Artificial intelligence in central banking: benefits and risks of AI for central banks

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2024

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Abstract

Artificial intelligence (AI) is a topic of interest in the finance literature. However, its role and implications for central banks have not received much attention in the literature. Using discourse analysis method, this article identifies the benefits and risks of artificial intelligence in central banking. The benefits of artificial intelligence for central banks are that deploying artificial intelligence systems will encourage central banks to develop information technology (IT) and data science capabilities, it will assist central banks in detecting financial stability risks, it will aid the search for granular micro economic/non-economic data from the internet so that the data can support central banks in making policy decisions, it enables the use of AI-generated synthetic data, and it enables task automation in central banking operations. However, the use of artificial intelligence in central banking poses some risks which include data privacy risk, the risk that using synthetic data could lead to false positives, high risk of embedded bias, difficulty of central banks to explain AI-based policy decisions, and cybersecurity risk. The article also offers some considerations for responsible use of artificial intelligence in central banking.

Keywords: central bank, artificial intelligence, financial stability, responsible AI, artificial intelligence model.

1. Introduction

Artificial intelligence is the imitation of human intelligence by machines or the ability of machines to perform tasks using human intelligence (Lin, 2019; Ozili, 2023a). The use of artificial intelligence (AI) systems in the financial services industry is transforming the way financial institutions use data to acquire, use and manage money, and it is changing how they serve their customers. The rise of artificial intelligence in the financial sector is also raising questions about the role of artificial intelligence for financial regulation and for central banking. This paper focuses on the latter – central banking.

Central banking is the activity performed by a central bank. A central bank is a public institution that manages the currency of a country and controls the amount of money in circulation (Goodhart, 1995). The core objectives of a central bank are price stability, financial stability, monetary stability, exchange rate management, lender of last resort, and banker to the government (Swinburne, 1991; Blinder, 2010; Ozili, 2020). Monetary stability means the provision of adequate money supply, price stability means achieving low inflation and financial stability means the absence of financial crisis or banking crisis.

Questions are emerging about how artificial intelligence would affect the operations and statutory objectives of a central bank. Some of the questions that have emerged are: Does artificial intelligence offer any benefits to central banks? Will artificial intelligence transform central banking? If so, will artificial intelligence usher in an era of modern central banking that is AI-led? Or are these questions the result of wishful thinking? The truth is: it is too early to know for sure whether and how AI would affect central banking. But what we know is that central banks are expected to respond to the pressure on financial institutions to use AI algorithm to serve their customers and to improve their operational efficiency. A central bank can participate in this process by developing a financial sector-wide AI regulatory framework. But this is not the only way in which central banks can get involved in the ongoing AI transformation of the financial sector. Apart from developing a financial sector-wide AI regulatory framework, central banks are expected to respond to the artificial intelligence transformation by using AI systems to improve central bank operational efficiency and to serve their institutional customers and the financial institutions they regulate or oversee. The

decision of central banks to adopt artificial intelligence systems will be determined by the need to catch-up with technological advancement and the need to reinvent central banking to meet the modern reality of the digital world.

There is limited knowledge in the literature about the role of artificial intelligence in central banking. A lot of debates have emerged about the role, benefits, and risks of artificial intelligence for private financial institutions such as the potential for financial institutions to use artificial intelligence systems to offer customized services to customers, automate tasks, manage risks and to offer more targeted advertising to customers (Fernández, 2019; Hu and Chen, 2022). Much of these debates are focused on private financial institutions (Johnson, Pasquale, and Chapman, 2019; Königstorfer and Thalmann, 2020). However, such debates do not exist for central banks despite the fact that central banks are responsible for the soundness and stability of the financial system (Sinclair, 2000; Goodhart, 2011), and they play a significant role in financial sector development (Neyapti, 2003). Therefore, in this paper, we highlight the benefits and risks of artificial intelligence in central banking.

