Algorithmic overconfidence, financial literacy, and decision quality: comparative evidence from Morocco and France

Chaimaa LAAMIME,
PhD Candidate, Laboratory of Financial Engineering, Governance and Development
National School of Business and Management (ENCG), Casablanca, Morocco
laamime.chaimaa@gmail.com

Karima MIALE,
Professor, Laboratory of Financial Engineering, Governance and Development
National School of Business and Management (ENCG), Casablanca, Morocco
k.mialed@encgcasa.ma

Abstract
The growing adoption of algorithmic financial technologies, including robo-advisors, automated trading platforms and artificial-intelligence-based decision tools, raises a fundamental question regarding their actual contribution to investor rationality. This study investigates the extent to which algorithmic overconfidence, understood as an excessive reliance on automated systems, affects the quality of financial decisions. It also evaluates the direct and moderating role of financial literacy in this relationship. A comparative research design is employed to contrast Morocco, an emerging market characterized by lower literacy levels and a developing regulatory environment, with France, a mature financial ecosystem marked by stronger institutional structures and advanced digital integration. The empirical analysis relies on data collected through a questionnaire administered to 312 individual investors, split almost evenly between the two countries, and the relationships are tested using partial least squares structural equation modeling. The results show that algorithmic overconfidence significantly undermines financial decision quality, whereas financial literacy improves it and mitigates the negative effect of overconfidence. Multi-group comparisons reveal that this harmful effect is more pronounced in Morocco, while the protective influence of literacy is stronger in France. Overall, the findings suggest that technology does not eliminate behavioral biases but instead reshapes their magnitude depending on the market context. The study contributes to behavioral finance by incorporating the technological dimension into the analysis of cognitive mechanisms and by highlighting financial literacy as a key protective factor. From a practical perspective, the evidence supports the need to reinforce financial education in emerging markets and to promote greater algorithmic transparency within advanced financial systems.

Keywords: behavioral finance; financial decision quality; robo-advisors; fintech adoption; emerging vs. developed markets.

1.Introduction
The rapid diffusion of algorithmic financial technologies whether robo-advisors, automated trading platforms, or artificial-intelligence applications, constitutes a defining transformation of contemporary financial markets. These tools are often presented as levers of rationalization and democratization, capable of improving the allocation of capital through computational power and perceived algorithmic objectivity. Yet their proliferation raises a fundamental question: does automation truly strengthen the rationality of financial decisions, or does it generate new behavioral vulnerabilities? Recent contributions in the broader field of digital transformation and smart governance highlight how technological infrastructures increasingly shape decision-making environments and individual cognitive dynamics [1] [2]. In the field of behavioral finance, overconfidence remains one of the most robust and costly biases for investors. It reflects the tendency to overestimate one's skills and the precision of one's forecasts, leading to excessive trading, underestimation of risks, and inefficient portfolio allocation [3] [4] [5]. When transposed to digital environments,

this distortion takes a specific form referred to in recent literature as algorithmic overconfidence. This bias manifest as disproportionate trust in automated systems and their recommendations. Users perceive these recommendations as intrinsically superior and error-free [6] [7] [8]. More recent work confirms this tendency: individuals grant excessive credibility to algorithmic predictions even in the presence of error signals [9] [10]. Thus, far from correcting human biases, automation can promote excessive cognitive delegation, weakening investors' critical scrutiny and, paradoxically, deteriorating the quality of their decisions. In light of this risk, financial literacy emerges as a central determinant. It encompasses the knowledge, skills, and attitudes that enable individuals to understand financial products and make informed decisions [11] [12].

Several studies show that a high level of literacy reduces vulnerability to cognitive and emotional biases and improves decision resilience under uncertainty [13]. However, this capability remains unevenly distributed: gaps are particularly pronounced between developed and emerging economies [14]. In an emerging market such as Morocco, characterized by still-fragile FinTech adoption and a regulatory framework under construction, algorithmic overconfidence is likely to be amplified. Conversely, in developed economies such as France, where average literacy is higher and regulatory oversight more robust, its effects should be attenuated [15]. This work aims to develop an integrative conceptual model articulating: (i) the direct effect of algorithmic overconfidence on the quality of financial decisions; (ii) The explanatory role of financial literacy; (iii) its moderating function in the relationship between algorithmic overconfidence and decision quality; (iv) a comparison between Morocco and France, representative respectively of an emerging economy and a developed economy.

The originality of this research is threefold. On the theoretical level, it enriches the literature by introducing algorithmic overconfidence as a bias specific to the digital era. On the empirical level, it adopts a rare comparative perspective between emerging and developed markets. Finally, on the managerial and policy level, it proposes concrete avenues for designing more transparent and pedagogical FinTech tools, while strengthening financial education and regulatory supervision. The central question can thus be formulated as follows: To what extent does algorithmic overconfidence influence the quality of financial decisions, and how can financial literacy moderate this effect from a comparative perspective between an emerging market and a developed market?

