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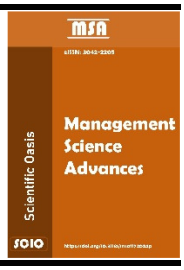

Behavioral Biases and Investment Management Decisions: The Mediating Role of Risk Perception and the Moderating Role of Financial Literacy

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ABSTRACT

The purpose of the study is to explore the impact of behavioral biases on the investment decisions of individual investors of the Pakistan Stock Exchange, with the mediation and moderation mechanism. The study employs both theoretical and empirical evidence to examine the influence of behavioral biases in deviating from the conventional model of investment decision. Data is analyzed with the help of SmartPLS software drawn from a sample of 297 responses. The study finds that self-attribution bias, confirmation bias, regret aversion, and framing bias significantly influence investment decisions through risk perception. Self-attribution bias and regret aversion bias have a significant direct effect on investment decisions. The confirmation bias and framing bias show no significant direct impact. Research indicates that financial literacy does not moderate the link between risk perception and investment decisions. The study offers deeper insight into investor psychology and advances the decision-making process. It aims to help investors, policymakers, and management science advisors improve the performance on stock markets.

1. Introduction

Investment decision-making has long been understood as a rational and objective process in which investors evaluate risks, expected returns, and available information to make optimal choices. However, behavioral finance has shown that investment decisions are not entirely rational [1]. They are shaped by cognitive, psychological, and emotional influences that often work subconsciously, leading to systematic departures from traditional rational models [2]. These influences, referred to as behavioral biases, distort perceptions and judgments, ultimately shaping financial behavior.

Among the most prominent biases are self-attribution bias, confirmation bias, regret aversion, and framing bias. Self-attribution bias encourages investors to attribute successful outcomes to

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personal ability while externalizing failures, thereby reinforcing overconfidence and risk-taking behavior [3].

Confirmation bias leads individuals to selectively process information that aligns with pre-existing beliefs, undermining objective assessment [4]. Regret aversion, on the other hand, causes investors to avoid decisions that may result in future regret, often fostering excessive conservatism [5]. Similarly, framing bias highlights the influence of how investment information is presented, where identical outcomes can be perceived as either advantageous or disadvantageous depending on contextual framing [6]. Collectively, these biases shape how investors evaluate risk and determine their investment strategies.

Risk perception plays a central role in this relationship, serving as the mechanism through which behavioral biases influence investment outcomes. Investors' interpretation of potential risks often dictates whether they pursue aggressive, balanced, or conservative strategies. However, when distorted by cognitive biases, risk perception can lead to misjudgments that result in suboptimal financial choices [7]. For example, regret aversion may exaggerate the perceived severity of losses, while framing effects may cause identical prospects to appear either riskier or safer depending on how they are communicated.

Financial literacy adds another dimension to this relationship, acting as a moderating factor. Strong financial knowledge enables individuals to better understand financial instruments, interpret market conditions, and assess risks accurately [8]. Higher literacy reduces the influence of biases by promoting evidence-based decision-making [9]. In contrast, limited literacy amplifies the effect of biases, leading to distorted risk perceptions and irrational decisions.

Previous studies on investment decisions were largely concentrated on a narrow set of behavioral biases, with several critical biases unexplored. Recent studies have identified that there is a need to examine additional biases [10], such as confirmation bias, framing effect, regret aversion, and self-attribution bias in the investment context [11]. These biases can significantly influence investment decisions, yet existing literature offers a limited insight into their impact. Furthermore, little empirical research has examined the mediating role of risk perception and the moderating role of financial literacy, leaving a substantial gap in the prevailing literature in understanding the underlying investor decision-making process. In addition, existing studies are largely concentrated in developed economies, leaving a limited understanding of these dynamics in emerging markets such as Pakistan. With the growing participation of individual investors in Pakistan's financial sector, exploring these interactions has become both timely and essential.

Therefore, this study proposes a comprehensive model that examines how behavioral biases affect investment decisions through risk perception, with financial literacy as a moderator. The findings aim to advance behavioral finance literature by offering deeper insights into the combined effects of biases, literacy, and risk on investment outcomes. Practically, the results can help policymakers, financial advisors, and market participants develop initiatives to enhance financial literacy and minimize the adverse impact of biases, thereby promoting more rational and effective investment behavior.

2. Literature Review

According to prospect theory, Kahneman & Tversky [12], individuals feel the intensity of loss more severely than the pleasure of gain and gauge the outcomes of their decisions to a certain reference point. Investment decision-making is a complex process [13], which is driven by many attitudinal, behavioral, and cognitive factors [14]. Some researchers argued that investors make irrational decisions because of their dependence on cognitive errors and behavioral biases [7]. The behavioral

biases determine the level of risk perceived by an investor, which deviates from the actual risk level [15]. Earning substantial returns is a major drive for investors to allocate their money into the stock market, which can be achieved through careful assessment of available investment alternatives [16]. Investors prioritize the use of heuristics over the objective evaluation, which influences the investment decisions and the ultimate satisfaction levels [17].

