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Research Article

Financial Allocation Management Using Behavioral Psychology

Krisha Borana[1*], Gaj Joshi[2], Fatema Dolaria[3], Viral Dalal[4], Neha Katre[5]

[1*]Department of Information Technology, D.J. Sanghvi College of Engineering, Mumbai, India https://orcid.org/0009-0005-3343-9524
[2]Department of Computer Science, D.J. Sanghvi College of Engineering, Mumbai, India. https://orcid.org/0009-0006-0801-5970
[3]Department of Computer Science, D.J. Sanghvi College of Engineering, Mumbai, India. https://orcid.org/0009-0009-9394-2729
[4]Department of Information Technology, D.J. Sanghvi College of Engineering, Mumbai, India https://orcid.org/0009-0003-6586-5937
[5]Department of Information TechnologyD.J. Sanghvi College of Engineering, Mumbai, India https://orcid.org/0000-0001-8320-7071

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ABSTRACT

In the fast-changing scenario of financial investment strategies, integration of behavioral psychology with advanced analytics has become one major trend that could help improve portfolio allocation decisions. This research paper discusses a new scenario in portfolio allocation that uses sentimental analysis to make proper considerations of an investor's risk tolerance and financial objectives. Unlike traditional methods, heavy on quantitative data, the research supplements insight into the investor's financial interest and disposition with behavioral cues emanating from social media interactions.

Artificial Intelligence, Behaviour, Investment, Modern Portfolio Theory, Portfolio, Psychology, True Risk Tolerance

II. INTRODUCTION

The foundation of the methodology is built on the principles of behavioral psychology, which help in understanding the underlying psychological factors that influence investment decisions. We can mine sentiment and behavioral insights from social media content, which can be a reflection of an individual's risk tolerance and investment choices. This analysis is then enhanced by a very comprehensive and intuitive personality test that aims to provide an extremely detailed and accurate rationale of the user. The questionnaire helps determine the investor type and provides increased accuracy in looking to match appropriate portfolio strategies that match personal financial goals.

The approach is based on modern portfolio theory (MPT), which rigorously evaluates each portfolio to ensure that the risk-to-reward ratio is calculated appropriately, resulting in maximum benefits for the investor. Combining sentimental analysis with MPT allows for a more adaptive and individualized approach to portfolio management, catering to individual investors' unique risk tolerance levels and preferences. This study describes the technique, implementation, and potential consequences of introducing sentimental analysis into portfolio allocation, opening the way for a more nuanced and psychologically informed investment environment.

A. Current System

Currently, drafting a financial portfolio relies heavily on quantitative analysis of historical data and current market conditions. This involves assessing factors like asset prices, past returns, volatility, correlations, and economic indicators. Investors also consider fundamental analysis, digging into company financials, news, and industry trends. However, this approach often neglects the "soft" side of the market - investor sentiment. This is where sentiment analysis emerges, harnessing techniques like natural language processing to quantify emotions from news, social media, and analyst reports, potentially offering additional insights and potentially leading to more efficient portfolios.

B. Need of the system

Currently, the tools and software utilized for building financial portfolios employ limited and rigorously trained algorithms to meet the specific requirements of customers. Presently, many systems primarily prioritize investment selection and portfolio development, disregarding other vital components of financial planning such as retirement planning, tax optimization, and estate planning. A human manager might adopt a comprehensive approach, taking into account the complete financial circumstances and objectives. Online solutions sometimes adhere to pre-established templates and may not accommodate distinctive investing objectives or intricate

financial circumstances. The primary objective of the project is to analyze the risk-return ratio and optimize investment strategies to achieve the highest possible returns while ensuring safety. This may highlight specific patterns in the investment behavior by drawing attention to the psychology. They usually ignore the psychology and behavior of individual investors, which can have a big impact on their investment decisions. An efficient instrument for managing a portfolio should provide direction and emotional support, especially during periods of market turbulence.

