10.16920/jeet/2026/v39is4/26127

Traditional Finance to Behavioural Finance to Neurofinance: A Journey and Its Implications for Financial Education

Dr Samuel E Chakkaravarthy[1], Kewal Roshan Ezra[2], and Dr Priyadarshini[3].
[1]Department of Management studies, T John College, Bangalore,
[2]Independent Researcher,
[3]Department of Statistics, Satyabhama Institute of Science and Technology, Chennai
[1]samuelezra@tjohngroup.com
[2]rezzisroshan@gmail.com
[3]priyaeb@gmail.com

***Abstract*—The outlook towards Finance evolved significantly over the past few decades, moving from the assumptions of traditional theories like the Efficient Market theory, Capital Asset Pricing theory to more interdisciplinary approaches that integrate psychology and more recently on neuroscience. Traditional finance is built on the foundation that investors are rational decision-makers who seek to maximize utility with complete access to information. In reality however, real-world financial behaviour often deviates from these assumptions. This gap led to the emergence of behavioural finance, which incorporates psychological insights to explain how cognitive biases, emotions, and heuristics influence financial decision-making. The evolution did not stop there. With advancements in brain-imaging technologies, neuroscience has developed into a leading area to study neural mechanisms underlying financial decisions, popularly known as Neurofinance. By examining how different regions of the brain respond to risk, reward, and uncertainty, Neurofinance provides deeper insights into investor behaviour beyond observable actions.**

This conceptual study traces the intellectual journey from traditional finance to behavioural finance and finally to Neurofinance. The paper highlights how each stage has expanded the understanding of financial decision-making. More importantly, the study explores how these insights can be incorporated into financial education. Integrating behavioural and Neurofinance concepts into academic curricula can help students develop a realistic understanding of financial markets, recognize cognitive biases, and make more informed financial decisions.

The study puts forth that incorporating interdisciplinary perspectives into finance education will not only improve financial literacy but also equip future professionals with better analytical and decision-making skills. Thus, the transition from traditional finance to Neurofinance represents not merely a theoretical evolution but also a significant opportunity for transforming financial education.

***Keywords*—Traditional Finance, Behavioural Finance, Neurofinance, Financial Decision-Making, Financial Education, Cognitive Biases, Investor Behaviour.**

I. INTRODUCTION

The principle of investment in the domain of finance has undergone a sea change over the last 100 years. The early theories were built upon the assumptions that investors are rational and were believed to take logical decisions to maximize their wealth. The Efficient Market Hypothesis (EMH) and Capital Asset Pricing Model (CAPM) models were the basis of both academic and practical perspectives.

But time and again there were repeated instances of anomalies in the financial markets like bubbles, crashes, behaviour of the markets at special days which beat all the traditional models

This deviation from rationality was the premise on which behaviour finance was built on. Behavioural finance integrated insights from psychology to explain the deviations from rationality.

More recently, Neurofinance has further deepened this understanding by examining financial decisions and deviation from rationality through the biological and neural processes.

This paper presents a. evolution from traditional finance to neuro finance, b. key theoretical contributions in each stage and c. implications for financial education

2. Traditional Finance: Foundations and Assumptions

2.1 Core Theories: Traditional finance was built on foundation models like a. Efficient Market Hypothesis (Fama, 1970), b. Capital asset pricing Models (Sharpe 1964, c. Modern Portfolio Theory (Markowitz, 1952). All the models assumed that investors are rational and are interested in maximizing their utility. Another key assumption is that the markets are always efficient and as such it reflects all available information. Finally, the decisions made by investors are always based on risk return optimization.

Risk- Return Characteristics: Based on the traditional theories it is imperative to understand the risk return payoff to

proceed further towards traditional finance theories. For any level of additional risk taken by the investor over and above the risk-free rate of return, the investor would expect a slightly more expected rate of return, i.e., the investor's expected rate of return increases along with an increase in risk.

