone the loss but are more willing to face it immediately. As to the reaction time, subjects under the loss framework need more time to make decisions, as they need to consider more factors.

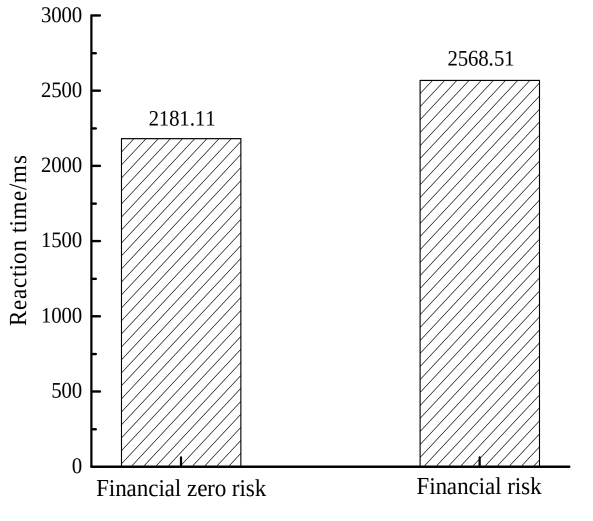

Figure 2. Subject's response time under two kinds of frame conditions

Brain Mechanism of Network Intertemporal Decision-making

Brain evoked potential of Network Intertemporal Decision-making

In order to further explore the brain mechanism of the difference in decision-making under the two framework conditions, this paper studies the asymmetry of intertemporal decision-making under the two framework conditions from the perspective of brain mechanism, that is, subjects will have differences in brain points (differences in ERP waveform). Figure 3 shows distribution of the electrode recording points on the scalp. The brain evoked potential test equipment used in the experiment is the Neurone EEG/ERP-related potential system, which consists of a brain evoked potential signal amplifier (Neurone Model Black amplifier) and an electroencephalogram cap (Ag/AgCl64 lead Neurone electrode cap), with a sampling frequency of 500Hz. The electrodes (reference electrodes) with relatively zero body potential are placed on the breasts of both sides. In the brain evoked potential data processing, the behavior data fusion must be first carried out, followed by reviewing of brain evoked potential, removal of electro-oculogram, segmentation of the brain evoked potential data, baseline correction, and removal of the artifacts, and then finally the ERP waveform can be obtained after digital filtering and smoothing.

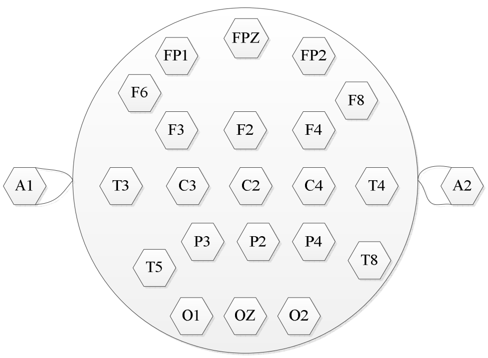

Figure 3. System electrode distribution

Figure 4 is a lead electroencephalogram of 8 electrode points, including FPz, FP1, FP2, AF3, F1, F3, F5 and F7, from where it can be seen that a convex positive wave appears at about 200 ms, and the downward positive wave direction obviously show that the wave amplitude under the financial risk condition is obviously larger than that under the zero-risk frame condition. P2 component of the brain evoked potential component corresponds to about 200ms, and the P2 component of the event-related potential is distributed in the prefrontal area of the brain. The P2 component mainly reflects the familiarity of the decision-makers with rapid exploration of stimulus information, attention to resource allocation, and decision-making issues. Through variance analysis of 8 electrode points, it is found that the decision type has significant main effect, but the electrode point has no main effect, and there is no interaction effect between the decision type and the electrode point. Figure 5 is an electroencephalogram of the F6 and F8 leads, where in about 250ms-300ms, a sudden wave, which is negative, will appear. Obviously, it can be seen that the volatility under the financial risk condition is obviously larger than that under the zero-risk framework condition. The N2 component of brain evoked potential components, corresponds to about 200ms and the N2 components of event-related potentials are mainly distributed in the forehead of the brain area, the forehead central junction area and the central area. During the experiment, the amplitude of the N2 component gradually increases as the negative component of the stimulus component increases. Through variance analysis of F6 and F8 electrode points, the results show that the decision type has significant main effect, the electrode has no main effect, and there is no interaction effect between the decision type and the electrode.