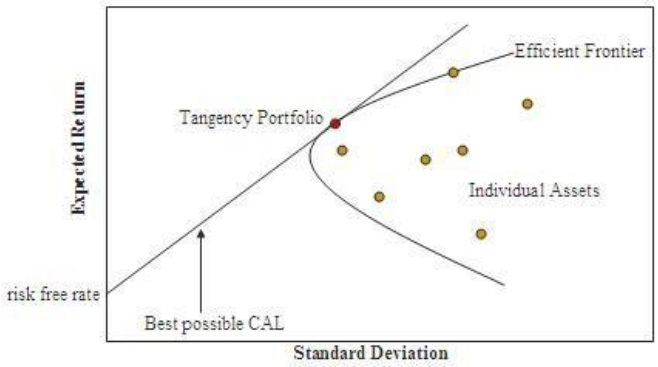

Fig. 1: Optimal risk portfolio

C. Advantages

There are a number of clear benefits to the suggested method of incorporating sentiment monitoring into financial portfolio management. Investors can obtain real-time insights into market sentiments and a more sophisticated knowledge of the emotional context surrounding financial assets by utilizing sentiment data from a variety of sources, including news articles and social media. Investors might use this method to spot new attitudes and patterns that conventional financial indicators might not show right away. Additionally, by assisting investors in anticipating future market movements and quickly adapting to shifting sentiments, sentiment research supports a more proactive approach to risk management. Sentiment analysis and conventional financial models are combined to provide a thorough and flexible framework for portfolio management, enabling investors to act more quickly and intelligently in the ever-changing and interconnected world of financial markets. One such example of an optimal risk portfolio is depicted in Fig 1

III. LITERATURE REVIEW

The paper by Boda [1] explores the psychological and emotional factors that influence individual investors' investment decisions. Behavioral finance, a sub-area of research, focuses on understanding how investors judge, predict, investigate, and review decision-making processes. Traditional finance theories assume investors are rational, but recent research shows that they are not always rational. Behavioral finance theory suggests that investors are not rational all the time and confirms that they are irrational in investment decisions. Understanding behavioral psychology provides insight into stock market anomalies and investment strategy selection. By converting behavioral biases into benefits, investors can convert their biases into benefits, motivating them to invest further. The study uses methods of analysis, synthesis, description, and comparison to study the psychological effects of investors.

A study on factors affecting investment decisions in India by Patil [2] was conducted on the Indian stock market, focusing on 10 sectors and 30 companies listed on BSE-30 SENSEX. The study found that'must be' attributes include financial statements, current economic indicators, technical analysis results, and insider information. The study aimed to understand the factors affecting investors' decision-making and whether these factors are general or sector-specific. The research aims to provide insights into the factors influencing investment decisions in India.

IV. METHODOLOGY

A. Dataset

The study utilizes a survey research approach, which was deemed essential to provide a comprehensive view of respondents' perceptions and attitudes toward various variables, determining whether they exhibit bias or not. The study's population comprised all individual investors in Nigeria; however, it was limited to students and staff at the University of Benin who are investors. Data was gathered using a structured questionnaire from 70 respondents, which included both open and close-ended questions. The questionnaire had three sections: demographic information (such as gender, age, education, financial management knowledge), stock market investment decisions, and respondents' behavioral biases in more understandable questions (like representativeness, overconfidence, loss aversion, and regret aversion). Respondents rated their responses on a Likert scale [12], with options ranging from strongly disagree to strongly agree. An example of a few sample questions and their answers is listed in the survey in Table I.

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B. Architecture diagram

The summarized system architecture is depicted in Fig 2

C. Validitity of the dataset

Before proceeding with the data, to validate it, a comprehensive pilot study was implemented that used tools and insights from industrial experts to modify and structure the questionnaire. The pre-testing phase involved providing the questionnaire to a carefully selected sample. This approach ensured that each factor was important

