

MPRA

Munich Personal RePEc Archive

Artificial intelligence and central bank digital currency

Ozili, Peterson K

2024

Online at <https://mpra.ub.uni-muenchen.de/121567/>
MPRA Paper No. 121567, posted 26 Jul 2024 09:02 UTC

Artificial intelligence and central bank digital currency

Peterson K. Ozili

Abstract

The purpose of this article is to explore the role of artificial intelligence, or AI, in a central bank digital currency project and its challenges. Artificial intelligence is transforming the digital finance landscape. Central bank digital currency is also transforming the nature of central bank money. This study also suggests some considerations which central banks should be aware of when deploying artificial intelligence in their central bank digital currency project. The study concludes by acknowledging that artificial intelligence will continue to evolve, and its role in developing a sustainable CBDC will expand. While AI will be useful in many CBDC projects, ethical concerns will emerge about the use AI in a CBDC project. When such concerns arise, central banks should be prepared to have open discussions about how they are using, or intend to use, AI in their CBDC projects.

Keywords: artificial intelligence, central bank digital currency, CBDC, machine learning, deep learning, cryptocurrency, CBDC project, CBDC pilot, blockchain.

JEL codes: O33, E42.

July 2024

To cite: Ozili, P. K. (2024). Artificial Intelligence and Central Bank Digital Currency. In *Global Developments in Central Bank Digital Currency* (pp. 117-125). IGI Global.

<https://doi.org/10.4018/979-8-3693-5588-6.ch008>

1. Introduction

The purpose of this article is to explore the role of artificial intelligence, or AI, in a central bank digital currency project and its challenges. It also suggests some considerations which central banks should be aware of when deploying artificial intelligence in their central bank digital currency project.

The interplay of technology and money is revolutionizing the financial landscape in unprecedented ways. Artificial intelligence now sits at the forefront of technological innovation and has made inroads into many disciplines including the banking, finance, and economics disciplines. Artificial intelligence is currently disrupting the financial sector and it is changing the way we use money. Likewise, the financial sector is witnessing a surge in the development of central bank digital currency around the world. Central bank digital currency and artificial intelligence are two disruptive innovations – one is a remarkable innovation in central bank money while the other is a remarkable technological innovation in the field of computer science.

Artificial intelligence is the field of computer science that focuses on creating systems that can perform tasks usually done by humans (Chowdhary, 2020). The goal of artificial intelligence is to imitate the decision-making capabilities of humans and possibly replace some tasks usually performed by humans (Chowdhary, 2020). It is common knowledge that artificial intelligence operates through two major processes: 'machine learning' and 'deep learning'. Machine learning is the use of computer algorithms to screen or filter through data, learn from it, and use embedded statistical tools to make accurate predictions or decisions (Soori, Arezoo and Dastres, 2023). Deep learning, which is a component of machine learning, uses artificial neural networks to process large data, recognize patterns, and make decisions based on recognized patterns, thereby imitating human decision-making (Soori, Arezoo and Dastres, 2023).

A central bank digital currency, on the other hand, is the digital equivalent of fiat money. It is a State-controlled digital currency or a digital legal tender that is issued by a central bank (Ozili, 2023). Central bank digital currency emerged in 2017 and gained prominence in 2019 just before the COVID-19 pandemic (Lee, Yan, and Wang, 2021; Ozili, 2023). Today, many central bank digital currency pilot tests and proof-of-concept have been launched by central banks in more than 30 countries, notably, in India, Brazil, Russia, China, UK, the European Union, Angola, Ghana, Jamaica, Israel and Saudi Arabia, to name a few. A recent Bank of International Settlement (BIS) report shows that 70 percent of central banks are researching central bank digital currency (Barontini and Holden, 2019), while more than 80 percent of central banks see value in having both a retail CBDC and a fast payment system (Kosse and Mattei, 2023). This demonstrates the widespread interest in central bank digital currency among central banks around the world.

Integrating artificial intelligence into a central bank digital currency project presents an opportunity to revolutionize central bank digital currency and pave the way for a more meaningful use of central bank digital currency by central banks, financial institutions, and individuals and for the benefit of society. To fully understand the benefits of the artificial intelligence and central bank digital currency innovations, it is important to explore the convergence or the meeting point of artificial intelligence and central bank digital currency and how it can revolutionise the delivery and use of fiat digital currency also known as central bank digital currency. To do this, this study focuses on the role and challenges of artificial intelligence in a central bank digital currency project. This study contributes to the literature that examines the factors influencing the digital transformation of money. This study also contributes to the artificial intelligence literature that examines the multi-disciplinary applications of artificial intelligence. The present study adds to the artificial intelligence literature by exploring the application of artificial intelligence in a central money digital currency project. The study further contributes to the CBDC literature that examines the determinants of a successful CBDC. This discussion in this article adds to the CBDC literature by showing that the way AI is used in a CBDC project will influence its success.