2.1 Self-Attribution Bias and Risk Perception

Self-attribution bias is the individual tendency to attribute their success to their innate skills while ascribing negative outcomes to external factors. Self-attribution bias prompts investors to underestimate the financial risk and persuade them to engage in aggressive trading, amplifying the volatility of their investment portfolios [18]. It boosts overconfidence in investors' behavior as they view gains as a reflection of their own exceptional judgments rather than positive market circumstances [3]. The overconfidence in behavior decreases risk perception and under-diversification of portfolio, leading to an investment bucket with higher idiosyncratic risk [19]. Jain & Kesari [20] indicated a positive association of self-attribution with risk perception of investors. Based on the above arguments, the following relationship is suggested:

H1: Self-attribution bias negatively influences risk perception.

2.2 Confirmation Bias and Risk Perception

Confirmation bias is a person's disposition to seek, recall, and interpret information that aligns with pre-established beliefs while overlooking contrary evidence, leading to a polarized perspective on an event or an issue [4]. This cognitive filtering strengthens the confidence of investors in the stock market as they rely on only supporting signals that are in line with their existing beliefs, whereas negative signals about stock market conditions are largely ignored [21]. Pan & Ryan [22] advocated the significant effect of confirmation bias on the risk perception of individuals in choosing public transit during the COVID-19 pandemic. Some researchers indicated that risk assessment in disaster management is greatly influenced by the leaders' confirmation bias [23]. Saivasan & Lokhande [24] demonstrated that the investors' risk perception stems from the interplay between behavioral considerations and rational considerations. Besides, the investor's psychometric risk attitude is also grounded in the investor's exposure to risk in the past. Investors high in confirmation bias frequently trade in the stock market as they underestimate the impact of random factors in the stock price movement and overrate the accuracy of their own beliefs [25]. On the basis of the above evidence, the following hypothesis is proposed:

H2: Confirmation bias negatively influences risk perception.

2.3 Regret Aversion and Risk Perception

Regret aversion is an emotional bias in which an investor avoids taking actions that cause the feeling of regret [26]. Due to this bias, investors become more loss-averse and experience the pain of losing twice than the pleasure of gaining [12]. Some researchers pointed out that regret aversion makes investors more risk-averse in their investment choices [27]. Investors with higher regret in their past investments compromise higher returns to minimize the risk of regret in their future decisions. This heightened sensitivity to regrets induces them to perceive the stock market as risky and leads them to choose conservative choices [5]. Furthermore, investors with high regret aversion behavior often hold losing stocks to prevent them from the error of commission or the error of

omission. They are more cautious with the risk level attached to securities and therefore, they trade less frequently than other investors [28]. The following hypothesis is proposed:

H3: Regret aversion bias positively influences risk perception.

2.4 Framing Bias and Risk Perception

Framing bias arises when the decision is made depending on the way information is communicated. Due to this bias, investors react to an identical piece of evidence differently [6]. Framing bias significantly affects loss and gain evaluation in investor decision-making. The information presented negatively creates fear and boosts pessimistic judgment, resulting in risk-averse choices. On the other hand, positively framed information tends to encourage optimistic thinking and triggers risk-seeking behavior [29]. Diacon & Hasseldine [30] found that presenting historical performance data in terms of percentage returns and fund values shapes the risk perception of retail investors and fund choices and enhances the investment volume of investors. Some researchers indicated that framing bias affects the risk assessment of both institutional and individual investors [31]. The study specified that risk perception is greater for variable income funds compared to fixed-yielding funds. Some researchers revealed that financial decisions and risk preferences of Italian investors are influenced by how the financial information is disseminated [32]. Changing the typology of data or the framing (such as numbers, words, etc.) changes the perceived risk of investors regarding financial products. Hence, the following hypothesis is developed:

H4: Framing bias significantly alters risk perception depending on how information is presented.

2.5 Risk Perception and Investment Decisions

Risk refers to the possibility of loss and the chance that the potential loss is lower than the expected gains [33]. Risk is linked to the extent to which individuals assume the possibility of the probable outcome of a future event. Risk perception may not always be objective [34]. It is a subjective and intuitive evaluation of investors regarding the riskiness of the security [35]. It plays a significant role in defining investment decisions and the ultimate satisfaction level of investors. Investors choose their portfolio as on their risk profiles and risk evaluation. Investors with a lesser risk perception are less tolerant of risk and can achieve greater benefits from risky evaluation [36]. Risk perception among investors derives from irrational judgments, resulting in erroneous decisions [37]. In contrast, some researchers established that risk perception has a significant positive impact on investment satisfaction as investors are more cautious while investing, resulting in higher performance [38].

