Neurofinance: The Influence of Neurofeedback Training on Investors' Behaviour

Masterarbeit

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Table of Content

1. Introduction

1.1 Motivation and Relevance

It is common knowledge that investors are not always behaving in a rational manner. If they can choose between different investment alternatives, e.g. different mutual funds, they tend to chase for those funds that had the highest returns in the past period without having a guarantee for future returns (Sirri, Tufano 1998). Another example for irrational investment behaviour is stock picking, where investors put their money only in a few stocks that they expect to increase in value instead of investing in a diversified portfolio.

But why are investors behaving irrational? Of course investors are influenced by their emotions and do not fully rely on facts and numbers (Lucey, Dowling 2005). There are a lot of scientific models and approaches that try to explain the investment process and decision making such as Markowitz Portfolio Theory (Markowitz 1952). But even though those approaches include, that different investors might have different risk preferences they still act on the assumption that the investors behave rational. In reality we can see that this is not the case, if we look at e.g. panic selling or the fact that bad performing funds are often held too long and that high performers are sold too early.

That´s why economists came along with the theory of behavioural finance. The goal is to explain how investors behave in reality and also how they interact under risk, which was e.g. examined by Kahneman, Tversky (1979). What behavioural finance cannot explain is the question of what drives the investors in their decision making and why they act and decide in a certain way. To answer this question scientists explored a new field of research, namely neurofinance. The aim is to analyse the activities and operations that take place in the brain when investors make investment decisions. As this tends to be a new field in science not much of research has been done in the past. But the field of neurofinance bears a lot of potential for scientists, and the number of studies in this field is increasing. Thaler (2000) wrote a paper to explore future directions for economic research and concluded that the role of emotions in the decision making process will become much more important. Accordingly, in November 2016 the first neurofinance conference of the DVFA and Brain & Business took place in Frankfurt where experts from different disciplines presented their work. Other big parts of the conference were the topics artificial intelligence and big data as they also bear the potential of overriding emotions from the decision process. Most of the studies are analysing similar things. This is basically the question if neurofinance can explain why decision making in reality differs from traditional financial theory (Simon 1956) and if emotions and feelings are influencing the investment behaviour (Lucey, Dowling 2005).

1. Introduction

Given that there are already researches working on the field of neurofinance, that are strongly focussing on the brain and neuroscientifical aspects, I want to take the given information and draw nearer with a more practical approach. If one knows, that the brain is not only driven by a rational site but also from an emotional site (Morse 2006, p. 44), I want to find out if it is possible to "train" the brain, such that investors are able to oppress the influence of emotions and decide in a more rational way.

1.2 Objective and Scope of Study

The research question for my master thesis is therefore:

Can neurofeedback training influence financial decision making?

Of course this has to be explained in more detail. The problem was already explained before, namely that investors behaviour in real life differs from the behaviour expected by the traditional finance approaches. This is because of emotions and environmental factors, as stated by the theory of neurofinance. We can find evidence for the influence of emotions in our daily life, more precisely in the purchasing patterns for our insurance. Johnson et al. (1983) showed in their paper that people are tending to insure against events that are emotionally more exhausting even if those events are less probable. The question is then, if it is possible to train the brain in a way, that investors are trusting in facts and not feelings.

The training aspect is possible using a technique called neurofeedback training. This is a computer supported training, where sensors on the scalp of the participants are used to measure brain activity. This activity is analysed using a specific software and is graphically presented to the participant in real time. The participant can then learn to increase or decrease certain kinds of brain waves which have different characteristics. Of course we have a certain way we want the brain to act, which can be different to the way it actually does. This is presented to the participant on a screen, so he is getting a feedback on his brain activity and tries to learn to control it. The exact way neurofeedback works and some necessary insights about the brain are given in the third chapter of this study.

The application field for neurofeedback is diversified. Essentially it is used for a therapeutic use, e.g. to treat attention-deficit hyperactivity disorder (ADHD), migraine, depression and patients with other sources of pain. But it is also used to enable participants to be better concentrated and more focussed which is called peak performance training (Norris, Currieri 1999). Of course the technique is also popular for competitive athletes (Arns et al. 2008; Maxeiner 2010), as they try to maximize their performance in every possible way.

