



Behavioral Biases and Investment Decisions: The Moderating Role of Financial Literacy among Retail Investors in the Digital Era

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Abstract

Background: Digital investment services have expanded retail participation in Indonesia's capital market, but easier market access does not necessarily produce more rational investor behavior. Psychological tendencies continue to shape individual choices, and prior evidence remains inconsistent regarding whether financial literacy can restrain those tendencies.

Objective: This research examines the relationship between an aggregate behavioral-bias construct and investment decisions, the direct role of financial literacy, and the extent to which financial literacy changes the behavioral-bias relationship among retail investors in a digital investment setting.

Methods: A quantitative explanatory design was applied to 300 retail investors who used digital investment platforms. The proposed direct and interaction relationships were estimated using Partial Least Squares Structural Equation Modeling (PLS-SEM).

Results: Behavioral biases were positively associated with investment decisions, while financial literacy also showed a positive direct relationship. The interaction coefficient was negative and significant, indicating that higher financial literacy reduces the strength of the association between behavioral biases and investment decisions.

Conclusion: Financial knowledge supports more informed investment judgment and can moderate behavioral influence, although it does not remove psychological tendencies entirely. Investor education should therefore integrate financial competence with awareness of common behavioral biases.

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INTRODUCTION

Online financial services have lowered many of the practical barriers that once limited individual participation in capital markets (Chen & Zhang, 2021; Kumar, 2024; Pokharel & Maharjan, 2024; Servon & Kaestner, 2008). Investors can now trade through mobile applications, access digital investment services, and obtain market-related information from social media, developments that have enlarged public participation and transaction activity (Buz & de Melo, 2024; Challa, 2025; Guijarro et al., 2019; Kong et al., 2024; Kumar, 2024). Easier access, however, does not ensure that every choice is formed through careful and rational judgment. In a highly connected investment environment, retail investors face both wider opportunities and a greater need to distinguish useful information from signals that may trigger biased responses (John et al., 2025; Lerman, 2020; Naheed et al., 2026; Zahera & Bansal, 2018).

KSEI statistics show that Indonesia recorded 11.6 million Single Investor Identification (SID) accounts at the end of September 2023, equivalent to 13.87% year-to-date growth (KSEI, 2023). Surabaya also experienced expansion during the same period, with the number of capital-market investors reaching roughly 307 thousand, about 9.98% above the previous period. The pattern indicates continued growth in public engagement with investment activities in Indonesia (Yuwana et al., 2025).

The 2024 National Survey of Financial Literacy and Inclusion, conducted jointly by OJK and BPS, placed Indonesia's financial literacy index at 65.43% and its financial inclusion index at 75.02% (OJK & BPS, 2024). The literacy figure for students and university students was lower, at 56.42%. KSEI data for 2024 further show that people younger than 30 years accounted for more than 54% of capital-market investors, although the assets managed by this group in November 2024 amounted to approximately Rp53.83 trillion, well below the value held by older groups. The contrast suggests that high participation among younger investors is not necessarily accompanied by equally strong financial knowledge or decision-making capability (Tamba et al., 2026).

Where conventional finance is built on the assumption of rational choice, behavioral finance emphasizes that actual investment behavior can be shaped by psychological tendencies. Overconfidence, herding, and loss aversion may interfere with objective assessments of risk and alternatives (Rumysa, 2024). Evidence across markets likewise shows that such biases matter for retail investors (Lepone, 2016; Talwar et al., 2021; Tan et al., 2024). Excessive confidence can encourage unnecessary trading, whereas herding can lead individuals to copy the actions of others without sufficient independent assessment. Both tendencies may raise the likelihood of poor investment choices.

Evidence concerning financial literacy as a moderating factor remains mixed. Firmansyah et al. (2023) found that financial literacy altered the effects of overconfidence and loss aversion, but did not significantly change the relationship between herding and investment decisions. Their result implies that moderation may depend on the particular behavioral tendency involved. Putri and Yulianti (2025) reported a moderating role for financial literacy in relationships involving anchoring and herding, while Malik et al. (2026) argued that stronger literacy supports more reasoned choices and reduces vulnerability to behavioral influence. Taken together, the literature has not produced a single, consistent pattern.