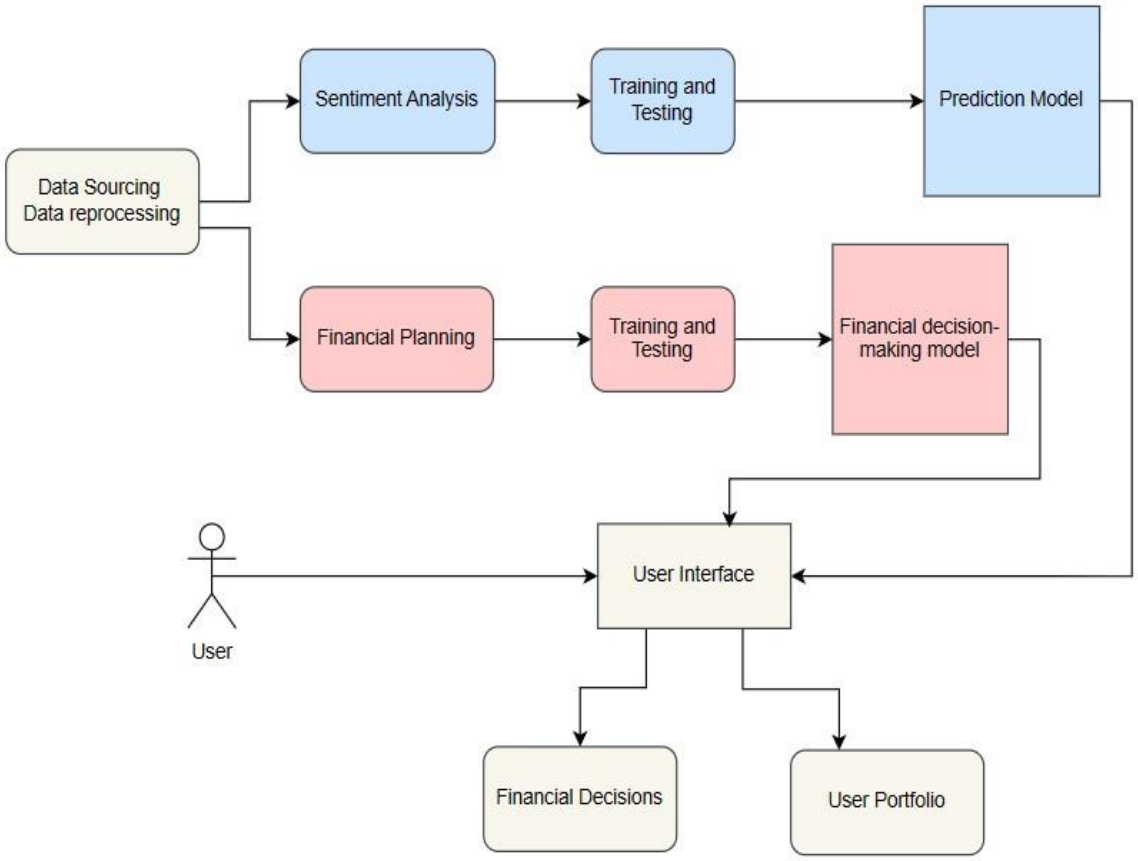

Fig. 2: System Architecture

and aligned to the research goals. The reliability of the questionnaire and the outcomes were rigorously analysed and also tested to measure consistency in responses across repeated trials. This process, allowed us to confirm that the questionnaire would yield similar and impactful results, minimizing ambiguity. The regression equation below was utilized:

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \epsilon \quad (1)$$

Where:

- Y = The dependent variable represents the individual investor decision and is measured by individuals' average return.
- X_1 = Representativeness bias
- X_2 = Loss aversion bias
- X_3 = Hindsight bias
- X_4 = Overconfidence/Self-attribution bias
- X_5 = Regret aversion bias

- $\beta_1 ... \beta_n$ = The predictors (coefficients)
- ϵ = Error term

D. Behavioral Psychology

Behavioral finance [3] is a new field of study that combines behavioral and cognitive psychological theories with economics and finance to explain irrational financial decisions. It focuses on cognitive psychology and the limits to arbitrage, which describe how people think. The field suggests that information structure and psychology-based factors influence investment decisions. [10] Behavioral finance theory aims to understand the psychological factors that influence investors' decision-making, including attitudes, emotions, moods, and sentiments. Psychological biases, such as herding, overconfidence, and reinforcement bias, can provide explanations and solutions to market anomalies. Research has shown that individual and retail investors can predict stock exchange movements better than institutional investors. Understanding the psychological effects of investing can help convert psychological biases into financial benefits for retail investors, allowing them to rectify errors in their investment decisions.
Behavioural factors significantly influence investment decisions, with economic, social, and psychological factors playing a significant role. Risk-taking and confidence are key factors, leading to high trading. Accounting information, neutral information, and advocate recommendations also influence investment decisions in the Indian stock market. Past performance of a firm's stock, including dividends and capital appreciation, is crucial

