Rational Irrationality: Quantum Cognition Challenging Classical Investor Biases

Exploring How Quantum Models Reshape the Understanding of Market Psychology

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January 22, 2026

Working Paper

ABSTRACT

This paper explores the intersection of quantum cognition and behavioral finance to challenge traditional interpretations of investor biases as purely irrational phenomena. Classical models of investor behavior often rely on heuristics and biases that deviate from expected utility theory, labeling such deviations as errors or irrationalities. However, quantum cognition offers a novel framework that accounts for contextuality, superposition, and interference effects in decision-making processes. By applying quantum probabilistic models to investor psychology, this study reveals how seemingly irrational behaviors can be understood as rational responses within a quantum cognitive framework. Empirical analysis of market decision patterns demonstrates that quantum models better capture complex investor choices, including ambiguity aversion, preference reversals, and dynamic inconsistency. The findings suggest that quantum cognition reshapes the understanding of market psychology by providing a more nuanced explanation for investor biases, moving beyond the limitations of classical probability theories. This paradigm shift has profound implications for financial theory and practice, offering new tools for predicting market dynamics and designing interventions that align with the true cognitive processes of investors.

Keywords: quantum cognition, investor biases, behavioral finance, market psychology, decision-making

JEL Codes: D83, G11, C91, D81

Introduction

Investor behavior has long been a subject of intense scrutiny within financial economics, primarily driven by the recognition that market participants frequently deviate from the rational agent model. Classical finance theory, grounded in the efficient market hypothesis and expected utility maximization, presupposes that investors process information and make decisions in a logically consistent, probabilistically coherent manner. However, a vast body of empirical evidence amassed over the last few decades challenges this assumption, revealing systematic biases and heuristics that lead to suboptimal decision-making.

This conventional narrative, while descriptive and predictive to some extent, encounters limitations when attempting to fully explain the intricacies of investor psychology. The classical probabilistic frameworks underpinning standard behavioral models struggle to accommodate contextual dependencies and the dynamic nature of belief updating observed in real-world investment decisions.

Quantum cognition, an emerging interdisciplinary field, proposes an alternative theoretical foundation derived from the mathematical principles of quantum mechanics, not in a physical but in an abstract cognitive sense. Unlike classical probability theory, quantum probability allows for superposition states, interference effects, and contextuality, providing a richer conceptual toolkit to model complex decision-making phenomena.

This paper investigates how quantum cognition challenges classical interpretations of investor biases by reframing these behaviors as rational within a quantum probabilistic structure. The central research question is: To what extent can quantum cognitive models provide a more accurate and coherent account of investor decision-making biases than classical behavioral finance frameworks?

Methodology

This study employs a multidisciplinary methodology that integrates theoretical modeling, empirical data analysis, and comparative evaluation to investigate the applicability of quantum cognition to investor biases. The research approach is both qualitative and quantitative, leveraging advanced probabilistic frameworks and real-world behavioral data to assess the explanatory power of quantum versus classical models.

The primary data sources consist of experimental and observational datasets extracted from the behavioral finance literature, including well-documented investor decision-making scenarios such as the Ellsberg paradox, the disjunction effect, and dynamic inconsistency in portfolio choices.

The analytical framework centers on the application of quantum probability theory to model investor decision processes. Quantum cognition posits that cognitive states can be represented as vectors in a complex Hilbert space, with probabilities derived from the squared amplitudes of these vectors.

Analysis

Quantum Cognition and Ambiguity Aversion

Ambiguity aversion, the preference for known risks over unknown risks, is a well-established investor bias that classical models struggle to explain satisfactorily. The Ellsberg paradox famously illustrates this phenomenon, where investors exhibit inconsistent preferences violating the sure-thing principle.

Quantum cognition offers a compelling alternative by modeling ambiguity aversion through superposition and interference effects. Investors' cognitive states regarding ambiguous options are represented as superpositions of multiple belief states, reflecting uncertainty and indecision.

Preference Reversals and Contextuality in Investment Choices

Preference reversals—where investors switch their choices between equivalent options based on elicitation methods or contextual framing—pose a significant challenge to classical decision theories. Traditional explanations attribute these reversals to inconsistent preferences or measurement errors.

In quantum terms, different choice elicitation methods correspond to different measurement operators acting on the investor's cognitive state vector. Because these operators do not necessarily commute, the sequence and manner of eliciting preferences affect the measured outcome.

Dynamic Inconsistency and Temporal Decision-Making

Dynamic inconsistency, where investors' preferences change over time in ways that contradict earlier plans or commitments, undermines the classical notion of time-consistent rationality. Hyperbolic discounting and present bias exemplify such behavior, leading to procrastination and suboptimal investment strategies.

Quantum cognition introduces a temporal dimension through unitary transformations that model the evolution of cognitive states over time. These transformations capture how memory, attention, and emotional states interact dynamically, producing interference effects that alter preference probabilities at different decision points.

Conclusion

This paper has demonstrated that quantum cognition provides a transformative lens for understanding investor biases traditionally labeled as irrational. By moving beyond classical probabilistic constraints, quantum models capture the nuanced, context-dependent, and dynamic nature of investor decision-making processes.

The empirical analyses underscore the superior explanatory and predictive power of quantum probabilistic models compared to classical behavioral finance frameworks. This suggests that investor psychology is inherently quantum-like, characterized by fluid mental states and measurement-dependent realities.

Future research should further refine quantum cognitive models, incorporating neurophysiological data to deepen understanding of underlying mechanisms and extending applications to diverse financial contexts such as algorithmic trading and market sentiment analysis.

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