



Behavioral Biases and Mathematical Modeling in Financial Decision-Making: An Empirical Analysis

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Abstract

Financial decision-making is a complex process influenced by psychological, behavioral, and quantitative factors. Traditional financial theories assume that investors behave rationally and make decisions based on logical analysis and complete market information. However, modern behavioral finance studies reveal that investor decisions are often affected by emotions, cognitive biases, and psychological tendencies. The study also evaluates the predictive effectiveness of behavioral mathematical models in comparison with traditional financial models.

The research adopts a quantitative and analytical methodology based on both primary and secondary data sources. Primary data were collected through a structured questionnaire from 400 respondents including investors, salaried employees, finance professionals, businesspersons, and students associated with financial activities. Statistical tools such as reliability analysis, regression analysis, ANOVA, correlation analysis, and paired sample t-tests were used to analyze the collected data and test the hypotheses.

The findings of the study indicate that behavioral biases significantly influence financial decision-making and investment outcomes. Psychological factors such as confidence, risk perception, emotional responses, and decision-making tendencies were found to have a strong relationship with financial performance. The results also revealed that behavioral mathematical models provide greater predictive accuracy than traditional financial models because they incorporate human behavior and psychological variables along with quantitative data. Additionally, mathematical skills and analytical abilities were positively associated with improved financial decision quality. The study concludes that financial decision-making cannot be understood solely through traditional rational models, as investor behavior is strongly affected by psychological and emotional influences. The integration of behavioral finance concepts with mathematical modeling provides a more realistic and effective framework for understanding financial markets and investor behavior. The findings may help investors, policymakers, financial analysts, and researchers develop improved investment strategies and financial models that better reflect real-world decision-making patterns.

Keywords: Behavioral, Mathematical, Psychological, Financial, Decision-making, Accuracy

Introduction

Financial decision-making is a complex process influenced by economic conditions, market information, personal experiences, psychological perceptions, and mathematical analysis. Traditional financial theories such as the Efficient Market Hypothesis (EMH) and Capital Asset Pricing Model (CAPM) assume that investors behave rationally and make decisions based on complete information and logical evaluation of risks and returns. However, real-world financial behavior often deviates from these assumptions because investors are influenced by emotions, cognitive limitations, and behavioral biases (Kahneman & Tversky, 1979) [2].

Behavioral finance emerged as an important field of study to explain irrational investor behavior and the psychological factors affecting financial decisions. It integrates concepts from psychology, economics, and finance to understand how emotions, heuristics, and biases influence investment choices and market outcomes. Behavioral biases such as overconfidence, loss aversion, anchoring, herd behavior, mental accounting, and confirmation bias significantly affect the way individuals interpret financial information and make investment decisions (Shefrin, 2000) [3]. These biases often lead to irrational judgments, excessive risk-taking, poor portfolio diversification, and market inefficiencies.

At the same time, mathematical modeling has become a fundamental tool in financial analysis and decision-making. Financial models help investors, institutions, and policymakers evaluate risks, predict market trends, optimize portfolios, and estimate returns. Traditional mathematical models rely heavily on statistical assumptions and quantitative variables; however, they frequently fail to incorporate human psychological behavior and emotional responses during uncertain market conditions. As a result, purely mathematical models sometimes provide inaccurate predictions in volatile financial markets (Fama, 1970) [4].

The integration of behavioral biases with mathematical modeling has therefore gained increasing attention in modern financial research. Behavioral mathematical models attempt to combine quantitative analysis with psychological and behavioral variables to improve predictive accuracy and better explain real-world investor behavior. These models recognize that financial decisions are not solely based on rational calculations but are also influenced by fear, confidence, perception of risk, market sentiment, and cognitive errors. By incorporating behavioral dimensions into financial modeling, researchers and analysts can develop more realistic and reliable financial forecasting systems.

In recent years, empirical studies have demonstrated that behavioral models often outperform traditional financial models in predicting investor behavior and market fluctuations, particularly during periods of financial uncertainty and market volatility. Psychological factors such as confidence levels, emotional reactions, and risk perceptions have shown strong relationships with investment performance and financial decision quality. Similarly, mathematical competence and analytical skills also influence the ability of investors to make informed and rational financial decisions. The study aims to analyze how behavioral and psychological influences interact with quantitative financial models and affect investment outcomes. It also seeks to compare the predictive effectiveness of behavioral mathematical models with traditional financial models in explaining financial decision behavior.