In principle, financial literacy should give investors a firmer basis for understanding risk, diversification, valuation, and financial management, thereby improving the quality of their choices. Yet prior findings differ on whether this knowledge consistently changes the strength of behavioral effects. Depending on the setting, literacy may weaken a bias, strengthen a relationship, or show no meaningful interaction. This unresolved pattern leaves an empirical gap regarding the moderating role of financial literacy, particularly for retail investors who make decisions through digital channels. The present research addresses that gap by combining overconfidence, herding, loss aversion, and anchoring within one higher-order behavioral-bias construct and examining financial literacy as its moderator among investors associated with the IDX Branch Office in Bandung.

The study is therefore directed at three related questions. First, it asks whether the combined behavioral-bias construct is associated with investment decisions. Second, it examines whether financial literacy has a direct relationship with those decisions. Third, it tests whether financial literacy changes the strength of the behavioral-bias relationship. These questions are examined in the context of retail investors linked to the Indonesia Stock Exchange (IDX) Branch Office in Bandung, with the broader objective of clarifying how behavioral tendencies and financial knowledge operate together in digital-era investment decision-making.

METHOD

A quantitative explanatory design was applied to test the proposed relationships among behavioral biases, financial literacy, and investment decisions. The empirical model was estimated with Partial Least Squares Structural Equation Modeling (PLS-SEM), an approach appropriate for models containing multiple latent relationships and an interaction term without requiring multivariate normality. The population consisted of retail investors associated with the Indonesia Stock Exchange (IDX) Branch Office in Bandung who used investment applications or digital trading services. Purposive sampling produced 300 respondents who were at least 17

years old, had been actively investing for six months or longer, and had completed investment transactions. Sample adequacy was considered with reference to (Hair et al., 2021).

Responses were gathered using a questionnaire scored on a five-point Likert scale from 1 (Strongly Disagree) to 5 (Strongly Agree). Model assessment proceeded in three parts. Indicator and construct quality were first examined through outer loadings, Average Variance Extracted (AVE), and Composite Reliability, using thresholds of 0.70, 0.50, and 0.70, respectively. The structural model was then assessed through R-square, path estimates, and bootstrapped T-statistics, with 1.96 used as the critical T-value. Finally, moderation was estimated by introducing the product term between behavioral biases and financial literacy. This specification allowed simultaneous testing of the behavioral-bias path, the financial-literacy path, and their interaction in explaining investment decisions.

RESULTS AND DISCUSSION

Results

Measurement Model (Outer Model) Evaluation

Outer Loadings

Indicator-level convergent validity was checked by comparing each observed measure with its intended latent construct. Outer loading served as the criterion, and indicators with values greater than 0.70 were treated as acceptable. The complete loading pattern for the constructs used in the model is reported in Table 1.

Table 1

Outer Loading

Variable	Indicator	Loading
Overconfidence	OC1	0.812
	OC2	0.845
	OC3	0.801
Herding	HD1	0.793
	HD2	0.822
	HD3	0.81
Loss Aversion	LA1	0.835
	LA2	0.854
	LA3	0.821
Anchoring	AN1	0.801
	AN2	0.832
	AN3	0.815
Financial Literacy	LK1	0.845
	LK2	0.872
	LK3	0.856
	LK4	0.838
Investment Decisions	KI1	0.82
	KI2	0.847
	KI3	0.831
	KI4	0.855

Every loading in Table 1 exceeds the 0.70 benchmark, with values extending from 0.793 to 0.872. Hence, the items assigned to overconfidence, herding, loss aversion, anchoring, financial literacy, and investment decisions meet the indicator-validity requirement. Because none fell below the specified cutoff, all items were retained for subsequent model assessment.

Validity and Reliability

Construct-level measurement quality was examined after the indicator loadings had been reviewed. Average Variance Extracted (AVE) was used to assess the share of indicator variance captured by each construct, whereas Composite Reliability (CR) and Cronbach's Alpha were used to assess internal consistency. The adopted criteria required AVE to be greater than 0.50 and both reliability coefficients to be greater than 0.70. Table 2 presents the resulting values.