1. Introduction

1.3 Research Design

Now I want to shortly explain the design of this paper. It is basically divided into three major parts, namely "Neurofinance", "Neurofeedback Training" and "Statistical Analysis". The second chapter gives all information that is needed to understand the topic neurofinance. I introduce the basic idea of neurofinance and explain the influence of emotions on financial decision making. After explaining two different relevant models from literature, I define the scopes of traditional finance, behavioural finance and neurofinance. Additionally I give a literature review over relevant studies and fields of application.

The third chapter gives information about the second important part of this work, namely neurofeedback training. After introducing the topic I derive the origin of neurofeedback. In the following I go into detail in terms of the technical application and the procedure of neurofeedback. The next step is the explanation of different types of neurofeedback training which are varying over different disciplines. At the end of the chapter I give a literature review about already existing neurofeedback papers, which are mostly case studies. This has to do with the strong relevance to application in practice.

The fourth chapter can be seen as the main part of this work as it includes a financial decision making survey and the statistical analysis of the results. At first I explain the motivation and the exact procedure of my analysis, including an explanation of which participants took part in the study and also how I included neurofeedback. I used a survey to get information about the financial decision making behaviour of 198 participants. I first used a factor analysis and after that a cluster analysis to examine the obtained data. After additionally applying linear regressions to get information about causal relationships I analyse if the applied neurofeedback has an influence on financial decision making.

6. Conclusion and Outlook

Finally I want to conclude the results of this paper and give a short review of the topics that were covered. It can be said, that rational decision making is an extensive discussed topic of financial theory. Over the years there was a need to implement new factors to really understand what really causes the final financial decisions. While traditional finance gives us a hint about the economically best decision under consideration of the individual risk preferences, behavioural finance explains how an investor decides in a certain situation. What both approaches are not considering is the influence of emotions on financial decision making and why they behave in a given way. Thus, I would not recommend to see neurofinance as a completely new field of science but as a substitution to the already existing concepts.

To pick up the issue of emotions influencing decision making I developed a methodology to test the hypothesis that the therapeutic application of neurofeedback can influence the decision making behaviour and attitude towards financial decisions. The starting point was to understand what the driving factors of decision making are. Hence, I decided to develop a survey questionnaire including 19 different questions, which are all fitting to the topic but refer to different aspects of decision making. All in all 198 participants were part of the study. Exactly 15 of those participants received neurofeedback training due to a medically confirmed depression prior to the fill in of the survey. After collecting the answers for the questions, I decided to start the analysis of the results using a factor analysis with a promax rotation. This analysis resulted in five factors that I interpreted with regards to the content. Afterwards I used the factor scores of the individuals for the five different factors and executed a cluster analysis. The goal of this procedure was to understand which factors are influencing financial decision making and also to be able to assign the participants into different investor categories on basis of the factor information. In the following I added the socio-demographic information and also the proposition which participant received was part of the neurofeedback treatment group.

The subsequently generated contingency table included all this information substituted with the percentages. Chi-squared tests and the Fisher exact test were used to test the hypothesis that the distributions of the clusters are independent of socio-demographic variables and the neurofeedback. Thy hypothesis was rejected for all variables (including neurofeedback) such that the distribution to the clusters is not independent of the variables. For neurofeedback in particular there is a significant difference in the distributions of healthy participants and the depression participants that received a treatment. The distribution of the treatment-group bears no clear result. On the one hand seven of the participants were distributed to the cluster of unconcerned spenders which suggests that neurofeedback did not change the financial behavioural patterns that are triggered by the depression. On the other hand there were also seven participants in the anxious savers cluster. The explanation for this contradiction is the

neurofeedback training that lead to a switch in financial decision making and especially the attitude towards risk. Additionally, I calculated regressions to see how much of the variance in the different factors is described by the socioeconomic variables and neurofeedback. Even though the regression beard poor results of significance, I looked at the algebraic signs of the estimates. The signs were underlining the hypothetical influence of neurofeedback in the assumed way, such that the risk loving behaviour, unconcerned spending, intuitiveness and anxiety were reduced (negative signs) while saving money for the future was increased (positive sign).

Interpreting the results gives a hint that neurofeedback can have an influence on financial decision making, but there is additional work to show this relationship with a statistical significance. I see this study as a step in the right way, namely pushing the finance research into the direction of neuronal processes. Further research is needed in this field in general, but additionally there is a need for research in the direction of behavioural control. Another aspect that is interesting for research, is the influence of emotions on stock and equity prices. The questions is if arbitrage due to emotions are already priced or if there is a mispricing because of arbitrage.