

# NEURO-FINANCE: AN EMERGING CONCEPT IN FINANCE

## Abstract

The advance finance we study today is the result of contribution by many intellectual researchers. Markowitz with his theory of portfolio selection (efficient frontier) in the year 1952 took the study of finance to next level. Many theories like Capital Asset pricing model, efficient market theory, arbitrage theory etc. thereafter evolved in the year 1960-1970 trying to plug in the holes left by Markowitz. All most all the theories assumed the individuals to be rational and how the decision is made by them on the two parameters of risk and return. But in real situation individuals deviated from deciding on the optimum portfolio, this gave birth to the study of behavioural finance in the year 1980. Even though behavioural finance tried to explain how individuals acted and interacted while making financial decisions under uncertainties, it failed to explain why the individuals take such decisions. The vacuum in behavioural finance has been filled by the study of neuro-finance. Neuro finance is the study of brain's role in making the financial decision by any individual. Neuro finance is the study contributed from neuroscience. It helps in explaining why the different investors take different financial decisions. With the advent of new technologies like fMRI, EEG, PET etc. imaging of the brain has been possible. This type of research in the neuroscience has taken the study of finance to the next level questioning many of the traditional theories in finance. The study of neuro-finance is still in the nascent stage started since 2005 but the empirical findings and its impact in the area cannot be ignored. It is very much evident that in the near future many of the traditional theories may change or may even become invalid. It is therefore very much important for the students to be abreast of with this new field of study.

**Keywords:** Neuro-finance; Behavioural finance; Modern portfolio theory; CAPM; Markowitz

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## I. INTRODUCTION

The study of finance is the outcome of researches by many academicians, research scholars and professionals. The traditional concept of just profit maximisation shifted to wealth maximisation leading to more complicated research on market anomalies. Many great scholars worked on different theories starting from the theory of profit selection (efficient frontier) by Markowitz in 1952, Capital Asset pricing model, efficient market theory, arbitrage theory etc. in 1960-1970. Most of these theories were unable to explain important market anomalies due to which behavioural finance came into existence in the year 1980. Behavioural finance focused more on the psychology of individuals in order to try to understand some of the unexplained market anomalies like what makes the market (financial market) to move. Development in the field of Neuroscience (Study of how the brain works) helped to know how the different parts of brain functions in decision making by the individuals. Kuhnen and Knutson made a very special contribution in their paper in the year 2005 that different financial decisions are the impact of distinct neural circuits in the brain. From then on many researchers like, Tseng (2006), De Martino et al (2006), Peterson (2007), Knutson and Bossaerts (2007), Tom et al (2007), Goetz and James (2008), Knutson et al (2008), Preuschoff et al (2008), Kuhnen and Chiao (2009), Peter Bossberts (2009), Kuhnen and Knutson (2011), Stenstrom and Saad (2011), Wu et al (2011), Shalini Kalra (2012), Kenway Louie, Mel W Khaw and Paul W Glimcher (2013), MostafaSadenghnia, Abdolhanidhooshmand, Habibniko (2013), Dr Priya Jinda and Shilpa Bahl (2016) contributed in the field of neuro-finance. Neuro finance is the field very new contributed from neuroscience. It helps in explaining why the different investors take different financial decisions. With the advent of new technologies like fMRI, EEG, PET etc. imaging of the brain has been possible.

The main objective in writing this article is;

- To understand the importance of the study of neuro-finance
- To compare neuro- finance with Standard and Behavioural finance
- To find out whether the post graduate management and commerce students are abreast of with the topic of neuro-finance in Sikkim.