The rest of the study is organized as follows. Section two identifies the role of artificial intelligence in a central bank digital currency project. Section three highlights the challenges that may be encountered when deploying AI systems in a central bank digital currency project. Section four suggests some considerations which central banks should be aware of when deploying artificial intelligence in a central bank digital currency project. Section five presents the conclusion of the article.

2. Role of AI in a central bank digital currency project

This section highlights eight ways in which artificial intelligence systems can support a central bank digital currency project.

2.1. Efficiency in one-tiered or two-tiered distribution of CBDC

One-tiered central bank digital currency distribution refers to the distribution of central bank digital currency directly from the central bank to customers without involving any financial intermediary such as commercial banks or fintech providers (Pocher and Veneris, 2022). Two-tiered central bank digital currency distribution refers to the distribution of central bank digital currency from the central bank to financial intermediaries, and the financial intermediaries will distribute the central bank digital currency to customers (Bindseil, 2020). Artificial intelligence systems will enable central banks and financial institutions to automate the processes involved in the distribution of central bank digital currency from the central bank to end users. There are many repetitive tasks or processes involved in the one-tiered or two-tiered distribution of a central bank digital currency. These repetitive processes can be fully

automated using robotic process automation (Meyer et al, 2020), so that customers will be able to receive the requested quantities of central bank digital currency as quickly as possible. Automating such processes also helps to save labour cost, save time, and reduce human error in the distribution of central bank digital currency either through a one-tiered or two-tiered distribution process.

2.2. Use AI data analytics to monitor and detect CBDC disintermediation risks

Central banks can use artificial intelligence systems to process, in real time, large amounts of industry-level central bank digital currency transaction data to detect abnormal bank disintermediation (i.e., bank-to-CBDC deposit migration) that could pose financial stability risks to the financial system. The central bank can use the insight gained from such artificial intelligence data analytics to spot potential disintermediation trends, quantify the disintermediation risk, determine whether the risk requires immediate regulatory action, and make informed decision on how to limit bank-to-CBDC deposit migration possibly by introducing additional price and quantity CBDC regulatory controls (Bindseil et al, 2021).

2.3. AI systems can offer excellent customer service to CBDC users

In a two-tiered central bank digital currency system, financial institutions can use artificial intelligence tools such as AI chatbots, AI robo advisors and virtual assistants, to offer quality customer service to their customers who are using retail or wholesale central bank digital currency (Ngai et al, 2021). Existing AI-oriented customer service tools can be used to respond quickly to customer queries on CBDC withdrawals, CBDC deposits, CBDC transfers to third parties and CBDC-to-cash conversion. These artificial intelligence tools offer significant improvement in customer experience for CBDC users because artificial intelligence tools can respond to customer queries at any time of the day. Also, artificial intelligence robo advisors which are equipped with natural language processing capabilities can advise customers on the amount of fiat currency they can conveniently convert to central bank digital currency units in real-time, and also advice customers on whether it is better to use central bank digital currency to pay for small-value transactions or large-value transactions.

2.4. AI can curb illicit financing and money laundering associated with CBDC

AI-based data mining tools can be used to process substantial amounts of retail central bank digital currency transaction data to detect suspicious low-value transactions that may be linked to illicit activities which are deliberately made in small amounts to bypass existing know-your-customer (KYC) anti-money laundering (AML) controls. When such suspicious transactions are detected, the artificial intelligence system can flag the suspicious transactions and provide a short AML risk summary report on why the artificial intelligence system considers such transactions to be suspicious (Han et al, 2020). The flagged transactions, together with the AML summary report, are then forwarded to the AML compliance staff to validate the accuracy of the AML risk

summary report, and to take appropriate action. Through real-time monitoring, these artificial intelligence systems can be effective in preventing CBDC-related illicit financial flows, preventing fraud and money laundering using central bank digital currency and enhancing the risk management of central bank digital currency by central banks and financial institutions.

