“Antecedents of investment decisions among retail investors: Mediating risk perception and moderating investment horizon”

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ANTECEDENTS OF INVESTMENT DECISIONS AMONG RETAIL INVESTORS: MEDIATING RISK PERCEPTION AND MODERATING INVESTMENT HORIZON

Abstract

Thai retail stock investors face competing pressures from sustainability criteria, behavioral bias, and volatility typical of an emerging market. The study examines relationships among sustainable investment, heuristic bias, and financial literacy in predicting investment decisions, and tests risk perception as a mediator and investment horizon as a moderator. A primary survey was administered from August 1 to August 31, 2025, using self-administered questionnaires. Data from 580 retail investors across six Thai regions were analyzed in SmartPLS 4.0 using 5,000 bootstrap resamples. The results indicate that heuristic bias ($\beta = 0.428$, $p < 0.001$) and financial literacy ($\beta = 0.401$, $p < 0.001$) emerged as the strongest predictors of risk perception, and sustainable investment also had a positive effect with a smaller magnitude ($\beta = 0.145$, $p < 0.001$). Risk perception had a positive effect on investment decisions ($\beta = 0.439$, $p < 0.001$) and mediated all three predictors, with the largest indirect effect observed for heuristic bias (indirect $\beta = 0.188$, $p < 0.001$). Investment horizon strengthened the association between sustainable investment and investment decision ($\beta = 0.417$, $p < 0.001$). The results confirm policy attention to financial education and bias-awareness initiatives and support efforts to encourage longer holding periods among retail investors. Market stakeholders can also improve the quality of environmental, social, and governance disclosures and promote practical risk-assessment frameworks to enable retail investors to translate sustainability information into more informed investment decisions.

Keywords behavioral finance, prospect theory, sustainable investment, heuristic bias, financial literacy, investment horizon, emerging markets, Thailand

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INTRODUCTION

Stock markets worldwide function as a key mechanism for mobilizing household savings into productive capital. In contrast, structural barriers to liquidity and transparency in emerging markets like Thailand remain stronger than in developed economies. Retail investor accounts in 2025 totaled 6,665,956, yet only 3.86% – approximately 257,501 accounts – are actively trading (SET, 2025). Paradoxically, this gap reflects more than mere access constraints; investors are drawn to markets through heuristic shortcuts (Chaudhary et al., 2025), yet simultaneously paralyzed by inflated risk perceptions and perceived financial illiteracy – preventing interest from translating into action.

Weak market governance, inaccurate financial reporting, and the distortion of sustainability signals through greenwashing (Owen, 2024) collectively erode investor trust – creating conditions in which hesitancy persists not from lack of access, but from lack of confidence in Thailand's stock market.

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Nevertheless, limited attention has been paid to how cognitive and behavioral factors – particularly under conditions of sustainability uncertainty and varying investment time horizons – shape actual investment decisions among Thai retail investors. The scientific problem of this study is therefore the incomplete understanding of how sustainable investment orientation, heuristic biases, and financial literacy influence investment decisions through risk perception, and whether these relationships are contingent on investors' time horizons, in the context of Thailand's retail investment market.

1. LITERATURE REVIEW

Traditional finance assumes that investors maximize expected utility through rational evaluation of available information, whereas behavioral finance argues that cognitive and emotional biases systematically affect investment decisions and can produce outcomes that depart from rational models (Barberis & Thaler, 2003; Kahneman & Tversky, 1979). Prospect theory explains that investors evaluate outcomes as gains or losses relative to a personal reference point, and losses tend to feel more severe than gains of equal size (Kahneman & Tversky, 1979). Loss aversion captures this asymmetry, as perceived pain from losses can outweigh pleasure from equivalent gains. Risk judgments also rely on intuitive impressions rather than objective probabilities, and rare events may be overweighted while frequent events may be underweighted. Investment decisions can thus depend more on subjective perceptions and bias than on strict calculation. Risk perception, defined as an investor's personal appraisal of potential gains and losses, functions as a key mechanism linking behavioral tendencies with sustainability considerations in investment choice (Ahmed et al., 2022; Chaudhary et al., 2025; Jain et al., 2023).

Most behavioral finance research on retail investors concentrates on developed markets, whereas fewer studies examine emerging markets, including Thailand (Paisarn et al., 2021). The Thai equity market faces information gaps, market volatility, and a large retail investor base, and these conditions can elevate reliance on personal judgment and perceived risk in decision-making (Sangkavadana, 2020). Besides, information asymmetry and volatility can increase dependence on informal cues and individual assessment in trading decisions. Empirical findings on loss aversion, overconfidence, and informal information use further position risk perception as a central psychological pathway through which behavioral tendencies and sustainability considerations relate to investment decisions (Paisarn et al., 2021).

The ESG segment in Thailand has expanded, as more firms appear on the Thailand Sustainability Investment list and ESG reporting has increased (SET, 2021). Retail investors, however, possess limited ESG knowledge and express concern about greenwashing practices (Owen, 2024; Suttipun, 2023). Sustainable investment can signal stronger firm quality and lower perceived long-term risk, and it can also raise short-term uncertainty due to complex and opaque ESG disclosures. The link between sustainable investment and risk perception remains theoretically ambiguous rather than clearly positive or negative, which calls for empirical investigation among Thai retail investors.

Heuristics, including representativeness, availability, anchoring, and overconfidence, lead investors to rely on mental shortcuts and simplified rules rather than fully evaluating objective information, and the process can distort probability judgments and risk evaluation in systematic ways (Kahneman & Tversky, 1979; Tversky & Kahneman, 1974). Research from Asian markets, involving emerging economies such as Nepal and Thailand, suggests that bias affects investment behavior mainly through subjective risk perception rather than through expected returns (Ahmed et al., 2022; Chaudhary et al., 2025; Jain et al., 2023; Lama et al., 2025). Thai retail investors commonly depend on peer recommendations, online forums, and familiarity-based judgments, and the pattern implies greater susceptibility to heuristic reasoning that aligns with prospect theory's reference-dependent evaluation and emphasis on perceived risk (Kahneman & Tversky, 1979; Paisarn et al., 2021). Heuristic bias can thus predict variation in risk perception, and it can also relate to investment decisions.