The discussion in this article contributes to the literature that identify the role of artificial intelligence in finance, but which have not considered the role of artificial intelligence in central banking. The discussion in the article also contributes to the literature that examine the digital transformation of central banks. Such studies have examined, extensively, how central banks have embraced digital innovations such as real-time gross settlement (RTGS)-based digital payment systems, central bank digital currency and cryptocurrency (Jackson and Manning, 2007; Nabilou and Prum, 2019; Keister and Sanches, 2023; Ozili, 2023b), but such studies have not considered the role of artificial intelligence in central banking. This article therefore contributes to this literature by focusing on the benefits and risks of artificial intelligence for central banks.

The rest of the paper is organised as follows. Section 2 presents the literature review. Section 3 presents the benefits of artificial intelligence in central banking. Section 4 presents the risks of artificial intelligence in central banking.

Section 5 highlights some technical difficulties in implementing artificial intelligence in central banking. Section 6 identifies some key considerations for central banks. Section 6 presents the conclusion.

2. Literature review

Some studies examine the digital transformation of central banking. For instance, Tucker and Council (2014) showed that central banks are witnessing the digital transformation of central banking especially the digital transformation of money. They argued that, despite the digital transformation of central banking, central bank money will continue to be the final settlement asset and many financial intermediaries involved in payments services, clearing or liquidity-insurance should continue to have access to central bank money even though money becomes fully digital. Dow (2019) contributes to the debate about the digitalisation of central banking. Dow (2019) emphasized that the focus should not be on developing digital currencies, rather the focus should be on upgrading regulation to make it fit for the digital age and to address other digital innovations that generate credit and liquidity in the financial sector. Raskin and Yermack (2016) showed that the digital transformation of central banking is challenging classical monetary economics because emerging digital innovations, such as central bank digital currencies and blockchain technologies, are helping to narrow the relationship between citizens and the central bank, and may eliminate the need for the public to keep deposits in fractional reserve commercial banks, thereby, challenging classical banking and monetary economics.

Other studies analyse the role of artificial intelligence in finance. Milana and Ashta (2021) support the AI revolution in finance and showed that AI could offer better efficiency, generation of new data and risk management advantages in the financial sector. Bahrammirzaee (2010) showed that AI may be helpful in dealing with non-linear financial problems. They argued that traditional models demonstrate some difficultly in dealing with nonlinearities in financial markets, and that artificial intelligence techniques, particularly those that involve artificial neutral networks, expert systems and hybrid intelligence systems may be immensely helpful in addressing non-linear problems in financial markets. Königstorfer and Thalmann (2020) showed artificial intelligence has applications in banking especially in the areas of investment banking and in back-office banking services. They found that the use of artificial intelligence may reduce credit losses, increase payment efficiency, automate compliance-related work, and improve customer service. Veloso et al (2021) emphasise that artificial intelligence has great application in the financial services industry where financial

institutions process huge cross-border payments daily, while stock markets and exchanges execute substantial amounts of trades and transactions.

Furthermore, Goodell et al (2021) conducted a literature survey and found that there are three common areas of research scholarship related to artificial intelligence in finance which are (a) portfolio and investor behaviour, (b) analysis of financial fraud and financial distress, and (c) sentiment inference and forecasting. Buchanan (2019) argued that artificial intelligence could disrupt the financial services industry. However, the author conducted a literature survey and notes that there is limited discussion about the econometric aspects of artificial intelligence applications in finance. Tadapaneni (2019) suggests some areas for considerations when using AI in finance. The considerations include the benefits to clients and firms, dealing with data privacy, data protection issues and the reduction in human labour which could create unemployment. Lin (2019) argued that despite the known applications of artificial intelligence in finance, the risks are still too great such as the risks related to cybersecurity and competition. Other studies such as Kahyaoglu (2021), Qian (2019), and Lopez-Corleone, Begum and Sixuan (2022) point to the use of artificial intelligence (AI) and machine learning to enhance the functionality, security, and efficiency of central bank products such as a central bank digital currency (e.g. the digital yuan, eNaira, DCash or the Sand Dollar).