Therefore, as per the traditional theories, risk and return are assumed to have a positive linear relationship. However, Behaviour fiancé theories posited that it need not be linear relationship. This can be due to market imperfections, behavioural factors, extreme risks etc.

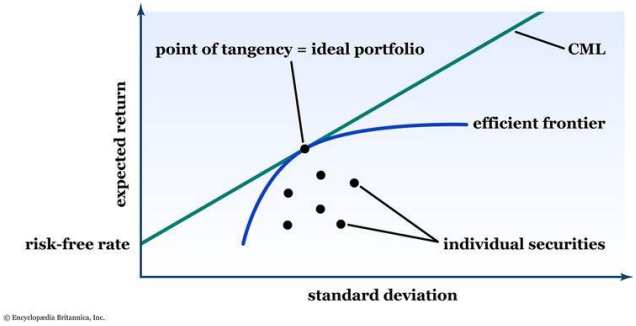
2.1.1 Modern Portfolio Theory (Markowitz, 1952): Markowitz focused on portfolio diversification by combining assets with different risk return characteristics. The foundation of this theory is that for a given level of risk how best to maximize the expected returns and for a given level of expected return how best to minimize the risk. This led to the development of the Modern portfolio theory wherein optimal portfolios (mixture of different assets) are identified as effective diversification for minimizing risk and maximizing expected return. The main idea behind the MPT is that:

Individual assets alone are not efficient—they carry unsystematic risk

By combining assets with low or negative correlation, we reduce overall portfolio risk and achieve better risk-return trade-offs

The Efficient Frontier shows that only those portfolios that cannot be improved further, any portfolio below the frontier is inefficient

Capital market line (CML) and the efficient frontier



Source: Brittanica

Portfolio variance = $\sigma_p^2 = \sum_{i=1}^{n} \sum_{j=1}^{n} w_i\, w_j\, \mathrm{Cov}(R_i, R_j)$

The main drawback of this method is that it relies on covariance terms to determine portfolio variance. As the number of assets increases, the number of covariance calculations increases significantly, making the computation complex. For a portfolio with **n assets**, the number of unique covariance terms is: $\frac{n(n-1)}{2}$.

William F. Sharpe developed the **Single Index Model** to overcome the computational complexity of the Markowitz approach.

$$\text{Total Risk} = \text{Systematic Risk} + \text{Unsystematic Risk}$$

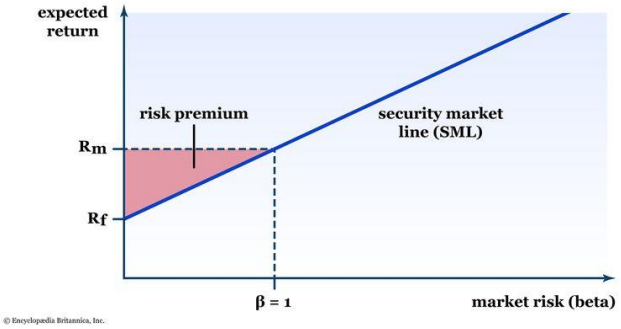
In this model, total risk is decomposed into **systematic (market) risk** and **unsystematic (security-specific) risk**. The theory assumed that market factor is common for all securities and thus it captures the co-movement of all securities, thereby reducing the need to calculate numerous covariances. Both risks are considered: **Systematic risk**, captured through market index (β) and **Unsystematic risk**, unique to each security (error term). The theory Replaced multiple **covariances** with a **single common factor (market index)** and simplified calculations easily.

2.1.2 Capital Asset Pricing Model (Sharpe, 1964): Sharpe explained the relationship between risk and expected return. Risk according to the theory consists of both systematic and unsystematic.

Systematic is that of the market risk measured by the Beta and cannot be avoided whereas unsystematic risk is specific to each security and as such can be minimized through diversification. stating that higher systematic risk (beta) leads to higher expected returns.