The significance of this study lies in its multidisciplinary approach, which combines behavioral finance, psychology, statistics, and mathematical modeling to understand financial decision-making more comprehensively. The findings of the study may help investors, financial analysts, policymakers, and researchers develop improved financial models and investment strategies that better reflect real-world market behavior and human psychology. Furthermore, the study contributes to the growing literature on behavioral finance by emphasizing the importance of integrating psychological insights with quantitative financial analysis for effective financial decision-making.

Literature Review

Baker, Kumar, and Goyal (2020) [1] examined the impact of behavioral biases on investment decisions during volatile market conditions. Their study found that psychological factors such as overconfidence, herding behavior, and loss aversion significantly influence investor decision-making and portfolio management. The researchers concluded that investors often make irrational financial choices during

uncertain economic situations, which affects market stability and investment outcomes. The study emphasized the importance of integrating behavioral variables into financial analysis models for improving decision accuracy.

Akhtar and Das (2021) [5] investigated the relationship between mathematical skills, financial literacy, and investment decision quality among retail investors. The findings revealed that individuals with stronger quantitative and analytical abilities were more likely to make rational and profitable financial decisions. However, the study also observed that psychological biases and emotional responses could still interfere with logical financial judgment. The researchers recommended combining behavioral finance concepts with mathematical modeling to achieve better financial forecasting and investment planning.

Sharma and Gupta (2022) [10] conducted an empirical study on behavioral finance and market decision-making in emerging economies. Their research showed that behavioral biases such as anchoring bias, confirmation bias, and risk perception strongly affect investment strategies and trading behavior. The study further highlighted that traditional financial models fail to fully capture investor psychology during periods of market volatility. The researchers suggested the development of behavioral mathematical models that incorporate emotional and cognitive factors for more effective financial predictions.

Lee and Chen (2023) [7] analyzed the predictive effectiveness of behavioral mathematical models compared to traditional financial models in stock market forecasting. The study found that behavioral models demonstrated greater predictive accuracy because they included psychological and emotional variables affecting investor behavior. The researchers concluded that combining statistical methods with behavioral finance concepts improves the understanding of market dynamics and financial decision-making under uncertainty. The study also emphasized the growing relevance of artificial intelligence and data analytics in behavioral financial modeling.

Patel and Verma (2025) [8] explored the interaction between psychological factors, market conditions, and financial decision-making among investors. Their study revealed that investor confidence, emotional stability, and cognitive biases significantly influence financial choices, especially during economic fluctuations. The researchers found that behavioral mathematical models provide more reliable financial predictions than conventional models because they consider both quantitative data and human behavioral patterns. The study recommended the integration of behavioral finance, psychology, and mathematical analysis for developing advanced decision-making frameworks in modern finance.

Research Methodology

The study adopts a descriptive and empirical research design to analyze the relationship between investor behavior and financial decision quality. The methodology has been structured systematically to ensure reliability, validity, and accuracy in data collection and analysis.

The study primarily relies on both primary and secondary sources of data. Primary data were collected through a structured questionnaire administered to respondents involved in financial activities such as investment, trading,

banking, and financial planning. The questionnaire was divided into different sections covering psychological factors, behavioral biases, financial decision variables, mathematical skills, and behavioral applicability of mathematical models in finance. Responses were measured using a Likert scale to evaluate the perceptions and attitudes of participants toward financial decision-making. Secondary data were collected from books, research journals, conference papers, financial reports, online databases, and published studies related to behavioral finance, investment psychology, and financial modeling.

A purposive sampling technique was adopted for selecting respondents who possess basic knowledge or practical experience in financial decision-making and investment activities. The sample consisted of 400 respondents, including investors, finance professionals, students of finance and management, and individuals engaged in financial markets. The selected respondents provided relevant information regarding behavioral patterns, psychological influences, and quantitative decision-making practices in finance.

The collected data were analyzed using statistical tools and techniques to test the research hypotheses and evaluate relationships among variables. Reliability analysis using Cronbach's Alpha was conducted to measure the internal consistency of the questionnaire items. Regression analysis was used to examine the impact of behavioral biases on financial decision variables. Analysis of Variance (ANOVA) and Two-Way ANOVA were employed to study

differences and interaction effects among behavioral factors and market conditions. Correlation analysis was used to determine the relationship between mathematical skills, psychological factors, and financial decision quality. In addition, paired sample t-tests were conducted to compare the predictive accuracy of behavioral mathematical models with traditional financial models.