Table 2*AVE, Composite Reliability, Cronbach Alpha*

Variable	AVE	CR	Alpha
Overconfidence	0.67	0.86	0.79
Herding	0.66	0.85	0.78
Loss Aversion	0.7	0.88	0.82
Anchoring	0.68	0.86	0.8
Financial Literacy	0.72	0.9	0.85
Investment Decisions	0.69	0.89	0.83

The AVE coefficients in Table 2 range between 0.66 and 0.72, so each construct captures more than half of the variance of its indicators. Composite Reliability ranges from 0.85 to 0.90 and Cronbach's Alpha from 0.78 to 0.85. All values are therefore above their respective minimum criteria, supporting adequate construct validity and internal consistency and allowing the analysis to proceed to the structural model.

Structural Model (Inner Model) Evaluation

R-Square

The explanatory capacity of the structural model was assessed with R-square. For the endogenous construct, this statistic represents the proportion of observed variance accounted for by the predictors included in the model; larger values imply greater explanatory strength. The R-square obtained for investment decisions is shown in Table 3.

Table 3*R-Square*

Variable	R ²
Investment Decisions	0.58

Investment Decisions has an R² of 0.58 in Table 3. In practical terms, the predictors specified in the model account for about 58% of the observed variation in investment decisions, leaving approximately 42% attributable to variables outside the present specification. Using the interpretation adopted for this analysis, the value indicates moderate explanatory strength. Figure 1 reports an R² of 0.582; the difference is solely due to rounding.

Hypothesis Testing (Path Coefficient)

Direct effects and the interaction effect were evaluated with bootstrapped PLS-SEM estimates. Statistical decisions considered the direction and magnitude of the path coefficient together with its T-statistic and P-value. A relationship was treated as significant when T exceeded 1.96 and P was below 0.05. The estimates used to evaluate H1-H3 are summarized in Table 4.

Table 4*Path Coefficient*

Hypothesis	Relationship	Coefficient	T-Stat	P-Value	Decision
H1	Behavioural Biases → Investment Decisions	0.462	5.832	< 0.001	Accepted
H2	Financial Literacy → Investment Decisions	0.318	4.215	< 0.001	Accepted
H3	Moderation (BB × LK) → Investment Decisions	-0.214	2.978	0.003	Accepted

H1 is supported because the path linking behavioral biases with investment decisions is positive and significant ($\beta = 0.462$; $T = 5.832$; $P < 0.001$). Since overconfidence, herding, loss aversion, and anchoring are modeled as components of one aggregate construct, the coefficient reflects their combined relationship with retail investors' decisions rather than separate effects for each bias.

H2 is also supported. Financial literacy has a positive coefficient of 0.318, with $T = 4.215$

and $P < 0.001$. Within the observed sample, stronger financial literacy is therefore associated with more favorable investment decision-making.

The interaction term provides support for H3 ($\beta = -0.214$; $T = 2.978$; $P = 0.003$). Its negative sign means that the behavioral-bias relationship becomes less pronounced as financial literacy increases. The result is consistent with the proposed role of financial literacy as a weakening moderator in the structural model.

Effect Size (f^2)

Effect size was examined after the significance tests to compare the relative contribution of each predictor to the endogenous construct. The f^2 statistic indicates the change in explained variance associated with a predictor while the remaining predictors are kept in the model. Values of 0.02, 0.15, and 0.35 were interpreted as small, medium, and large effects. Table 5 reports the calculated effect sizes.

Table 5

Effect Size

Variable	f^2
Behavioural Biases	0.32 (medium)
Financial Literacy	0.18 (medium)
Moderation	0.12 (small)

Behavioral biases produce the largest f^2 among the modeled effects, at 0.32, which falls in the medium category and approaches the large-effect benchmark. Financial literacy has an f^2 of 0.18 and is likewise categorized as medium. The interaction effect is smaller, with $f^2 = 0.12$. Thus, the aggregate behavioral-bias construct contributes most strongly to the explained outcome, followed by financial literacy and then the moderation term.