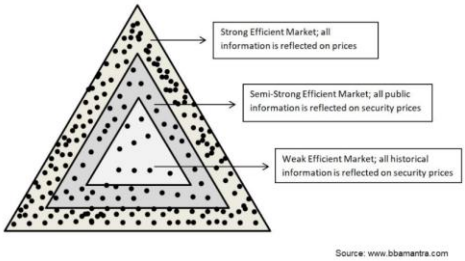
The formula for CAPM is $E(R_i) = R_f + \beta_i(R_m - R_f)$ where R_f is the **risk-free rate**, R_m is the **market return**, and β_i measures the **systematic risk (sensitivity) of the stock relative to the market**. In other words, R_f is the intercept in the equation, $(R_m - R_f)$ is the slope and β_i is the sensitivyt measure and shows how much the a particular

Capital asset pricing model (CAPM)



Source: Britannica

2.1.3E**fficient Market Hypothesis (Fama, 1970):** states that the security prices fully reflect the all available information which makes it nearly impossible to earn abnormal returns. In other words, no investor can consistently beat the market. Market efficiency as per Fama consists of three forms, a. the weak form: prices reflect the past data and volume data, hence technical analysis is ineffective, b. semi strong form: prices reflect all public information; hence Fundamental Analysis is ineffective, c. strong form: prices reflect both publicly and privately available information, hence no insider trading can be done. The main criticism is that there always exists an asymmetry in information, investors are affected by behaviour biases, markets need not be efficient always.



Source: bbamatra.com

2.2 Limitations of traditional finance and the need for alternate theories:

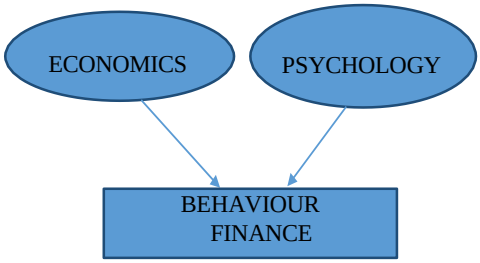
2.2.1 Empirical evidence highlights several anomalies:
Market bubbles and crashes: Prices invariable wanders from their intrinsic value. Over sentiments in a particular industry may cause the markets to be overvalued and the resultant bubble waiting to be burst. In the late 1990s, Investors heavily invested in internet-based companies and some of the firms had no profits or weak fundamentals. The stock prices rose purely on expectations and hype and around 2000 the bubble burst leading to huge amount of loss to investors. This contradicts the premise that markets are fully efficient and there exists no mispricing.

2.2.2 Overreaction and underreaction to information: Investors generally tend to Overreact to news resulting prices overshooting. Alos, they tend to adjust slowly to information, leading to underreacting. For example, Momentum effect is such that past winners continue to perform well (underreaction) and the Reversal effect leads to overvalued stocks eventually correcting (overreaction). This contradicts the random walk assumption

2.2.3Herd behaviour: By this bias, Investors tend to follow the crowd rather than rely on fundamentals. This leads to asset bubbles and sudden crashes. Classical example being panic selling during crisis and excessive buying during bull markets.

These limitations paved the way for alternative perspectives.