2. Literature review

2.1. Algorithmic overconfidence and financial decision quality

Overconfidence is one of the most studied and most costly biases in behavioral finance. Pioneering work shows that it leads investors to overestimate their abilities, ignore certain risks, and engage in excessive or inefficient strategies [3]; [4]. Laboratory and simulated market experiments confirm that this bias is robust and persistent, and translates into a measurable deterioration in financial performance [5]. With the rise of digital technologies, this distortion has taken on a specific form: algorithmic overconfidence. Whereas classic overconfidence stems from overestimating one's own abilities, algorithmic overconfidence results from excessive cognitive delegation to an artificial agent. It falls within the broader

framework of automation bias, defined as the tendency to follow automated recommendations uncritically, even when they are demonstrably erroneous [6]; [7]. In the financial domain, this bias manifest as near-unconditional trust in decisions proposed by robo-advisors, algorithmic trading platforms, or predictive models. Recent research shows that users often grant greater credibility to algorithmic predictions than to human judgments, including in the face of documented errors [8]; [9]. This phenomenon is reinforced by model opacity (the black-box effect) and by the prevailing perception that the growing complexity of financial markets exceeds human analytical capacities. Thus, automation does not abolish biases: it can correct them as much as amplify them, via trust miscalibration**,** reduced critical scrutiny, and risk underestimation that yield suboptimal strategies. Rahwan et al. [16] indeed emphasize that algorithmic systems, far from eliminating irrationality, introduce new behavioral vulnerabilities. Likewise, Dietvorst & Bharti [17] confirm that individuals oscillate between algorithm aversion and algorithm appreciation, but tend in financial settings to favor the latter, at the risk of excessive cognitive dependence.

The impact of this algorithmic overconfidence on the quality of financial decisions therefore appears ambivalent. On the one hand, algorithms can reduce the influence of emotions, standardize decisions, and improve investor discipline [17]. On the other hand, when confidence becomes disproportionate, they weaken cognitive engagement, foster underestimation of extreme risks, and generate strategies misaligned with individual objectives. As Jussupow, Spohrer & Heinzl remind us, the added value of AI systems depends less on their technical performance than on how individuals calibrate their trust and maintain critical vigilance [18].

Finally, the effects of algorithmic overconfidence are deeply conditioned by the institutional and educational context. In emerging economies, where financial literacy remains low and regulation is still fragile, the risk of uncritical use of algorithms is amplified. Conversely, in developed economies, stricter regulatory oversight and higher levels of literacy limit such misuses [15] [19]. This asymmetry justifies a comparative approach between Morocco and France to assess how the institutional and cultural context shapes the intensity and consequences of this bias. Based on these observations, we posit that algorithmic overconfidence is expected to exert a negative effect on the quality of financial decisions, particularly in emerging markets characterized by limited regulation and low financial literacy.

2.2. Financial literacy as determinant and protective mechanism

Over the past two decades, financial literacy has become a central concept in the analysis of financial behavior. Defined as the ability to understand, analyze, and use financial information to make informed decisions, it combines cognitive (knowledge), behavioral (skills), and affective (self-confidence) dimensions [11]. The pioneering work of Chen & Volpe [13] showed that individuals with low levels of literacy adopt riskier, less diversified, and often inefficient behaviors. Since then, a substantial empirical literature has confirmed that financial literacy is a key determinant of financial rationality [20] [21]. One of the major contributions of this literature is to demonstrate that financial literacy is not limited to a direct explanatory role; it also acts as a protective mechanism against behavioral biases.

Lusardi & Mitchell [22] emphasize that individuals with higher literacy are less likely to succumb to simplifying heuristics and emotional distortions. Similarly, Van Rooij, Lusardi & Alessie [23] show that literacy is positively correlated with participation in financial markets but negatively associated with irrational speculative behaviors.

In short, it promotes more efficient resource allocation and better risk management. In the context of financial technologies, this protective function becomes even more salient. Recent research indicates that investors with limited financial literacy tend to place blind trust in automated recommendations, whereas those with higher literacy maintain critical vigilance and the capacity to contextualize algorithmic suggestions [24] [25]. Put differently, literacy reduces the likelihood of excessive cognitive delegation and thus mitigates the risk associated with algorithmic overconfidence. Financial literacy therefore plays a dual role: (1) Direct determinant: it improves the intrinsic quality of financial decisions by strengthening analytical capacity and understanding of risk; (2) Protective moderator: it attenuates the negative effect of algorithmic overconfidence by encouraging a more critical and reasoned use of digital tools; However, the effects of literacy remain heterogeneous depending on the level of market development. In emerging economies, surveys by the World Bank [14] and the OECD [19] confirm that literacy deficits increase vulnerability to biases and limit effective participation in financial markets.