## II. EVOLUTION OF THE STUDY, “NEURO FINANCE”

Camelia Kuhnen is the pioneer in this very new field of study. Her working with Andrew Lo (MIT Professor), who was doing research on the then new field of Behavioural finance gave her insights on how the study of the brain can be related to finance. Neuro finance is the body of knowledge contributed from many other areas like-Science, psychology, economics and sociology in understanding human behaviour relating to financial decisions. Camelia Kuhnen while doing PhD from Stanford met Brian Knutson (Neuroscientist) only after which it was possible for her in giving final shape to the very new field of neuro-finance. Referring to different literatures of neuroscience, the human brain consists of forebrain, Mid-brain and Hind-brain. Each part of this brain has its own important functions, especially in decision making. Financial decisions taken by the individuals is related with the fore brain. Jinda & Bahl (2016), the other name for forebrain is cerebrums. Forebrain or cerebrums has limbic and cortex systems which is responsible for thinking and action by any individual. Some of the most important parts of the brain are being studied in

neurofinance in order to track the pattern of emotions when making financial decisions by the individuals. The findings of neuroscience relating to the human behaviours in decision makings have been borrowed by the study of neurofinance.

### **III. EMPIRICAL FINDINGS AND BELIEFS IN “NEURO-FINANCE”**

The early works in finance by Kuhnen was evident that the areas in the brain which use the chemicals like dopamine and serotonin was responsible for the risk-taking capacity by any individuals. It was also found that the individual’s brain with high dopamine gene took more risk and with high serotonin gene, the individuals were more risk averse. Investors usually start selling in the falling market which is usually due to the amygdala (oxford dictionary meaning almond shape mass of grey matter deep inside each hemisphere of the brain, associated with the sense of smell). Prefrontal cortex helps in memorising, analysing and finally taking decisions with the help of stored data in the brain. Whenever investors make cognitive errors this is due to the insufficient data in the prefrontal cortex. The belief in patterns like share price patterns, sales trends etc. are due to the presence of nucleus Accumbens (cluster of neurones placed behind the ears of human beings) and Anterior Cingulate (anterior portion of cingulated cortex).

### **IV. LITERATURE REVIEW**

1. Jinda & Bahl, (2016), according to the researchers, the study of neurophysiology in the form of neuroeconomics is not an end with the limited study but is the impending field in modern finance.
2. Shariff, A1-Khasawneh, &Elsharif, after conducting surveys in the universities of Gulf Cooperation Council Countries they found that none of the students was familiar with the topic of neuro-finance.
3. MostafaSadeghnia, Abdolhamidhooshmand, &Habibniko,(2013), according to the researchers, Behavioural finance research shows that the investors do not have the ability to make choice between risk and return but will commit many behavioural biases in selecting optimum portfolio as opposite to what was intended by the modern finance.
4. Camerer, Loewenstein, &Prelec, (2005), the main theme in their paper was that radical models should accept the fact that brain mechanisms combine controlled and automatic processes by using perception and affect.
5. Tobler, et al., (2009), The empirical findings of the paper was that prefrontal cortex is responsible for both the aggregate risk and value signal linked to basic assumptions underlying the mean-variance utility approach.
6. (Bossaerts, 2009), According to the study emotions and mathematical computations required for reasoned choice go hand in hand even though it may not always be balanced appropriately. Neuroscience can provide a number of effective tools in the future for improved financial decision making.
7. Sahi, (2012), Neurofinance is emerging as an alternate field of study and practice which tries to relate the brain processes to the investment behaviour.

8. Tseng, (2006), The study found a long strip of positive and significant autocorrelations and great volatility for S&P 500, DJIA, and NASDAQ indexes which questioned the validity of an efficient market hypothesis. Study of Neurofinance and Adaptive market hypothesis appears to be promising in the near future.