TABLE I: Summary of Investment Preferences and Risk Tolerance

Question	Answer Option	Number of Responses
What is your preferred investment horizon?	1. Short-term (less than a year)	15
	2.Medium-term (1-5 years)	20
	3. Long-term (5+ years)	30
	4. I'm unsure	5
	Total	70
How would you describe your risk tolerance?	1. Very conservative	10
	2. Conservative	15
	3. Moderate	25
	4. Aggressive	20
	Total	70
How patient are you with investment returns?	1. I expect quick returns	5
	2. I'm willing to wait a few years	20
	3. I'm patient and can wait for a decade or more	35
	4. I'm not sure	10
	Total	70
How do you approach budgeting for investments?	1. I don't have a specific budget	10
	2. I allocate a small percentage of my income	25
	3. I have a well-defined budget for investments	30
	4. I'm not sure	5
	Total	70
What level of profit margin are you comfortable with in your investments?	1. Minimal, but consistent	15
	2. Moderate	25
	3. High, even with higher	20

	risk	
	4. I'm not sure	10
	Total	70

for investors. Expected bonus shares, a non-cash form of dividend paid, also influence stock prices. Positive reactions to bonus announcements can lead to increased stock prices. One such example fo a risk return behavioral psycology is depicted in Fig 3 Stock marketability [4] refers to the speed at which a security can be converted into cash or near cash, affecting individual investors' decision-making. Liquid stocks, such as those with high liquidity, can minimize crashrisk and help strategic traders purchase additional stocks at lower trading costs. Expected corporate earnings, also known as the bottom line, are also considered in investment decisions. Condition of financial statements, such as balance sheets and profit and loss accounts, is an important factor in investing. Affordable share prices also influence investment decisions, with a positive relationship between stock price and affordability. Stock splits or capital increases can also influence stock prices.

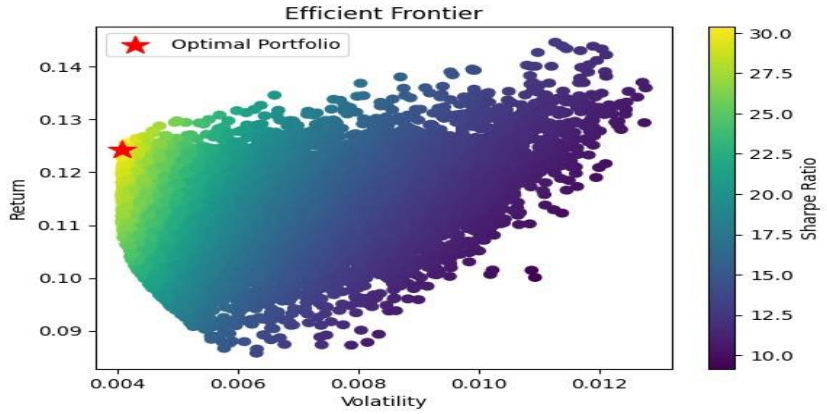

Fig. 3: Experimentally found Efficient Frontier for a set of randomly generated sample assets found using Python

E. Stock market

Neutral information, technical analysis, internet information, insiders' information, rumors, press coverage, and economic indicators are all crucial factors in the stock market. Neutral information, such as financial press coverage and recent price movements, is a significant influencing factor for investors. Technical analysis helps predict future stock prices and has been proven to be profitable. Insiders' information, particularly from directors and large shareholders, has positive predictive power for future returns. Rumours, which are unverified and difficult to believe, can also impact stock prices. Press coverage affects stock price volatility, with good news leading to increased stock prices and bad news leading to decreased returns. Economic indicators, such as GDP, inflation, unemployment rate, and interest rates, a positive relationship with stock market indices. The stock market volatility is dependent on the health of the economy and the relationship between stock prices and GDP.

F. Impact of social media

The study focuses on the factors investors consider when making investment decisions, particularly in the Indian stock market. The sample includes full-time traders with over 10 years of experience and varied experience in the market. The 14 attributes were tested for internal consistency using Cronbach alpha [5], and the content validity of the research tool was confirmed through expert recommendations. The study found that past performance of a firm's stock is the most important attribute for investors, followed by condition of financial statements. The derived importance of these attributes was computed using the KANO model [2], and the study identified four quadrants: must be, linear, and delight attributes. The study's findings help understand the relationship between satisfied investments in equity and BSE-30 listed companies.