While the literature has examined the digital transformations in central banking and the various applications and benefits of artificial intelligence in the financial sector, there is little or no discussion or research on the role, benefits and risks of artificial intelligence in central banking. This paper fills this gap in the literature by identifying the potential benefits and risks of artificial intelligence in central banking.

3. Benefits of artificial intelligence in central banking

The use of artificial intelligence in central banking offers many benefits. The benefits are identified below.

3.1. It will encourage central banks to develop information technology (IT) and data science capabilities

Deploying artificial intelligence systems in a central bank would give central banks an opportunity to develop information technology and data science capabilities. Many central banks lag behind private financial institutions in IT and data science capabilities. Therefore, deploying artificial intelligence systems in central banking will not only close the gap in IT and data science capabilities for central banks, but it will also enable central banks to enjoy the benefits that come with artificial intelligence and data science development.

3.2. AI systems can assist in detecting financial stability risks.

One of the objectives of a central bank is to maintain or preserve financial stability. Using artificial intelligence systems can assist a central bank in fulfilling this objective. Financial institutions, such as banks, often use artificial intelligence applications in ways that create value and create new risks or amplify existing financial and non-financial risks, and such risks could affect the soundness and safety of financial institutions. Financial institutions often submit financial returns to the central bank and to other regulators. A central bank can use AI systems to analyse the data in the financial returns submitted by commercial banks to the central bank. A central bank can use AI systems to detect quickly, within seconds, any abnormal change in the financial data submitted by financial institutions that may indicate a vulnerability or deteriorating condition of one or more financial institutions in the financial system. This would allow the central bank to make a timely assessment of the observed change and intervene in the financial system to mitigate risks before they become systemic in nature.

3.3. Searching the internet for granular micro economic/non-economic data

Central banks can use AI tools to search the Internet and online media platforms (e.g., news media and social media) to obtain granular and micro data. There are lots of granular or micro economic and non-economic data about markets that ordinary

people and businesses publish on the Internet (Shabsigh and Boukherouaa, 2023). These data, if utilised by central banks, could offer additional insights and improve central bank policy formulation. Many central banks rarely use such granular micro economic data either because they are unaware that such data exist on the Internet or because they are not confident in using unstructured third-party data for policy formulation. There is a need for central banks to use all data available, wherever it can be found, to improve policy decision making. Central banks may also use AI tools to obtain Internet information about what people think about central bank policies and their impact on households and businesses. This information can help central banks to improve policy formulation.

3.4. Using synthetic data on AI system offers benefits for central banks.

Modern artificial intelligence systems can generate synthetic data that mimic real world data (Shabsigh and Boukherouaa, 2023). Many central banks will prefer to use both synthetic data and real-world data for AI algorithm training because they offer mutual benefits. However, some central banks may prefer to use synthetic data to train their enterprise AI algorithm because it would allow them to avoid using real-world data that contains personal and sensitive information, and it also allows them to bypass existing legal and regulatory bottlenecks associated with using real-world data on AI systems. The use of synthetic data has great appeal for central banks for three main reasons. One, it saves cost of finding real-world data. Two, it completely and perfectly diminishes all privacy risks because synthetic data do not contain personal or sensitive information. Three, it saves time that would be used to obtain real-world information from economic agents in the field or in markets. Central banks can also use synthetic data to emulate the behaviour patterns of economic agents and gain actionable insights for policy decision making. Despite the benefits of synthetic data, central banks should not be blinded to the risks of using synthetic data. It might be better and safer for central banks to use both synthetic and real-world data.

3.5. AI systems enable task automation for central banks.

Artificial intelligence systems can automate several aspects of central bank operations. Central banks can use AI systems to automate repetitive tasks in central banking operations. This would allow central banks to reduce human errors, increase efficiency and save labour costs and time. Using artificial intelligence systems can also

enable frictionless interaction between the internal operational systems in the central bank. It can also ease the interaction between central bank systems and the systems of financial institutions and enable frictionless and timely submission of regulatory and compliance reports to the central bank.