Financial literacy is linked to stronger financial planning, broader portfolio diversification, and higher-quality investment decisions (Baker et al., 2019; Deka et al., 2023). Its relationship with risk-taking and risk perception remains complex, and it can vary across situations. Greater financial knowledge can reduce perceived risk through better evaluation of information, and it can also raise risk-taking through greater confidence. Recent research identifies risk perception as a central pathway connecting financial literacy to investment decisions, meaning that financial knowledge affects behavior mainly through changes in perceived risk rather than through a direct shift in risk appetite (Almansour et al., 2023; Almansour et al., 2025; Deka et al., 2023). The pattern is salient in emerging markets like Thailand, where financial education initiatives exist, and investor understanding of complex financial and ESG-related information remains uneven (Paisarn et al., 2021; Wendy, 2024).

Prospect theory positions risk perception, defined as investors' subjective evaluation of potential gains and losses, as a key mediating construct linking sustainable investment, heuristic bias, and financial literacy to investment decisions (Ahmed et al., 2022; Chaudhary et al., 2025; Jain et al., 2023). Risk perception captures how investors interpret information, compare alternatives, and convert beliefs into portfolio choices, so it functions as the psychological mechanism through which judgments become action. Recent studies report that risk perception connects cognitive shortcuts, limited knowledge, and sustainability preferences to observed behavior in emerging markets, including India and Nepal, and heuristics relate to investment decisions mainly through subjective risk evaluation rather than through direct effects (Ahmed et al., 2022; Chaudhary et al., 2025; Jain et al., 2023). Experimental research also finds that structured financial training can systematically shift risk perception and subsequent financial choices, supporting the view that perceived risk can be adjusted in practice (Togan et al., 2025). Under sustainable investing conditions, risk perception can operate as the main pathway through which ESG considerations relate to actual investment behavior, particularly under information asymmetry and uncertainty about sustainability outcomes.

Investment horizon functions as a key conditioning factor in sustainability-oriented investment behavior. ESG-related value creation unfolds over extended periods, and longer horizons can reduce sensitivity to short-term volatility and increase tolerance for interim losses, which may reinforce ESG-aligned investment decisions (Sultana et al., 2018). Research on the Thai market reports that retail investors frequently maintain short holding periods driven by speculative motives and socially reinforced trading patterns (Paisarn et al., 2021). The pattern raises questions about whether extended horizons strengthen ESG-driven decision-making in practice. The role of investment horizon in the relationship between sustainability considerations and investment decisions remains unsettled and requires further empirical examination.

In summary, the literature identifies sustainable investment, heuristic bias, financial literacy, and risk perception as interconnected determinants of retail investment decisions, with risk perception as the primary mechanism linking cognitive and behavioral factors to action. Nevertheless, their simultaneous examination within a mediated and moderated framework remains absent in emerging markets, and evidence specific to Thai retail investors is limited (Chairit et al., 2025).

This study aims to examine the relationships among sustainable investment, heuristics, financial literacy, and investment decision, with risk perception as a mediator and investment horizon as a moderator. The hypotheses are as follows:

H1: Sustainable investment positively influences risk perception.

H2: Sustainable investment positively influences investment decisions.

H3: Heuristics positively influence risk perception.

H4: Heuristics positively influence investment decisions.

H5: Financial literacy positively influences risk perception.

H6: Financial literacy positively influences investment decisions.

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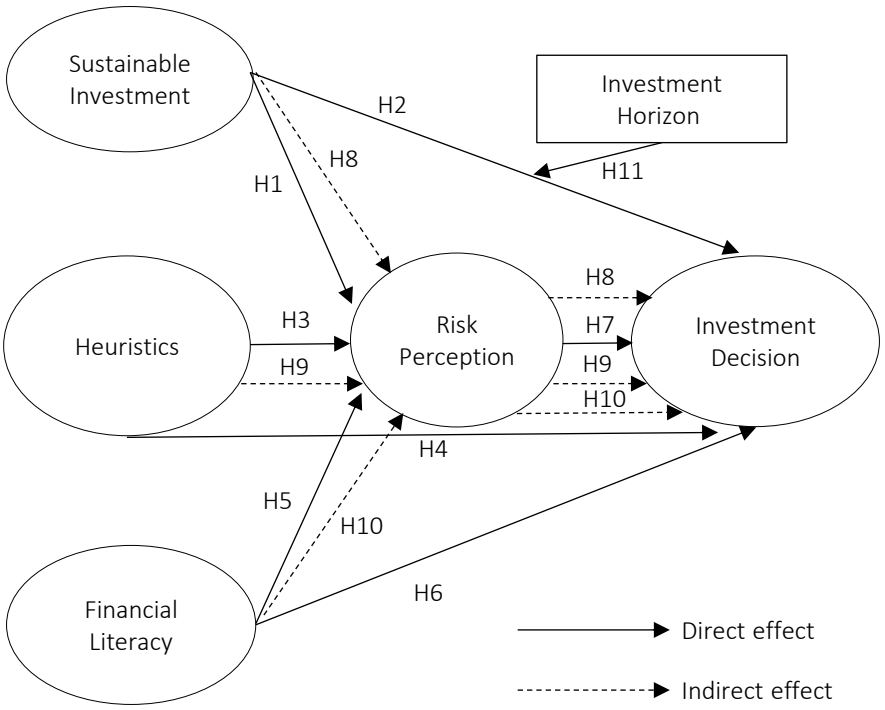

Figure 1. Conceptual framework

H7: Risk perception positively influences investment decisions.

H8: Risk perception mediates the relationship between sustainable investment and investment decision.