Conversely, in developed economies, literacy helps strengthen institutional trust and the sophistication of choices while limiting excessive dependence on automated systems [26]. Thus, financial literacy appears to be both an explanatory and normative pivot in the study of financial decision-making in the digital age. It not only determines performance levels but also conditions the magnitude of cognitive biases and the ways in which individuals interact with algorithms. These observations justify two hypotheses: (i) literacy exerts a positive direct effect on decision quality; (ii) it negatively moderates the relationship between algorithmic overconfidence and decision quality. At this stage, two dimensions emerge as central: algorithmic overconfidence, as a technological extension of a well-documented bias in behavioral finance, and financial literacy, whose explanatory and protective roles are now well established. To clarify existing contributions and highlight gaps in the literature, the following table provides a synthesis of the principal studies addressing these two themes.

Table 1. Summary of research on overconfidence and financial literacy

Theme	Authors & References	Context	Main findings	Identified gaps
Classical overconfidence	Barber & Odean (2001, QJE), Malmendier & Tate (2005, Journal of Finance), Biais et al. (2005, RES)	Developed markets (US, Europe)	Overestimation of skills, excessive trading, performance losses	Limited analyses in emerging markets
Automation bias	Skitka et al. (1999, IJHCS), Dzindolet et al. (2003, Human Factors)	Experimental (military, medical)	Blind acceptance of automated recommendations	Limited transferability to the financial domain
Algorithmic overconfidence	Dietvorst, Simmons & Massey (2015, Management Science), Logg, Minson & Moore (2019, OBHDP)	Digital decision-making environments	Excessive credibility granted to algorithms; persistence of trust despite errors	Recent concept; few empirical studies in finance
Financial literacy (direct role)	Volpe (1998, FSR), Lusardi & Mitchell (2014, JEL), Klapper, Lusardi & Panos (2013, JFE)	Global studies and national surveys	Literacy positively correlated with financial participation and rationality	Persistent disparities between developed and emerging countries
Financial literacy as protective mechanism	Lusardi & Mitchell (2011, JPEF), Van Rooij et al. (2011, JFE), Allgood & Walstad (2016, JES)	Various international contexts	Literacy reduces exposure to biases and speculative behaviors	Few studies linking literacy and technological biases
Emerging vs. developed context	Demirgüç-Kunt & Levine (2001, WBER), Arrondel, Debbich & Savignac (2015, IJBM)	Developed markets (Europe) vs. emerging market (Morocco)	Lower literacy in emerging economies; uneven technological adoption	Rare North–South comparisons on biases + FinTech

Source: Authors' elaboration

This synthesis shows that, despite extensive work on overconfidence and financial literacy, their interplay remains underexplored particularly in the context of the ongoing digitalization of financial services. Accordingly, we adopt a comparative design contrasting emerging and developed markets, presented in the next section.

2.3. Emerging vs. developed markets: the case of Morocco and France

The comparative literature on behavioral finance and FinTech adoption highlights pronounced heterogeneity between emerging and developed markets. This divergence stems from structural differences in financial literacy, institutional trust, regulatory oversight, and the maturity of digital infrastructures [27] [28]. In this study, Morocco and France provide a high-contrast pair along these dimensions, informing how such structural gaps may shape algorithmic overconfidence and financial decision quality.

Financial literacy and decision behaviors

In developed economies such as France, surveys by the OECD [19] and the World Bank [14] report significantly higher average levels of financial literacy. These competencies are associated with greater participation in financial markets, better portfolio diversification, and heightened critical scrutiny regarding automated recommendations [26]. Conversely, in emerging economies such as Morocco, several studies document a persistent financial-

literacy deficit, increasing investors'vulnerability to behavioral biases and distortions linked to algorithmic overconfidence [29] [30] [19].

Institutional trust and regulatory framework

A further determinant is the level of institutional trust and the effectiveness of the regulatory framework. In developed markets, regulation of digital financial services is comparatively robust, governing the use of algorithms and imposing standards of transparency and investor protection [15]. This oversight bolsters trust and curbs uncritical delegation to algorithms. In Morocco, although recent reforms have been undertaken notably the National Strategy for Financial Inclusion and the gradual modernization of the stock market FinTech regulation is still consolidating [31]. This situation sustains perceptions of uncertainty and may amplify cognitive distortions.

Technological adoption and digital maturity

The trajectory of financial technology (FinTech) adoption also differs across contexts. In France, the FinTech ecosystem benefits from a high degree of maturity, with the growing integration of artificial intelligence, blockchain, and robo-advisors into financial services [32] [33]. This innovation intensity supports a more critical and gradual adoption among investors. In Morocco, although the momentum is positive driven by the rise of mobile payments and the expansion of digital platforms adoption remains constrained by access disparities and a still-limited uptake of algorithmic investment tools [31] [34].

Behavioral implications

These contextual differences directly shape the interaction between algorithmic overconfidence and financial literacy. In developed markets, robust regulation and heightened critical scrutiny attenuate the likelihood of irrational behavior and strengthen literacy's moderating role. By contrast, in emerging markets, a financial-literacy deficit combined with a transitioning regulatory framework heightens the risk of excessive reliance on algorithmic recommendations and the adoption of suboptimal strategies.