4. Risks of artificial intelligence in central banking

The use of artificial intelligence in central banking offers many benefits but it also poses some risks that should be minimised or avoided if possible. The risks include the following.

4.1. Data privacy risk

The use of artificial intelligence systems by central banks may violate privacy rules. This may occur by unintentionally unmasking private and confidential central bank data. The use of artificial intelligence systems by central banks may also lead to data leakages. There is also the risk that artificial intelligence systems can recall data about regulated entities and data about the central bank that were recorded in the training dataset after the data are used and deleted by the central bank. Therefore, central banks must be cautious about the potential for privacy violation when using artificial intelligence systems. If central banks must use artificial intelligence systems, they should upgrade artificial intelligence privacy rules and improve existing legal and regulatory frameworks to adhere to strong privacy standards. There is also the risk that the artificial intelligence systems used by central banks may intentionally or unintentionally collect and use personal information without obtaining explicit consent from the owners of such information (Shabsigh and Boukherouaa, 2023). While it is possible for central banks to develop an enterprise-level AI system that is relevant for central banking operations, such enterprise-level AI system may enhance data security for central banks, but residual privacy concerns may remain because low-level central bank employees may gain unauthorised access to central bank information which they do not need especially when the enterprise-level AI system remembers information or data that were deleted by top management.

4.2. Using synthetic data to mimic real word data could lead to false positives.

There is the risk that deploying artificial intelligence systems might make central banks become lazy especially when central banks rely heavily on synthetic data. Instead of going out to the field to search for real-world data, central banks may prefer to utilize algorithm-created synthetic data that statistically mimic real-world data. Central banks may use algorithm-created synthetic data to train their artificial intelligence algorithms and the generated data may have poor quality and could give rise to many false positives in short-term or long-term forecasting of inflation and interest rates. The result generated by artificial intelligence systems using synthetic data, if implemented, could lead to wrong policy formulation, and may have disastrous effects on society (Shabsigh and Boukherouaa, 2023).

4.3. Elevated risk of embedded bias

Embedded bias occurs when the data used by central banks to train the artificial intelligence system are discriminatory or unrepresentative or when the data reinforces existing prejudice and inequality in society. Such bias may also arise in the artificial intelligence system if the artificial intelligence algorithm is designed with human bias (Shabsigh and Boukherouaa, 2023). When this happens, it could lead to unfair central bank policy decisions. For example, a central bank may train the algorithm of its artificial intelligence system with data collected from economic agents who have personal bias and from a wide range of biased sources in urban areas to inform their monetary policy and financial stability decisions. Central banks may use this data and the artificial intelligence system to make policies that affect everyone in the country such as setting the policy interest rate. The AI-generated policy decision may be biased because the policy decisions generated by the AI system is a product of embedded bias, and the consequences are that it could lead to distrust of the central bank, and it could lead to economic hardship for people living in rural areas.

4.4. Difficulty in explaining AI-based central bank policy decisions.

Central banks may find it difficult to explain AI-based policy decisions to members of the public, especially those decisions that were based on the solutions derived from artificial intelligence algorithms (Shabsigh and Boukherouaa, 2023). The ability to explain central bank policy decisions is at the core of sound central banking, but artificial intelligence systems could introduce complexity and complications in central

bank's effort to explain the AI-based decisions because artificial intelligence solutions are derived from a set of interconnecting models whose assumptions and inputs may not be clearly known to a central bank. Therefore, many central banks may be reluctant to adopt artificial intelligence systems to support policy decision-making. Notwithstanding, central banks that are willing to develop an enterprise level artificial intelligence system must be prepared to deal with the complexity associated with explaining central bank policy decisions that are based on artificial intelligence systems.

4.5. Prone to cybersecurity risk

External hackers or malicious actors may use sophisticated hacking tools to gain access into the enterprise artificial intelligence systems used by central banks. Once, they gain entry into the artificial intelligence system, they may impersonate central banks through identity theft. Artificial intelligence systems are prone to data attacks at the data training stage as malicious actors may add destructive or disruptive elements to the training dataset to undermine the accuracy of artificial intelligence algorithms (see Shabsigh and Boukherouaa, 2023). Therefore, central banks may need to think deeply about the cybersecurity risks that may arise from adoption of artificial intelligence systems in central banking operations and decision making.

