Linking Artificial Intelligence into Management of Liquidity by Central Bank: An Exploratory Review of Nigerian Financial System

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Abstract

This paper explores the use of artificial intelligence (AI) in liquidity management role of Central Bank in Nigerian financial system. This research aims to identify how central bank can leverage AI to improve liquidity management and bolster monetary stability using content and discourse analysis. Deploying discourse analysis method, this article identifies the strengths, weaknesses, opportunities and threats of using AI in liquidity management role of central banking monetary policy. This exploratory study examines optimization algorithms, which involves formulating mathematical optimization models that consider various constraints, objectives, and market conditions to determine the optimal allocation of liquidity resources. In conclusion, while the adoption of AI in liquidity management of central bank monetary policies presents significant opportunities for improving efficiency, accuracy, and risk management, it also poses challenges related to technical expertise, data quality, regulatory compliance, and cybersecurity. Addressing these challenges will be essential for Nigeria to harness the full potential of AI in enhancing financial stability and promoting inclusive economic growth.

Keywords: AI Automation technologies, Data Science, central banking, liquidity management, Optimization Algorithms, SWOT analysis

Jel Classification: G21, G21, O3, C0, C6,C19

Background to the Study

Central banks in developed nations, such as the Federal Reserve in the United States, the European Central Bank, and the Bank of England, have been at the forefront of adopting AI and machine learning technologies in liquidity management (Akpanobong and Essien, 2022). These central banks utilize AI for tasks such as real-time monitoring of financial markets, predictive analytics for liquidity forecasting, algorithmic trading, and risk assessment (Salemcity *et al.*, 2023). They have dedicated teams of data scientists, economists, and

technologists working on AI projects to enhance the effectiveness of monetary policies and ensure financial stability.

Central banks in some developing nations have also begun exploring the adoption of AI in liquidity management, albeit to a lesser extent compared to their counterparts in developed nations (Ozili, 2020). According to Ozili (2020), adoption of AI may be constrained by factors such as limited technical expertise, data infrastructure challenges, and budgetary constraints. However, there is growing recognition of the potential benefits of AI in improving liquidity management and supporting monetary policy objectives, leading to increased interest and investment in AI initiatives by central banks in developing nations.

Conceptual review

Artificial Intelligence (AI) is the branch of computer science that aims to create intelligent machines capable of performing tasks that typically require human intelligence. These tasks may include recognizing patterns, making predictions, understanding natural language, and interacting with the environment (Veloso *et al.*, 2021). The relevant key concepts in AI are deep learning, supervised learning, unsupervised learning, reinforcement learning, data mining, pattern recognition, cognitive computing, speech recognition, image processing. The basic concepts of AI (Artificial Intelligence) revolve around creating systems or machines capable of performing tasks that typically require human intelligence. Here are some fundamental concepts:

Machine learning is a subset of AI that focuses on enabling machines to learn from data without being explicitly programmed (Yarlagadda, 2021). Algorithms are trained on large datasets to identify patterns and make predictions or decisions based on new data. Deep learning is a type of machine learning that uses artificial neural networks with multiple layers to learn complex representations of data. It has been particularly successful in tasks such as image recognition, natural language processing, and speech recognition (Haakman *et al.*, 2021).

Natural Language Processing enables computers to understand, interpret, and generate human language. It encompasses tasks such as language translation, sentiment analysis, and text generation. Computer vision involves teaching computers to interpret and understand visual information from images or videos (Yarlagadda, 2021). It enables applications such as object detection, facial recognition, and image classification.

Neural networks are computational models inspired by the structure and function of the human brain (Kahyaoglu, 2021). They consist of interconnected nodes (neurons) organized in layers, with each layer processing and transforming input data to produce an output. Supervised learning is a type of machine learning where algorithms are trained on labeled data, with each input data point associated with a corresponding output label (Doumpos *et al.*, 2022). The goal is to learn a mapping from inputs to outputs that can be generalized to new, unseen data.

Data science involves preparing and cleaning raw data before feeding it into machine learning algorithms (Dhanabalan and Sathish, 2018). It includes tasks such as data cleaning, feature selection, normalization, and handling missing values. Unsupervised learning involves training algorithms on unlabeled data to find hidden patterns or structures within the data. It includes techniques such as clustering, dimensionality reduction, and anomaly detection. Understanding these basic concepts is crucial for developing AI systems and applying machine learning techniques effectively to solve real-world problems (Dhanabalan and Sathish, 2018).