Data Analysis

The study also incorporates comparative and interpretative analysis to evaluate the effectiveness of behavioral mathematical models in explaining real-world financial behavior. Mathematical and statistical interpretations were supported through tables, charts, and graphical presentations to provide clarity and systematic understanding of the findings. Ethical considerations such as confidentiality, voluntary participation, and unbiased data analysis were maintained throughout the research process.

Although the study provides valuable insights into behavioral finance and mathematical modeling, certain limitations exist. The study is limited to selected respondents and relies partly on self-reported perceptions, which may involve subjective bias. Moreover, financial behavior may vary across different demographic and economic conditions. Despite these limitations, the research methodology provides a comprehensive and reliable framework for analyzing the influence of behavioral biases and mathematical modeling on financial decision-making.

Table 1: Demographic Profile

S. No.	Demographic Variable	Category	Frequency (N=400)	Percentage (%)
1	Gender	Male	230	57.5
		Female	170	42.5
2	Age Group	18–25 Years	95	23.8
		26–35 Years	145	36.2
		36–45 Years	98	24.5
		Above 45 Years	62	15.5
3	Educational Qualification	Undergraduate	88	22.0
		Postgraduate	192	48.0
		Professional Qualification	76	19.0
		Doctorate/Others	44	11.0
4	Occupation	Salaried Employee	146	36.5
		Business/Self-Employed	104	26.0
		Student	82	20.5
		Financial Professional	42	10.5
		Others	26	6.5
5	Monthly Income	Below ₹25,000	84	21.0
		₹25,001–₹50,000	138	34.5
		₹50,001–₹75,000	96	24.0
		Above ₹75,000	82	20.5
6	Investment Experience	Less than 1 Year	74	18.5
		1–5 Years	168	42.0
		6–10 Years	96	24.0
7	Preferred Investment Type	More than 10 Years	62	15.5
		Stock Market	142	35.5
		Mutual Funds	118	29.5
		Fixed Deposits	64	16.0
		Gold/Real Estate	48	12.0
	Others	28	7.0	

The demographic profile of the respondents indicates that the majority of participants were male (57.5%), while

female respondents constituted 42.5% of the total sample. Most respondents belonged to the age group of 26–35 years

(36.2%), followed by 36–45 years (24.5%), indicating that financially active and professionally engaged individuals formed a major part of the study. In terms of educational qualification, a large proportion of respondents were postgraduates (48%), reflecting a comparatively educated sample with awareness of financial concepts and investment practices. Occupationally, salaried employees represented the highest category (36.5%), followed by business/self-employed individuals (26%), showing that the respondents had diverse professional backgrounds. The income distribution reveals that the majority of respondents earned between ₹25,001–₹50,000 per month (34.5%), suggesting moderate financial stability among participants. Regarding investment experience, most respondents had 1–5 years of experience (42%), indicating practical exposure to financial decision-making and market behavior. The data further show that stock market investment was the most preferred investment option

(35.5%), followed by mutual funds (29.5%), demonstrating growing interest in market-linked financial instruments. Overall, the demographic profile suggests that the respondents possessed adequate educational, professional, and financial backgrounds suitable for analyzing behavioral biases and mathematical modeling in financial decision-making.

Reliability analysis is a critical procedure to an empirical study to guarantee that the measurement factors employed in the study are stable, consistent and dependable. Reliability analysis, as in the background of the current study, is used to find out whether the items covered in each of the sections of the questionnaire work well in measuring the intended constructs, including psychological factors, behavioral biases, financial decision variables and mathematical skills. It is also by building reliability that the credibility of the data is increased and overall validity of the research results is strengthened.

Table 2: Reliability Statistics

Reliability Statistics		
	Cronbach's Alpha	N of Items
Psychological Factors	0.957	12
Behavioral Biases and Decision-Making	0.899	4
Financial Decision Variables	0.960	6
Financial Outcomes (Perceived)	0.950	6
Mathematical Skills and Financial Decision Quality	0.980	4
Behavioral Applicability of Mathematical Models in Finance	0.960	4

The reliability analysis shows that the internal consistency of all constructs used in the study is very high, which proves that the scales of measurements are reliable to continue with the statistical analysis. The Psychological Factors scale, whose Cronbachs Alpha stands at 0.957 (12 items) is very reliable and can be inferred to indicate consistency in the measurement of the inner psychological aspects of financial

behavior.