5. Technical difficulties in implementing AI in central banking

There are technical difficulties in implementing artificial intelligence in central banking. The first difficulty is the size of datasets for algorithm training. The datasets for algorithm training may be too small which could diminish AI model's predictive accuracy and mislead central banks into making wrong policy decisions, or the datasets may be too large and give out false positives which may also mislead central banks into making wrong policy decisions. Knowing the right size of datasets for algorithm training is difficult. Another technical difficulty relates to the quality of the data that is fed into the AI model used by central banks. Another difficulty is that central banks that use AI systems may face a situation where the AI infrastructure utilises significant computing resources for AI model training and deployment than is

necessary. Lastly, central banks may find it difficult to deal with AI ethical and moral issues due to a host of factors such as the bias in algorithmic decision making caused by flawed training data prepared by human engineers. There is also the moral dimension which revolve around whether central banks are attempting to replace human workers with robots. And finally, there is concern about the inability of AI systems to explain the reasoning behind their decisions.

6. Responsible AI – a consideration for central banks

An important consideration for central banks in the future will be how to design, develop and deploy artificial intelligence with good intentions and good ethics to support central bank policy decisions and improve the lives and welfare of everyone in a fair and meaningful way (Dignum, 2019), so that there will be greater trust in the central bank. A term used to describe this is 'responsible artificial intelligence' in central banking. Responsible artificial intelligence, if properly implemented, would reduce unintentional bias, increase transparency in artificial intelligence processes, protect data privacy, promote fairness, and create welfare benefits for those affected by central bank policy decisions. In the coming years, calls for the ethical and responsible use of artificial intelligence in central banking will increase, and central banks must be well-prepared for it. The major principles that will guide responsible artificial intelligence design and deployment will be fairness, privacy, security, and transparency (Dignum, 2019). But the major challenge that will arise for many central banks will be how to transition from 'principles' to 'practice' when deploying artificial intelligence systems. Central banks will also need to critically evaluate the different AI models used in central banking and how these models address security and data privacy concerns. AI models are programs or algorithms that rely on training data to recognize unique patterns and make predictions. As additional data points are added into an AI model, the more accurate the AI model will be in identifying unique patterns and in making forecast, and the greater the risk for data privacy and data security.

7. Conclusion

This paper assessed the benefits and risks of artificial intelligence in central banking. It showed that the benefits of artificial intelligence for central banks are that deploying artificial intelligence systems will encourage central banks to develop information technology (IT) and data science capabilities, it will assist central banks in detecting financial stability risks, it will aid the search for granular micro economic/non-economic data from the internet so that the data can support policy making, it enables the use of AI-generated synthetic data, and it enables task automation in central banking operations. However, the use of artificial intelligence in central banking poses some risks which include data privacy risk, the risk that using synthetic data could lead to false positives, high risk of embedded bias, difficulty in explaining AI-based central bank policy decisions, and cybersecurity risk. The implication is that the use of public or enterprise-level artificial intelligence systems have benefits for central banks, but they also pose some risks. Therefore, central banks should be cautious in deploying artificial intelligence systems. The risks they pose are significant, and if the risks materialise, they could tarnish the reputation of a central bank. Using artificial intelligence systems in central banking needs close monitoring by humans. The level of human monitoring should be proportionate with the risks that may arise from using artificial intelligence systems in central banking operations or decision making. Although robust regulatory frameworks to guide central banks in using artificial intelligence have not yet been developed, central banks should continue to monitor the evolving use of artificial intelligence in the financial sector and study the benefits, risks and applications of artificial intelligence in central banking so as to determine the best use case of artificial intelligence systems in central banking. While such monitoring may continue for a long time, many central banks will prefer to take a cautious approach to artificial intelligence due to the time and cost that would be involved in developing, training, and supervising artificial intelligence systems.

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