Investors become more rational and apply their analytical skills to interpret the inherent risk associated with the financial products, avoiding risky assets and contributing to a greater investment performance. Otuteye & Siddiquee [39] also established that investors with higher risk-taking propensity underperform in the financial markets. Investors with lower risk perception show flawed behavior and generate poor returns as they excessively trade in the financial market by ignoring fundamental values of the available investment opportunities [40]. Some researchers found that investors with higher risk perception take more caution and are better able to forecast investment returns, yielding improved decisions [7]. Hence, it is hypothesized that:

H5: Risk perception positively influences investment decisions.

2.6 Self-Attribution Bias and Investment Decisions

Self-attribution bias significantly influences investment decisions and causes investors to blame failure on outside factors and believe in evidence what they desire, creating irrational denial [41]. It boosts overconfidence in their abilities, due to which investors excessively trade in the markets, neglecting the securities' fundamentals [3]. Naveed & Taib [42] revealed that self-attribution bias induces investors to sell winning shares and hold the losing stocks, which negatively impacts their performance. Koo & Yang [43] asserted that institutional investors learn from the pattern of their past decisions and alter their behavior to the outcome of their judgments, and this effect is amplified by the favorable outcome. However, Moeller *et al.* [44] reported that acquisition deals that suffered big losses were those of firms with successful experience. Investors affected by this bias often earn suboptimal returns as they ignore important market signals and underestimate the need for professional advice, impeding them from making rational investment decisions [45]. Czaja & Röder [46] found that stock traders show lower performance because of under-diversification and high trading frequency. Based on these arguments, the following hypothesis is developed:

H6: Self-attribution bias significantly influences investment decisions.

2.7 Confirmation Bias and Investment Decisions

Investors with confirmation bias overemphasize their information while making decisions, leading to poor investment performance. This is because they trade excessively, speculating on higher returns, but they are unable to offset the higher trading cost [25]. Investors with confirmation bias are more likely to neglect the key information signals, which play a significant role in altering their information processing and financial decisions [47]. Adiputra & Nathaerwin [48] designated that the reasons for confirmation bias are cognitive or motivational; it is either due to the subconscious mind or one's desire to confirm their beliefs. However, the study results showed that confirmation bias did not affect investment choices of generation Z in Jakarta. Owing to this bias, investor miss the substantial information of the financial market or interpret the available information wrongly, resulting into irrational investment decisions [49]. Given these arguments, it is proposed that:

H7: Confirmation bias significantly influences investment decisions.

2.8 Regret Aversion and Investment Decisions

Hans *et al.* [50] discovered that regret aversion bias has a significant influence on the investment decisions of retail equity investors in India. Edison & Aisyah [51] explored the behavior of stock market investors, found that investors with bad investment experience try to minimize regret in their future investment. The study posited that regret aversion bias significantly shapes the subsequent investment decisions of stock market investors. Investors become more careful while making investment decisions and perform a more thorough analysis to avoid losses in uncertain situations [52]. Investors with regret aversion bias tend to invest in stocks that pay dividends regularly [53]. Kengatharan & Kengatharan [54] display that regret aversion, along with other prospect factors, has a positive influence on the investment decision. Ngoc [55] proposed that regret aversion compels investors to perform technical analysis while investing, which protects investors from excessive losses. These investors also miss the highly rewarding opportunities, but they play it safe to lessen the emotional cost of making erroneous decisions. In stock markets, winning stocks are sold at higher volume than the losing stocks, which depicts investor fear of loss [56]. The following relation is hypothesized:

H8: Regret aversion significantly influences investment decisions.

2.9 Framing Bias and Investment Decisions

Wang [57] corroborated that investors are influenced by the manner in which information is conveyed, and this framing influences investors' objective evaluation of their decisions. Individuals affected by framing bias evaluate gains and losses disproportionately. The framing effect has extensive application in consumer behavior. Bunčić *et al.* [58] demonstrated that the occurrence of biases in human behavior encourages advertisers to positively frame the message for distorting consumer perception, which encourages consumers to make a purchase decision. In an experimental study, Hillenbrand *et al.* [59] found that the framing effect substantially impacts the retail investor's asset allocation choices. Jain *et al.* [14] exhibited that framing bias strongly influences investment decisions as investors react to the information either negatively or positively framed and invest funds accordingly. Based on partial information, investors are stimulated to capitalize on securities with high historical returns, leading to irrational judgments, as it prevents them from earning high returns in the future [60]. The following relationship is proposed:

H9: Framing bias significantly influences investment decisions.

2.10 Mediating Role of Risk Perception

Earlier studies have shown the mediating role of risk perception on the association between behavioral biases [61] and investment decisions [62]. Ahmad & Shah [63] represented that the relationship between overconfidence bias and investment decision and investment performance is significantly mediated by risk perception of investors. The study found that overconfidence bias has a negative indirect effect on the investment decision and investment performance through risk perception, as investors undervalue the risk, leading to absurd decisions, which in turn hampers performance [63]. Due to behavioral biases, investors make decisions on outdated information and develop excessive or conservative risk attitudes towards investment, which leads to adverse investment choices [64]. Ahmed *et al.* [61] also posited that individuals under the influence of cognitive and behavioral errors make adverse investment choices because of differential risk preferences.