2.5. Using AI algorithms to manage the demand and supply of CBDC

Central banks need to find innovative ways to manage the demand and supply of retail and wholesale CBDC (Burlon et al, 2022). Central banks can use artificial intelligence algorithms to assess the pattern of the demand for retail and wholesale central bank digital currency. They can use artificial intelligence systems to determine the peak month of the year, the peak week of the month, and the peak days of the week when central bank digital currency demand is high and the peak time of the day when most people make central bank digital currency transactions. Central banks can use this information to improve the supply of central bank digital currency to meet central bank digital currency demand at these times. Central banks can also deploy artificial intelligence algorithms that can learn from historical central bank digital currency data and make accurate predictions about the quantity of central bank digital currency that customers may demand today and in the near future.

2.6. AI can promote diversity, equity, and inclusion (DEI) in the use of CBDC

Some individuals face institutionalised bias and discrimination when accessing or using financial services in the financial sector (Brock and De Haas, 2023; Howell et al, 2024). These individuals are also at risk of facing institutionalised bias and discrimination when accessing or using central bank digital currency in the financial system. Central banks can mitigate this risk by deploying an AI-based system that ensure access to central bank digital currency for everyone without requiring information about customers' age, ethnicity, race, migration status, credit history, income, employment status. This will help to reduce bias and discrimination in access to, and use of, central bank digital currency, thereby promoting diversity, equity, and inclusion in the use of central bank digital currency especially for credit and mortgage purposes.

2.7. Using AI to detect and manage public sentiments about CBDC

Central banks can use artificial intelligence tools to analyse diverse public sentiments about the issued central bank digital currency. Central banks can do this by using an artificial intelligence sentiment-data curation tool to collect all publicly available mentions of the central bank digital currency in the comment section of popular websites, social messaging blogs, forums, podcasts and the online platforms used by young people and older adults such as Tumblr, Twitter (now X), Facebook, Instagram, Telegram, Tik Tok, YouTube, LinkedIn, Reddit and Quora. The AI sentiment-data curation tool can divide the collected sentiment data into positive sentiments, negative

sentiments and neutral sentiments (Taherdoost and Madanchian, 2023). After collecting the information and its categorisation, the central banks can set up an in-house team to evaluate the sentiments in each category and determine the segment of the population where there is much negative sentiment about central bank digital currency. It may be discovered that the negative sentiments are due to lack of understanding of the purpose and usefulness of central bank digital currency. With this information, the central bank can direct its awareness effort and central bank digital currency literacy programs to specific segments of the population in order to increase positive attitudes towards the central bank digital currency and its acceptance by all segments of the population.

2.8. Using AI tools to stay up-to-date with the latest CBDC research

It is important for central banks to stay up to date with current industry, policy, and academic central bank digital currency research. Central banks can deploy artificial intelligence tools that send instant notification to the research department of central banks whenever any new central bank digital currency research is published by the Bank of International Settlement (BIS), the International Monetary Fund (IMF), recognised Institutes and from leading CBDC scholars. The central banks that use these artificial intelligence tools to follow and track the latest central bank digital currency research will be able to learn about new innovations that could be introduced into their existing central bank digital currency project, learn about new opportunities, learn about emerging risks that could affect their existing central bank digital currency project, and learn about new regulatory controls that could be incorporated into existing central bank digital currency regulatory frameworks. A central bank can also deploy other online artificial intelligence tools that read and summarize the latest CBDC research articles (Wagner et al, 2022), to enable the central bank to know quickly whether the content of the research is relevant to the central bank's CBDC project. A central bank can also develop its own in-house central bank digital currency research capabilities by deploying online artificial intelligence tools that assist in developing official central bank digital currency research working papers and provide citation sources and articles that support or refute a hypothesis put forward by central bank economists about their central bank digital currency project.

3. Challenges that may be encountered

It should be admitted that central banks may face several challenges when using artificial intelligence systems in their CBDC project. The first challenge is the risk of violating data privacy of customers (Jabbar et al, 2023; Ozili, 2024). When central banks deploy artificial intelligence systems in their CBDC project, there is the risk that central banks will use artificial intelligence systems to analyse individual and aggregated CBDC transaction data, without obtaining the consent of the individual(s) who made the CBDC transactions. If this occurs, it will be a breach of data privacy.

