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THE INTERSECTION OF AI AND QUANTUM COMPUTING IN FINANCIAL MARKETS: A CRITICAL REVIEW

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ABSTRACT

This review explores the intricate and evolving relationship between Artificial Intelligence (AI) and Quantum Computing within the realm of financial markets. As technology continues to advance, the integration of AI and quantum computing has emerged as a paradigm-shifting force, promising unprecedented capabilities to analyze and navigate the complexities of financial systems. This critical review delves into the synergies, challenges, and potential disruptions arising from the intersection of these two transformative technologies. The utilization of AI in financial markets has witnessed remarkable progress in recent years, with machine learning algorithms,

deep neural networks, and natural language processing contributing to enhanced data analysis, predictive modeling, and decision-making. However, the computational demands of these sophisticated algorithms often surpass the capabilities of classical computing architectures, paving the way for the exploration of quantum computing as a potential solution. Quantum computing, with its ability to process vast datasets and perform complex calculations at speeds inconceivable by classical computers, presents a revolutionary approach to addressing the computational challenges faced by AI in financial applications. The review critically examines the potential advantages of quantum computing, such as its capacity to solve optimization problems, simulate financial scenarios, and secure data through quantum cryptography. Despite the promises, the integration of AI and quantum computing in financial markets is not without hurdles. The review investigates the current limitations, including hardware constraints, error correction challenges, and the high costs associated with quantum computing infrastructure. Ethical considerations and regulatory frameworks surrounding the implementation of such powerful technologies in financial decision-making also warrant careful examination. This critical review provides a comprehensive analysis of the intersection of AI and quantum computing in financial markets, shedding light on the transformative potential, challenges, and ethical implications that accompany this cutting-edge convergence of technologies. Understanding this intersection is crucial for stakeholders seeking to navigate the evolving landscape of finance and technology.

Keywords: AI, Quantum, Computing, Financial Market, Review.

INTRODUCTION

The intersection of AI and quantum computing in financial markets represents a cutting-edge area of research that has gained significant attention in recent years. Quantum computing offers the potential to revolutionize financial markets by providing solutions to computationally complex problems such as derivative pricing, risk analysis, portfolio optimization, and fraud detection (Herman et al., 2022). This is particularly significant as traditional computational methods struggle to efficiently handle these tasks due to the curse of dimensionality (Li & Neufeld, 2023). Furthermore, the integration of AI in financial markets has greatly enhanced the efficiency of financial services by creating readily accessible digital financial platforms and expanding the breadth and depth of financial services (Shao et al., 2021). The combination of AI and quantum computing has the potential to further amplify these benefits by enabling more accurate and efficient solutions to financial problems.

The purpose of this critical review is to provide a comprehensive assessment of the current state of the intersection of AI and quantum computing in financial markets. This review aims to analyze the existing literature and research in this field, identify the key advancements, and evaluate the potential implications for the financial industry. By critically examining the research and developments in quantum computational finance, this review seeks to provide insights into the opportunities and challenges associated with the integration of AI and quantum computing in financial markets. Additionally, the review aims to highlight the significance of this intersection by

emphasizing its potential to address computationally intractable problems in finance, such as forecasting financial crashes and portfolio optimization (Orús et al., 2019; , Tang et al., 2021).

In conclusion, the intersection of AI and quantum computing in financial markets represents a transformative area of research with the potential to revolutionize traditional financial practices. This critical review aims to provide a comprehensive analysis of the current state of this intersection, its significance in addressing complex financial problems, and the potential implications for the financial industry.

AI in Financial Markets

AI has made significant strides in revolutionizing financial markets through various applications. Machine learning algorithms, deep neural networks, and natural language processing are at the forefront of AI applications in finance (LeCun et al., 2015). These methods have dramatically improved the state-of-the-art in various domains such as financial analysis, fraud detection, trading, and risk management (Sharma, 2023). For instance, machine learning algorithms have been used for sentiment analysis to develop market-neutral trading strategies, while deep neural networks have been employed for optimal market making in response to market conditions (Wang et al., 2021; Gasperov et al., 2021). Additionally, natural language processing has been utilized for customer service and portfolio optimization (Sharma, 2023).