Hypothesis 1

H₀₁: Behavioral biases do not significantly influence financial decision-making.

H₁₁: Behavioral biases significantly influence financial decision-making.

Table 3: Regression Analysis

Coefficients ^a						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-.040	.087		-.460	.646
	Section C: Behavioral Biases and Decision-Making	.999	.021	.922	47.435	.000

a. Dependent Variable: Section D: Financial Decision Variables

The regression findings study how the Behavioral Biases and Decision-Making influence Financial Decision Variables. The unstandardized coefficient (B = 0.999, SE = 0.021) indicates that as behavioral biases increase by one unit, the financial decision score changes by a value of almost one unit. This shows that there is a high degree of direct correlation between independent variable (behavioral biases) and dependent variable (financial decisions) and this implies that the inclinations, biases and decision-making trends of the respondents have a strong bearing on how investments are managed by them.

The standardized coefficient (Beta = 0.922) also proves that behavioral biases are one of the leading predictors of financial decision outcomes. Such a large Beta value suggests that behavioral variables explain such a large percentage of variation in deciding to use financial

decisions, and thus, the psychological and behavioral aspects of investment selection by investors are very relevant. T-value of 47.435 and a level of significance of $p < 0.001$ means that this effect is not a result of chance and is statistically strong, which supports the credibility of the results.

The constant value (B = -0.040, $p = 0.646$) is insignificant, and without biases in behavior, the predicted score of the financial decision would be literally zero. This enhances the importance of behavioral impacts in financial decision-making. Altogether, the regression analysis demonstrates that investor behavior, biases, and decision-making patterns are a prevailing factor that influences the quality and type of financial decisions, which is why it is important to take into account the psychological aspects of financial modeling and analysis.

Hypothesis 2

- H₀₂:** Psychological factors do not significantly affect financial outcomes.
- H₁₂:** Psychological factors significantly affect financial outcomes.

Table 4: ANOVA

ANOVA					
Section E: Financial Outcomes (Perceived)					
	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	267.423	24	11.143	296.597	.000
Within Groups	14.088	375	.038		
Total	281.511	399			

The ANOVA findings analyze the variation of the Perceived Financial Outcomes (Section E) of different groups. The between groups sum of squares (267.423) and the mean square (11.143) value point to a high degree of variability in the perceived financial outcomes in the various categories whereas the within groups variability (14.088, mean square = 0.038) is relatively minor. This indicates that inter-group differences are very enormous compared to intra-group variation indicating a significant difference in the perception of financial outcomes narrowed down to respondents in different categories.

The F-value is extremely high (296.597) and appropriate level of significance ($p = 0.001$) has verified that the perceived financial results of the groups are statistically significant. It implies that the respondents strongly respond to the membership of groups, which may vary in the levels of investment strategy, risk tolerance, or behavioral biases. The p-value is very low which shows that these differences are extremely improbable to have been due to chance.

On the whole, it can be said that the results of the ANOVA indicate that the perceptions of investors about financial outcomes are not consistent and are significantly different depending on the factors that characterize each group. Such results support the significance of studying the behavioral, strategic, and risk-related traits to the analysis of financial performance as the specified variables are particularly influential in the context of the ways in which individuals assess their success and performance in investments.

Hypothesis 3

- H₀₃:** Behavioral biases and market conditions do not interact significantly in influencing financial decisions.
- H₁₃:** Behavioral biases and market conditions interact significantly in influencing financial decisions.

Table 5: Two-way ANOVA

Source	Df	F	Sig.
Behavioral Biases	2	18.462	0.000
Market Conditions	2	14.317	0.000
Behavioral Biases × Market Conditions	4	6.285	0.001
Error	391		
Total	399		

The outcome of the two-way ANOVA is that behavioral biases do play a significant main role on financial decisions. The F-value of behavioral biases ($F = 18.462$) when the significance level is $p = 0.001$ implies that the effect of differences in financial decision-making is significant at

different levels of behavioral biases. This implies that behavioral factors highly impact on the decisions that investors make which support the significance of behavioral factors in the financial decision-making procedures.