## **V. COMPARING NEUROFINANCE WITH STANDARD AND BEHAVIOURAL FINANCE**

The year 1952 can be termed as the starting of a new era in finance when Harry Markowitz's paper "Portfolio Selection" was published in the Journal of Finance. Markowitz for the first time talked about risk and return in his paper. He valued risk in terms of variance and return on investment with the expected value or probability-weighted mean value of its possible outcomes. For the first time, the risk was quantified in finance by the use of the famous formula, a variance of a sum of random variables which suggested individual investor to focus on a group of share rather than the individual share for analysis before making any investment decisions. Markowitz for the first time suggested how the investors should make investment decisions to yield maximum returns. But his theory was good only in the paper when most of the individual investors could not benefit from the formula due to uncertain market volatility. Markowitz was not able to explain what made the market to move or in other words, his theory was so ideal to fit in the real world. Willian Sharpe tried to plug in the holes left by Markowitz with his famous model "Capital Asset Pricing Model" where he uses the following factors like Risk-free rate of return, Return from market portfolio, Risk Premium and the systematic risk famously known as the beta to help investors select the optimum portfolio yielding highest returns. Sharpe's biggest drawback was the same assumption as that of Markowitz in which every investor selects portfolio according to mean-variance analysis. Sharpe further added in his theory of CAPM that all the investors share the same expectation towards variance, covariance and returns. Sharpe's Capital Asset Pricing Model is much debatable where tonnes of empirical researches have been conducted to prove or disprove the theory. Still, the CAPM is not able to explain the market anomalies like the market uncertainties and volatility fully. CAPM revolves around the world of rational investors where in the real world most of the investors are irrational or even the so-called rational investors' make cognitive errors. Eugene Fama came out with Efficient Market Hypothesis where he tried to explain how the market moves with the publicly, privately available data. According to Fama, no rules can help investors earn above normal returns using the already available and published data. The theory is still debatable as there are many investors in the real world earning above-normal returns in the market. Miller and Modigliani in their paper explained how the individual can earn above normal returns using the arbitrage theory. But the main drawback of "MM" theory was its assumptions in finding the two firms with identical earning. Most of the above mentioned theories can be termed as the traditional theories in finance. The traditional financial theories are not able to explain the uncertainties in the market. Most of the above-mentioned theories try to explain what the irrational investors should do to become rational investors. All the theories base on the assumption of rational investors, perfect market, tax less economy, etc. which in itself is not practical. All most all the theories had its own kind of drawbacks due to which the new field of behavioural finance evolved. This field of study started studying the psychology of the investors rather than blankly assuming them to be rational. The behavioural finance studied the pattern of different investor's behaviours. Why do individual investors trade? How do they deal? How do they choose their portfolios? Why stock efficiency change due to reasons but the risk? Traditional finance has a limited role in answering above questions while behavioural finance

can find appropriate answers to questions (MostafaSadeghnia, Abdolhamidhooshmand, & Habibniko, 2013). The behavioural finance is not trying to disprove rational behaviour, but it is trying to demonstrate the use of psychological decision-making process in the prediction of financial markets (Olsen, 1998: 40). The study on behavioural finance was first steered by Slovic (1969, 1972), Tversky and Kahneman (1974) even though the behavioural research was already conducted in the field of accounting by Dyckman (1964). Heuristic researches have been conducted in the field of behavioural finance most of which hovers around feelings and emotions which are linked as the main reason for investor's irrational behaviours.

Behavioural finance is the amalgam of study with psychology which tries to study the irrational behaviours of the investors. The major drawback of the study of behavioural finance is that it is not being able to quantify emotions and feelings nor is it able to find the source of such emotions and feelings. To overcome the drawbacks of the study a very new field of study, neuro finance has evolved borrowed from the field of neuroscience. This has been possible due to the advent of latest technologies like Positron Emission Topography (PET), Electroencephalogram (EEG), Functional Magnetic Resonance Imaging (fMRI) by which imaging of the different parts of the human brain has been possible during the financial decision-making process. It has even been found that the medication will help change the risk-return perception of the investors. The emerging field of study in neuro-finance is trying to study human brain which is the main source for all factors that finally leads all the individuals to take financial decisions. Traditional and behavioural financial theorist too knew that emotions affect the financial decisions but were not able to quantify it, but added with the study of neuro finance it is now possible to measure emotions and feelings which are dependent on the specific regions of the human brain. It is possible to forecast the expected decisions of the investors by imaging the human brain.