G. Modern Portfolio Theory

Modern Portfolio Theory (MPT) [7], developed by Harry
Markowitz in the 1950s, provides a foundational framework for portfolio management based on the principles of diversification and risk-return trade-offs. The proposed approach of integrating sentiment analysis into financial portfolio management aligns with and extends the principles of MPT, enhancing the traditional model in several ways. Firstly, MPT emphasizes the importance of diversification to achieve optimal risk-adjusted returns.

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What is your preferred investment horizon?
1. Short-term (less than a year)
2. Medium-term (1-5 years)
3. Long-term (5+ years)
4. I'm unsure
Select an option [1-4]: 1
How would you describe your risk tolerance?
1. Very conservative
2. Conservative
3. Moderate
4. Aggressive
Select an option [1-4]: 4
How patient are you with investment returns?
1. I expect quick returns
2. I'm willing to wait a few years
3. I'm patient and can wait for a decade or more
4. I'm not sure
Select an option [1-4]: 1
How do you approach budgeting for investments?
1. I don't have a specific budget
2. I allocate a small percentage of my income
3. I have a well-defined budget for investments
4. I'm not sure
Select an option [1-4]: 3
What level of profit margin are you comfortable with in your investments?
1. Minimal, but consistent
2. Moderate
3. High, even with higher risk
4. I'm not sure
Select an option [1-4]: 3

Your top investor profiles:
High-Risk Speculator: 4 points
Active Swing Trader: 4 points
Opportunistic Trend Follower: 3 points
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Fig. 4: Profile Classification

By incorporating sentiment analysis, investors can refine their asset allocation strategies based not only on historical risk and return data but also on realtime market sentiments. This allows for a more dynamic and responsive portfolio allocation that considers the emotional context of the market, potentially leading to improved risk mitigation and return optimization. First, in order to achieve the best risk-adjusted returns, MPT highlights the significance of diversification. Investors can improve their asset allocation methods by integrating sentiment research, which takes into account both current market sentiments and historical risk and return data. This makes it feasible to allocate the portfolio in a more dynamic and responsive way that takes the market's emotional context into account, which could improve risk reduction and return optimization.Second, MPT makes the assumption that investors only consider the standard deviation of returns and expected returns when making decisions. Given that investor sentiments have a big influence on market movements, the incorporation of sentiment analysis adds a behavioral finance component to the decision-making process. The suggested method contributes to a more comprehensive understanding of market dynamics by acknowledging the impact of psychological variables on investment decisions through the incorporation of sentiment data [11]. Furthermore, MPT makes the assumption that every investor has the same informational resources and expectations. Sentiment analysis enables a more individualized and flexible approach to portfolio management by acknowledging the diversity in investor behavior and information consumption. By utilizing sentiment insights that might not be fully represented in historical data or publicly accessible financial information, investors can obtain a competitive edge.

H. True Risk Tolerance

In order to determine claimed risk tolerance—which measures an investor's self-reported comfort level with volatility—traditional financial planning frequently uses surveys and models. This professed tolerance, however, might not always represent true risk tolerance, or the capacity to sustain losses in the face of actual market fluctuations. This discrepancy becomes even more significant when sentiment research is used to build a portfolio. True risk tolerance [8] has the following advantages:

- Discovering emotional influences: Sentiment research explores the market's emotional undercurrents and may reveal biases and hidden anxieties that affect investment choices. This may indicate a mismatch between declared and actual risk tolerance. An investor who claims to have a high risk tolerance, for instance, may panic sell during a downturn led by negative sentiment, exposing a lower genuine tolerance.
- Tailoring portfolios to emotional reality: By understanding true risk tolerance, you can create portfolios that align not just with stated preferences but also with an investor's emotional makeup. This could involve incorporating more stable assets or using hedging strategies to mitigate potential anxieties triggered by negative sentiment shifts.
- Dynamic adjustments for changing emotions: True risk tolerance isn't static. Sentiment analysis, by providing real-time insights into prevailing emotions, enables dynamic adjustments to portfolios. If negative sentiment spikes, adjustments might be made to reduce risk exposure, even if the investor's stated tolerance remains high.