3. Behavioural Finance



3.1 Integrating Psychology

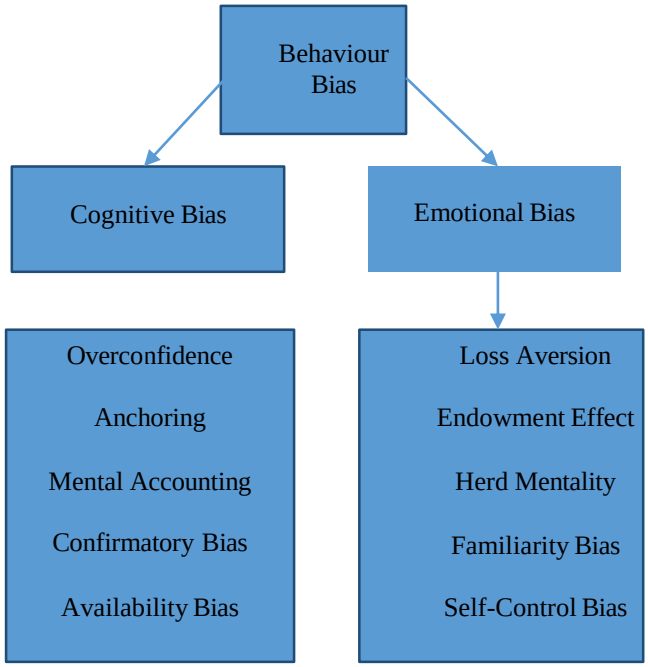
Behavioural finance emerged to explain irrational financial behaviour using psychological theories.

Behaviour finance substituted the classical theories which were based on rationality assumptions. Supporters of Behaviour finance argue that investors are irrational and as such make decisions based on the certainty of the situations and the biases which they have inculcated. Behaviour studies show that investors seldom make decisions logically and tend to mostly make decisions emotionally.

The concept of Behavioural finance is an integration of social, economics, and psychology. **Deshmukh and Joseph (2016).**

Kahneman and Tversky (1979) in their paper ―Prospect theory: An analysis of decision under risk‖ explain how the investors make decisions based on the alternatives involving risk when the probable outcomes are known. They said that investor perceives losses and gains differently. They pointed out that losses loom large than the potential gains in the minds of the investor.
The Prospect theory as such challenged the efficient market theory and paved a lot of research work to be done on the new stream of Behaviour Finance.

Pompain (2006) classified behaviour biases into two as Cognitive deviation and Emotional deviation. Both these bias result in irrational choices and judgements. Cognitive deviations are the result of faulty reason and logical errors whereas emotional deviations happen because of intuitions



3.1.1 Cognitive biases

Cognitive biases that affect decision making is based on conventional ideas that may or may not be accurate. A rule of thumb is an example where investors tend to follow in investing which may or may be appropriate for them. As such because of the cognitive bias present, individuals tend to take short cuts, become overconfident and try to oversimplify in their decision making

3.1.2 Emotional biases influence decision making based on feelings leading to irrational behaviour at that point in time. They can also be some deep-rooted personal experiences that can influence investment decision making. It is all about how one feels and how at that point one reacts. As such they are ingrained in the psyche of the investors and it very difficult to overcome them, unlike the cognitive bias. However certain emotional biases can be very useful in the decision making process.

3.2 Contributions of Behavioural Finance

Behavioural finance, influenced by scholars like Daniel Kahneman and Amos Tversky, integrates psychology with finance to better explain real-world market behaviour.

3.2.1 Provides Realistic Insights into Investor Behaviour: The main assumption in the traditional theories is that investors are rational but behavioural fiancé shows that in reality they are psychologically influenced.
Key Insights: Behavioural finance posits that investors are affected biases like cognitive biases and emotional biases. For example, Investors hold losing stocks too long (loss aversion), Investors trade excessively (overconfidence). This makes behavioural finance more realistic and practical
3.2.2. Explains Market Inefficiencies: Behavioural fiancé theories contradict Fama's theory of efficient market and goes on to explain why the markets inefficient. It explains market inefficiency through bubbles and crashes, mispricing of assets, etc., Also, Collective biases of investors lead to: Overreaction, Underreaction, Herd behaviour etc which cause deviations from the intrinsic value.