The achievements and advancements in AI for financial analysis have been substantial. AI has significantly impacted various aspects of financial analysis, including governance, revenue raising, pooling, and strategic purchasing (Sharma, 2023; Adaga et al., 2024). Furthermore, AI has been instrumental in predictive analytics, risk management, and automation, revolutionizing financial processes (Berikashvili, 2024). These advancements have engendered new opportunities for continued innovation in algorithmic machine learning and autonomous decision-making (Dwivedi et al., 2021).

However, AI in financial applications faces computational challenges. As AI models continue to advance into real-life applications, their ability to maintain reliable quality over time becomes increasingly important (Vela et al., 2022). Additionally, the full connectivity of deep neural networks makes them prone to overfitting data, posing a significant computational challenge (Zhan, 2022). Moreover, there is a growing need for Explainable AI (XAI) to build trust and understanding in AI decision making, highlighting the challenge of interpretability in AI models (Tiwari, 2023; Abrahams et al., 2024).

In conclusion, AI has significantly transformed financial markets through machine learning algorithms, deep neural networks, and natural language processing. These advancements have led to substantial achievements in financial analysis, while also posing computational challenges that need to be addressed for the continued progress of AI in financial applications.

Quantum Computing in Financial Markets

Quantum computing is a revolutionary field that leverages the principles of quantum mechanics to process and analyze information in ways that surpass the capabilities of classical computers. At the core of quantum computing are quantum bits, or qubits, which can exist in a state of superposition, allowing them to represent both 0 and 1 simultaneously (D'Hooghe & Pykacz, 2004). This

property enables quantum parallelism, where quantum computers can perform multiple calculations at once, leading to exponential speedups for certain problems (O'Leary et al., 2006). Furthermore, entanglement, a phenomenon where the state of one qubit is dependent on the state of another, provides additional computational power by enabling complex correlations between qubits (Ding & Jin, 2007).

In the realm of financial markets, quantum computing holds immense potential for various applications. One such application is the optimization of complex financial problems, such as portfolio management and risk assessment. Quantum computers can efficiently solve optimization problems by exploring multiple solutions simultaneously, leading to more effective and accurate results compared to classical methods (Han & Kim, n.d.). Additionally, quantum computing can facilitate financial scenario simulations by rapidly processing numerous variables and potential outcomes, providing valuable insights for decision-making in dynamic market environments (Tang et al., 2020; Hassan et al., 2024). Moreover, the use of quantum cryptography offers enhanced security measures for financial transactions and data protection, leveraging the principles of quantum entanglement to secure communications and prevent unauthorized access (Ahn et al., 2000).

The potential of quantum computing in financial markets is underpinned by the advancements in qubit technologies, such as superconducting circuits and trapped ions, which are paving the way for the development of scalable quantum computers capable of handling real-world financial datasets and computations (Martinis et al., 2002). Furthermore, the exploration of quantum entanglement and its dynamics in higher-dimensional quantum systems is contributing to the refinement of quantum information processing, which is crucial for the effective implementation of quantum algorithms in financial applications (Abrahams et al., 2023; Arthur et al., 2018).

In conclusion, quantum computing offers a paradigm shift in computational capabilities, with profound implications for the financial industry. The unique properties of qubits, quantum parallelism, and entanglement provide a powerful framework for addressing complex financial challenges, ranging from optimization problems to secure data transmission. As quantum computing technologies continue to advance, their integration into financial markets has the potential to revolutionize decision-making processes and risk management strategies.

The Intersection: Synergies and Advantages

To address the computational challenges of AI in financial markets, quantum computing has emerged as a promising solution. Quantum computing utilizes qubits, which can exist in a superposition of states, allowing for simultaneous computation of multiple possibilities. This capability can potentially overcome the computational limitations faced by classical computers, enabling more efficient processing of complex financial data and algorithms (Zhang, 2010; Egger et al., 2020). Furthermore, quantum-inspired algorithms have demonstrated exponential speedup compared to classical methods for specific problems in finance, indicating their potential to enhance predictive modeling and decision-making in financial markets (Arrazola et al., 2020).

Quantum computing and quantum-inspired algorithms offer opportunities to revolutionize financial markets by significantly improving predictive modeling and decision-making processes.

These technologies have the potential to provide exponential speedup over classical algorithms for solving complex financial problems, such as derivative pricing, risk analysis, and portfolio optimization (Herman et al., 2022). Additionally, quantum-inspired algorithms have shown promise in enhancing the precision, recall, and F-measure of classification, where traditional methods fall short (Tiwari & Melucci, 2019). This suggests that quantum-inspired algorithms can contribute to more accurate and reliable predictive modeling in financial markets.