Model Fit Assessment

Two indices were used to examine overall fit: the Standardized Root Mean Square Residual (SRMR) and Normed Fit Index (NFI). The model produced SRMR = 0.065, below the 0.08 cutoff, and NFI of approximately 0.91, above the 0.90 reference value. Under the criteria applied here, both statistics indicate an acceptable correspondence between the specified model and the observed data.

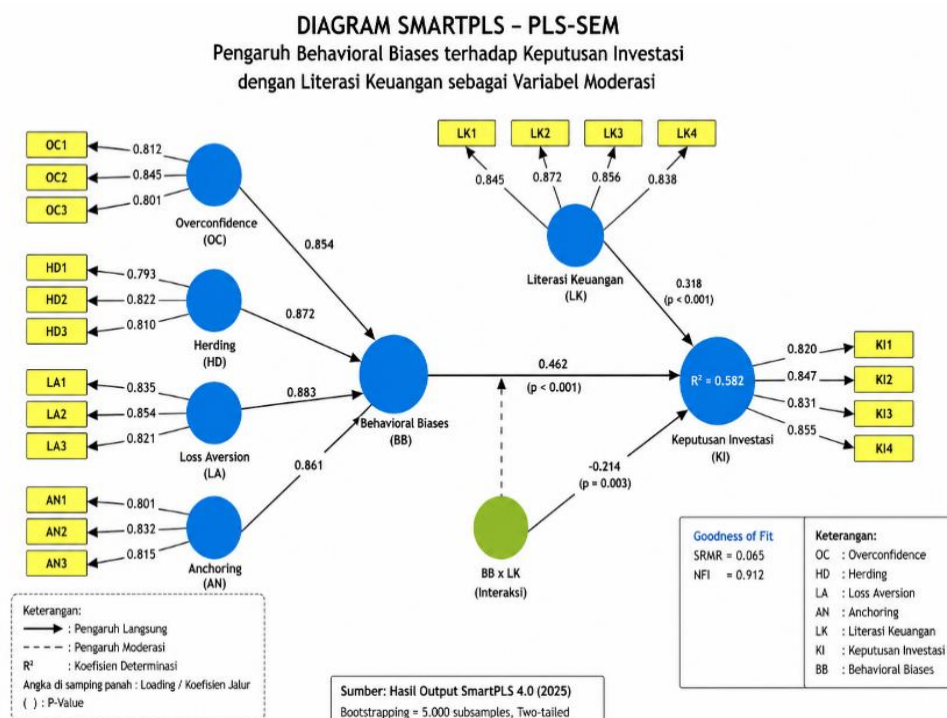


Figure 1. SMARTPLS Diagram

Figure 1 summarizes the estimated PLS-SEM model, in which the aggregate behavioral-bias construct predicts investment decisions and financial literacy enters both as a direct predictor and as a moderator. Overconfidence, herding, loss aversion, and anchoring form the behavioral-bias construct. The displayed indicator loadings are all above 0.70, consistent with Table 1. The figure also reports $R^2 = 0.582$ for investment decisions, meaning that the modeled predictors account for about 58.2% of its variance.

Discussion

The Influence of Behavioral Biases on Investment Decisions

The estimated behavioral-bias path is positive and statistically significant ($\beta = 0.462$; $T = 5.832$; $P < 0.001$). This result shows that behavioral tendencies remain relevant to investment choices even when retail investing is conducted in a digitally mediated environment. Because the model represents overconfidence, herding, loss aversion, and anchoring as dimensions of one aggregate construct, the coefficient should be read as evidence for their joint association with investment decisions, not as an individual effect for each dimension.

The pattern is compatible with Aqham et al. (2024), whose findings indicate that psychological tendencies can influence investment choices beyond the information supplied by the market. Aigbovo and Ilaboya (2019) similarly identify psychological factors as important determinants of investor behavior and question the assumption that financial choices are always produced by fully rational deliberation. These studies support the interpretation that cognitive and emotional tendencies contribute to the way investors evaluate alternatives.

Prospect theory offers an additional explanation for this result (Kahneman & Tversky, 2013). The theory proposes that choices under uncertainty are shaped by reference points and the way gains and losses are perceived, rather than by objective calculation alone. The significant path found in this study therefore suggests that greater access to financial information through digital platforms is insufficient, by itself, to remove psychological influence from retail investors' decisions.