H9: Risk perception mediates the relationship between heuristics and investment decisions.

H10: Risk perception mediates the relationship between financial literacy and investment decision.

H11: Investment horizon positively moderates the effect of sustainable investment on investment decisions.

Figure 1 presents the conceptual framework for the proposed relationships.

2. METHODOLOGY

A quantitative survey design was used to examine how sustainable investment, heuristic bias, and financial literacy relate to investment decisions among Thai retail investors. Risk perception was specified as a mediator, and investment horizon was specified as a moderator. The target group included retail investors who actively trade common stocks on the Stock Exchange of Thailand and report total financial assets below 30 million baht.

Data collection took place from August 1 to August 31, 2025, using a structured, self-administered paper questionnaire adapted from established empirical scales. Sampling ensured representation from Thailand's six regions, including Bangkok and its vicinity, Central, Northern, Northeastern, Eastern, and Southern, and regional quotas followed population proportions. Informed consent was obtained from all respondents prior to participation.

A total of 800 questionnaires were distributed, and 600 were returned, yielding a 75% response rate. Data screening removed incomplete responses and systematically patterned answers, leaving 580 valid cases for analysis and an effective response rate of 72.5%. The final sample was adequate for Partial Least Squares Structural Equation Modeling. The survey contained 58 Likert-type items, and the final sample met common guidance that recommends 5 to 10 respondents per item, and it also met a stricter check based on the pre-

dictor structure of the most complex model that included the investment horizon interaction. The sample included 61.7% female respondents and 38.3% male respondents. Age distribution concentrated in early to mid-adulthood, with 42.2% aged 23-42 years and 32.2% aged 43-57 years, whereas 21.2% were under 23 years and 4.3% were 58 years or older. Educational attainment was high, with 59.5% holding a bachelor's degree and 38.4% holding postgraduate qualifications, whereas 2.1% reported education below the bachelor's level. The investment horizon also varied, and 55.5% reported a short-term horizon of less than five years, whereas 44.5% reported a long-term horizon of five years or more.

The questionnaire consisted of two sections. The first section collected demographic and investment profile information and classified the investment horizon as short-term or long-term. The second section measured five constructs on a five-point agreement scale. Content validity was reviewed by five experts in behavioral finance and survey methodology, and the instrument was pilot tested with 30 Thai retail investors to confirm clarity and wording. Minor revisions were made after the pilot. The average item objective congruence score was 0.89, which exceeded the 0.50 benchmark. Item wording for sustainable investment, heuristic bias, financial literacy, and risk perception appears in Appendix A.

PLS-SEM analyses were conducted in SmartPLS 4 using a two-step procedure. Measurement quality was evaluated through indicator reliability using outer loadings at or above 0.70, internal consistency using Cronbach's alpha, and composite reliability at or above 0.70, convergent validity using AVE at or above 0.50, and discriminant validity using HTMT below 0.85. Structural relationships were then tested, and multicollinearity was examined using a VIF below 5. Hypotheses were evaluated using path coefficients and significance tests, and model performance was assessed using R^2 and adjusted R^2. Effect sizes were examined using f^2, and predictive relevance was assessed using Q^2 based on blindfolding. Moderation by investment horizon was tested using interaction terms, and conditional effects were examined through simple slope analysis.

The research received approval from the Human Research Ethics Committee at Thaksin University (COA No. TSU 2025_219; REC No. 0446). Participation in the survey was entirely voluntary, and the anonymity and confidentiality of all respondents were protected.

3. RESULTS

The measurement model was assessed through indicator reliability, internal consistency reliability, convergent validity, and discriminant validity (Hair et al., 2024). Measurement items are presented in Appendix A, while Table 1 reports the statistical results. As shown, all outer loadings exceeded 0.70, VIF values were below 5, Cronbach's alpha and CR exceeded 0.70, and AVE exceeded 0.50 (Hair et al., 2019), confirming that the measurement model is robust and suitable for structural analysis.

All outer loadings exceeded the 0.70 criterion and ranged from 0.737 to 0.936, which supports indicator reliability. The strongest loadings appeared for Availability (AV2 = 0.936) and Governance (G2 = 0.925). Sustainable investment indicators performed well across dimensions, with Environment ranging from 0.848 to 0.893, Social ranging from 0.845 to 0.903, and Governance ranging from 0.871 to 0.925. Heuristic indicators also performed strongly, with Anchoring ranging from 0.809 to 0.877, Availability ranging from 0.878 to 0.936, Representativeness ranging from 0.820 to 0.851, and Overconfidence ranging from 0.862 to 0.907. Financial literacy indicators were acceptable to strong, with Financial Knowledge ranging from 0.847 to 0.885, Financial Behavior ranging from 0.737 to 0.883, and Financial Skill ranging from 0.887 to 0.913. Risk perception indicators were consistently high, with Financial Risk ranging from 0.815 to 0.909, Time Risk ranging from 0.856 to 0.919, and Personal Risk ranging from 0.807 to 0.908. Investment decision indicators also met standards, with Financial Factors ranging from 0.854 to 0.911 and Nonfinancial Factors ranging from 0.844 to 0.896, and all dimensions met the indicator reliability requirement.