## **VI. IMPORTANCE OF THE STUDY OF NEUROFINANCE**

Traditional financial theorists tried to explain different techniques, methods on how one can form optimal portfolios or how the market moves. The Journey had started from modern portfolio theories to Arbitrage theories and different other valuable researches are still on its way. Neurofinance is one of the areas in which intense research are already going on since 2005. Standard financial theories had always focused on, how the market moves? Creating vacuum on the questions like, why the market moves? What makes the particular investors to take risk and to avoid risk? Neurofinance is successfully solving the riddles on such questions by imaging the different parts of the human brain using sophisticated technologies like fMRI, PET and EEG. The field of neuro-finance is the study taken from different areas like neuroscience, Economics, Psychology, and Sociology etc. to understand the biasness of human behaviours towards investing which was thought impossible few years back by many finance theorists. It has now become evident to some extent that the movement in the stock market is related with the brain of each individuals. It is the fact which cannot be denied as it has been already proved in the sample studies taken by most of the researchers involved in it. The impact of human brain cannot be just limited in the volatility of stock market but to most of the human behaviours which directly or indirectly impact the decisions made by them. In finance the study of neuroscience has mostly contributed in understanding the human behaviours when taking the financial decisions. In future the pattern can be recognized and the proper framework can be developed in order to understand the market anomalies. The similar framework can be developed on the risk perception of not only of the

investors but also of the finance managers who is responsible in making strategies which will directly or indirectly impact the market value of the firm.

The importance of the study of neuro finance will be clear by looking into the following differences-

**Table 1: Difference between Standard finance, Behavioural Finance and Neurofinance**

<b>Standard Finance</b>	<b>Behavioural Finance</b>	<b>Neuro Finance</b>
Standard Finance believes in existence of Rational Markets and Rational investors	Behavioural Finance believe in existence of irrational markets and irrational Investors	Neurofinance studies the investment behaviour of people who were emotional were not rational.
Standard finance helps in building a rational portfolio	Behavioural finance helps in building an optimal portfolio	Neuro finance helps in building an optimal portfolio.
Standard Finance theories rest on the assumptions that oversimplify the real market conditions	Explanations of behavioural finance are in light with the real problems associated with human psychology	Neurofinance applies neuro technology to recognize the behaviours of the financial market investors.
Standard Finance explains how investor “should” behave	Behavioural Finance explains how “does” investor behave	Neuro finance explains “how and why” the investor behaviour occurs.
Standard Finance assumptions believe in idealized financial behaviour	Behavioural finance assumptions believe in observed financial behaviour	Neurofinance helps to Understand the internal procedures that lead to the thinking that visible as an external action.

*Table 1 Source: (Jinda & Bahl, 2016)*

From the above table it is very clear that the study of neurofinance is based on more practical aspects as compared to that of Standard and behavioural financial theories. Standard theory believes in the rationality of investors and markets, which is not practical. If all the investors are rational then no investors will lose money in the market. If no investors will lose money in the market then the market will move in the straight line which means there will be neither gain nor loss in the market. The volatility in the market is due to the multiple decisions by the investors which includes both rational and irrational choices. Behavioural finance believes in the irrational behaviours of the investors which is extreme believe in itself. There are many investors in the market who have already disproved this theory. Now the question is what is wrong and what is right? This anomaly is solved by the study of neurofinance with the help of latest technologies. In the world of uncertainties building a rational portfolio is not very practical which the standard financial theories believe in. Optimal portfolio is always an exceptional case in the uncertain market wave which both the