3.2.3. Bridges the Gap Between Theory and Practice: Traditional models (like CAPM and MPT) are theoretical and assumption-based, whereas behavioural finance connects them to real-world behaviour. It incorporates human psychology into financial models; Helps explain why actual outcomes differ from theoretical predictions and Improves decision-making in investment. Financial advisors in recent years are considering investor emotions and risk perception and not. The idea of risk assessment using psychometric tools is one of the key outcomes of Behavioural fiancé theories
Limitations: One of the major limitations of behavioural fiancé is lack of biological foundation in explaining the decision-making process. Also, most of the behavioural theories are descriptive in nature focusing on explaining observed behaviour rather than predicting future market outcomes

4. Neurofinance: The Neuroscientific Approach
4.1 The Neural Basis of Financial Decision-Making: Financial decision making is a complex process making choices under uncertainty. The process involves evaluating risk and rewards and it involves engaging multiple areas of the brain. A detailed study on the neural basis of financial decision making can provide insights as why certain people make choices and how these choices can be optimised or influenced.

4.2 Understanding Neuro finance

The main objective of Neuro finance is to identify the brain regions that get activated during financial decisions. This can be fear, greed, satisfaction etc. Another key objective will be to analyse how different brain functions relate to financial behaviour. Finally, it will be interesting to find how external factors like social influence impact neural activity and financial decisions

4.3 Key Brain Regions

4.3.1 Prefrontal Cortex (PFC): Miller, E. K., & Cohen, J. D. (2001) posited that the PFC is involved in executive functions, such as planning, decision-making, and impulse control. In finance, the PFC plays a critical role in evaluating risks and rewards and making rational financial decisions.

4.3.2 Amygdala: Phelps, E. A. (2006) associate the Amygdala with emotional processing, particularly fear and reward. The amygdala influences risk perception and emotional responses to financial gains or losses. De Martino, B., Camerer, C. F., & Adolphs, R. (2010). In their study brought out that the damage to Amygdala eliminates monetary loss aversion

4.3.3 Ventromedial Prefrontal Cortex (vmPFC): Levy, D. J., & Glimcher, P. W. (2012) point out the vmPFC integrates emotional and cognitive information to assess the value of different options. They also found that it is crucial for making decisions based on personal values and preferences.

4.3.4 Nucleus Accumbens: Schultz, W. (2015) point ou that Nucleus accumbens is part of the brain's reward system and it is activated by the anticipation of financial rewards and is involved in the motivation to pursue gains.

4.3.5 Insula: Kuhnen, C. M., & Knutson, B. (2005) point to the fact that the insula is linked to the perception of bodily states and emotional awareness and plays a vital role in experiencing and avoiding financial losses.

4.4 Methods of Investigation

4.4.1 Functional Magnetic Resonance Imaging (fMRI): Measures brain activity by detecting changes in blood flow, allowing researchers to see which areas of the brain are active during financial decision-making tasks. It is frequently used to localize neural activity related to subjective value representation, such as in the ventromedial prefrontal cortex (vmPFC) (Mallio et al., 2024). Researchers use fMRI to test economic theories by demonstrating how neural signals correlate with behavioural phenomena, including the "disposition effect" in financial trading (Rutkowska, 2022).

4.4.2 Electroencephalography (EEG): Records electrical activity in the brain, providing insights into the timing and neural dynamics of financial decisions. Zhu et al (2019) studied Event Related Potentials (ERP) and observed that the subjective value options can be encoded before a final choice is made

4.4.3 Transcranial Magnetic Stimulation (TMS) non-invasively stimulates specific brain regions to study their role in financial behaviour. (Sliwinska et al., 2014) posted that by observing pulses to target areas, causal relationships between neural activity and financial behaviour can be established.
Behavioural Experiments use neuroimaging techniques to correlate brain activity with specific financial decisions and behaviours. (Sharp et al., 2012) posted that reward related decision making can be mapped to specific neural corelates thus bridging the gap between theory and biological process.

5. Implications for Financial Education

5.1 Need for Curriculum Transformation

Financial education is rooted in traditional theories like Efficient Market Hypothesis and rational decision-making concepts, largely influenced by the works of Eugene F. Fama (1970) and Harry Markowitz (1952). The drawback to these models were that they overlook very often the psychological neurological understanding in financial decision making. These models provide a strong analytical foundation but they often overlook the psychological and neurological dimensions of financial decision-making.