Aren & Zengin [65] presented that risk perception is impacted by many emotional and cognitive factors, which further lead to aggressive or risk-averse investment choices. Sathya & Prabhavathi [66] indicated that information obtained from social media helps in framing investors' risk perception and eventually their choices. Some researchers studied the effect of herding bias, disposition effect, blue chip stocks bias, and overconfidence on investment decisions via risk perception [7]. They revealed that risk perception significantly mediates the connection between these biases and investment decisions. Investors with regret aversion bias prefer less risky choices for their investments to subsequently lessen the emotional pain of their past decisions, which affects their investment portfolio performance [67]. Based on the above discussion, it is hypothesized that:

H10: Risk perception mediates the relationship between self-attribution bias and investment decisions.
H11: Risk perception mediates the relationship between confirmation bias and investment decisions.
H12: Risk perception mediates the relationship between regret aversion bias and investment decisions.

H13: Risk perception mediates the relationship between framing bias and investment decisions.

2.11 Moderating Role of Financial Literacy

Financial literacy is the skills, attitude, and knowledge required to make informed financial decisions. It can be measured both objectively and subjectively [8]. Individuals having high financial literacy are capable of showing sound financial behavior regarding saving, budgeting, and investing. They have the capacity to plan and understand the complexity of investment decisions, which makes them better at investing than individuals with low financial literacy [68]. Some researchers studied financial literacy as a moderator between risk perception and investment decision [9]. They found that individuals with high financial literacy levels are more prone to invest in the stock market than the savings accounts [9]. Financial literacy reduces the irrationality in investment decision-making. Financially literate investors are better able to analyze risk and reward trade-offs among different financial products and adopt an appropriate strategy for improving the performance of their chosen investment options [69]. The study conducted on Chinese households exhibited that financial literacy increases risk-taking behavior while making financial decisions [70]. Investors who possess higher financial literacy are more likely to allocate their funds in riskier options like the stock market, while those with lower financial literacy prefer safer investments, like bank deposits [65]. It is hypothesized that:

H14: Financial literacy moderates the association between risk perception and investment decisions.

2.12 Research Model

Based on the research gaps identified from the previous literature, the research model depicted in Figure 1 has been proposed for the study.

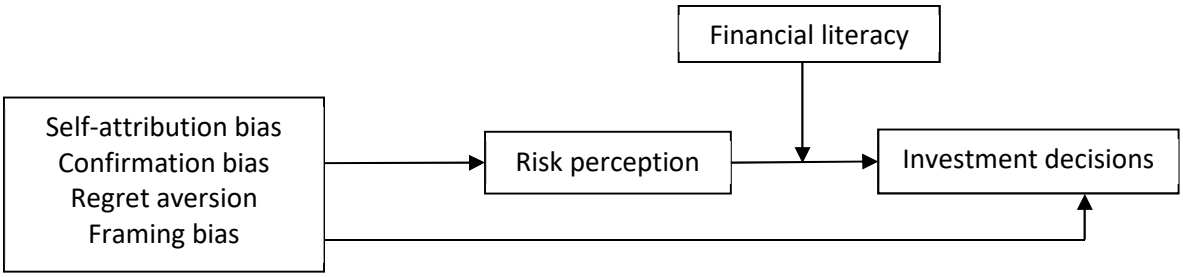

Fig. 1. Research model

3. Research Methodology

This study employed a quantitative research design to collect primary data directly from respondents, ensuring context-specific findings, particularly in relation to individual investors' behavior towards investment decisions. The design was based on validated constructs from prior research [71], which eliminated the need for developing new measures and reduced the necessity of qualitative methods. Data were obtained through a structured, self-administered questionnaire, enabling empirical testing of hypotheses and allowing analysis of responses across a larger sample.

The questionnaire was organized into two sections. The first gathered demographic details, while the second focused on the study's main variables. All items were adapted from credible academic sources to maintain validity and reliability and were rated using a five-point Likert scale, ranging from

strongly disagree (1) to strongly agree (5). In line with [72], emphasis on effective survey administration, the instrument was carefully designed and administered to minimize bias and enhance the accuracy of responses.

Overall, the quantitative approach was well-suited to the research objectives, as it facilitated hypothesis testing, supported generalizability, and provided robust insights into the relationships among the variables [73].

3.1 Questionnaire Design

The questionnaire was accompanied by a covering letter that outlined the study's purpose, significance, and confidentiality measures, assuring respondents of their anonymity. It also included the contact information of the principal investigator (PI) to allow participants to seek clarification if needed. To minimize social desirability bias, standard procedures were followed to ensure that responses reflected genuine opinions rather than socially acceptable ones.