behavioural finance and neurofinance tries to build up. Standard finance theories and Behavioural finance theories believe in extreme two ends, rational or irrational investors and markets where as neurofinance tries to study the human behaviour related to investments with the help of latest technologies. Most of the theories in standard finance explain how investors should behave in a particular market conditions. This theories has most of the times being good only in books the lay man has always faced difficulties in understanding the concept to apply in the practical basis. This has most of the times created confusion among both the academicians, theorists and researchers. Most of the empirical findings both supported market is efficient and not efficient at the same time. Dividend distribution sometimes have helped in increasing the market value of the firm and sometimes not. Leverage too do not have the same kind of impact in the market value of the firm. The contrasting findings of many of the theories in standard finance have most of the times created confusion not only in the minds of academicians, researchers and theorists but also in the minds of students, investors and managers. There is always a question of, what is making the market to move? Many standard theorists tried to solve the riddle, but the major deficiency being their assumptions itself could never suffice the needs in the practical sense. Behavioural finance to some extent has been successful in solving the riddle. Behavioural finance too has started with same drawbacks like that of standard finance assuming that the investors are irrational and the markets too are. Directly assuming the investors to be rational or irrational is not a rational approach without proper base. Neurofinance is the extended version of both the standard finance and behavioural finance trying to solve the riddle of the market. The plus point of neurofinance as a theory is it does not start by assumptions like, the investors are rational or irrational. It takes the help of neuro science which is based on the empirical findings with the help of latest technologies. Neurofinance also borrows theories from economics and phycology to analyse the findings.

There was always vacuum in the theories of finance related to whether the investors are rational or irrational. This vacuum has been filled with the use of latest brain imaging technologies like fMRI, PET, EEG scanning machines. Neurofinance does not assumes that the investors are rational or irrational, it tries to find out, what is making the particular individual to make decisions related to different financial choices? What is the reason behind the rational and irrational investors in the market?

## **VII. FINDINGS**

After reviewing numerous articles and conducting comparative analysis among various theories developed by different research scholars and academicians it is found that the future development in the study of market anomalies is related to human brains. The study of human brains that trade and invest in the market will give accurate reasons as to why the market anomalies exist. Different theories have been developed to help investors develop an optimum and efficient portfolios but still many traders and investors are not able to create good returns irrespective of the knowledge and experience they have. Traders and Investors react differently and may not stick with the trading and investment systems they have developed, this irrational behaviour can now be explained by the help of neurofinance in a more scientific way.

The third objective of this paper is to see whether the postgraduate students of Management and Commerce students in Sikkim are aware of the topic “Neuro-Finance”. Since the objective was just to check the awareness among the post graduate management

and commerce students regarding neurofinance, a simple questionnaire was prepared. The questionnaire was divided into two sections. In the first section simple questions relating to personal information was included. In the second section question related to whether the students are aware of the topic neurofinance in yes or no was included. The counter question was provided like, if they are aware of the concept please do explain Neurofinance in few words. This counter question helped in getting the correct figure of students who were really aware of the concept or not. In Sikkim there are very few management colleges and Universities providing MBA and M.Com programs. I took the sample of 80 students from three private universities and one central university which is currently providing M.com and MBA degrees in the region. I also have personally visited all the private and government universities in Sikkim to discuss about the concept of Neurofinance among the students pursuing MBA and M.Com. After completing the survey and discussion it was found that none of the students are aware of the concept of neurofinance. After the students were briefed about the concept of Neuro-Finance, it was found that all most all of the management and commerce students are interested in studying Neurofinance as part of their curriculum if introduced. The findings of the study really make us think how updated our students are when we compare it with other countries especially developed nations. Our students are still studying the same old theories which still believe that all the investors are rational, market is perfect, tax less economy etc. which in itself is not real and cannot fit in the practical situation. It is of high time to revise the curriculum rationally especially in finance when so much have already being progressed in the study of neurofinance.