V. RESULTS

A total of 70 individual data was used to predict the true risk tolerance score. A number of Machine Learning Prediction models were used for this purpose. Some fundamental exmaples of the template questions are depicted in Fig 4.

We consider the regular SVR technique and the risk score provided by the authority as two benchmarks. We used the actual risk score and ran a linear regression to predict the actual risk taken by the individuals. Many of the nonlinear models can outperform the risk score calculated by the regulator. Primarily we have studied a few nonlinear ML model's performance, namely K-nearest neighbor (KNN), lasso, Xgboost, and Regression Trees for Machine Learning (RT). Most of the models do better than SVR. The boosting methods mainly do better; Xgboost does even better than the rest. So, hidden nonlinearities in the risk choice allow the alternative

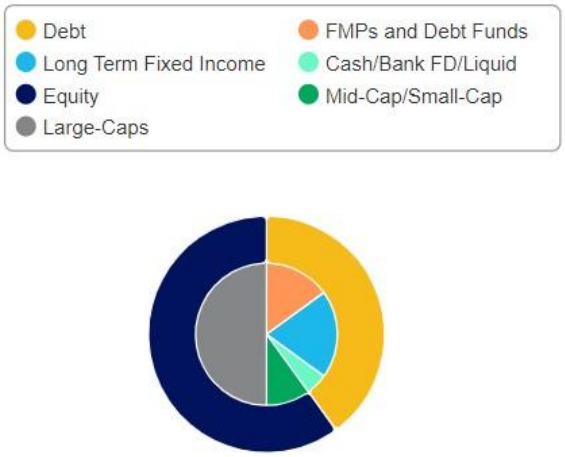

Fig. 5: Portfolio Allocation

models to fare better than SVR. Also, additional inclusion of more other demographics is necessary in order to improve the actual risks taken. In Fig 5 shown above, an example of a user who is a steady risk taker (neither takes high risks nor low), an informed fundamental investor, with balanced equity and debt is portrayed. On analysing the sentiments of the user to be a patient long-term investor with considerable risk taking capacity and seeking balance and diversification: 50% percent of his investment is suggested to be invested in largecap companies which have high market value, are dependable, show slow growth but are reliable in the long-term. 21% of his investment is suggested to be directed towards mid-cap/ small-cap investments.

VI. CONCLUSION

The integration of behavioral psychology and sentimental analysis into financial portfolio management opens up several promising avenues for future research and application. One potential direction is the refinement of sentiment extraction methods through the use of advanced machine learning algorithms, which could allow for more accurate and nuanced understanding of investor behavior. Additionally, expanding the data sources beyond social media to include other platforms such as forums, blogs, and news articles can further enrich the behavioral profiles of investors.

Another area of future exploration involves the application of this model to real-time financial decision-making. Incorporating real-time sentiment analysis would allow for dynamic adjustments to portfolio allocations in response to sudden changes in market sentiment or investor outlook. There is also potential to explore the effectiveness of this approach across different investor demographics, ensuring that it can be tailored for diverse age groups, income brackets, and investment objectives.

Finally, further validation of this approach through largescale experimental studies could provide empirical evidence of its benefits, fostering wider adoption in the financial industry. Collaboration with financial institutions to integrate this methodology into existing advisory platforms would be an important step towards commercialization and practical implementation.

VII. FUTURE SCOPE

This research introduces a novel and impactful approach to portfolio allocation by integrating sentimental analysis with behavioral psychology, shifting away from traditional quantitative methods that often overlook psychological factors. By leveraging data from social media interactions and using modern portfolio theory (MPT) as a

framework, we have developed a method that personalizes investment strategies based on an investor's unique risk tolerance and financial objectives.

The proposed approach not only offers a more comprehensive understanding of individual investor behavior but also highlights the potential for enhanced portfolio performance through dynamic, sentiment-driven adjustments. This innovative fusion of psychology and finance paves the way for a more personalized, responsive, and effective portfolio management strategy, ultimately empowering investors to make more informed and aligned financial decisions.

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