

Generative Artificial Intelligence in Finance: Applications, Opportunities, and Challenges

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Abstract: A paradigm shift is underway in banking and finance driven by artificial intelligence, with Generative AI (GenAI) emerging as a transformative force beyond traditional predictive analytics. This paper provides a comprehensive review of GenAI applications across the financial services ecosystem, extending beyond customer support to areas such as risk management, algorithmic trading, fraud detection, financial reporting, and regulatory compliance. Drawing on advances in deep learning, multimodal systems, and ethical AI, the study examines key technologies—including large language models, generative adversarial networks, and diffusion models—and their role in enabling dynamic interactions, hyper-personalized financial products, and synthetic data generation for model training and stress testing. Comparative analysis shows that GenAI significantly outperforms conventional rule-based systems (e.g., IVR and basic chatbots) in flexibility, contextual understanding, and value creation. However, challenges related to data privacy, model hallucination, regulatory oversight, and ethical concerns remain critical. The paper emphasizes the need for robust governance, explainability, and human–AI collaboration frameworks. Overall, GenAI represents not an incremental improvement but a fundamental rethinking of financial service delivery, offering enhanced accessibility, personalization, and efficiency while introducing new risks that require responsible management.

Keywords: Generative AI, Banking, Financial Technology, Large Language Models, Synthetic Data, Customer Experience, Risk Management, Algorithmic Trading, Regulatory Technology.

1. Introduction

Financial services industry is at the level of an inflection point, at which the artificial intelligence shifts to creative generation rather than augmentation of the analysis. As much as supervised machine learning and deep learning have transformed credit scoring, fraud detection, as well as algorithmic trading the Generative Artificial Intelligence (GenAI) presents features that radically changes service provision, product creating, and risk evaluation (Ghori, 2018; Ghori, 2019, Ghori, 2021). Otherwise, in contrast to discriminative models that classify or predict, GenAI models generate new data instances, i.e., text, code, images, audio, structured financial situations, etc., that are similar to training data (Ghori, 2021).

In this paper, the investigation that was first presented by Puchakayala (2024) into the transformative potential of GenAI in Customer Support Services (CSS) in banking is placed within a wider framework of financial innovation. We say that the application of GenAI is not limited to conversational interfaces to core banking functions. We apply a multimodal learning perspective (Sardesai et al., 2025), an evolutionary optimization perspective (Shalini et al., 2024), and a responsible AI framework (Puchakayala, 2022) to construct a complete taxonomy

of GenAI applications and look at both potential opportunities and major issues that may arise because of the heavily regulated financial industry.

2. Generative AI Technologies: Foundations for Financial Innovation

In finance, GenAI makes use of a number of sophisticated architectures (Shalini & Patil, 2021):

- **Large Language Models (LLMs) (e.g., GPT, Llama):** They do well in generating text, text translation, text summarization and code synthesis trained on large corpora. They drive high-level chatbots and document inspection in finance as well as creating reports (Ghori, 2023).
- **Generative Adversarial Networks (GANs):** GANs produce realistic images on synthesis by having a discriminator and generator as part of the adversarial training (Ghori, 2018). They play a vital role in financial information augmentation and simulation of fraud and they are based on parallel concepts of Spatio-Convolutional GAIN that is used to impute missing data (Bansal et al., 2025).
- **Variational Autoencoders (VAEs) & Diffusion Models:** Applicable to portfolio simulation and market scenario generation Used to generate complex data structures and synthetic market datasets of high fidelity (Bansal et al., 2025).
- **Multimodal Generative Models:** Multi data type (text, table, chart) processing and generating models are necessary to perform the holistic financial analysis, tackle problems presented by multimodal machine learning researchers (Sardesai et al., 2025).

3. Application Domains in Banking and Finance

3.1. Customer Experience and Engagement

In addition to the use of rule-based IVR and chatbots, GenAI can be used to (Puchakayala, 2024):

- **Hyper-Personalized Conversational AI:** The LLMs are capable of having context-driven conversations, which are understanding, that solve diverse queries, synthesizing data based on the transaction history, market-related news, and product-related documents of a buyer. This is a super leap of the conventional supervised learning methods that were revised to estimate student performance (Ghule et al., 2024).
- **Dynamic Content Creation:** Personalized financial advice summary, investment report, and educational content generated automatically, according to the level of individual literacy and interests.
- **Omni-channel Experience Synthesis:** Consistent and context-sensitive dialogues between web, mobile and voice interfaces through the generation of contextually correct responses and delivery of those responses to the correct channel.

3.2. Risk Management and Compliance (RegTech)

- **Synthetic Data Generation for Model Validation:** Instead of having to expose sensitive customer data to risk, GANs can generate realistic and synthetic financial information (records of transactions, market, etc.) to train and test risk models. This resolves the issue of limited data and privacy that is comparable to medical imaging (Amudala Puchakayala et al., 2023).
- **Automated Regulatory Reporting and Documentation:** Writing the compliance report, tracking the regulatory changes, and creating audit trails LLMs can analyze the

complicated legal documents, turning manual and mistake-ridden processes into automated ones.

- **Anti-Money Laundering (AML) and Fraud Detection:** GenAI is capable of modeling advanced patterns of money laundering and synthesizing fake transactions of fraud to enhance detection systems to supplement deep learning methods of anomaly detection (Ghori, 2018).