Recent advances in behavioural finance, as highlighted by Daniel Kahneman and Amos Tversky (1979), demonstrate that individuals frequently deviate from rationality due to heuristics and biases. Furthermore, neurofinance research, including studies by Brian Knutson (2005), shows that brain regions associated with reward anticipation and fear significantly influence financial choices. Therefore, there is a pressing need to transform finance curricula by integrating behavioural insights, real-world decision-making contexts, and neuroscientific understanding. Such a shift would enable learners to bridge the gap between theoretical constructs and actual investor behaviour, fostering a more holistic and realistic comprehension of financial markets.

5.2 Integration of neuroscience into financial education

Multiple pedagogical and practical benefits can be achieved by integrating neuroscience into financial education. (Lusardi & Mitchell, 2014) in their study stressed the importance of integrating Neuro financial studies suggesting that they can enhance financial literacy by understanding both the cognitive process and financial concepts. (Knutson et al., 2005) posited that incorporating neurocognitive understanding improves risk assessment skills. This is because individuals become more aware of how emotions such as fear and overconfidence affect their perception of risk . Awareness of cognitive biases like loss aversion, anchoring, overconfidence will help learners to identify and mitigate errors.

Emotional regulation and self-awareness important traits which are needed in volatile financial environments is enhanced with the inclusion of Neurofinance perspectives in financial education

(Lo & Repin, 2002) in their paper posted that empirical studies point to the fact that individuals trained in behavioural and neurofinance concepts show more consistent, rational investment behaviour compared to those trained solely in traditional finance

5.3 Suggested Curriculum Additions

- Precise curriculum additions are needed to integrate Neuro finance with traditional financial theories. The curriculum should introduce Behavioural finance modules to students on key concepts like Cognitive and Emotional biases. Suggested case studies in the curriculum should focus on practical insights into deviation from market efficiency as detailed in the Efficient market hypothesis. For example, analyses of historical events like the Dot-com bubble, the 2008 financial crisis can illustrate the role of investor psychology in market dynamics.
- Simulations and Experiential learning tools can be used to imitate real-world financial decision-making environments, allowing students to observe their behavioural responses uncertainty.
- Students understanding can be even more enhanced by introducing them to concepts like brain imaging studies and how biological process affect financial behaviour.

This type of multidisciplinary approach to financial education can align it to the growing field of neuroeconomics, which integrates insights from neuroscience, psychology, and economics (Camerer et al., 2005).

5.4 **Pedagogical Approaches**

In order to for this integrated curriculum to be effective, there needs to be a paradigm shift in Pedagogical approaches for the curriculum to be effective. The Pedagogy should be engaging and experiential shifting away from passive and lecture bases teaching.

Andrew Lo (2004) emphasizes that financial behaviour evolves with experience and environmental conditions. Educational research by David A. Kolb (1984) emphasizes that knowledge is best constructed through experience and reflection, while Jean Piaget highlights the importance of active involvement in cognitive development.

Interactive learning approaches like group discussions, role-playing exercises, and behavioural experiments allow students to actively participate in the learning process. thereby improving both engagement and long-term retention. These methods can help learners adopt complex concepts like risk perception and decision biases by experiencing them firsthand rather than merely studying them theoretically.

Another interesting approach in the curriculum could be the introduction of data-based analysis which can close the gap between theory and practice. Scholars such as Andrew Lo (2004) argue that financial decision-making evolves through interaction with dynamic market environments, reinforcing the need for students to engage directly with data rather than rely solely on static models.

Through this, students can work with actual data sets, understand behavioural metrics and develop critical analytical skill. This also will bring together evidence-based learning in finance where empirical proof is central to understand market behaviour.