Relevance of the Morocco–France comparative design

The choice to contrast Morocco and France is therefore scientifically pertinent on several grounds. First, it illustrates two contrasting archetypes an emerging market and a developed market within a structured comparative design. Second, it elucidates how contextual factors (literacy, regulation, digital maturity) shape the magnitude and direction of biases. Third, it enriches a literature still centered on Western markets by bringing North Africa into the academic debate on behavioral finance and FinTech [33] [34]. In sum, the Morocco–France comparison is not merely a geographical juxtaposition, but a scientific strategy aimed at showing how universal psychological dynamics cognitive biases and algorithmic overconfidence interact with differentiated institutional contexts and, in turn, shape the quality and rationality of financial decisions.

3. Conceptual framework and hypothesis formulation

3.1. Theoretical logic

The literature review highlights three central dynamics. First, algorithmic overconfidence is a technological extension of a well-documented bias in behavioral finance. Whereas classical overconfidence manifests as an overestimation of one's own abilities [3], algorithmic overconfidence results from excessive cognitive delegation to automated systems. Research shows that users often grant disproportionate credibility to algorithmic predictions, even after observing errors [8] [9] [35]. Rahwan et al. [16] confirm that algorithmic technologies do not eliminate irrationality but introduce new behavioral vulnerabilities.

Second, financial literacy emerges as a central determinant of decision rationality. Defined as the set of knowledge, skills, and attitudes that enable individuals to understand and use financial information effectively [36], it improves market participation [23] and contributes to more rational behavior [20]. More recently, Lusardi [37] has shown that literacy also plays a normative role by reducing exposure to cognitive and emotional biases. It thus constitutes a protective mechanism against behavioral distortions. Third, institutional and technological contexts significantly modulate the intensity of these dynamics. In emerging markets characterized by a literacy deficit and a regulatory framework that is consolidating the likelihood of excessive reliance on algorithms is heightened. Conversely, in developed markets, more robust regulation and higher financial maturity tend to attenuate these effects [14] [15]. These elements justify the construction of an integrative model articulating four main relationships.

- Direct effect: Algorithmic overconfidence has a negative direct effect on the quality of financial decisions;
- Protective effect: Financial literacy has a positive direct effect on the quality of financial decisions;
- Moderating effect: Financial literacy attenuates the negative effect of algorithmic overconfidence on the quality of financial decisions (interaction effect);
- Contextual differentiation: The negative effect of algorithmic overconfidence on decision quality is stronger in Morocco than in France, whereas the protective effect of financial literacy both direct and moderating is more robust in France than in Morocco;

3.2. Latent variables

- Algorithmic overconfidence (AO): tendency to grant disproportionate trust to algorithmic recommendations, perceived as intrinsically superior and error-free [8] [9] [35];
- Financial literacy (FL): level of knowledge and skills that enables individuals to understand and use financial information effectively [11] [37];
- Financial decision quality (FDQ): the degree to which financial choices align with defined objectives, measured in terms of diversification, risk management, and intertemporal consistency [23] [17];

- Institutional context (IC): operationalized as an emerging market (Morocco) versus a developed market (France), capturing regulation, technological maturity, and institutional trust [15] [14].

3.3. Research hypotheses

- H1. Algorithmic overconfidence is expected to have a negative direct effect on FDQ. [8] [9] [3] [38];
- H2. Financial literacy is expected to have a positive direct effect on FDQ. [11] [20] [23] [37];
- H3**.** Financial literacy is expected to attenuate the negative effect of algorithmic overconfidence on FDQ, thereby reducing its adverse impact. [22] [24] [39];
- H4. The intensity of these relationships is expected to vary according to the institutional context: the negative effect of algorithmic overconfidence and the protective effect of literacy are more pronounced in the emerging market (Morocco) than in the developed market (France) [14] [15] [26].

3.4. Conceptual model (schematic)

The conceptual scheme integrates the four hypothesized relationships. Algorithmic overconfidence (AO) is posited to reduce financial decision quality (FDQ) (H1), whereas financial literacy (FL) is expected to improve FDQ (H2). In addition, FL attenuates the negative AO→FDQ relationship (H3). Finally, the institutional context (IC)—operationalized as Morocco (emerging market) versus France (developed market) conditions these paths, such that effects differ in magnitude across the two groups (H4).