3.3. Investment and Trading

- **Algorithmic Strategy Generation:** All to formulate, and to test, new dream trading signals and portfolio allocations under evolutionary algorithms (Shalini et al., 2024) that are implemented with GenAI.
- **Market Scenario Simulation and Forecasting:** Causally simulating future market conditions (including tail risks) in which portfolios are stressed, beyond the conventional time-series forecasting frameworks (Ghori, 2019).
- **Earnings Call and Sentiment Analysis:** LLMs are capable of producing summaries and sentiment analysis reports based on earnings calls, analyst reports, and news based on the subtle notes and contradictions.

3.4. Product Development and Personalization

- **AI-First Financial Products:** Creating tailored insurance documents, loan contracts, or investment portfolios under the input of risk profile, objectives, and behavioral information of an individual and applying tenets in artificial intelligence in behavioral economics (Ghule, 2025).
- **Smart Contract Generation:** In the case of blockchain-based finance, the LLMs will be able to write, audit, and interpret a complex smart contract code, minimizing errors and time spent on the code development.

3.5. Operational Efficiency

- **Code Generation for Financial Models:** Automating quantitative model development, data pipeline development and analytics dashboards (Sheela and Shalini, 2024; Sardesai and Gedam, 2025).
- **Document Processing and Knowledge Management:** Automated detection, summary, and connection of information across various sources (PDFs, emails, databases, etc.), and formation of dynamic organizational knowledge graph (Sheela and Shalini, 2024; Sardesai and Gedam, 2025).

4. Implementation Framework and Integration Challenges

Adopting GenAI in finance has to be done in a systematic fashion:

1. **Data Foundation & Model Selection:** Quality, domain-specific financial datasets. Fine-tuning foundation models with curated high-quality datasets. There are trade-offs in control, cost and capability that exist between proprietary development (e.g. BloombergGPT) and the fine-tuning of open-source models.
2. **Hybrid Architecture Design:** Combination of GenAI with current systems of discriminative ML systems (e.g. a GenAI chatbot asking a traditional credit risk model) and IoT data streams to provide real-time, context-dependent services, such as insurance telematics.

3. **Validation and Hallucination Mitigation:** The addition of strict layers of fact-checking, confidence scoring, and grounding schemas that will guarantee the generated content is correct and valid is a key requirement the implementation of which would have dire financial implications in case of a hallucination where highly founded falsehoods might cost a significant amount of money.
4. **Human-in-the-Loop (HITL) Systems:** Creating processes in which human experts conduct and ratify AI-generated data (e.g. loan approval recommendations, investment advice) is accountable.

5. Critical Challenges and Risk Mitigation

GenAI has unprecedented risks that it is always better to mitigate:

1. **Model Hallucination and Accuracy:** GenAI algorithms can produce realistic and yet not accurate monetary data. Mitigation: Use strong verification pipelines, reference, and use clear disclaimers on AI-generated content.
2. **Data Privacy and Security:** Sensitive Financial data training brings about confidentiality issues. Mitigation: Use federated learning, different privacy, and synthetic data generating methods (Bansal et al., 2025) in compliance with the principles of responsible AI (Puchakayala, 2022).
3. **Algorithmic Bias and Fairness:** GenAI has the ability to propagate and escalate any bias in training observations which promotes unfair credit decisions. Mitigation: Persistent bias auditing, various training data and impartial limitations in model enhancement.
4. **Regulatory and Compliance Risks:** Artificial intelligence is being examined by financial regulators. Models should be open and should correspond to such regulations as GDPR, CCPA, and the industry-specific regulations. There is not a compromise on explainable AI (XAI) techniques.
5. **Systemic Risk and Market Stability:** The scenario of extensive use of the similar GenAI trading strategies is likely to raise the market correlation and volatility. Mitigation: Stress-testing of AI strategies by the regulators and encouraging diversity in model construction.
6. **Operational and Cybersecurity Risks:** New types of adversarial attacks of GenAI systems (prompt injection, data poisoning) are also vulnerable. Mitigation: Red teaming, effective cybersecurity models, and secure application deployment models.

6. Conclusion and Future Scope

Generative AI is a game changer in banking and finance, not just in terms of improved customer service, but in all aspects of the industry. According to the definition given by Puchakayala (2024) and with similar trends observed in all subfields of AI, GenAI allows achieving unprecedented individualization, productivity, and creativity. Nonetheless, it requires a delicate balancing of important technical, ethical, and regulatory obstacles to implement it. The successful financial institutions are the ones adopting a responsible innovation strategy that will utilize the creative opportunities of GenAI but adopts a strong governance system, provides transparency, and human checks and balances. Through combining GenAI with the insights of the evolutionary optimization, multimodal learning, and ethical AI frameworks, the

finance industry is able to open up new value and more resilient and inclusive as well as trustful financial systems in the future.

The future of GenAI in finance is more integration, more specialization and regulation:

- **Domain-Specific Foundation Models:** Training financial LLMs (e.g., BloombergGPT) to have profound knowledge of financial terms, rules, and math.
- **Multimodal Financial Agents:** Artificial intelligence that is capable of handling the audio of an earnings call, executing the necessary presentation charts (with similar methods to CBIR (Marathe et al., 2022)) and the resulting press release, and creating a complete thesis on what to invest in.
- **Generative AI for Financial Inclusion:** Developing simplified financial products and educational tools with the help of GenAI through the application of underserved populations, which may be combined with the provision of services to remote regions using IoT-based solutions.
- **Quantum-Enhanced Generative Models:** Research on quantum computing to train the complex generative models used in generating simulations in high-dimensional financial simulations faster.
- **Regulatory Sandboxes and Standards:** Development of GenAI testing environments and industry standards in finance, in safe innovation.

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