Accurate measurement of variables formed a critical part of the research process [74]. The study examined self-attribution bias [75], confirmation bias, regret aversion bias, and framing bias as independent variables, with their influence on investment decisions mediated by risk perception and moderated by financial literacy [76]. To ensure validity and reliability [77], questionnaire items were adopted from established literature and reviewed by experts and professionals in the field (Table 1).

Table 1
Questionnaire items and sources

Variables	Items	Sources
Self-attribution bias	3	[74]
Confirmation bias	4	[74]
Regret aversion bias	4	[27]
Framing bias	3	[75]
Financial literacy	7	[76]
Risk perception	6	[61]
Investment decisions	8	[77]
Total	35	

Expert assessment ensured that the questionnaire items accurately reflected the intended constructs. To further confirm validity, confirmatory factor analysis (CFA) was conducted, demonstrating that the items corresponded with their theoretical dimensions. This process reinforced the study's overall credibility.

3.2 Population and Sample

The target population of this study consisted of individual investors of the Pakistan Stock Exchange (PSX). A sample of 350 investors was drawn, from which approximately 297 valid responses were obtained and used for the final analysis. The manageable sample size allowed the researcher to reduce selection bias and enhance the validity of the findings [78]. Relying on these 297 responses ensured that the data was both relevant and meaningful, providing a solid basis for analysis and conclusions [79]. To collect the data, the researcher employed a combination of personal and electronic distribution methods. Printed questionnaires were delivered to participants who could not be reached online, while an electronic survey was shared via a digital platform to engage those who preferred the convenience of responding electronically.

3.3 Pilot Testing: Confirmatory Factor Analysis, Reliability, and Validity

After developing the questionnaire, validation was carried out with a selected panel of experts to establish content validity in the Pakistani context. Consistent with the view that smaller expert groups facilitate consensus [80,81], feedback was obtained from three subject specialists and three industry professionals. Their suggestions led to refinements that improved the questionnaire's clarity, comprehensiveness, and effectiveness in measuring the impact of psychological biases on investment decisions.

Following this stage, a pilot test was carried out with 50 participants representing the target population. The pilot assessed the instrument's face validity and tested the validity of individual items using the CFA, conducted through SmartPLS software. This process confirmed that the questionnaire items were both reliable and aligned with the theoretical constructs.

4. Results and Discussion

4.1 Descriptive Statistics

The study sample consisted of 65.3% males (*n*=194) and 34.7% females (*n*=103). In terms of age, 22.6% (*n*=67) were between 35–40 years, 28.6% (*n*=85) fell within the 41–50 years range, and 24.9% (*n*=74) were aged 50 years or above (Table 2).

Table 2
Descriptive statistics of demographic variables

Variables		Frequency	Percentage
Age	35-40	67	22.6
	41-50	85	28.6
	Above 50	74	24.9
	Total	297	100
Gender	Female	103	34.7
	Male	194	65.3
	Total	297	100
Education	Bachelors	103	34.7
	Masters	99	33.3
	Other	95	32
	Total	297	100
Experience	5-10 years	71	23.9
	10-15 years	170	57.2
	Above 15 years	56	18.9
	Total	297	100

Educational qualifications showed that 34.7% (*n*=103) had a Bachelor's degree, 33.3% (*n*=99) held a Master's degree, and 32% (*n*=95) possessed other qualifications. Regarding work experience, 23.9% had 5–10 years, 57.2% had 10–15 years, and 18.9% reported more than 15 years of experience.

4.2 Reliability and Validity Analysis

Reliability and convergent validity of the constructs were examined using Cronbach's alpha, composite reliability (CR), and average variance extracted (AVE) (Table 3). All Cronbach's alpha values were above the recommended threshold of 0.70 [82], ranging from 0.794 for framing bias to 0.938 for investment decisions, reflecting strong internal consistency. Similarly, CR values exceeded the suggested benchmark of 0.70 [82], ranging from 0.879 to 0.948, further supporting the reliability of the constructs.

Table 3
Cronbach's alpha and average variance extracted

Research variables	Cronbach's alpha	Composite reliability	Average variance extracted
Self-attribution	0.815	0.89	0.729
Confirmation bias	0.853	0.9	0.693
Regret aversion	0.866	0.909	0.713
Framing bias	0.794	0.879	0.707
Risk perception	0.919	0.936	0.711
Financial literacy	0.926	0.936	0.677
Investment decisions	0.938	0.948	0.697

For convergent validity, all AVE values exceeded the recommended threshold of 0.50, ranging from 0.677 for financial literacy to 0.729 for self-attribution. This demonstrates that each construct explains more than half of the variance of its indicators, supporting convergent validity.

Overall, the results provide evidence that the measurement model demonstrates adequate reliability and convergent validity across all study variables. Furthermore, the examination of correlations between latent constructs, using the Fornell-Larcker criterion, revealed that these correlations were lower than the respective square roots of the AVE values [82], confirming the discriminant validity of the construct (Table 4). Combined with the evidence of reliability and convergent validity, the measurement model can be considered both reliable and valid.

