

# INTEGRATING ARTIFICIAL INTELLIGENCE INTO CENTRAL BANKING: OPPORTUNITIES, CHALLENGES, AND IMPLICATIONS

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**Abstract:** Artificial intelligence is increasingly being used in a variety of areas, including central banking, to improve decision-making, business efficiency, and risk management. Today, practically all central banks are investigating the use of artificial intelligence in their operations, such as economic forecasting, risk analysis, policy research, and market analysis. All of these can help to increase the financial system's resilience at a time when the global economy is becoming more interconnected and complex. On the other hand, it is vital to highlight the emerging obstacles of artificial intelligence, such as cyber security, data privacy, and algorithm transparency, which central banks must address to effectively utilize the benefits of artificial intelligence applications. When deploying artificial intelligence, central banks should take a thorough and balanced approach, considering the ethical, legal, and social implications while maximizing on all of the benefits that artificial intelligence may provide. Continuous monitoring of regulatory frameworks and international cooperation can assist central banks in realizing the potential of these technologies. In this paper, we will analyze the integration of artificial intelligence into central banking: opportunities, challenges, and implications. We will examine the opportunities, challenges, and implications, as well as the use of artificial intelligence in the operations of leading central banks, with a particular emphasis on its use in Serbia's banking sector.

**Keywords:** Artificial intelligence, Central banking, Price and financial stability, Risk management.

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## 1. Introduction

Artificial intelligence, like in various other sectors, has the potential to play a significant role in central banking. Central banks are actively studying various applications of artificial intelligence to improve their operations and decision-making processes. The advantages of adopting artificial intelligence include lower operating costs and risks, enhanced identification of fraud and regulatory compliance, improved loan decision-making, and automation of the investment process. Central banks throughout the globe are increasingly recognizing the

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importance of collaborative efforts in order to properly address all of the difficulties and benefits of the potential presented by artificial intelligence. Central banks' key channels of cooperation in the field of artificial intelligence are experience exchange, research review and analysis, and best worldwide practices. As artificial intelligence becomes more advanced, central banks can use these technologies for economic data analysis, modeling, and other complex processes. Cooperation and experience sharing at the regional and international levels are becoming increasingly crucial since they allow for the coordination of efforts to support the secure implementation of artificial intelligence.

Artificial intelligence increases financial sector efficiency, enhances communication through chatbots, allows automated loan approval, and makes user identification easier. These processes are altering financial institutions' operations, saving large amounts of money through process automation, leveraging predictive analytics to improve product and service offerings, and developing more efficient risk management processes while complying to regulatory compliance. Central banks can use artificial intelligence for a variety of purposes, including information and market analysis, economic forecasting ("nowcasting"), financial stability assessments (network analysis), and improving external communication.

In this paper, we will analyze the integration of artificial intelligence into central banking: opportunities, challenges, and implications. Following the introduction, there is a literature review and a discussion of the benefits, challenges and risks associated with deploying artificial intelligence. The fourth section of the paper discusses the use of artificial intelligence in the activities of the most prominent central banks, with a focus on the banking sector in Serbia. In conclusion, we outlined the key findings of this paper.

## 2. Literature review

Central banks are quite interested in artificial intelligence because it is still being investigated in terms of the tasks that can be performed with this technology. Thus, artificial intelligence can change many central bank operations and significantly improve their efficiency. Central banks must carefully examine the possibilities and challenges connected with the application of artificial intelligence, as well as create suitable strategies to maximize advantages while reducing risks. Artificial intelligence is not a new concept, and its application dates back to the creation of the first mechanical calculating machine in 1642 by the French mathematician Blaise Pascal, while the term was coined by John McCarthy in 1955 (Yadav et al., 2024). The continued development of artificial intelligence is linked to the publication of the work "Computing Machinery and Intelligence" by the English mathematician Alan Turing in 1950, in which he analyzed the idea of building a computer capable of limiting human thoughts. In 1997, IBM developed the supercomputer Deep Blue, which defeated world champion Garry Kasparov in a chess match (Mullin, 2023). During the 2000s, two significant initiatives helped to significantly develop artificial intelligence. The first is the Stanley protocol, designed in 2002 by the Defense Advanced Research Projects Agency (DARPA) to produce a vehicle capable of reaching 225 kilometers per hour in the desert using lasers, cameras, and processors. Another research is Google Brain, which tested a neural network with 10 million photos from YouTube videos in 2012. After three days, Google Brain recognized 16% of 22,000 categories on 1,000 servers, representing a 70% improvement over earlier testing (Da Costa, 2018). Following that, the digital age continued to evolve, as did other disciplines such as nanotechnology, genetics, and mechatronics, all of which contributed to the achievement of the space economy. Other developments, such as artificial intelligence, have a direct or indirect impact on the economy (Dirican, 2015).