The integration of quantum computing and quantum-inspired algorithms in finance presents various opportunities for the development of innovative solutions. For instance, quantum-accelerated multilevel Monte Carlo methods have demonstrated exponential speedup over classical algorithms for solving stochastic differential equations in mathematical finance (An et al., 2021). Moreover, the application of quantum-inspired evolutionary algorithms has shown potential for addressing optimization problems in finance, such as the quadratic assignment problem (Chmiel & Kwiecień, 2018). These examples illustrate the diverse opportunities for leveraging quantum-inspired approaches to enhance computational capabilities and decision-making processes in financial markets.

In conclusion, the intersection of AI and quantum computing offers synergies and advantages for addressing computational challenges, enhancing predictive modeling, and unlocking opportunities in financial markets. Quantum computing and quantum-inspired algorithms have the potential to revolutionize financial decision-making processes by providing exponential speedup, improving classification accuracy, and addressing complex optimization problems.

Challenges and Limitations of AI and Quantum Computing in Financial Market

The integration of artificial intelligence (AI) and quantum computing in the financial market presents both opportunities and challenges. AI has the potential to revolutionize financial services, offering improved decision-making, risk management, and customer experience (Ghandour, 2021). However, several challenges need to be addressed to fully leverage the potential of AI in the financial market. These challenges include job displacement, privacy concerns, and the loss of the human touch in customer interactions (Ghandour, 2021). Additionally, the implementation of AI in financial services requires vast amounts of high-quality data, alignment with business strategies, and addressing the digital divide (Ghandour, 2021). Furthermore, the regulatory framework for AI in financial services needs to be carefully designed to ensure access to finance while managing risks (Lee, 2020).

Quantum computing also holds promise for transforming the financial market by enabling complex calculations and simulations that are currently infeasible with classical computers. However, the practical implementation of quantum computing in finance faces significant challenges. These challenges include the need for robust governance models to manage AI models in financial services, ensuring transparency, fairness, and accountability in AI decision-making (Kurshan, 2020). Moreover, the limitations of AI-related technologies, particularly in the context of economic growth and financial crises, pose additional challenges to the adoption of AI in financial markets (Milana & Ashta, 2021).

In the context of the COVID-19 pandemic, AI has been identified as a potential tool for small and medium-sized enterprises (SMEs) to address challenges in marketing, financial performance, and data management (Ho et al., 2022). However, the successful integration of AI into the digital marketing of financial services also presents challenges, particularly in reaching vulnerable customers and ensuring ethical deployment of AI technologies (Mogaji et al., 2020).

In addition to AI, quantum computing has the potential to enhance financial market predictions and trading strategies. However, the applicability of self-play algorithms to trading and forecasting financial markets requires careful consideration and evaluation (Posth et al., 2021). Furthermore, the use of improved soft computing techniques, such as artificial neural networks, for stock market forecasting highlights the potential of AI in resolving financial issues, but also underscores the need for rigorous analysis and implementation to ensure effectiveness (Kumawat et al., 2022).

In conclusion, while AI and quantum computing offer significant potential for transforming the financial market, addressing the challenges and limitations is crucial for their successful integration. This includes managing the impact on employment, addressing privacy and ethical concerns, ensuring robust governance and regulatory frameworks, and carefully evaluating the applicability and effectiveness of AI and quantum computing techniques in financial decision-making and market predictions.

Case Studies of AI and Quantum Computing in Financial Market

Successful implementations of AI and quantum computing in financial markets have been documented in various studies. For instance, AI has been utilized to manage behavioral biases among financial planners, with techniques such as backpropagation within neural networks and deep reinforcement learning proving effective in overcoming biases (Hasan et al., 2023). Additionally, AI has been successfully employed to analyze stock market activities, demonstrating its potential to contribute to decision-making processes in financial markets (Song & Jain, 2022). Furthermore, the use of AI in financial market predictions has been explored, particularly in navigating through crises such as the COVID-19 pandemic, showcasing its potential in providing valuable insights for market participants (Sharma et al., 2020).

Lessons learned from early adopters and experiments in the application of AI in financial markets have also been highlighted. Studies have emphasized the need for appropriate measures to protect data and ethical responsibility when implementing AI and machine learning in the financial capital market (Abuzov, 2023). Furthermore, the challenges of implementing and running an AI-Lab have been discussed, shedding light on the time-consuming nature of the implementation process and the unexpected challenges that may arise (Hergan, 2022). These insights provide valuable lessons for organizations and policymakers looking to integrate AI into financial market operations.