Variance inflation factors ranged from 1.747 to 4.385, and all values remained below 5, which re-

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Table 1. Measurement model

Variable	Item	Outer Loading	VIF	Cronbach's Alpha	CR	AVE
Sustainable Investment						
Environment	EN1	0.893	3.093	0.892	0.925	0.755
	EN2	0.858	2.289			
	EN3	0.876	2.919			
	EN4	0.848	2.259			
Social	S1	0.889	3.340	0.904	0.933	0.776
	S2	0.845	2.150			
	S3	0.903	3.479			
	S4	0.885	2.793			
Governance	G1	0.920	3.278	0.890	0.932	0.820
	G2	0.925	3.513			
	G3	0.871	2.064			
Heuristics						
Anchoring	AN1	0.834	2.238	0.860	0.905	0.704
	AN2	0.835	2.274			
	AN3	0.809	1.747			
	AN4	0.877	2.913			
Availability	AV1	0.909	3.546	0.893	0.934	0.824
	AV2	0.936	3.839			
	AV3	0.878	2.720			
Representativeness	RE1	0.849	2.501	0.863	0.907	0.709
	RE2	0.851	2.427			
	RE3	0.820	2.354			
	RE4	0.847	2.438			
Overconfident	OV1	0.862	2.531	0.905	0.934	0.779
	OV2	0.907	3.188			
	OV3	0.891	2.849			
	OV4	0.871	2.543			
Financial Literacy						
Financial Knowledge	FK1	0.885	2.650	0.886	0.921	0.744
	FK2	0.851	2.102			
	FK3	0.866	2.442			
	FK4	0.847	2.220			
Financial Behavior	FB1	0.822	2.369	0.836	0.891	0.673
	FB2	0.883	2.702			
	FB3	0.832	2.134			
	FB4	0.737	1.832			
Financial Skill	FS1	0.900	3.168	0.925	0.947	0.816
	FS2	0.887	2.840			
	FS3	0.913	3.410			
	FS4	0.913	3.456			
Risk Perception						
Financial Risk	RPF1	0.854	2.478	0.890	0.924	0.752
	RPF2	0.889	3.968			
	RPF3	0.909	4.385			
	RPF4	0.815	2.149			
Time Risk	RPT1	0.856	2.417	0.908	0.936	0.784
	RPT2	0.919	3.698			
	RPT3	0.890	3.018			
	RPT4	0.876	2.490			
Personal Risk	RPP1	0.807	1.860	0.892	0.925	0.756
	RPP2	0.908	3.335			
	RPP3	0.869	2.377			
	RPP4	0.891	3.014			

Table 1 (cont.). Measurement model

Variable	Item	Outer Loading	VIF	Cronbach's Alpha	CR	AVE
Investment Decision						
Financial Factors	IDF1	0.884	3.442	0.900	0.930	0.770
	IDF2	0.859	2.327			
	IDF3	0.911	3.382			
	IDF4	0.854	2.769			
Nonfinancial Factors	IDN1	0.881	3.419	0.900	0.930	0.769
	IDN2	0.896	3.877			
	IDN3	0.887	2.806			
	IDN4	0.844	2.595			

Note: Detailed measurement items are provided in Appendix A.

duces concern about multicollinearity. The lowest VIF was for AN3 at 1.747, and the highest for RPF3 at 4.385; both values remained acceptable.

Internal consistency reliability was supported by Cronbach's alpha and composite reliability. Cronbach's alpha ranged from 0.836 to 0.925, exceeding the 0.70 benchmark across constructs, and the highest value was observed for Financial Skill at 0.925, followed by Time Risk at 0.908 and Social at 0.904. Composite reliability ranged from 0.891 to 0.947, and Financial Skill recorded the highest value at 0.947, followed by Time Risk at 0.936 and Availability at 0.934, which confirms strong internal consistency.

Convergent validity was supported by average variance extracted, with values ranging from 0.673 to 0.824 and all exceeding the 0.50 criterion. Availability recorded the highest AVE at 0.824, followed by Governance at 0.820 and Financial Skill at 0.816, and Financial Behavior recorded the lowest AVE at 0.673 while still meeting the required threshold. The pattern indicates that each construct captures substantial variance in its indicators.

Discriminant validity was assessed using the Heterotrait-Monotrait (HTMT) ratio of correlations (Henseler et al., 2015). Table 2 presents the results, and all HTMT values were below the threshold of 0.85, confirming that the constructs are empirically distinct and that discriminant validity is established.

Discriminant validity was evaluated using the heterotrait-monotrait ratio, and Table 2 reports the results. HTMT values ranged from 0.373 to 0.773, and all remained below the conservative cutoff of 0.85, which supports discriminant validity. The lowest value appeared between Sustainable Investment and Financial Literacy at 0.373, which indicates a clear separation between the constructs. The highest value at 0.773 appeared between Heuristics and Risk Perception and remained within the acceptable range. Additional HTMT values were moderate, including Heuristics and Financial Literacy at 0.649, Financial Literacy and Risk Perception at 0.754, and Risk Perception and Investment Decision at 0.685, confirming that the constructs are related yet empirically distinct.

The structural model was evaluated for hypothesis testing by examining path coefficients and significance. Following Hair et al. (2024), model quality was assessed using R^2, adjusted R^2, Q^2, and SRMR. The assessment followed these thresholds: a Q^2 val-

Table 2. Discriminant validity: Heterotrait-Monotrait (HTMT) ratio

Variable	SI	HE	FL	RP	ID
SI					
HE	0.478				
FL	0.373	0.649			
RP	0.501	0.773	0.754		
ID	0.490	0.585	0.511	0.685	

Note: SI-Sustainable Investment; HE-Heuristics; FL-Financial Literacy; RP-Risk Perception; ID-Investment Decision.

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Table 3. Coefficient of determination (R2) and adjusted R2 for endogenous constructs

Dependent Variable	R^2	Adjusted R^2	Q^2	SRMR
RP	0.670	0.668	0.665	0.075
ID	0.485	0.479	0.400	

Note: RP-Risk Perception; ID-Investment Decision; R2-Coefficient of determination; Q2- predictive relevance; SRMR- standardized root mean square residual.

ue greater than 0 indicates predictive relevance; an SRMR value below 0.08 indicates an acceptable fit; and R^2 values of 0.75, 0.50, and 0.25 are considered substantial, moderate, and weak, respectively. The adjusted R^2 was also reported to account for model complexity and ensure parsimony. Table 3 presents the results.