Finally, the integration of technology significantly enhances the effectiveness of financial education by creating immersive and realistic learning environments. Simulation software, virtual trading platforms, and neuro-feedback mechanisms enable students to experience market volatility, and decision-making under uncertainty in a controlled setting. Research in neuroeconomics, including studies by Colin Camerer et al. (2005), demonstrates that experiential and technology-enabled learning can better capture the cognitive and emotional processes underlying financial behaviour.

6.Conclusion

Core Idea

- Traditional finance → assumes rational decision-making
- Behavioural finance → explains psychological biases

- Neurofinance → goes one step deeper and studies what happens inside the brain

The evolution of finance from traditional theories to behavioural and Neurofinance reflects the increasing complexity of understanding financial decision-making.
Traditional finance fails to capture real-world behaviour. Behavioural finance addresses this gap by incorporating psychological insights,
Neurofinance further advances the field by exploring neural mechanisms.
This study concludes that integrating interdisciplinary perspectives into financial education is essential. For this, an integrated curriculum should be incorporated, both theoretical as well as practical concepts needs to be designed. Also, there should also be an entire rework in the pedagogy outlook. Financial education needs to be a combination of theoretical and practical exposure. Simulation software coupled with real life data sets can be used to so that the student gets a real life experience of practical exposure. Thus, the shift should be from theorical learning to experiential learning. Such integration will enhance financial literacy, improve decision-making capabilities, and better prepare future professionals for dynamic financial environments.

References:

Camerer, C. F., Loewenstein, G., & Prelec, D. (2005). Neuroeconomics: How neuroscience can inform economics. Journal of Economic Literature, 43(1), 9–64. https://doi.org/10.1257/0022051053737843

Fama, E. F. (1970). Efficient capital markets: A review of theory and empirical work. Journal of Finance, 25(2), 383–417. https://doi.org/10.2307/2325486

Kahneman, D., & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. Econometrica, 47(2), 263–291. https://doi.org/10.2307/1914185

Lo, A. W. (2005). Reconciling efficient markets with behavioral finance: The adaptive markets hypothesis. Journal of Investment Consulting, 7(2), 21–44.

Mallio, C. A., Buoso, A., Stiffi, M., Cea, L., Vertulli, D., Bernetti, C., Di Gennaro, G., van den Heuvel, M. P., & Beomonte Zobel, B. (2024). Mapping the neural basis of neuroeconomics with functional magnetic resonance imaging: A narrative literature review. Brain Sciences, 14(5), 511. https://doi.org/10.3390/brainsci14050511

Markowitz, H. (1952). Portfolio selection. Journal of Finance, 7(1), 77–91. https://doi.org/10.2307/2975974

Rutkowska, A. (2022). Nowoczesne metody neuroobrazowania we współczesnej neuroekonomii i neurozarządzaniu. Olsztyn Economic Journal, 17(2), 247–263. https://doi.org/10.31648/oej.8767

Sharp, C., Monterosso, J., & Montague, P. R. (2012). Neuroeconomics: A bridge for translational research. Biological Psychiatry, 72(2), 87–92. https://doi.org/10.1016/j.biopsych.2012.02.029

Sharpe, W. F. (1964). Capital asset prices: A theory of market equilibrium under conditions of risk. Journal of Finance, 19(3), 425–442. https://doi.org/10.2307/2977928

Sliwinska, M. W., Vitello, S., & Devlin, J. T. (2014). Transcranial magnetic stimulation for investigating causal brain-behavioral relationships and their time course. Journal of Visualized Experiments, (93), e51735. https://doi.org/10.3791/51735

Thaler, R. H. (1999). Mental accounting matters. Journal of Behavioral Decision Making, 12(3), 183–206. https://doi.org/10.1002/(SICI)1099-0771(199909)12:3<183::AID-BDM318>3.0.CO;2-F

Zhu, C., Pan, J., Wang, Y., Li, J., & Wang, P. (2019). Neural dynamics underlying the evaluation process of ambiguous options during reward-related decision-making. Frontiers in Psychology, 10, 1979. https://doi.org/10.3389/fpsyg.2019.01979