The impact of AI and quantum computing on financial decision-making and market dynamics has been a subject of extensive research. AI has been shown to influence financial decision-making by transforming the finance sector through synergizing, innovating, and transforming financial services, economy, technology, media, and communication (Cui, 2022). Moreover, the influence of institutional ownership on the value relevance of AI in developing markets has been investigated, providing insights into the broader impact of AI on market dynamics (Diab et al.,

2021). Additionally, the potential for AI to shield firms from risks and its implications for firm performance have been explored, highlighting its role in shaping market dynamics (Ho et al., 2022).

In conclusion, the literature provides compelling evidence of the successful implementation of AI and quantum computing in financial markets, along with valuable lessons learned from early adopters and experiments. Furthermore, the impact of AI on financial decision-making and market dynamics has been extensively studied, offering insights into its transformative potential in the financial sector.

Future Directions and Trends of AI and Quantum Computing in Financial Market

The future of AI and quantum computing in the financial market holds promising potential advancements and emerging trends. In the realm of quantum computing, there is a growing focus on advancements in technology that can revolutionize financial applications. This includes the development of quantum algorithms capable of solving complex financial problems with unprecedented speed and efficiency (Gill, 2022). As quantum computing matures, it is expected to enable the processing of vast amounts of financial data and the optimization of portfolio management strategies (Umer et al., 2019). Additionally, the evolution of AI algorithms and models in financial applications is a key area of interest. Research has shown that AI, particularly deep learning and machine learning, has been extensively utilized for sentiment-based stock prediction and time series data analysis in financial markets (Asgarian et al., 2022; Biju et al., 2023). Furthermore, the integration of AI and quantum computing in finance is an emerging trend that is gaining traction. Studies have highlighted the potential of AI in predicting stock market trends and the value it can create in financial market predictions (Sharma et al., 2020; Mariani et al., 2019). Moreover, the collaborative intelligence between human and artificial intelligence is expected to create value along the B2B sales funnel in the financial sector (Paschen et al., 2020). The integration of AI and quantum computing is also anticipated to enhance the understanding of chaotic financial environments and improve decision-making processes (Hafezi, 2019). As a result, the future of AI and quantum computing in the financial market is poised to bring about transformative advancements, revolutionizing the way financial data is processed, analyzed, and utilized for decision-making.

RECOMMENDATION AND CONCLUSION

The integration of AI and quantum computing presents significant synergies, addressing computational challenges and enhancing decision-making in financial markets. Quantum-inspired algorithms have the potential to revolutionize financial modeling and analysis.

Hardware constraints in quantum computing, including issues related to qubit stability and error correction, pose significant challenges. High costs associated with quantum computing infrastructure, coupled with ethical and regulatory considerations, present barriers to widespread adoption. Algorithmic bias, data security, and privacy concerns demand careful attention to ensure the responsible and ethical use of AI and quantum computing in financial decision-making. Transparency and accountability in the intersection of these technologies are critical for building trust in financial systems. The lack of quantum-specific regulations and the need for international

coordination underscore the importance of developing clear regulatory frameworks for the financial application of quantum computing.

The intersection of AI and quantum computing is poised to disrupt traditional financial paradigms, offering new tools for risk management, portfolio optimization, and fraud detection. Financial institutions embracing these technologies may gain a competitive advantage in terms of efficiency and innovation. The inherent uncertainties associated with quantum computing, coupled with evolving regulatory landscapes, may introduce new dimensions of risk for financial markets. Adequate risk management strategies must be developed to navigate these uncertainties effectively. Encouraging collaboration between academia, industry, and regulatory bodies is essential for fostering a holistic understanding of the intersection of AI and quantum computing. Educational programs and initiatives are needed to build a skilled workforce capable of navigating these technologies in financial settings.

Invest in research to develop and implement quantum-resistant cryptographic solutions to safeguard financial data and transactions. Support research and development efforts focused on overcoming hardware constraints in quantum computing, such as improving qubit stability and reducing error rates. Develop ethical frameworks specifically tailored to the intersection of AI and quantum computing in financial markets, addressing issues of bias, transparency, and accountability. Collaborate with regulatory bodies to provide guidance and establish clear regulations for the ethical use of AI and quantum computing in financial decision-making. Encourage the creation of case studies and best practices to showcase successful implementations of AI and quantum computing in financial institutions.