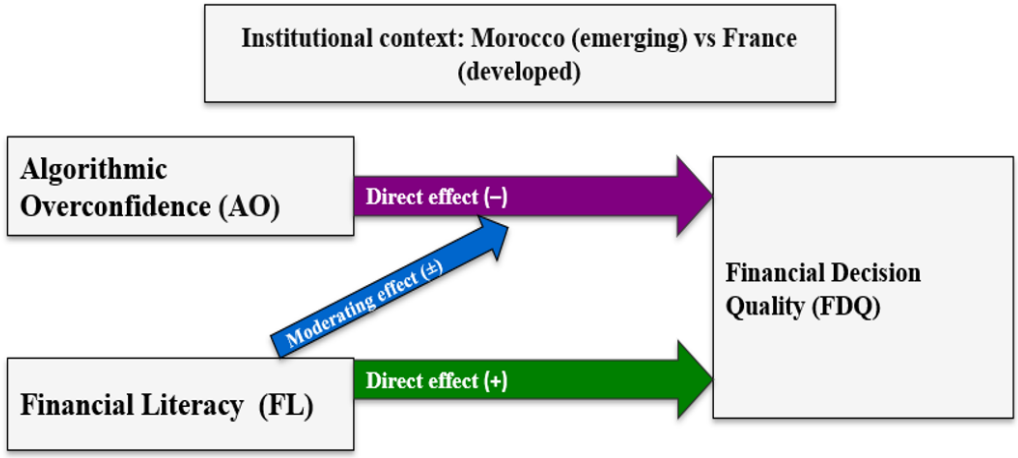

Fig. 1: Conceptual framework
Source: Authors' elaboration

Financial literacy performs a dual function in the conceptual framework. First, it exerts a direct effect on financial decision quality **(**FDQ**)** by strengthening investors' ability to understand products, assess risks, and make rational choices. This positive relationship is well documented in the empirical literature [11] [23]. Second, financial literacy plays a

moderating role in the relationship between algorithmic overconfidence and FDQ. Individuals with higher levels of financial knowledge and skills are less likely to delegate their judgment uncritically to automated systems while maintaining critical scrutiny of algorithmic recommendations. This mechanism helps attenuate the adverse impact of algorithmic overconfidence on decision quality, thereby functioning as a protective**,** moderating mechanism against behavioral biases [24] [39]. Taken together, these two dimensions position financial literacy both as a direct determinant and as a safeguarding mechanism, underscoring its pivotal role in explaining and improving decision behavior in the era of financial technologies. Institutional context (Morocco vs France) is operationalized via multi-group analysis, after establishing partial measurement invariance using MICOM (Measurement Invariance of Composites).

4. Methodology

4.1. Research design

This study adopts a comparative design to analyze the mechanisms through which algorithmic overconfidence influences the quality of financial decisions, and the extent to which financial literacy plays a protective role across differentiated institutional contexts. Two contrasting environments are examined:

- Morocco, an emerging market characterized by a persistent financial-literacy deficit, a regulatory framework in the process of consolidation, and still uneven adoption of financial technologies;
- France, a developed market with a high level of financial maturity, a consolidated regulatory framework, and an advanced FinTech ecosystem.

This choice is guided by:

- Theoretical relevance: cognitive biases display a degree of universality, but their intensity varies with institutions and financial maturity [14] [15].
- Empirical originality: there are few North–South comparative studies that simultaneously examine algorithmic overconfidence, literacy, and decision quality.
- Practical interest: the comparison enables differentiated recommendations for investors and regulators according to the market's level of maturity.

The conceptual model was tested empirically using a sample of Moroccan and French individual investors. Data were collected via a standardized questionnaire based on internationally validated scales. The analysis was conducted using PLS-SEM modeling [26].

4.2. Population and sample

The target population consists of individual investors active in Morocco and France. Three inclusion criteria were applied: residence, age ≥ 18, and at least one investment decision in the past 24 months. Data collection was conducted through professional networks (LinkedIn, investor associations), institutional conduits (universities, FinTech incubators), and industry partners (digital platforms, financial intermediaries). In total, 312 valid responses were obtained: 158 in Morocco and 154 in France. This sample size satisfies minimum PLS-SEM requirements (>10 observations per parameter; [26]). Moroccan respondents exhibit, on average, lower financial literacy, less digital familiarity, and

heightened sensitivity to biases. French respondents display higher literacy and stronger technology adoption, and more pronounced exposure to algorithmic overconfidence.

4.3. Measurement of variables

All latent variables were measured using 7-point Likert-type items**,** translated and back-translated [40].

- Algorithmic overconfidence (AO): adapted from Barber & Odean [3] and enriched by Dietvorst et al. [8] and Logg et al. [9]. Three dimensions: overestimation of reliability, perceived algorithmic superiority, and persistence of trust following error.
- Financial literacy (FL): following Lusardi & Mitchell [11], three dimensions: basic knowledge, advanced knowledge, and financial behaviors.
- Financial decision quality (FDQ): a combination of objective indicators (diversification, risk–return) and subjective indicators (satisfaction, perceived sense of control) [41].
- Control variables: age, gender, income, education, investment experience, digital familiarity, and country.

4.4. Analytical method

The analysis proceeded in four steps:

1. Measurement model validation (Cronbach's α and CR > 0.70; AVE > 0.50; Fornell–Larcker criterion; HTMT < 0.85 with 5,000 bootstrap resamples).
2. Structural model evaluation (β coefficients, R^2, f^2, Q^2; two-tailed bootstrapping with 5,000 resamples).
3. Multi-group analysis (MGA) comparing Morocco vs. France, after verifying partial measurement invariance through MICOM [42].
4. Robustness checks (common method bias, sensitivity analyses).