Table 4
Discriminant validity - Fornell-Larcker criterion

Constructs	CB	FL	FB	INV	RA	RP	SA
CB	0.832						
FL	0.019	0.823					
FB	0.04	0.064	0.841				
INV	-0.095	0.565	-0.122	0.835			
RA	-0.022	0.008	0.008	0.583	0.844		
RP	-0.345	-0.064	-0.335	0.61	0.596	0.843	
SA	-0.169	0.022	-0.073	-0.205	0.029	-0.338	0.854

4.3 Model Fitness

The analysis of the measurement model showed an acceptable level of fit (Table 5).

Table 5
Model fit indices and model summary

Model fit	Saturated model	Model summary	R-squared	R-squared adjusted
SRMR	0.04	Investment decisions	0.455	0.446
d_ULS	0.998			
d_G	0.506	Risk perception	0.77	0.763
Chi-square	868.139			
NFI	0.881			

The SRMR value (0.04) was well below the cut-off of 0.08, suggesting excellent fit, while the NFI (0.881) was near the recommended 0.90 threshold, indicating moderately good fit. Discrepancy measures (*d_ULS* = 0.998; *d_G* = 0.506) pointed to minimal misspecification, and although the Chi-square statistic (868.139) was large, such values are common in models with larger samples and complex structures. Overall, the findings confirm that the saturated model provides a satisfactory representation of the observed data.

For the model summary, the coefficient of determination (R^2) illustrates the proportion of variance explained by the predictors. For investment decisions, the predictors explained 45.5% of the variance (R^2 = 0.455), with an adjusted R^2 of 0.446, indicating moderate explanatory strength after accounting for model complexity. For risk perception, the explanatory power was substantially higher, with 77% of the variance explained (R^2 = 0.770) and an adjusted R^2 of 0.763, suggesting a strong model fit. In sum, although both models were effective, the predictors had greater explanatory strength for risk perception than for investment decisions, highlighting risk perception's central role within the study.

4.4 Correlation Analysis

Pearson's correlation analysis was performed to examine the direction and strength of the relationships among variables. The results, presented in Table 6, highlight several noteworthy correlations.

Table 6
Correlations

Variables	SA	CB	RA	FB	RP	FL	INV
SA	1						1
CB	-.174**	1					-.174**
RA	0.033	-0.022	1				0.033
FB	-0.071	0.033	0.006	1			-0.071
RP	-.332**	-.353**	.594**	-.338**	1		-.332**
FL	0.016	-0.001	0.015	0.052	-0.051	1	0.016
INV	-.203**	-0.102	.582**	-.125*	.609**	.574**	-.203**

** Correlation is significant at the 0.05 level (2-tailed)

Table 6 reports the Pearson correlation coefficients among the study variables. Investment Decisions showed significant positive correlations with regret aversion (r = .582, p < .01), risk perception (r = .609, p < .01), and financial literacy (r = .574, p < .01), suggesting that higher levels of these factors are associated with stronger investment decisions.

Conversely, investment decisions were negatively correlated with self-attribution (r = –.203, p < .01) and framing bias (r = –.125, p < .05), indicating that these biases may undermine effective decision-making. Risk perception was positively related to regret aversion (r = .594, p < .01) but negatively correlated with self-attribution (r = –.332, p < .01), confirmation bias (r = –.353, p < .01), and framing bias (r = –.338, p < .01). Overall, these findings suggest that financial literacy, risk perception, and regret aversion support sound investment decisions, whereas cognitive biases can weaken them.

4.5 Regression Analysis

The direct effects analysis between psychological biases and investors' investment decisions (Table 7) showed that self-attribution had a significant negative effect on investment decisions (β = –0.073, t = 2.15, and p = .031), indicating that greater reliance on self-attribution bias reduces the quality of investment choices. Thus, H6 was supported. Regret aversion, on the other hand, had a strong and positive effect (β = 0.315, t = 8.02, p < .001), highlighting its crucial role in encouraging more deliberate decision-making; supporting H3. Conversely, confirmation bias (β = .049, t = 1.44, p = .150) and framing bias (β = –.017, t = 0.55, p = .585) did not exhibit a meaningful effect, resulting in the rejection of H7 and H9. Results also indicated that risk perception has a significant positive effect on investment decisions (β = 0.437, t = 9.062, p = 0.000), proving H5 true. The moderating effect was

also found to be non-significant (β = –.034, t = 1.24, p = .215), and therefore H14 was not supported. Overall, the results highlight regret aversion as a key determinant of investment behavior, whereas other cognitive biases and the moderator did not yield significant influences.