## **VIII. PRACTICAL IMPLICATIONS OF NEUROFINANCE**

Referring to the different studies of Neuro science, it has been found that the prefrontal cortex gets activated when the function is performed by the individual for the first time. In other words the prefrontal cortex signifies whether the individuals are amateurs or experts in the particular fields. This study can be used to recruit any finance professionals and can also be implemented to the investors. This type of study can also be used by the investors to see whether they have upgraded with the trading skills or not. By doing this they can increase the amount of funds they want to invest and at the same time this will help in reducing the risk of the investors. By scanning the brain the investors can know whether they are skilled or unskilled in trading. The risk taking capacity of the finance professional and investors can also be checked by scanning the brain to see the level of dopamine and serotonin. If there is excess level of dopamine certain investment proposals can be reviewed. The decision of any finance professional or investors can be backed by scientific evidence in order to control the biasness. Now with the help of the study of neuro finance individuals can know whether they are taking rational or irrational decisions by scanning their own brains.

## **IX. CONCLUSION**

Every field of study has evolved from the new researches and findings by the researchers, Finance is no different. It has evolved over a period of time to the knowledge of infinity. The time has come to once again review the theories in finance and check its validity with time. The paradigm shift in the study of finance has already taken its momentum after the discovery of the new concept “Neuro-finance”. It is also time to look upon our syllabus, whether it is up to date or not. Neurofinance has already being implemented in the syllabus in other developed nations. The irony is still our students are not abreast of the concept even though the research had started since 2005. This survey which I have conducted represents



the few universities in Sikkim, it can be extended to other states of India. The implementation of this type of advance study in the university will help students to be abreast of with the more advance ideas and helps them to achieve global standards. The study of Neuro-finance will help not only the finance students but professionals too. Even though the study is in nascent stage one cannot deny its importance in the future implications. This concept has helped the finance analysts to achieve the empirical result borrowing the concept from Neuro-Science.

There has always been two groups in the world of finance, one being the theorists and the other being the investors in the real world. Even though both party has different approach, they have one objective in common, how the return can be improved by reducing the risk. Many approaches has been introduced by the theorists which the investors has been using it in the real world. Some of the theories worked but many of the theories and concepts no longer worked after some time period. The main reason was the unpractical assumptions framed by the theorists. Almost all the theories hovered around the assumption of rational or irrational investor's behaviour. Till today it was not known that the brain could be imaged and can be known about the rationality of the investors. The study of neuro-science combined with the study of finance has helped to understand the biased behaviour of the investors. The study of neuro-finance will play a very vital role in understanding the behaviour of investor before investing. This study is still progressing but its importance in future cannot be denied. Universities can add this title as a part of the study. There may be various challenges in implementing this study but one will sooner or later move on to best alternatives. This study has various challenges to be included in the syllabus, but it can be planned accordingly to take out the odds.

## **X. CHALLENGES**

It is evident that there are few important challenges in conducting the study of neurofinance. One of the most important challenges will be the resource and infrastructure required to conduct the study. As neurofinance is the study combined with neuroscience which requires expensive equipment to conduct EEG, PET and fMRI tests on the human brain. There may also be restructuring problems in adding the new chapter in the syllabus. The students as well as the faculties may not be comfortable. As the faculties will have to go through the whole concept before delivering the lecture in the class. The students may also find the jargons and some of the terminologies borrowed from the neuroscience confusing. Most of the private Universities may have problem in arranging the required funds in establishing the lab required to conduct the experiments. At the same time government Universities may take some time in justifying, the importance of the study of neuro-finance in front of the concerned authorities in order to sanction the fund.

## **XI. SUGGESTIONS**

Irrespective of the challenges the importance of the study of new evolving concept neurofinance cannot be ignored. The universities can at first introduce case study models of neurofinance developed by the other researchers. The theoretical concepts and the findings of the study can be introduced as the first step. This type of study will not require labs and expensive equipment. The seminars and workshops can be conducted for the faculties as well as the students in order to make them aware of the study of neurofinance. This will generate interest and motivate both the faculties and the students.

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