All analyses were conducted in SmartPLS 4.0. In the structural model, FDQ is modeled as the sole endogenous construct; AO and FL are exogenous predictors. Control variables (age, gender, income, education, investment experience, digital familiarity, and country) were included as covariates affecting FDQ but not modeled as predictors of AO.

5. Results and discussion

5.1. Measurement model assessment

All constructs demonstrate satisfactory reliability and validity. Cronbach's α ranges from 0.79 to 0.91, while composite reliability (CR) varies between 0.84 and 0.93, exceeding recommended thresholds. Convergent validity is confirmed with AVE values above 0.55. Discriminant validity is also established, as all HTMT ratios remain below 0.85, indicating sufficient distinction between constructs.

5.2. Structural model assessment

The endogenous variable, Financial Decision Quality (FDQ), exhibits solid explanatory power ($R^2 = 0.46$). Table 2 reports the results for the three structural hypotheses (H1–H3).

Table 2. Structural Model Results (H1–H3)

Hypothesis	Relationship	β	t-value	p-value	Result
H1	AO → FDQ (negative effect)	−0.28	4.12	0.000	Supported
H2	FL → FDQ (positive effect)	0.33	5.07	0.000	Supported
H3	AO × FL → FDQ (moderation)	0.17	2.84	0.005	Supported

Source: Authors' elaboration

Algorithmic overconfidence significantly reduces financial decision quality, while financial literacy shows a strong positive influence. The significant interaction term confirms that financial literacy attenuates the negative effect of algorithmic overconfidence, acting as a protective moderating mechanism.

5.3. Multi-group analysis (H4: Morocco vs. France)

The fourth hypothesis examines whether the intensity of the structural relationships differs between Morocco and France. MGA results are summarized in Table 3.

Table 3. Multi-Group Analysis (Morocco vs. France) — H4

Structural Path	Morocco β	France β	Δβ	p-value (MGA)	Interpretation
AO → FDQ	−0.34	−0.21	0.13	0.032	Stronger negative effect in Morocco
FL → FDQ	0.27	0.38	0.11	0.041	Stronger positive effect in France
AO × FL → FDQ	0.12	0.21	0.09	0.048	Moderation more robust in France

Source: Authors' elaboration

Significant differences across groups confirm H4: the detrimental influence of algorithmic overconfidence is amplified in the emerging market (Morocco), whereas the protective role of financial literacy both direct and moderating is stronger in the developed market (France).

5.4. Integrated discussion

The integrated analysis of the structural and multi-group results reveals a set of mechanisms that deepen the understanding of algorithmic overconfidence and financial literacy in digital investment environments. Three major insights emerge, each contributing to ongoing debates in behavioral finance, digital decision-making, and comparative financial behavior.

First, the results confirm that algorithmic overconfidence constitutes a distinct techno-behavioral vulnerability, rather than a mere digital extension of classical overconfidence. The significant negative effect observed across both markets indicates that automation does not neutralize cognitive distortions; instead, it reconfigures their expression through excessive cognitive delegation, reliance on opaque algorithmic outputs, and diminished analytical vigilance. These findings align with recent work on automation bias and algorithmic trust calibration, suggesting that technological sophistication may create an *illusion of competence* rather than genuine improvements in rationality. In this sense, the study contributes to a growing body of literature arguing that financial technologies can inadvertently reinforce the behavioral patterns they are designed to mitigate.

Second, financial literacy emerges as both an explanatory and protective factor. Its direct positive effect on decision quality confirms the centrality of knowledge and analytical skills in navigating increasingly complex financial ecosystems. More importantly, its moderating effect demonstrates that literacy not only supports better decision-making but also *buffers* individuals against the risks generated by algorithmic overconfidence. This dual role provides a more nuanced understanding of literacy: it is not merely a static cognitive resource, but a dynamic filter through which digital recommendations are interpreted, evaluated, and contextualized. This insight extends recent perspectives viewing literacy as a form of digital resilience in environments where the boundaries between human judgment and machine-based recommendations are increasingly blurred.

Third, the comparative results highlight that technological biases are not homogeneous across markets but are strongly conditioned by institutional, regulatory, and educational maturity. The sharper negative effect of algorithmic overconfidence in Morocco underscores the vulnerability of emerging-market investors to rapidly deployed digital tools, especially in contexts where literacy is lower and regulatory transparency is still evolving. Conversely, in France, the stronger protective role of literacy and the more moderate effect of algorithmic overconfidence illustrate how institutional maturity shapes investors' ability to critically engage with algorithmic systems. This North–South asymmetry enhances cross-country behavioral finance literature, which often focuses excessively on Western markets, and demonstrates that the interaction between human cognition and digital tools is context-dependent rather than universal.