In conclusion, navigating the intersection of AI and quantum computing in financial markets requires a delicate balance between embracing technological advancements and addressing associated challenges. By fostering collaboration, advancing research, and developing ethical and regulatory frameworks, the financial industry can harness the transformative potential of these technologies responsibly, ensuring a future characterized by innovation, efficiency, and ethical integrity.

Reference

Abrahams, T.O., Ewuga, S.K., Kaggwa, S., Uwaoma, P.U., Hassan, A.O., & Dawodu, S.O. (2024). Mastering compliance: A comprehensive review of regulatory frameworks in accounting and cybersecurity. *Computer Science & IT Research Journal*, *5*(1), 120-140.

Abrahams, T.O., Ewuga, S.K., Kaggwa, S., Uwaoma, P.U., Hassan, A.O., & Dawodu, S.O. (2023). Review of strategic alignment: Accounting and cybersecurity for data confidentiality and financial security.

Abuzov, A. (2023). The role of technological innovations in institutional regulation of the financial capital market. *E3s Web of Conferences, 376*, 05047. https://doi.org/10.1051/e3sconf/202337605047

Adaga, E.M., Egieya, Z.E., Ewuga, S.K., Abdul, A.A., & Abrahams, T.O. (2024). Philosophy In Business analytics: a review of sustainable and ethical approaches. *International Journal of Management & Entrepreneurship Research*, *6*(1), 69-86.

Ahn, J., Weinacht, T., & Bucksbaum, P. (2000). Information storage and retrieval through quantum phase. *Science*, *287*(5452), 463-465. https://doi.org/10.1126/science.287.5452.463

An, D., Linden, N., Liu, J., Montanaro, A., Shao, C., & Wang, J. (2021). Quantum-accelerated multilevel Monte Carlo methods for stochastic differential equations in mathematical finance. *Quantum*, *5*, 481. https://doi.org/10.22331/q-2021-06-24-481

Arrazola, J., Delgado, A., Bardhan, B., & Lloyd, S. (2020). Quantum-inspired algorithms in practice. *Quantum*, *4*, 307. https://doi.org/10.22331/q-2020-08-13-307

Arthur, T., Tchoffo, M., & Fai, L. (2018). Dynamics of entanglement and quantum states transitions in spin-qutrit systems under classical dephasing and the relevance of the initial state. *Journal of Physics Communications*, *2*(3), 035031. https://doi.org/10.1088/2399-6528/aab51b

Asgarian, S., Ghasemi, R., & Momtazi, S. (2022). Generative adversarial network for sentiment-based stock prediction. *Concurrency and Computation Practice and Experience*, *35*(2). https://doi.org/10.1002/cpe.7467

Berikashvili, I. (2024). The role of ai in improving municipal finance in Georgia. *Economics*, *105*(11-12), 60-75. https://doi.org/10.36962/ecs105/11-12/2023-60

Biju, A., Thomas, A., & Thasneem, J. (2023). Examining the research taxonomy of artificial intelligence, deep learning & machine learning in the financial sphere—a bibliometric analysis. *Quality & Quantity*, *58*(1), 849-878. https://doi.org/10.1007/s11135-023-01673-0

Chmiel, W., & Kwiecień, J. (2018). Quantum-inspired evolutionary approach for the quadratic assignment problem. *Entropy*, *20*(10), 781. https://doi.org/10.3390/e20100781

Cui, Y. (2022). Sophia sophia tell me more, which is the most risk-free plan of all? AI anthropomorphism and risk aversion in financial decision-making. *The International Journal of Bank Marketing*, *40*(6), 1133-1158. https://doi.org/10.1108/ijbm-09-2021-0451

D'Hooghe, B., & Pykacz, J. (2004). Quantum mechanics and computation. *Foundations of Science*, *9*(4), 387-404. https://doi.org/10.1007/s10699-005-4827-y

Diab, A., Abdelazim, S., & Metwally, A. (2021). The impact of institutional ownership on the value relevance of accounting information: evidence from Egypt. *Journal of Financial Reporting and Accounting*, *21*(3), 509-525. https://doi.org/10.1108/jfra-05-2021-0130

Ding, S., & Jin, Z. (2007). Review on the study of entanglement in quantum computation speedup. *Chinese Science Bulletin*, *52*(16), 2161-2166. https://doi.org/10.1007/s11434-007-0324-8

