


Chapter 10

AI-Driven Financial Risk Assessment and Management

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ABSTRACT

Artificial intelligence is rapidly reshaping how we understand and manage financial risk. This chapter explores the convergence of AI, neurofinance, and behavioral finance in building systems that can not only crunch numbers but also decode human irrationality. As machine learning algorithms evolve, they are increasingly capable of identifying subtle patterns in investor behavior, market sentiment, and cognitive biases—elements long considered elusive and subjective. Yet, this fusion raises urgent questions about trust, transparency, and ethical boundaries. This chapter offers a critical examination of how AI-driven models assess financial risks, the psychological frameworks they embed, and the implications for decision-making in increasingly volatile environments. In doing so, it charts a path forward—one that embraces complexity while demanding accountability.

INTRODUCTION

Risk has always been the shadow partner of ambition in finance. Every investment, loan, and strategic decision walks the tightrope between opportunity and potential loss. For centuries, financial institutions have relied on quantitative models, historical data, and human intuition to measure and manage this delicate balance. Yet, as markets grow more complex and interconnected—and as behavioral anomalies

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persist despite sophisticated forecasting tools—traditional risk models often fall short. The world no longer fits neatly into bell curves and normal distributions. Enter artificial intelligence.

In the past decade, the financial sector has witnessed a paradigm shift. Artificial intelligence (AI), once confined to theoretical circles and experimental labs, has become a mainstream force in financial modeling, decision-making, and risk assessment (Challoumis, 2024). Banks, hedge funds, and insurance firms are increasingly turning to algorithms that learn, adapt, and evolve—tools capable of digesting vast amounts of structured and unstructured data, recognizing patterns invisible to the human eye, and responding to market fluctuations in milliseconds. But this isn't just about speed or scale; it's about depth. AI doesn't simply replicate human judgment—it augments it, challenges it, and at times, subverts it.

At the intersection of AI and finance lies a curious and fertile domain: the fusion of *neurofinance* and *behavioral finance* with intelligent systems (COSTANTINO et al, 2024). Where traditional models falter due to the unpredictable nature of human decision-making, this interdisciplinary space offers a powerful corrective. By embedding psychological and neurological insights into algorithmic frameworks, financial institutions are beginning to model not just risk, but *how* people perceive and react to risk. Cognitive biases, emotional responses, heuristics, and even stress-related neural responses—long considered too slippery to quantify—are now becoming integral inputs in next-generation AI systems.

Yet the promise of AI-driven risk assessment comes tethered to profound challenges. The opacity of machine learning models—particularly deep learning networks—poses serious questions about interpretability, accountability, and trust. Financial regulators, stakeholders, and the public are increasingly wary of systems that make high-stakes decisions without clear rationale or explanation. Moreover, there's a risk that such systems, if poorly designed, could amplify rather than reduce bias—reproducing historical inequalities under the guise of objectivity. There's also a growing concern over data ethics, surveillance, and the tension between personalization and privacy in financial services.

This chapter embarks on a journey through this evolving terrain. It begins by examining the theoretical and practical limitations of conventional financial risk assessment models and explores how AI—particularly in its machine learning and deep learning incarnations—is being used to reframe the risk landscape (Kayyali, 2025). It delves into how behavioral finance and neurofinance enrich these models, offering deeper insight into investor psychology and market sentiment. Drawing on real-world applications, case studies, and current research, the chapter scrutinizes both the potential and the perils of these innovations. Finally, it offers a forward-looking reflection on what it means to entrust machines with the nuanced, messy, and profoundly human task of evaluating financial risk. Because at the heart of every

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