The structural model demonstrated strong explanatory capacity. Risk perception accounted for 67.0% of the variance, with $R^2 = 0.670$ and adjusted $R^2 = 0.668$, and sustainable investment, heuristic bias, and financial literacy jointly explained a substantial share of variation in risk perception. Investment decision accounted for 48.5% of the variance, with $R^2 = 0.485$ and adjusted $R^2 = 0.479$, and risk perception, heuristic bias, and the interaction between sustainable investment and investment horizon explained nearly half of the variation in investment decision. Small gaps between R^2 and adjusted R^2, equal to 0.002 for risk perception and 0.006 for investment decision, support model parsimony and reduce concern about overfitting.

Predictive relevance was evaluated using Stone Geisser's Q^2. Both endogenous constructs produced positive values: Q^2 for risk perception was 0.665, and Q^2 for investment decision was 0.400, which supports predictive relevance. The value for risk perception was high and indicates strong predictive performance, whereas the value for investment decision was moderate and indicates acceptable predictive accuracy.

Model fit was assessed using the standardized root mean square residual. The SRMR value was 0.075 and remained below the 0.08 guideline, which supports an acceptable fit between the model and the observed data.

The structural relationships and research hypotheses were tested using a bootstrapping procedure with 5,000 resamples. Following Hair et al. (2024), model quality was assessed through path coefficients β, t-statistics, and p-values for direct, indirect, and moderating effects. The assessment applied specific thresholds: a t-statistic greater than 1.96 and a p-value below 0.05 were required to in-

Table 4. Hypotheses testing

Construct	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T-Statistics (|O/STDEV|)	P-values	f^2	Result
Direct Effects							
H1: SI → RP	0.145	0.146	0.031	4.693	0.000	0.050	Accepted
H2: SI → ID	0.053	0.053	0.057	0.922	0.356	0.002	Rejected
H3: HE →RP	0.428	0.429	0.039	10.979	0.000	0.314	Accepted
H4: HE →ID	0.125	0.126	0.047	2.684	0.007	0.013	Accepted
H5: FL → RP	0.401	0.400	0.034	11.729	0.000	0.303	Accepted
H6: FL → ID	0.008	0.008	0.040	0.199	0.842	0.000	Rejected
H7: RP → ID	0.439	0.438	0.059	7.378	0.000	0.118	Accepted
Indirect Effect (mediation analysis)							
H8: SI → RP → ID	0.064	0.064	0.017	3.783	0.000		Accepted
H9: HE → RP→ ID	0.188	0.188	0.030	6.308	0.000		Accepted
H10: FL→ RP → ID	0.176	0.175	0.029	6.121	0.000		Accepted
Moderation Effect							
H11: SI× IH → ID	0.417	0.417	0.078	5.311	0.000		Accepted

Note: SI = Sustainable Investment; HE = Heuristics; FL = Financial Literacy; RP = Risk Perception; ID = Investment Decision; IH = Investment Horizon. Original Sample (O) represents the standardized path coefficient (β). Significance assessed using $|t| > 1.96$ and $p < 0.05$ simultaneously (Hair et al., 2024). T-statistics and p-values based on 5,000 bootstrap samples.

dicate statistical significance. Additionally, effect sizes f^2 were interpreted based on Cohen's (1988) benchmarks, where values of 0.02, 0.15, and 0.35 represent small, medium, and large effects, respectively. Table 4 presents the comprehensive results of the hypothesis testing.

3.1. Direct effect

Path estimates revealed clear differences in the strength of predictors of risk perception. Heuristic bias produced the largest positive effect on risk perception ($\beta = 0.428$, $t = 10.979$, $p < 0.001$), and financial literacy followed closely ($\beta = 0.401$, $t = 11.729$, $p < 0.001$). Sustainable investment also had a positive effect on risk perception, and the effect was statistically significant although smaller in magnitude ($\beta = 0.145$, $t = 4.693$, $p < 0.001$). The pattern supports *H1*, *H3*, and *H5*.

Effect size results reinforced the same ordering. Heuristic bias produced a large effect on risk perception ($f^2 = 0.314$), and financial literacy also produced a large effect ($f^2 = 0.303$), whereas sustainable investment produced a small effect ($f^2 = 0.050$). Cohen's (1988) benchmarks classify f^2 values of 0.02 as small, 0.15 as medium, and 0.35 as large, and the results position heuristics and financial literacy as the dominant drivers of risk perception in the model.

Direct effects on investment decisions were limited. Sustainable investment was not statistically significant ($\beta = 0.053$, $t = 0.922$, $p = 0.356$), and financial literacy was also not statistically significant ($\beta = 0.008$, $t = 0.199$, $p = 0.842$), so *H2* and *H6* were rejected. Heuristic bias produced a positive direct effect on investment decisions ($\beta = 0.125$, $t = 2.684$, $p = 0.007$), which supports *H4*, and the corresponding effect size remained small ($f^2 = 0.013$). Risk perception had a strong positive effect on investment decisions ($\beta = 0.439$, $t = 7.378$, $p < 0.001$), which supports *H7*, and the effect size was moderate ($f^2 = 0.118$), positioning risk perception as the central pathway in the model.

3.2. Indirect effect (mediation analysis)

Mediation analysis confirmed risk perception as a significant mediator linking all three predictors to the investment decision. The indirect effect of sustainable investment on investment decision through risk perception was significant ($\beta = 0.064$, $t = 3.783$, $p < 0.001$), which supports *H8*. The direct path from sustainable investment to investment decision was not significant, so the result supports full mediation.

The indirect effect of heuristic bias on investment decision through risk perception was significant ($\beta = 0.188$, $t = 6.308$, $p < 0.001$), supporting *H9*. A significant direct effect from heuristic bias to investment decisions also remained, so the result supports partial mediation. The indirect effect ($\beta = 0.188$) exceeded the direct effect ($\beta = 0.125$), and the pattern indicates that the risk-evaluation pathway carried more weight than the direct pathway.