Dwivedi, Y., Hughes, L., Ismagilova, E., Aarts, G., Coombs, C., Crick, T., … & Williams, M. (2021). Artificial intelligence (AI): multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy. *International Journal of Information Management*, *57*, 101994. https://doi.org/10.1016/j.ijinfomgt.2019.08.002

Egger, D., Gambella, C., Marecek, J., McFaddin, S., Mevissen, M., Raymond, R., … & Yndurain, E. (2020). Quantum computing for finance: state-of-the-art and future prospects. *IEEE Transactions on Quantum Engineering, 1*, 1-24. https://doi.org/10.1109/tqe.2020.3030314

Gasperov, B., Begušić, S., Šimović, P., & Kostanjčar, Z. (2021). Reinforcement learning approaches to optimal market making. *Mathematics, 9*(21), 2689. https://doi.org/10.3390/math9212689

Ghandour, A. (2021). Opportunities and challenges of artificial intelligence in banking: systematic literature review. *TEM Journal,* 1581-1587. https://doi.org/10.18421/tem104-12

Gill, S. (2022). Ai for next generation computing: emerging trends and future directions. https://doi.org/10.48550/arxiv.2203.04159

Hafezi, R. (2019). How artificial intelligence can improve understanding in challenging chaotic environments. *World Futures Review, 12*(2), 219-228. https://doi.org/10.1177/1946756719880539

Han, K., & Kim, J. Genetic quantum algorithm and its application to combinatorial optimization problem. https://doi.org/10.1109/cec.2000.870809

Hasan, Z., Vaz, D., Athota, V., Désiré, S., & Pereira, V. (2023). Can artificial intelligence (AI) manage behavioural biases among financial planners?. *Journal of Global Information Management, 31*(2), 1-18. https://doi.org/10.4018/jgim.321728

Hassan, A.O., Ewuga, S.K., Abdul, A.A., Abrahams, T.O., Oladeinde, M., & Dawodu, S.O. (2024). Cybersecurity in banking: a global perspective with a focus on Nigerian Practices. *Computer Science & IT Research Journal*, *5*(1), 41-59.

Hergan, K. (2022). challenges implementing and running an ai-lab: experience and literature review. *Biomedical Journal of Scientific & Technical Research, 45*(4). https://doi.org/10.26717/bjstr.2022.45.007222

Herman, D., Googin, C., Liu, X., Galda, A., Safro, I., Sun, Y., … & Alexeev, Y. (2022). A survey of quantum computing for finance.. https://doi.org/10.48550/arxiv.2201.02773

Ho, L., Gan, C., Jin, S., & Le, B. (2022). Artificial intelligence and firm performance: does machine intelligence shield firms from risks*?. Journal of Risk and Financial Management, 15*(7), 302. https://doi.org/10.3390/jrfm15070302

Kumawat, S., Bansal, A., & Saini, S. (2022). Design analysis and implementation of stock market forecasting system using improved soft computing technique. *International Journal on Future Revolution in Computer Science & Communication Engineering, 8*(4), 09-16. https://doi.org/10.17762/ijfrcsce.v8i4.2110

Kurshan, E. (2020). Towards self-regulating ai: challenges and opportunities of ai model governance in financial services. https://doi.org/10.48550/arxiv.2010.04827

LeCun, Y., Bengio, Y., & Hinton, G. (2015). Deep learning. *Nature, 521*(7553), 436-444. https://doi.org/10.1038/nature14539

Lee, J. (2020). Access to finance for artificial intelligence regulation in the financial services industry. *European Business Organization Law Review, 21*(4), 731-757. https://doi.org/10.1007/s40804-020-00200-0

Li, Y., & Neufeld, A. (2023). Quantum Monte Carlo algorithm for solving black-scholes pdes for high-dimensional option pricing in finance and its proof of overcoming the curse of dimensionality. https://doi.org/10.48550/arxiv.2301.09241

Mariani, G., Zhu, Y., Li, J., Scheidegger, F., Istrate, R., Bekas, C., … & Malossi, A. (2019). Pagan: portfolio analysis with generative adversarial networks. https://doi.org/10.48550/arxiv.1909.10578

Martinis, J., Nam, S., Aumentado, J., & Urbina, C. (2002). Rabi oscillations in a large josephson-junction qubit. *Physical Review Letters, 89*(11). https://doi.org/10.1103/physrevlett.89.117901