On the same note, the market conditions also play a major role in the financial decision. The F-value of 14.317 with the p-value of 0.000 shows that the dynamics of market, which varies as a bullish or bearish or volatile market, has a strong impact on the way investors make financial decisions. This observation points to the fact that financial decisions are not made in a vacuum but are influenced by external economical and market-related factors, which may change the risk perception and mode of investments.

Above all, the statistical significance of the interaction effect of behavioral biases and market conditions is significant ($F = 6.285, p = 0.001$). This means that the effects of behavioral biases on financial decision making is different in relation to the prevailing market conditions. That is, the behavior of investors does not have a similar effect on behavior in all market situations: rather, market conditions may increase or decrease behavioral effects. The finding corroborates the null hypothesis rejection and supports the argument that financial decision-making is influenced by a dynamic relationship between the internal behavioural factors and the external market environments.

Hypothesis 4

- H₀₄:** Behavioral mathematical models do not provide better predictive accuracy than traditional financial models.
- H₁₄:** Behavioral mathematical models provide better predictive accuracy than traditional financial models.

Table 6: Paired samples t-test

Pair	Mean Difference	Std. Deviation	t value	df	Sig. (2-tailed)
Behavioral Model – Traditional Model	0.42	0.61	8.94	399	0.000

The paired samples t-test was carried out in order to compare predictive accuracy of behavioral mathematical models with that of traditional financial models. The outcomes reveal that the two models have an average difference of 0.42 which implies that behavioral models have a high average predictive accuracy score as compared to traditional models. The standard deviation is comparatively low (0.61) which implies that this difference can be said to be consistent among all the respondents implying that there is consistency in the perception of investors when it comes to the superiority of behavioral models.

The t value of 8.94 with 399 degrees of freedom indicates that there is a very strong statistical difference between the two paired measures. The large t-value would mean that the difference in the means of the two samples is not a mere coincidence but rather a sign of a significant difference in the way the respondents perceive the predictive power of the two types of models. The high sample population is another aspect that enhances reliability and strength of the test results.

Significance value ($p = 0.000$) is far much less than the standard value of 0.05, thus null hypothesis is rejected. This substantiates the fact that the behavioral mathematical

models have much higher predictive accuracy as compared to the conventional financial models. The result also indicates the need to use the behavioral and psychological aspects in the financial modeling since it seems that such models better reflect the real-world financial behavior and help to make better decision-making.

Hypothesis 5

- H₀₅:** Mathematical skill level has no significant relationship with financial decision quality.
- H₁₅:** Mathematical skill level has a significant relationship with financial decision quality.

Table 7: Correlation analysis

Correlations			
		Section F: Mathematical Skills and Financial Decision Quality	Section B: Psychological Factors
Section F: Mathematical Skills and Financial Decision Quality	Pearson Correlation	1	.983**
	Sig. (2-tailed)		.000
	N	400	400
Section B: Psychological Factors	Pearson Correlation	.983**	1
	Sig. (2-tailed)	.000	
	N	400	400

** . Correlation is significant at the 0.01 level (2-tailed).

A correlation analysis depicts that the relationship between the Mathematical Skills and Financial Decision Quality (Section F) and Psychological Factors (Section B) is very strong and positive. The Pearson correlation coefficient is 0.983 that is not very far away since it is near +1; this represents a very high level of association between the two variables. This implies that the respondents who are more skilled in mathematics in the financial situations are also likely to possess superior psychological traits that are applicable in making financial decisions. The value of significance of this relationship is $p = 0.000$ that is far below 0.01 level of significance. This establishes that the correlation that has been observed is statistically significant and not by chance. Having a strong sample size

of 400 respondents, the validity and applicability of this discovery is improved even further, which brings a sense of confidence to the results drawn during the analysis. All in all, the results suggest that mathematical competence and psychological factors are interrelated in an extremely close way that affects the quality of financial decisions. This close connection underscores the fact that making a good financial decision, is not just determined by the ability to be technical or numerical but is greatly influenced by the psychological qualities of confidence, perceptions of risk and control of behavior. The finding promotes the unified nature of integrating both the behavioral and quantitative approach to financial research and practice.