Presently, some central banks obtain bank customer information through the customer's bank, the customer is not notified that the central bank is assessing his bank transaction data, and the customer's consent is never sought. There is the risk that such practice would occur more freely when artificial intelligence systems are used in CBDC projects. The second challenge is national security risk. Central banks often use proprietary information to design a CBDC, and such information is not made available to the public because of the national security consequences that may arise if such data is leaked to the public. Foreign enemies of the State should not be allowed to access such data as they could use it to launch an attack against the State. There is also the risk that the artificial intelligence systems used in a CBDC project may suddenly go rogue and expose important sensitive CBDC proprietary information to the public, and the leaked information could be used by foreign enemies of the State to launch an attack on the country's central bank digital currency infrastructure, thereby weakening national security and undermining the economic security of the country. The third challenge is the risk of embedded bias. There is the risk that central banks may unintentionally use discriminatory and bias data to train the artificial intelligence algorithms used in different aspects of the CBDC project (Ozili, 2024). When such embedded bias exists in the dataset, it could lead to incorrect CBDC policy decisions. Another challenge is cybersecurity risk. The artificial intelligence systems used in a CBDC project can be attacked by external and malicious hackers (Tian et al, 2023; Ozili, 2024). Hackers can gain access into the CBDC infrastructure to either: (i) steal large amounts of CBDC, convert the stolen funds to US dollars and transfer the funds to an overseas offshore account, or (ii) steal the propriety information used to develop the CBDC and sell it to the foreign enemies of the State or to other foreign entities, or (iii) return the stolen proprietary information in exchange for huge ransom payment.

4. Considerations for the future

The central banks interested in using artificial intelligence to enhance their CBDC project should give serious consideration to the following. One, the level of public trust in government. This is very crucial for the success of an AI-assisted CBDC project. A high level of distrust in government can lead to public resistance of the central bank's attempt to use artificial intelligence systems in the CBDC project. Many people are already uncomfortable with the potential risk of artificial intelligence (see. Schoenherr and Thomson, 2024), and they have raised concerns that the government could use artificial intelligence systems and CBDC as tools for state surveillance of citizens' financial activities (Dwork and Minow, 2022; Ballaschk and Paulick, 2021). Given this existing sentiment, any attempt by the central bank to use artificial intelligence systems in the CBDC project may be resisted by the public. Therefore, central banks should be aware that the ability to use artificial intelligence systems in a CBDC project depends largely on the level of public trust in government. Two, there should be transparency

on how the central bank is using artificial intelligence in its CBDC project. The central bank should, as a matter of necessity, explain to the public and offer full disclosure on how it is using artificial intelligence to distribute CBDC to citizens. Three, a central bank should ensure that the AI-generated information that is used in the CBDC project are accurate and reliable. Four, the central bank should ensure that its algorithms do not contain any bias that would discriminate against any group or member of society. Five, some elements of the human touch should be maintained in an AI-assisted CBDC project. Artificial intelligence systems should not completely take over all aspects of the CBDC project. The central bank should strike the right balance between maintaining the human-touch and the need for artificial intelligence automation of the CBDC project. We want to see a future where artificial intelligence systems enhance the value of CBDC in society, not a future where artificial intelligence systems replace the entire human element involved in the CBDC project.

5. Conclusion

This article examined the role and challenges of artificial intelligence, or AI, in a central bank digital currency project and suggests some considerations which central banks should be aware of when deploying artificial intelligence in their central bank digital currency project. Using artificial intelligence to manage and deliver central bank digital currency is crucial for central banks looking to develop a successful end-to-end central bank digital currency project in an evolving AI-finance landscape. By harnessing the potential of artificial intelligence algorithms, central banks can excel in their ambition to develop a meaningful central bank digital currency project. Central banks can use artificial intelligence systems to promote efficiency in the one-tiered or two-tiered distribution of central bank digital currency, monitor and detect central bank digital currency disintermediation risks, offer excellent customer service to CBDC users, curb illicit financing and money laundering associated with central bank digital currency, manage the demand and supply of central bank digital currency, use artificial intelligence to detect and manage public sentiments about CBDC, use artificial intelligence tools to stay up-to-date with the latest CBDC research, and promote diversity, equity, and inclusion in the use of central bank digital currency. Despite these opportunities, some challenges may be encountered by central banks when using artificial intelligence systems in a country's CBDC project. The challenges include the potential for data privacy violation, national security risks, the risk of embedded bias in the dataset used to train AI algorithms, and cybersecurity risk. However, these challenges are surmountable if appropriate controls and regulations are put in place. As artificial intelligence continues to evolve, its role in developing a sustainable CBDC project will likely expand, and it will prompt concerns about ethics and the need for the responsible use of artificial intelligence systems in CBDC projects. As a result, central banks will need to have open discussions with the public about how they are addressing all ethical concerns in their quest to develop a sustainable central bank digital currency project.