Central banking is the action performed by a central bank. A central bank is an apex financial institution that manages the currency of a country and controls the amount of money in circulation (Dow, S. (2019)). The core objectives of a central bank are liquidity management, price stability, financial stability, monetary stability, exchange rate management, lender of last resort, and banker to the government (Ozili, 2020).

Nwosu (2018) defines liquidity management as the central bank's efforts to maintain an adequate level of liquidity in the banking system to meet the demand for funds and facilitate the transmission of monetary policy. Central banks monitor key indicators of liquidity, such as interbank lending rates and money market activity, to assess liquidity conditions and implement appropriate policy measures. The relevant key concepts of liquidity management are central banking system, interbank lending, money market, monetary transmission, policy measures, liquidity indicators, fund demand (Ozili, 2020).

Theoretical framework

Optimization Algorithms Theory

Researchers like Smith et al. (2018) have explored the application of optimization algorithms, such as genetic algorithms and simulated annealing, to optimize liquidity provision by central banks (Alim *et al.*, 2020).

Optimization algorithms have been applied to liquidity management since the early 2000s, with ongoing research and development in this area (Milana and Ashta, 2021). The proposal involves formulating mathematical optimization models that consider various constraints, objectives, and market conditions to determine the optimal allocation of liquidity resources (Mehrabi *et al.*, 2021). Optimization Algorithms' assumptions include the existence of well-defined optimization objectives, the availability of accurate input data, and the ability to solve complex optimization problems efficiently (Alim *et al.*, 2020).

AI-powered optimization algorithms can assist central banks in determining the optimal allocation of liquidity across different financial markets and institutions (Chen *et al.*, 2021). By maximizing the efficiency of liquidity provision, central banks can enhance market liquidity and mitigate systemic risks. According to Lopez-Corleone *et al.* (2022), AI-powered algorithms can execute trades automatically based on pre-defined criteria. This can help in managing liquidity by providing liquidity when needed and withdrawing it when markets are overheated.

Limitations of the theory include computational complexity, the sensitivity of optimization results to model assumptions, and the challenge of incorporating uncertainty into optimization frameworks .Central banks leverage optimization algorithms driven by AI to optimize the allocation of liquidity resources across different financial markets and institutions (Lopez-Corleone *et al.*, 2022). AI algorithms can consider various constraints, objectives, and market conditions to determine the optimal distribution of liquidity. According to Kahyaoglu (2021), by maximizing the efficiency of liquidity provision, central banks can enhance market liquidity, mitigate systemic risks, and achieve their monetary policy objectives more effectively.

Tools of liquidity management role in central banking

Liquidity management is the process through which central banks regulate the availability of liquid assets in the economy to achieve their policy objectives. Central banks use a combination of conventional and unconventional monetary policy tools to influence money market conditions, including quantitative easing, forward guidance, and asset purchases. The following are the tools that central bank can use to manage liquidity (Ozili, 2020).

Open Market Operations (OMO): Central banks buy or sell government bonds to control the amount of money in circulation. Buying bonds puts money into the economy, while selling bonds takes money out, affecting interest rates and inflation.

Discount Window Operations: Central banks offer short-term loans to commercial banks when they need extra cash. This helps banks cover sudden shortages of money and keeps the banking system stable.

Reserve Requirements: Central banks require commercial banks to keep a portion of their deposits as reserves. This ensures that banks have enough money on hand to meet customer withdrawals and helps control the amount of money circulating in the economy.

Standing Facilities: Central banks provide overnight loans to banks at preset interest rates. Banks can borrow money from these facilities when they need it urgently, helping to maintain stability in the banking system.

Repo Operations: Central banks buy securities from banks with an agreement to sell them back later. This provides banks with short-term cash and helps regulate the amount of money available in the financial system.

Term Auction Facilities (TAF): Central banks offer longer-term loans to banks through auctions. Banks bid for the loans, and the central bank provides funds to the winning bidders, helping to ensure banks have enough money to lend to businesses and consumers.

Foreign Exchange Interventions: Central banks buy or sell foreign currency to influence exchange rates. Buying currency strengthens the domestic currency, while selling currency weakens it, affecting international trade and the flow of money.

Standing Deposit Facilities: Central banks accept deposits from commercial banks at preset interest rates. Banks can deposit excess funds in these facilities overnight, helping to control the amount of money in the banking system.