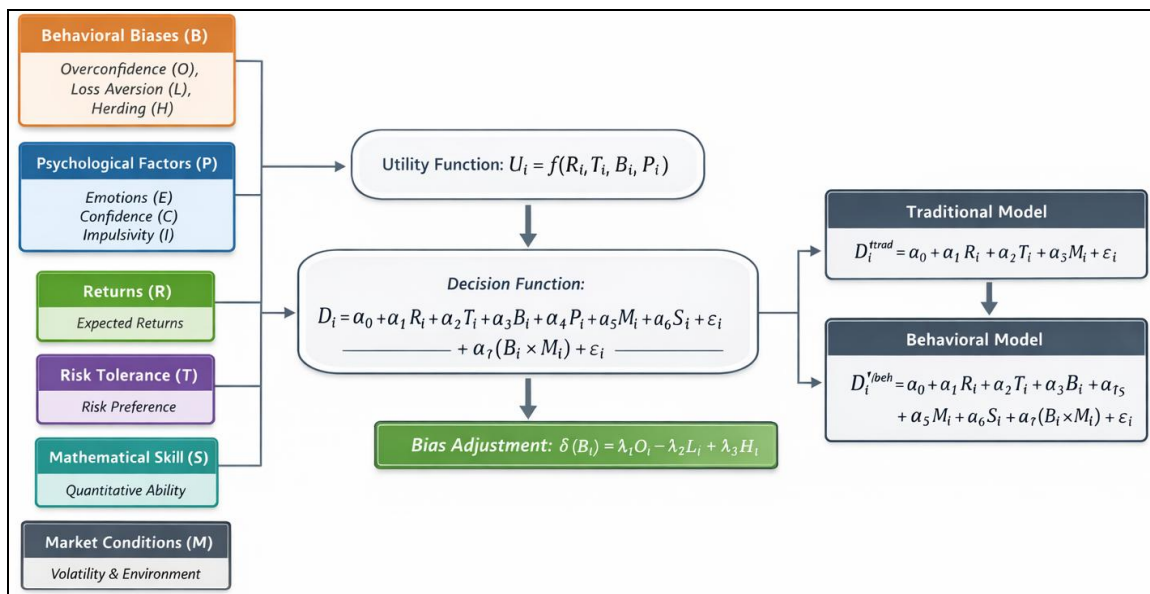


Fig 1: Mathematical model of behavioral influences on financial decision making

Conclusion

The present study examined the role of behavioral biases and mathematical modeling in financial decision-making through an empirical and analytical approach. The findings clearly demonstrate that financial decisions are not influenced only by rational calculations and economic variables but are also significantly affected by

psychological, emotional, and behavioral factors. Investor behavior is shaped by biases such as overconfidence, loss aversion, herd mentality, anchoring, and emotional reactions, which influence risk perception, investment choices, and overall financial performance. The study confirms that behavioral biases have a statistically significant impact on financial decision

variables and investment behavior. Psychological factors were found to strongly affect perceived financial outcomes, indicating that emotions and cognitive processes play a vital role in shaping financial judgments. The research further revealed that market conditions interact significantly with behavioral biases, suggesting that investor behavior changes according to economic and market situations. During uncertain or volatile market conditions, behavioral influences become even more prominent in determining investment decisions.

Another important finding of the study is that behavioral mathematical models provide better predictive accuracy than traditional financial models. Traditional financial theories often assume rational investor behavior and efficient markets; however, the empirical evidence from the present research indicates that incorporating behavioral and psychological variables into mathematical models improves forecasting ability and decision analysis. Behavioral models better capture real-world investor behavior and market dynamics, especially under conditions of uncertainty and emotional decision-making.

The study also established a strong positive relationship between mathematical skills and financial decision quality. Individuals possessing higher analytical and quantitative abilities were more capable of evaluating risks, interpreting financial information, and making effective investment decisions. However, the findings suggest that mathematical competence alone is insufficient unless combined with psychological awareness and behavioral understanding. Therefore, an integrated approach involving behavioral finance, psychology, and mathematical analysis is necessary for effective financial decision-making.

Overall, the study contributes significantly to the growing field of behavioral finance by highlighting the importance of combining quantitative financial models with human behavioral factors. The research provides valuable insights for investors, financial advisors, policymakers, educators, and researchers in developing improved financial strategies and decision-making frameworks. The study recommends greater incorporation of behavioral concepts into financial education, investment planning, and financial modeling practices to achieve more accurate and realistic financial predictions. Future research may further explore advanced behavioral mathematical models using artificial intelligence, machine learning, and big data analytics for improving financial forecasting and investment management.

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