Brain network of network intertemporal decision-making

The characteristics and differences of intertemporal decision-making brain networks under two framework conditions are discussed by introducing brain networks. This paper bases on the fact that different brain waves have different brain networks. In other words, the brain network based on functional connectivity is different under two different framework conditions. The research method and contents are exactly the same as the above experiment. At the data processing stage, several brainwave segmentation data can be obtained after the same pre-processing as that of the brainwave data. The phase lock value is selected as an index for calculating the correlation between the two leads. The calculation formula is as shown in Formula 1:

$$\text{PLV}=\frac{1}{N}\left|\sum_{n=1}^{N}\exp(i\theta(t))\right| \quad (1)$$

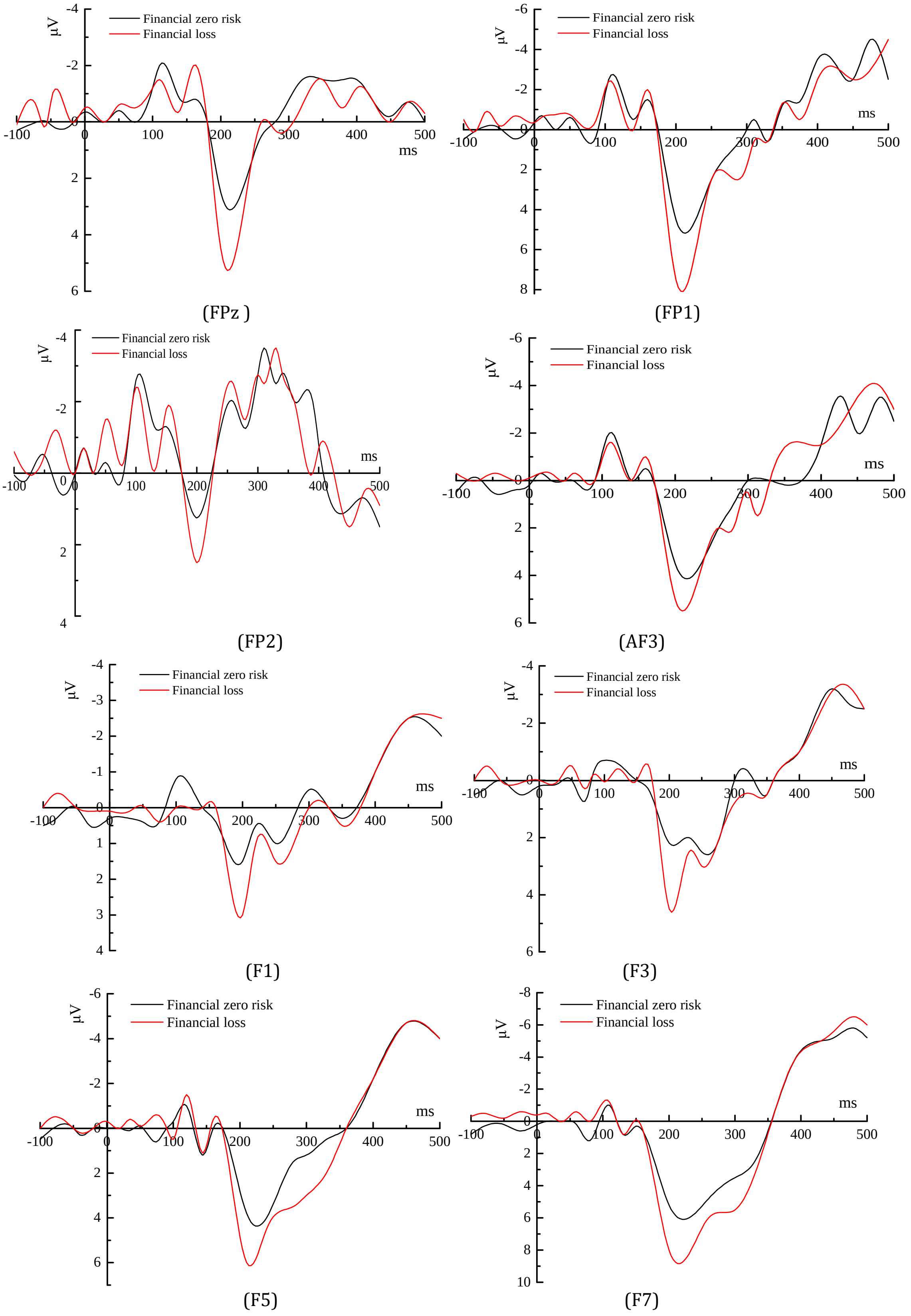

Figure 4. The lead ERP waveform of eight electrode points: FPz, FP1, FP2, AF3, F1, F3, F5 and F7