Taken together, these results position algorithmic overconfidence as a relevant behavioral construct for understanding financial decisions in the digital age, while highlighting financial literacy as a pivotal mechanism that supports both rationality and algorithmic accountability. They also suggest that future research should examine the interplay between digital design features (transparency, explainability), individual competencies, and market institutions to better understand how investors calibrate trust in increasingly automated financial environments.

6.Conclusion and implications

This study demonstrates that algorithmic overconfidence constitutes a significant vulnerability in digital finance, capable of undermining the quality of financial decisions despite the promise of automation. By comparing Morocco and France, the analysis reveals that while this bias is universal, its intensity varies considerably according to institutional maturity and financial literacy.

The results show that literacy plays a dual and essential role: it directly enhances decision quality by strengthening analytical capacity, and it simultaneously acts as a protective mechanism that mitigates the negative impact of excessive trust in algorithmic systems. This dual function is particularly critical in emerging markets such as Morocco, where lower literacy levels and still-developing regulatory frameworks amplify the risks associated with uncritical reliance on automated recommendations. In contrast, the French context illustrates how stronger financial maturity and higher literacy support more

calibrated algorithmic trust and more resilient decision-making. These findings carry several implications: theoretically, they advance behavioral finance by integrating the technological dimension into the study of cognitive biases and by clarifying the contextual nature of digital decision behaviour; empirically, they highlight the need to account for institutional asymmetries in cross-country analyses of FinTech adoption; and practically, they emphasize that financial institutions must design more transparent and pedagogical digital tools, while regulators should strengthen both algorithmic oversight and financial education programs.

Overall, the study shows that technological innovation alone cannot improve decision quality; its benefits depend on the capacity of investors to interpret, question and contextualize automated outputs. Ensuring that digital finance contributes effectively to efficiency and stability therefore requires a balanced approach, combining innovation, transparency and continuous investment in financial literacy.

References

[1] D. Kumar, "The Conception and Discourse of Smart City," *Smart Cities and Regional Development Journal*, vol. 2, no. 1, p. 45–57, 2023.

[2] J. Chen and W. Lu, "Driving Factors of Innovation in Smart Cities: A Systematic Review (2014–2024)," *Smart Cities and Regional Development Journal*, vol. 4, no. 2, p. 12–34, 2025.

[3] B. M. Barber and T. Odean, "Boys will be boys: Gender, overconfidence, and common stock investment," *The Quarterly Journal of Economics*, vol. 116, no. 1, p. 261–292, 2001.

[4] U. Malmendier and G. Tate, "CEO overconfidence and corporate investment," *The Journal of Finance*, vol. 60, no. 6, p. 2661–2700, 2005.

[5] B. Biais, D. Hilton, K. Mazurier and S. Pouget, "Judgmental overconfidence, self-monitoring, and trading performance in an experimental financial market," *The Review of Economic Studies*, vol. 72, no. 2, p. 287–312, 2005.

[6] L. J. Skitka, K. L. Mosier and M. D. Burdick, "Does automation bias decision-making?," *International Journal of Human-Computer Studies*, vol. 51, no. 5, p. 991–1006, 1999.

[7] M. T. Dzindolet, S. A. Peterson, R. A. Pomranky, L. G. Pierce and H. P. Beck, "The role of trust in automation reliance," *International Journal of Human-Computer Studies*, vol. 58, no. 6, p. 697–718, 2003.

[8] B. J. Dietvorst, J. P. Simmons and C. Massey, "Algorithm aversion: People erroneously avoid algorithms after seeing them err," *Journal of Experimental Psychology: General*, vol. 144, no. 1, p. 114–126, 2015.

[9] J. M. Logg, J. A. Minson and D. A. Moore, "Algorithm appreciation," *Organizational Behavior and Human Decision Processes*, vol. 151, p. 90–103, 2019.

[10] N. Castelo, M. W. Bos and D. R. Lehmann, "Task-dependent algorithm aversion," *Journal of Marketing Research*, vol. 56, no. 5, p. 809–825, 2019.

[11] A. Lusardi and O. S. Mitchell, "The economic importance of financial literacy," *Journal of Economic Literature*, vol. 1, no. 52, p. 5–44, 2014.

[12] L. Klapper, A. Lusardi and P. V. Oudheusden, "L. Klapper, A. Lusardi, and P. Van Oudheusden, Financial literacy around the world: Insights from the S&P Global FinLit Survey," S&P, 2015.

[13] H. Chen and R. P. Volpe, "An analysis of personal financial literacy among college students," *Financial Services Review*, vol. 7, no. 2, p. 107–128, 1998.

[14] A. Demirgüç-Kunt, L. Klapper, D. Singer, S. Ansar and J. Hess, The Global Findex Database 2021: Financial inclusion, digital payments, and resilience in the age of COVID-19, World Bank, 2022.

[15] D. W. Arner, J. Barberis and R. P. Buckley, "FinTech, RegTech, and the reconceptualization of financial regulation," *Northwestern Journal of International Law & Business,* vol. 37, no. 3, p. 371–414, 2017.