Table 7
Regression weights – direct effects and moderation with investment decisions

Paths	Beta coefficient	SD	*t*	*p* values	Hypothesis
SA -> INV	-0.073	0.034	2.153	0.031	Accepted
CB -> INV	0.049	0.034	1.44	0.150	Rejected
RA -> INV	0.315	0.039	8.023	0.000	Accepted
FB -> INV	-0.017	0.03	0.546	0.585	Rejected
RP -> INV	0.437	0.048	9.062	0.000	Accepted
Moderator effect ->INV	-0.034	0.028	1.24	0.215	Rejected

The direct effects between psychological biases and risk perception (Table 8) revealed that self-attribution significantly decreased risk perception (β = –.448, t = 15.47, p < .001), indicating that individuals who attribute outcomes primarily to themselves are less sensitive to potential risks. Confirmation bias also negatively influenced risk perception (β = –.403, t = 13.76, p < .001), suggesting that a focus on confirmatory information limits risk assessment. Thus providing support for H1 and H2. Conversely, regret aversion was a strong positive predictor (β = .600, t = 21.48, p < .001), implying that those motivated to avoid future regret are more likely to recognize and evaluate risks carefully, confirming H3. Framing bias similarly had a significant negative effect (β = –.359, t = 12.76, p < .001), reflecting the tendency to underestimate risk depending on how information is presented, supporting H4

Table 8
Regression weights – direct effects with risk perception

Paths	Beta coefficient	SD	*t*	*p* values	Hypothesis
SA -> RP	-0.448	0.029	15.471	0.000	Accepted
CB -> RP	-0.403	0.029	13.755	0.000	Accepted
RA -> RP	0.6	0.028	21.48	0.000	Accepted
FB -> RP	-0.359	0.028	12.763	0.000	Accepted

Collectively, these findings indicate that while regret aversion increases risk awareness, cognitive biases such as Self-attribution, confirmation bias, and framing bias reduce individuals' ability to accurately perceive risk.

4.6 Mediation Analysis

Table 9 indicates that risk perception significantly mediates the relationships between cognitive biases and investment decisions. The indirect effect of self-attribution on investment decisions through risk perception was significant (β = –.196, t = 8.04, p < .001), supporting H10. Confirmation bias also showed a significant negative indirect effect via risk perception (β = –.176, t = 7.43, p < .001), supporting H11. Regret aversion had a significant positive indirect effect on investment decisions through risk perception (β = .262, t = 8.60, p < .001), confirming H12, whereas framing bias exhibited a significant negative indirect effect (β = –.157, t = 8.00, p < .001), supporting H13.

Overall, these results highlight risk perception as a key mediating mechanism that strengthens the positive influence of regret aversion while transmitting the negative effects of self-attribution, confirmation bias, and framing bias on investment decisions.

Table 9
Mediation analysis

Paths	Beta coefficient	SD	*t*	*p* values	Hypothesis
SA -> RP -> INV	-0.196	0.025	8.039	0.000	Accepted
CB -> RP -> INV	-0.176	0.024	7.429	0.000	Accepted
RA -> RP -> INV	0.262	0.031	8.598	0.000	Accepted
FB -> RP -> INV	-0.157	0.02	7.995	0.000	Accepted

5. Discussion

The purpose of this paper was to analyze the impact of four behavioral biases on investment decisions through the mediating role of the risk perception of investors of PSX. The moderating role of financial literacy on the relationship between investor risk perception and investment decision was also examined.

The results of the study indicated that our hypotheses H1 and H2 are accepted. Self-attribution bias and confirmation bias have a significant negative impact on risk perception. Investors with self-attribution bias credit the successful outcome of their decisions to themselves, which enhances the overconfidence and sense of control in their behavior, reducing the risk perception of securities in the stock market. These investors found risky assets less threatening as they overestimate their ability to manage risk and the outcomes. The hypothesis aligns with the findings of [3]. Furthermore, confirmation bias also lessens the risk perception of investors. Investors with this bias selectively collect or interpret the information and neglect the contradictory evidence. This narrowed view and overestimation of their own beliefs develop a self-reinforcing loop of confidence that decreases their sensitivity to risk. The findings corroborated the study [21]. The results prove our hypothesis H3 true, showing that the effect of regret aversion on risk perception is significantly positive. Regret aversion increases the emotional discomfort with the earlier decision, which makes them more cautious in their investment decisions and encourages conservative risk assessment. Another hypothesis H4, was also accepted i.e. framing bias is significantly and negatively related to investor risk perception. The results depict that positive framing negatively shapes the investor's evaluation of risk. Investors exposed to a positively framed message tend to underestimate the risks associated with the security.

The findings demonstrated that risk perception positively affects investment decisions, supporting H5. If investors perceive a higher level of risk in the stock market instruments, they will be more careful and make informed investment choices. Such investors cautiously identify market volatility and downtrends and will conduct a more thorough valuation and analysis of the available securities in the market, which will help them improve their investment decision and ultimate performance. This finding is in line with the study [63].