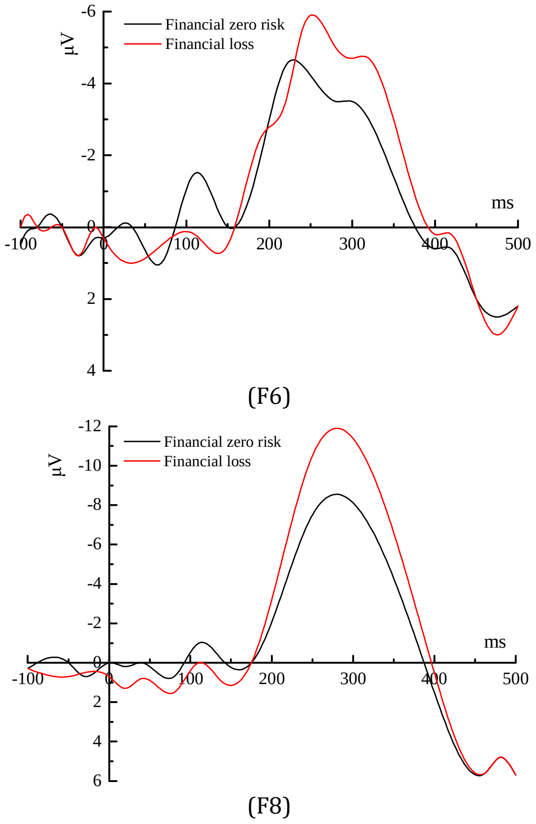

Figure 5. The lead ERP waveform of F6 and F8

Table 1. Comparison of brain network parameters under two conditions

	Zero risk condition	Risk conditions	t
Degree distribution	0.52	1.06	-2.643
Clustering coefficient	0.31	0.66	-2.366
Shortest path length	2.26	2.67	-1.445

With the lead tested as a node, and the intensity of the phase lock value as the edge, when the intensity is greater than 0.3, the two leads can be regarded as having a connection function. According to the analysis of the functional connectivity brain network of phase lock value, there are significant differences in the two network diagrams of intertemporal decision-making under the two framework conditions, and the complexity of brain network under the condition of financial risk is obviously higher than that under the condition of zero risk. Table 1 shows the comparison of brain network parameters under two framework conditions. The degree distribution, clustering coefficient and shortest path length under the two framework conditions are different, indicating that the function and efficiency of brain network are different. Through analysis of the critical nodes by degree distribution, it is found that the FC4 leads are the key nodes of the whole brain network under the zero-risk framework, while in the case of a risk framework, the PO5 lead is the key node of the entire network. The difference in key nodes also shows that the brain mechanism is different under the two conditions.

Conclusions

Under the zero-risk framework and the risk framework, this paper studies different behavioral performances and brain-mechanism responses of corporate decision-makers shown in inter-temporal decision-making. The specific conclusions are as follows:

(1) The basic characteristics of financial risk of network intertemporal decision-making show in poor account receivable management capabilities, unreasonable capital structure, insufficient cash flow, high corporate investment and financing risks, and unsatisfactory profitability.

(2) Through the analysis of the P2 and N2 components of brain evoked potential during intertemporal decision-making, it is found that the decision type has significant main effect, but the electrode point has no main effect, and there is no interaction effect between the decision type and the electrode point.

(3) According to the analysis of the functional connectivity brain network of phase lock value, there are significant differences in the two network diagrams of intertemporal decision-making under the two framework conditions, and the complexity of brain network under the condition of financial risk is obviously higher than that under the condition of zero risk.

Acknowledgements

The Paper is supported by Fujian Social Science Fund Project: Research on Risk Ripple Effect and Crisis Management of Internet Corporate Reporting Based on SAR Framework (FJ2017C015).

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