Milana, C., & Ashta, A. (2021). Artificial intelligence techniques in finance and financial markets: a survey of the literature. *Strategic Change, 30*(3), 189-209. https://doi.org/10.1002/jsc.2403

Mogaji, E., Soetan, T., & Kieu, T. (2020). The implications of artificial intelligence on the digital marketing of financial services to vulnerable customers. *Australasian Marketing Journal (AMJ), 29*(3), 235-242. https://doi.org/10.1016/j.ausmj.2020.05.003

O'Leary, D., Brennen, G., & Bullock, S. (2006). Parallelism for quantum computation with qudits. *Physical Review A, 74*(3). https://doi.org/10.1103/physreva.74.032334

Orús, R., Mugel, S., & Lizaso, E. (2019). Forecasting financial crashes with quantum computing. *Physical Review A, 99*(6). https://doi.org/10.1103/physreva.99.060301

Paschen, J., Wilson, M., & Ferreira, J. (2020). Collaborative intelligence: how human and artificial intelligence create value along the b2b sales funnel. *Business Horizons, 63*(3), 403-414. https://doi.org/10.1016/j.bushor.2020.01.003

Posth, J., Kotlarz, P., Misheva, B., Osterrieder, J., & Schwendner, P. (2021). The applicability of self-play algorithms to trading and forecasting financial markets. *Frontiers in Artificial Intelligence, 4*. https://doi.org/10.3389/frai.2021.668465

Shao, J., Lou, Z., Wang, C., Mao, J., & Ye, A. (2021). The impact of artificial intelligence (ai) finance on financing constraints of non-soe firms in emerging markets. *International Journal of Emerging Markets, 17*(4), 930-944. https://doi.org/10.1108/ijoem-02-2021-0299

Sharma, G., Erkut, B., Jain, M., Kaya, T., Mahendru, M., Srivastava, M., … & Singh, S. (2020). Sailing through the covid-19 crisis by using ai for financial market predictions. *Mathematical Problems in Engineering, 2020*, 1-18. https://doi.org/10.1155/2020/1479507

Sharma, P. (2023). The future of finance. https://doi.org/10.4018/979-8-3693-1902-4.ch011

Song, G., & Jain, A. (2022). Can artificial intelligence beat the stock market?. *Studies in Economics and Finance, 39*(5), 772-785. https://doi.org/10.1108/sef-03-2022-0133

Tang, H., Pal, A., Qiao, L., Wang, T., Gao, J., & Jin, X. (2021). Quantum computation for pricing the collateralized debt obligations. *Quantum Engineering, 3*(4). https://doi.org/10.1002/que2.84

Tang, J., Hou, Z., Shang, J., Zhu, H., Xiang, G., Li, C., … & Guo, G. (2020). Experimental optimal orienteering via parallel and antiparallel spins. *Physical Review Letters, 124*(6). https://doi.org/10.1103/physrevlett.124.060502

Tiwari, P., & Melucci, M. (2019). Towards a quantum-inspired binary classifier. *IEEE Access*, *7*, 42354-42372. https://doi.org/10.1109/access.2019.2904624

Tiwari, R. (2023). Explainable AI (xai) and its applications in building trust and understanding in ai decision making. *International Journal of Scientific Research in Engineering and Management*, *07*(01). https://doi.org/10.55041/ijsrem17592

Umer, M., Awais, M., & Muzammul, M. (2019). Stock market prediction using machine learning(ml)algorithms. *Adcaij Advances in Distributed Computing and Artificial Intelligence Journal*, *8*(4), 97-116. https://doi.org/10.14201/adcaij20198497116

Vela, D., Sharp, A., Zhang, R., Nguyen, T., Hoang, A., & Pianykh, O. (2022). Temporal quality degradation in ai models. *Scientific Reports*, *12*(1). https://doi.org/10.1038/s41598-022-15245-z

Wang, C., Wang, T., Yuan, C., & Rong, J. (2021). Learning to trade on sentiment. *Journal of Economics and Finance*, *46*(2), 308-323. https://doi.org/10.1007/s12197-021-09565-5

Zhan, T. (2022). Hyper-parameter tuning in deep neural network learning. https://doi.org/10.5121/csit.2022.121809

Zhang, G. (2010). Quantum-inspired evolutionary algorithms: a survey and empirical study. *Journal of Heuristics*, *17*(3), 303-351. https://doi.org/10.1007/s10732-010-9136-0