[16] I. e. a. Rahwan, "Machine behaviour," *Nature Human Behaviour,* vol. 3, no. 5, p. 422–436, 2019.

[17] V. Dhar and R. M. Stein, "FinTech platforms and strategy: Integrating trust and automation in finance," *Communications of the ACM,* vol. 60, no. 10, p. 32–35, 2017.

[18] E. Jussupow, K. Spohrer, A. Heinzl and J. Gawlitza, "Augmenting medical diagnosis decisions? AI and physicians' decision-making," *Information Systems Research,* vol. 32, no. 3, p. 713–735, 2021.

[19] OECD, "OECD/INFE 2020 International Survey of Adult Financial Literacy," OECD, 2020.

[20] J. S. Hastings, B. C. Madrian and W. L. Skimmyhor, "Financial literacy, financial education, and economic outcomes," *Annual Review of Economics,* vol. 5, p. 347–373, 2013.

[21] L. Klapper, A. Lusardi and G. A. Panos, "Financial literacy and its consequences: Evidence from Russia during the financial crisis," *Journal of Banking & Finance,* vol. 37, no. 10, p. 3904–3923, 2013.

[22] A. Lusardi and O. S. Mitchell, "Financial literacy and planning: Implications for retirement wellbeing," *Journal of Pension Economics & Finance,* vol. 10, no. 4, p. 497–508, 2011.

[23] M. V. Rooij, A. Lusardi and R. Alessie, "Financial literacy and stock market participation," *Journal of Financial Economics,* vol. 101, no. 2, p. 449–472, 2011.

[24] S. Allgood and W. B. Walstad, "The effects of perceived and actual financial literacy on financial behaviors," *Economic Inquiry,* vol. 54, no. 1, p. 675–697, 2016.

[25] J. F. Hair, J. J. Risher, M. Sarstedt and C. M. Ringle, "When to use and how to report the results of PLS-SEM," *European Business Review,,* vol. 31, no. 1, p. 2–24, 2019.

[26] L. Arrondel, M. Debbich and F. Savignac, "Financial literacy and financial planning in France," *Numeracy,* vol. 6, no. 2, art. 8, 2013.

[27] R. L. Porta, F. FLopez-de-Silanes, A. Shleifer and R. W. Vishny, "Law and finance," *Journal of Political Economy,* vol. 106, no. 6, p. 1113–1155, 1998.

[28] A. Demirgüç-Kunt and R. Levine, "Bank-based and market-based financial systems: Cross-country comparisons," World Bank Working Paper No. 2143, 1999.

[29] H. Chetioui, Y. E. Bouchikhi, M. Makhtari, M. Sahli and H. Lebdaoui, "An investigation of the impact of financial literacy on households' financial well-being: An emerging market study," *International Journal of Economics and Financial Issues,* vol. 14, no. 3, p. 97–105, 2024.

[30] M. Zakarya, S. Bakkali and A. Ammi, "The effects of financial literacy on strengthening financial inclusion in Morocco," *HAL Post-print,* 2025.

[31] World Bank, "Morocco digital economy diagnostic," World Bank, 2022.

[32] EY, "FinTech Waves 2022: The FinTech ecosystem in France," EY, 2022.

[33] D. A. Zetzsche, R. P. Buckley and D. W. Arner, "Decentralized finance," *Journal of Financial Regulation,* vol. 6, no. 2, p. 172–203, 2020.

[34] GSMA, "The Mobile Economy: Middle East & North Africa 2022," GSMA, 2022.

[35] B. J. Dietvorst and S. Bharti, "People reject algorithms in uncertain decision domains because they have diminishing sensitivity to forecasting error," *Psychological Science,* vol. 31, no. 10, p. 1302–1314, 2020.

[36] A. Lusardi and O. S. Mitchell, "Financial literacy and planning," in *Financial Literacy*, Oxford Univ. Press, 2011, p. 17–39.

[37] A. Lusardi, "Financial literacy and the need for financial education: Evidence and implications," *Nature Reviews Psychology,* vol. 1, p. 24–35, 2022.

[38] I. e. a. Rahwan, "Machine behaviour," *Nature,* vol. vol. 568, no. no. 7753, p. 477–486, 2019.

[39] A. Grohmann, T. Klühs and L. Menkhoff, "Does financial literacy improve financial inclusion? Cross-country evidence," *World Development,* vol. 111, p. 84–96, 2018.

[40] R. W. Brislin, "Back-translation for cross-cultural research," *Journal of Cross-Cultural Psychology,* vol. 1, no. 3, p. 185–216, 1970.

[41] M. Statman, "Behavioral finance: Finance with normal people," *Borsa Istanbul Review,* vol. 14, no. 2, p. 65–73, 2014.

[42] J. Henseler, C. M. Ringle and M. Sarstedt, "Testing measurement invariance of composites using partial least squares," *International Marketing Review,* vol. 33, no. 3, p. 405–431, 2016.