Reference

- Ballaschk, D., & Paulick, J. (2021). The public, the private and the secret: Thoughts on privacy in central bank digital currencies. *Journal of Payments Strategy & Systems*, 15(3), 277-286.
- Barontini, C and H Holden (2019). Proceeding with caution – a survey on central bank digital currency, BIS Papers, no 101, February.
- Bindseil, U. (2020). Tiered CBDC and the financial system. Available at SSRN 3513422.
- Bindseil, U., Panetta, F., & Terol, I. (2021). Central Bank Digital Currency: functional scope, pricing, and controls. *ECB Occasional Paper*, (2021/286).
- Brock, J. M., & De Haas, R. (2023). Discriminatory lending: Evidence from bankers in the lab. *American Economic Journal: Applied Economics*, 15(2), 31-68.
- Burlon, L., Montes-Galdon, C., Muñoz, M. A., & Smets, F. (2022). *The optimal quantity of CBDC in a bank-based economy* (No. 2689). European Central Bank.
- Chowdhary, K. R. (2020). *Fundamentals of artificial intelligence* (pp. 603-649). New Delhi: Springer India.
- Dwork, C., & Minow, M. (2022). Distrust of artificial intelligence: Sources & responses from computer science & law. *Daedalus*, 151(2), 309-321.
- Han, J., Huang, Y., Liu, S., & Towey, K. (2020). Artificial intelligence for anti-money laundering: a review and extension. *Digital Finance*, 2(3), 211-239.
- Howell, S. T., Kuchler, T., Snitkof, D., Stroebel, J., & Wong, J. (2024). Lender automation and racial disparities in credit access. *The Journal of Finance*, 79(2), 1457-1512.
- Jabbar, A., Geebren, A., Hussain, Z., Dani, S., & Ul-Durar, S. (2023). Investigating individual privacy within CBDC: A privacy calculus perspective. *Research in International Business and Finance*, 64, 101826.
- Kosse, A., & Mattei, I. (2023). Making headway-Results of the 2022 BIS survey on central bank digital currencies and crypto. *BIS Papers*. BIS Papers, No 136.
- Lee, D. K. C., Yan, L., & Wang, Y. (2021). A global perspective on central bank digital currency. *China Economic Journal*, 14(1), 52-66.
- Meyer, C., Cohen, D., & Nair, S. (2020). From automats to algorithms: the automation of services using artificial intelligence. *Journal of Service Management*, 31(2), 145-161.

Ngai, E. W., Lee, M. C., Luo, M., Chan, P. S., & Liang, T. (2021). An intelligent knowledge-based chatbot for customer service. *Electronic Commerce Research and Applications*, 50, 101098.

Ozili, P. K. (2023). Central bank digital currency research around the World: a review of literature. *Journal of Money Laundering Control*, 26(2), 215-226.

Ozili, P. K. (2024). Artificial intelligence in central banking: benefits and risks of AI for central banks. In *Industrial Applications of Big Data, AI, and Blockchain* (pp. 70-82). IGI Global.

Pocher, N., & Veneris, A. (2022). Central bank digital currencies. *Handbook on blockchain*, 463-501.

Schoenherr, J. R., & Thomson, R. (2024). When AI Fails, Who Do We Blame? Attributing Responsibility in Human-AI Interactions. *IEEE Transactions on Technology and Society*.

Soori, M., Arezoo, B., & Dastres, R. (2023). Artificial intelligence, machine learning and deep learning in advanced robotics, a review. *Cognitive Robotics*.

Taherdoost, H., & Madanchian, M. (2023). Artificial intelligence and sentiment analysis: A review in competitive research. *Computers*, 12(2), 37.

Tian, S., Zhao, B., & Olivares, R. O. (2023). Cybersecurity risks and central banks' sentiment on central bank digital currency: Evidence from global cyberattacks. *Finance Research Letters*, 53, 103609.

Wagner, G., Lukyanenko, R., & Paré, G. (2022). Artificial intelligence and the conduct of literature reviews. *Journal of Information Technology*, 37(2), 209-226.