Forward Guidance: Central banks provide guidance on future monetary policy decisions to influence market expectations. This helps shape interest rates and inflation expectations, influencing economic activity and investment decisions.

Quantitative Easing (QE): Central banks buy long-term securities like government bonds to inject money into the economy. This lowers interest rates and encourages borrowing and spending, stimulating economic growth during times of recession.

These tools are like levers that central banks use to control the flow of money in the economy, ensuring stability and supporting economic growth.

Fig. 1: Tools of liquidity management role in central banking

Source: Authors' View, 2024.

SWOT analysis

Strengths:

1. Efficiency Boost: AI streamlines tasks like data analysis, making liquidity management more efficient (Jinsung *et al.*, 2020; Zhang, 2020;).

2. Accuracy Improvement: AI can analyze vast data, providing precise predictions for liquidity needs (Euijong -Whang and Jae-Gil, 2020).

3. Real-Time Monitoring: AI enables quick detection of liquidity risks, enhancing financial stability (Jesper *et al.*,2020).

4. Risk Management Enhancement: AI helps in identifying and managing liquidity risks effectively (Reddy, 2018).

Weaknesses:

1. Technical Skill Requirement: Implementing AI demands specialized expertise that may be lacking (Minaee *et al.*, 2021;Tavana et al., 2018).

2. Data Quality Challenges: AI relies on high-quality data, which may be lacking in developing economies (Chen *et al.*, 2021; Schelter *et al.*, 2018).

3. Cost Concerns: Developing AI systems can be expensive, posing budgetary challenges (Cubric, M., 2020).

Opportunities:

1. Skill Development: Investing in AI education can build a skilled workforce in Nigeria .

2. International Partnerships: Collaborating with international organizations can provide valuable resources and expertise (Javaid *et al.*, 2022).

3. Financial Inclusion: AI-powered solutions can expand access to financial services in Nigeria (Naim, 2022).

Threats:

1. Regulatory Hurdles: Nigeria's regulatory environment may not be equipped to handle AI complexities (Samara et al., 2020).

2. Ethical Considerations: AI adoption raises concerns about fairness and transparency in decision-making (Vrontis *et al.*, 2022)

3. Cybersecurity Risks: AI systems are vulnerable to cyber threats, posing risks to financial stability (Wirtz *et al.*, 2020).

By addressing these issues, Nigeria can leverage AI to improve liquidity management and bolster economic growth.

Conclusion and recommendations

This paper explores the usage of artificial intelligence (AI) in liquidity management role of Central Bank in Nigerian financial system. This research aims to identify how central bank can leverage AI to improve liquidity management and bolster monetary stability using content and discourse analysis. Deploying discourse analysis method, this article identifies the strengths, weaknesses, opportunities and threats of using AI in liquidity management role of central banking monetary policy.

This exploratory study examines optimization algorithms, which involves formulating mathematical optimization models that consider various constraints, objectives, and market conditions to determine the optimal allocation of liquidity resources. In conclusion, while the adoption of AI in liquidity management of central bank monetary policies presents significant opportunities for improving efficiency, accuracy, and risk management, it also poses challenges related to technical expertise, data quality, regulatory compliance, and cybersecurity. Addressing these challenges will be essential for Nigeria to harness the full potential of AI in enhancing financial stability and promoting inclusive economic growth.

Central Bank of Nigeria (CBN) should train people in AI-related skills like data analysis and machine learning. This will help build a workforce capable of using AI effectively. CBN should make sure there are good systems in place for collecting and storing data. This data will be used by AI systems, so it needs to be accurate and easy to access (Kahyaoglu, 2021).

CBN should partner with technology companies to develop AI tools specifically for managing liquidity (Ozili., 2020). These companies can help create and implement AI systems. It is recommended that CBN should begin with small AI projects to see how they work in practice. This could involve testing AI systems for predicting liquidity needs or identifying risks. Monetary policy experts should create rules and guidelines for using AI in liquidity management. This ensures that AI is used responsibly and ethically.

Furthermore, central bank management should learn from other countries and organizations that are already using AI in liquidity management. This could involve attending conferences or joining international groups. They should continuously check how well AI systems are working. This helps identify any problems and makes sure AI is helping, not hindering, liquidity management. Finally, financial authority should be prepared to deal with challenges like privacy concerns or resistance to change. Addressing these issues will help AI adoption go smoothly. By following these steps, Nigeria can effectively use AI to manage liquidity, which will ultimately help its economy grow and prosper.

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