The Influence of Financial Literacy on Investment Decisions

The direct path from financial literacy to investment decisions is positive and significant ($\beta = 0.318$; $T = 4.215$; $P < 0.001$). This direction suggests that investors with stronger financial understanding tend to make better-quality choices. Knowledge of investment instruments can help them compare expected returns with risk, recognize relevant product characteristics, and align investment actions with their own financial objectives.

This interpretation corresponds with Reinholtz et al. (2021), who associate financial literacy with a stronger capacity to evaluate financial information and make effective choices. Cavezzali et al. (2015) likewise show that financially knowledgeable investors are better positioned to reason about risk, diversification, and the consequences of alternative investment strategies. The present result therefore reinforces the practical value of financial knowledge in investment judgment.

Human capital theory provides a useful theoretical basis for the positive path (Becker, 1964). From this perspective, knowledge and skills are productive resources that expand an individual's ability to process information and choose among alternatives. Applied to retail investing, financial literacy functions as a knowledge resource that can improve the interpretation of market information, comparison of risks, and evaluation of available investment options.

The Role of Financial Literacy in Moderating the Influence of Behavioral Biases on Investment Decisions

The moderation estimate indicates that financial literacy reduces the strength of the association between behavioral biases and investment decisions. The interaction coefficient is -0.214 ($T = 2.978$; $P = 0.003$). Accordingly, the relationship attributable to behavioral tendencies becomes weaker at higher levels of financial literacy. Investors who understand financial concepts more thoroughly may be better able to check initial impressions, evaluate information on its merits, and avoid relying excessively on behavioral shortcuts.

Agarwal et al. (2025) provide comparable evidence by arguing that literacy can limit the

adverse consequences of behavioral bias through better risk understanding and more disciplined comparison of alternatives. Basha et al. (2022) also describe financial literacy as a mechanism capable of constraining cognitively or emotionally driven choices. These perspectives are consistent with the negative interaction estimated in the present model.

The result can further be interpreted through bounded rationality Simon (1955), which recognizes that decision makers operate with limited information-processing capacity and incomplete knowledge. Financial literacy cannot remove these constraints, but it can provide a more structured basis for interpreting financial information and may therefore reduce dependence on heuristics. Importantly, the behavioral-bias direct effect remains significant, showing that literacy attenuates rather than eliminates behavioral influence.

CONCLUSION

The empirical results answer the study objectives in three ways. First, the aggregate construct formed by overconfidence, herding, loss aversion, and anchoring is positively related to investment decisions among digital-era retail investors. Second, financial literacy has a separate positive association with investment decisions. Third, the significant negative interaction term shows that financial literacy dampens the relationship between behavioral biases and investment decisions. Financial knowledge therefore contributes both directly to investment judgment and indirectly by limiting, rather than completely removing, the role of behavioral tendencies.

The findings suggest that investor education should address financial competence and behavioral awareness together. Regulators and education providers can combine instruction on investment instruments, risk, and financial management with practical guidance on recognizing biased patterns of judgment. Digital investment platforms may support this objective through clear risk disclosures and educational features embedded in the user experience. Because the sample is confined to investors associated with the IDX Branch Office in Bandung and behavioral bias is modeled as an aggregate construct, future work should test individual bias dimensions separately and include broader investor groups and geographic settings.

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AUTHOR CONTRIBUTION STATEMENT

Duduh Sujana, Nugraha, Dismam, and Imas Puramasari contributed collaboratively to the overall research process and the preparation of this manuscript. The authors jointly participated in developing the research framework and ensuring that the research objectives were consistently addressed throughout the study.

All authors contributed to the scholarly development of the manuscript, including the interpretation and presentation of the research findings concerning behavioral biases, financial literacy, and investment decisions. The authors also worked collaboratively in refining the manuscript to ensure consistency between the research objectives, methodological approach, results, discussion, and conclusions.

All authors participated in the completion of the manuscript and took collective responsibility for the academic content presented in the article. Each author read, critically considered, and approved the final version of the manuscript submitted for publication and

agreed to be accountable for the integrity of the published work.

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