The indirect effect of financial literacy on investment decision through risk perception was significant ($\beta = 0.176$, $t = 6.121$, $p < 0.001$), which supports *H10*. The direct path from financial literacy to investment decision was not significant, so the result supports full mediation.

3.3. Moderation effect

Moderation analysis found a positive and statistically significant interaction effect between sustainable investment and investment horizon on investment decision ($\beta = 0.417$, $t = 5.311$, $p < 0.001$), which supports *H11*. The result indicates that investment horizon moderates the association between sustainable investment and investment decision. A simple slope analysis was then conducted to interpret the interaction, and Figure 2 presents the pattern.

Figure 2 displays the simple slope analysis for the moderating role of investment horizon. Two lines appear in the plot, with short-term investors coded as 0 in red and long-term investors coded as 1 in green. The slope for short-term investors is weak and nearly flat, and the investment decision remains relatively stable across levels of sustainable investment. The slope for long-term investors is steeper and positive, and investment decisions increase substantially as sustainable investment rises. The pattern indicates that the positive association between sus-

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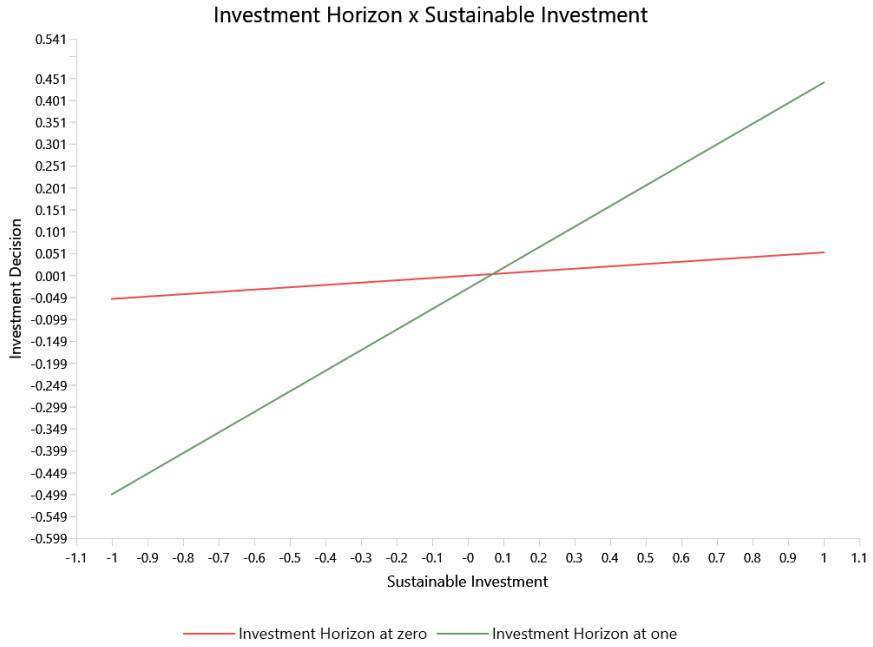

Figure 2. Simple slope for the statistically significant moderating role of investment horizon

tainable investment and investment decision is stronger for investors with longer horizons and minimal for those with shorter horizons.

The diagram reports relationships among sustainable investment, heuristic bias, financial literacy, risk perception, and investment decision, and it includes the moderating role of investment horizon. The R^2 values appear within the endogenous constructs, with 0.670 for risk perception and 0.485 for investment decision, and the values represent the proportion of variance explained by the model. The structure confirms risk perception as the central mediator connecting sustainable investment, heuristic bias, and financial literacy to investment decisions, and it confirms investment horizon as a significant moderator of the sustainable investment and investment decisions. Figure 3 presents the confirmed research model.

4. DISCUSSION

The study examined relationships among sustainable investment, heuristic bias, financial literacy, risk perception, and investment decision among Thai retail investors, and it tested investment horizon as a moderator. Risk perception emerged as the central mediator linking cognitive and behavioral factors to investment decisions. Sustainable investment had a positive effect on risk perception ($\beta = 0.145$, $p < 0.001$), which aligns with prospect theory (Kahneman & Tversky, 1979). In emerging markets with limited ESG disclosure quality, investors may interpret sustainability attributes as sources of regulatory or reputational risk rather than as signals of return potential (Friede et al., 2015; Suttipun, 2023). The direct path from sustainable investment to investment decision was not significant ($\beta = 0.053$, $p = 0.356$), which aligns with prior findings (Ahamed & Ahammed, 2023; Shah & Mishra, 2021). ESG information appears to operate through risk evaluation before it relates to actual decisions, particularly among short-horizon traders (Yadav & Chaudhary, 2022).

Heuristic bias had a strong positive effect on risk perception ($\beta = 0.428$, $p < 0.001$) and a smaller direct effect on investment decision ($\beta = 0.125$, $p = 0.007$), which is consistent with behavioral finance theory (Jain et al., 2023; Tversky & Kahneman, 1974; Yadav & Chaudhary, 2022). Salient events can dominate attention and increase the weight assigned to downside outcomes. The indirect effect of heuristics through risk perception ($\beta = 0.188$, $p < 0.001$) exceeded the direct effect, confirming partial mediation and positioning risk evaluation as the primary pathway linking heuristics to behavior.