The hypotheses H6, H7, H8, and H9 explored the influence of self-attribution bias, confirmation bias, regret aversion, and framing effect on investment decisions. The study revealed that the direct effect of self-attribution bias on investment decision was significantly negative, proving H6 true. Investors who rely excessively on their own abilities and blame negative outcomes on external factors are overly aggressive in their portfolio choices. They judge the existing opportunities inadequately, hampering the prudence of their investment decisions. The results substantiated the studies [13] and [83]; i.e., that behavioral biases significantly affect the investment decisions. In contrast, the direct effect of confirmation bias and framing bias on investment decision was insignificant, rejecting hypotheses H7 and H9. This indicates the evidence of full mediation between these paths. The hypothesis H8 was accepted as the research indicated a positive influence of regret aversion bias on investment decisions. This shows that investors who are risk-averse judiciously evaluate the possible

negative signals before making a commitment to the investments, and they are able to attain positive performance. This finding aligns with the research of Kengatharan & Kengatharan [54].

The findings confirm that risk perception significantly mediates the association between all the behavioral biases under consideration and investment decisions, supporting our hypotheses H10, H12, H13, and H14. Self-attribution bias negatively affects investment decisions through risk perception. Investors with self-attribution bias tend to underestimate the risk because of their over-reliance on their skills, leading to suboptimal investment decision risk [19]. These investors show behavior such as under-diversification and excessive investment while compromising the rationality of their choices. Investors with confirmation bias usually neglect unfavourable market signals and favour only the information that supports their beliefs, inclining them to undervalue the risk level of the stocks under consideration. The lower risk perception inspires them to take irrational investment decisions, which in turn reduces the safety of their portfolio choices. On the other hand, regret aversion enhances the risk perception level of investors and ultimately elevates the rational investment decision-making. Due to higher perceived risk, they become more risk-averse and cautious. In order to reduce the riskiness, they tend to perform technical and fundamental analysis and use other valuation techniques, which help them to make profitable judgments in the stock market [67]. In contrast, Investors under the influence of positive framing overemphasize the potential gains over the losses and causing them to ignore significant risk in the market [84]. Due to this reason, they make overly optimistic choices, which increases the likelihood of making adverse investment decisions. The findings regarding the mediating function of risk perception are consistent with the study [14].

The study found that financial literacy does not moderate the connection between risk perception and investment decisions, rejecting our hypothesis H14. It is because financial literacy provides the necessary skills that investors may not necessarily translate into the risk perception and actual investment behavior. The results correspond to the study [85], which claims that financial literacy fails to moderate the impact of risk-averse behavior on investment judgments. The direct effect of risk perception on investment decisions is more dominant than the impact of financial literacy on the link between risk perception and investment decisions. The risk perception limits the role of financial literacy in shaping the investor's choices.

6. Conclusion

The study seeks to investigate the link between behavioral biases and investment decisions through the view of heuristics and prospect-based cognitive shortcuts. The research concluded that behavioral biases significantly shape the investment decisions of investors. The study found that self-attribution bias, confirmation bias, and framing bias have significant negative effects on the investment decision through the mediating role of risk perception. Whereas, the effect of regret aversion on investment decision was significantly positive via risk perception. The mediating role of risk perception accentuates the psychological mechanisms involving behavioral biases to investment decisions. Self-attribution bias hampers the investment decision of the investor, whereas regret aversion bias improves the prudent investment decision-making. However, the direct effect of confirmation and framing biases was insignificant. Moreover, financial literacy fails to moderate the relationship between risk perceptions on investment decisions. Overall findings indicate that investors behave irrationally while making investment judgments, which impacts the prudence of their investment choices.

6.1 Implications

The biases examined in this study have previously been linked to investment decisions. However, previous studies overlooked the likely mediating variables. The study contributed to the behavioral finance field by examining the influence of behavioral biases and the underlying mechanisms involving investment decisions through risk perception. The study suggests that addressing these biases is crucial for investors because of their significance in improving risk awareness and enhancing decision quality and investment performance. The study provides valuable implications for financial advisors, brokers, and policymakers in refining accurate risk recognition and behavioral training to mitigate the adverse effects of biases and mental shortcuts. Policy makers can use the study findings in designing investor awareness campaigns aimed at helping investors recognize biases in their investment decision-making. It will help policy-makers to take initiatives and introduce programs for reducing irrational investment decisions, enabling investors to make profitable decisions. It would help them in enhancing the attractiveness of the stock market and positioning the stock market as a lucrative investment option.

6.2 Limitations and Future Recommendations

Like other empirical studies, this study has a few limitations that provide avenues for setting directions for future research. First, the present study relied only on the quantitative data. Future studies can encompass both qualitative and quantitative data for comprehensive insight. Secondly, the study is confined to the investors of PSX, which hampers the generalizability of the results. Future studies should be extended to other stock markets of the world to assess the generalizability of the findings. Furthermore, the study has examined a few behavioral biases in the context of investment decisions, which limits the scope of the present research. The studies in the future can incorporate other biases, such as recency bias, gambler's fallacy, and ostrich effect, which influence the risk perception and investment decisions. This study also lays a foundation for future studies to examine moderating variables for developing a deeper understanding of investor behavior.

Conflict of Interest

The authors declare no conflict of interest.

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