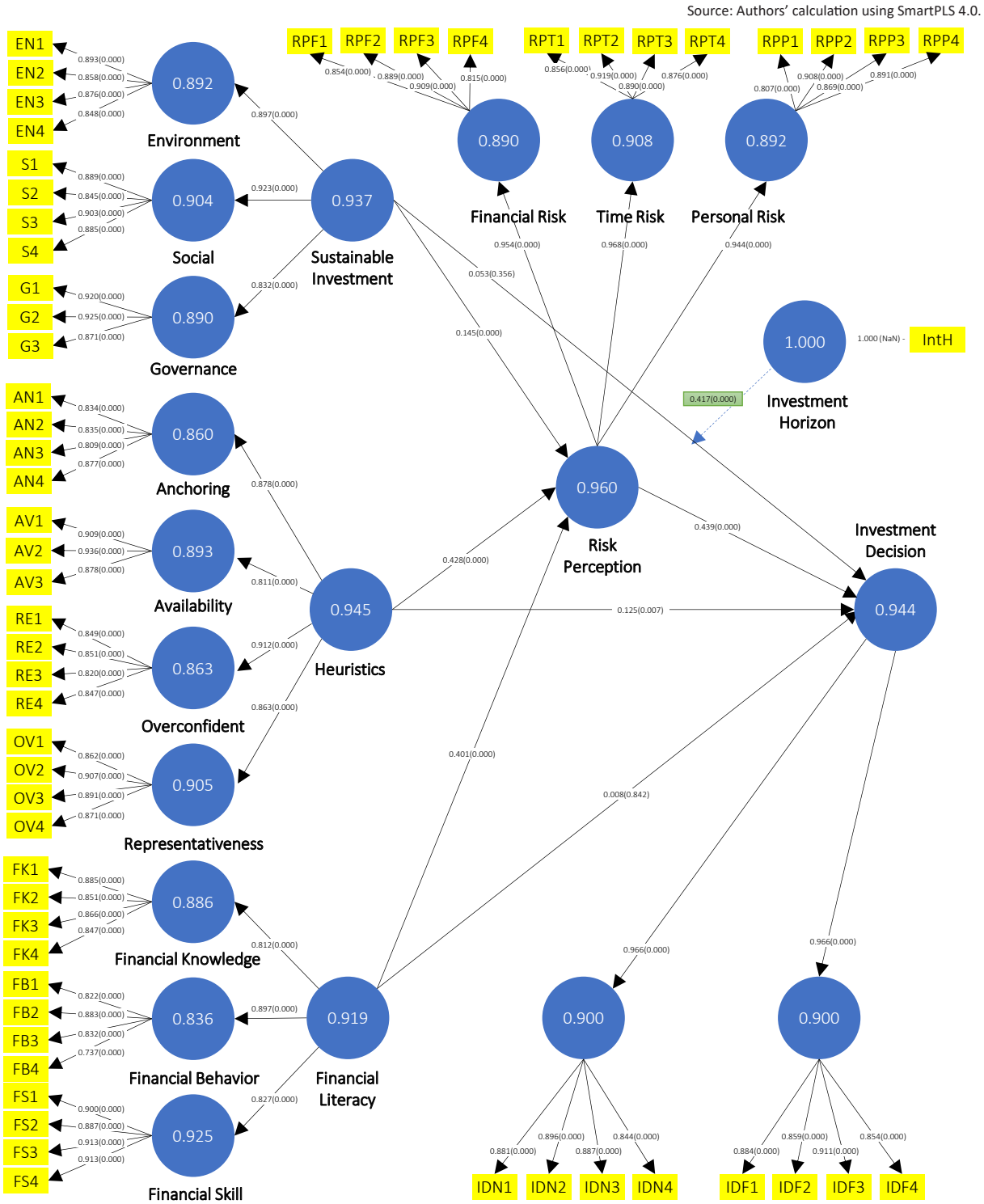

Figure 3. Confirmed research model

Financial literacy had a positive effect on risk perception (β = 0.401, p < 0.001), which aligns with research reporting that financially literate investors recognize a wider range of risks and volatility (Aren & Zengin, 2016; Waheed et al., 2020). Experimental findings report that targeted training can raise measured risk perception, as participants become more attentive to potential losses (Togan et al., 2025). The cross-sectional design used here permits associational interpretation rather than causal inference. The direct path from financial literacy to investment decision was not significant (β = 0.008, p = 0.842), which aligns with prior studies (Johri et al., 2023; Oppong et al.,

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2023; Wendy, 2024). The indirect effect through risk perception was significant ($\beta = 0.176$, $p < 0.001$), which supports full mediation and indicates that financial literacy relates to behavior primarily through perceived risk (Rahyuda & Candradewi, 2023; Waheed et al., 2020).

Risk perception had a strong positive effect on investment decision ($\beta = 0.439$, $p < 0.001$), which aligns with prior research (Ainia & Lutfi, 2019; Almansour et al., 2023; Hidayah & Irowati, 2021). Risk perception functions as a cognitive filter that converts complex financial and nonfinancial information into actionable portfolio choices. Mediation tests confirmed full mediation for sustainable investment and financial literacy and partial mediation for heuristics. Investment horizon moderated the relationship between sustainable investment and investment decision ($\beta = 0.417$, $p < 0.001$), which aligns with ESG research (Sultana et al., 2018). Sustainability attributes had stronger relevance for investors with longer horizons, whereas short-horizon traders focused more on immediate price movements. The findings confirm the central mediating role of risk perception and identify investment horizon as a boundary condition for the effectiveness of sustainable investment.

CONCLUSIONS

This study examined the relationships among sustainable investment, heuristic biases, and financial literacy in predicting investment decisions among Thai retail investors, with risk perception as a mediator and investment horizon as a moderator.

The findings reveal that heuristic biases and financial literacy are the primary predictors of risk perception, which subsequently serves as the central mechanism driving investment decisions. Also, while sustainable investment influences decisions only indirectly, its effect is significantly strengthened when moderated by a long-term investment horizon.

These findings confirm that Thai retail investors operate within the framework of prospect theory – decisions are not driven by objective information but filtered through subjective risk assessments shaped by behavioral biases and financial competence. Consistent with behavioral finance theory, heuristic shortcuts distort risk evaluation and remain the dominant pathway to investment action, even when sustainability information and financial knowledge are available. The moderating role of investment horizon further indicates that ESG considerations become behaviorally relevant only when investors adopt a long-term orientation. Regulators and financial institutions should therefore prioritize bias-awareness training and practical risk-assessment tools over passive financial education to help retail investors in emerging markets translate information into deliberate, sustainable investment decisions.

DECLARATION OF GENERATIVE AI IN THE WRITING PROCESS

In preparing this manuscript, the author used generative AI tools (e.g., OpenAI's ChatGPT) for language editing and translation to improve the manuscript's grammar, clarity, and readability. All research design, data analysis, interpretation of results, and conclusions were conducted entirely by the authors.

AUTHOR CONTRIBUTIONS

Conceptualization: Supakkoon Chairit, Orachan Sirichote, Chetsada Noknoi.
Data curation: Supakkoon Chairit.
Formal analysis: Supakkoon Chairit.
Investigation: Supakkoon Chairit.
Methodology: Supakkoon Chairit, Orachan Sirichote, Chetsada Noknoi.

Project administration: Orachan Sirichote, Chetsada Noknoi.
Supervision: Orachan Sirichote, Chetsada Noknoi.
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Visualization: Supakkoon Chairit.
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APPENDIX A

Table A1. Questionnaire items

Variable	Item
Sustainable Investment Adapted from Deka et al. (2023), Sultana et al. (2018), and Zhang et al. (2024).	
Environment	**EN1** I wish to invest in companies that care about the risk of climate change issues, like global warming and the greenhouse effect.
	EN2 Optimum use of materials, energy, or water, and to find more environmentally friendly solutions, like solar power.
	EN3 Reducing harmful gases (carbon dioxide and chlorofluorocarbons) from the production process.
	EN4 Creating new market opportunities through new environmental technologies and processes.
Social	**S1** Workplace health and safety of employees and workers. **S2** Respecting the fundamental human rights conventions (not using children, forced or compulsory labor, etc.). **S3** Developing the employees' skills, competencies, employability, and careers by arranging training and education. **S4** Producing quality goods and services, considering the customers' health and safety, and providing accurate product information.
Governance	**G1** Financial reporting requirements.
	G2 Independence of auditors.
	G3 Taking necessary actions to control corruption and bribery issues in the organization.
Heuristics Adapted from Kaban and Linata (2024), Pathak and Thapa (2024), Deka et al. (2023), Jain et al. (2021), Jain et al. (2023), Yadav and Chaudhary (2022), and Zhang et al. (2024).	
Anchoring	AN1 I predict stock prices from the latest market prices.
	AN2 I compare current prices with recent highs and lows before buying stocks.
	AN3 If a stock hits its year high, I will sell the stock immediately.
	AN4 I use the stock purchase price as a reference point for trade.
Availability	**AV1** When investing in a company, I rely on information from reliable sources, such as the SET.
	AV2 I usually make an investment decision on the stocks that have more information available to me.
	AV3 I consider the recent records of a security before investing.
Representativeness	**RE1** I buy stocks in the capital market that are "bullish."
	RE2 Good avenues are firms with past consistent earnings growth.
	RE3 I prefer to invest only in familiar stocks.
	RE4 If other stocks of a company are performing well and the same company offers new shares, I will buy the same.
Overconfident	**OV1** I believe that my knowledge about the stock market can help me outperform my peers.
	OV2 I am confident in my ability to make better investment decisions than others.
	OV3 I trust my intuition while making investment decisions.
	OV4 I keep the best stocks in my portfolio.
Financial Literacy Adapted from Abideen et al. (2023), Chairit and Sirichote (2024), Thailand Development Research Institute (2024), and Zhang et al. (2024).	
Financial Knowledge	**FK1** I know how the stock market works.
	FK2 I understand the relationship between risk and investment returns.
	FK3 I am knowledgeable about the time value of money.
	FK4 I can calculate principal and interest accurately.
Financial Behavior	**FB1** I usually follow the stock market through financial news (TV, newspapers, financial reports, prospectuses, and manuals).
	FB2 I set financial goals for myself.
	FB3 I carefully consider my options before making an investment decision.
	FB4 I consistently maintain a personal income and expense record.
Financial Skill	**FS1** I am capable of applying my financial knowledge and skills to manage resources efficiently for financial well-being.
	FS2 I can prepare and manage a personal budget effectively.
	FS3 I can evaluate and select appropriate financial products.
	FS4 I can analyze investments using fundamental factors.

Table A1 (cont.). Questionnaire items

Variable	Item
Risk Perception Adapted from Ahmed et al. (2022), Deka et al. (2023), Ferdinand (2023), and Jain et al. (2023).	
Financial Risk	**RPF1** I understand that higher returns involve higher risk.
	RPF2 I know diversification reduces financial risk.
	RPF3 I am cautious with stocks that fluctuate sharply.
	RPF4 I worry about stocks with past negative performance.
Time Risk	**RPT1** I can tolerate stock price drops and hold until recovery.
	RPT2 I understand that seeking quick returns increases investment risk.
	RPT3 I accept short-term losses for long-term gains.
	RPT4 I am aware of investment risks that may affect my future savings.
Personal Risk	**RPP1** I can tolerate a high level of investment risk.
	RPP2 I keep my investment strategy within my risk tolerance.
	RPP3 I believe that the more familiar an investment is, the lower its risk.
	RPP4 I believe returns depend on the level of risk I can accept.
Investment Decision Adapted from Deka et al. (2023) and Jain et al. (2023).	
Financial Factors	**IDF1** I consider financial statements and company performance reports before making an investment decision.
	IDF2 I invest in common stocks based on return on equity; the higher, the better.
	IDF3 If a stock price is below its fair value, I buy more shares when I have additional funds.
	IDF4 I prefer investing in common stocks for capital gains rather than other financial assets.
Nonfinancial Factors	**IDN1** I tend to invest in reputable companies.
	IDN2 I make investment decisions based on past performance.
	IDN3 I feel a sense of ownership and increase my shareholding as the company grows.
	IDN4 I invest in companies that prioritize environmental, social, and governance practices for sustainability and positive social impact.

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