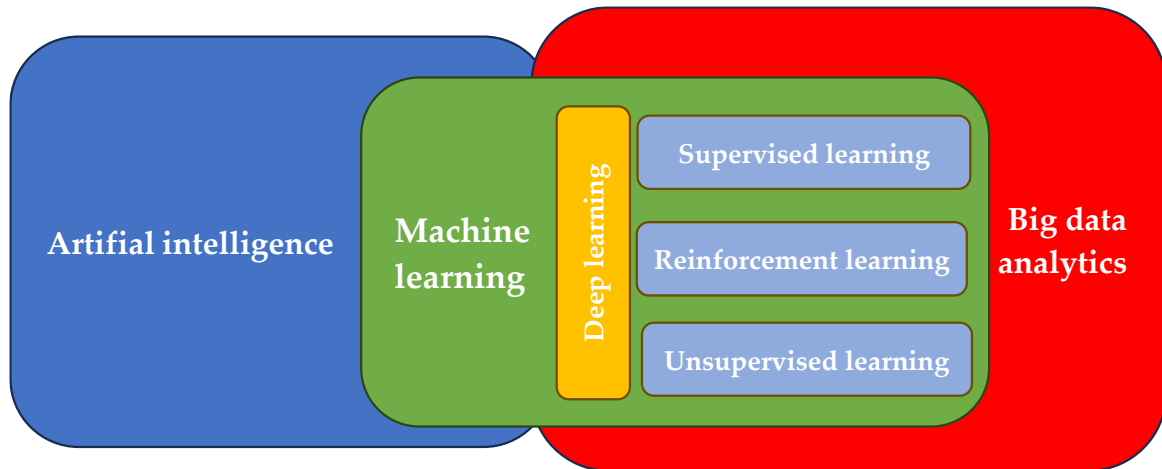
The transition from analog to digital risk management is required before banks can execute digital initiatives. The important step toward achieving that goal is the optimal usage of artificial intelligence (Dzhaparov, 2020). In the digital economy, artificial intelligence has considerably improved banking activities. Its application inspired banking activities to be more innovative and appealing to its customers (Mi Alnaser et al., 2023). According to Ghandour (2021), the banking sector has emerged as the leading pioneer in the application of artificial intelligence. The introduction of online banking and the creation of a network of self-service branches marked a significant representation of artificial intelligence in banks. According to Khan and Malaika (2021), digitization in the financial sector has resulted in the creation of digital risks, including those related to cyber security and artificial intelligence. These authors state that diverse solutions for the digitalization of banking sector activities necessitate distinct designs, infrastructures, and technologies, resulting in the appearance of various dangers. As a result, digital solutions must consider risks and their implications for processes, people, technology, and data. According to Yamaoka (2023), artificial intelligence represents the future of central banking in the area of financial services, as well as trading and investment strategies in financial markets. The application of artificial intelligence in finance is attracting a lot of interest, as it may automate time-consuming and labor-intensive processes while also providing novel services to clients. Artificial intelligence techniques are increasingly used in finance, such as algorithmic trading, asset management, and blockchain-based financing (Sugiharto et al., 2023).

Acceptance of artificial intelligence depends on preparedness and openness to the use of technological advancements, recognizing the benefits of its application, and collected experience in the use of artificial intelligence in the sector of financial services (Piotrowski & Orzeszko, 2023). A 2018 study conducted by the global management consulting firm McKinsey concluded that by 2030, more than 70% of companies will adopt at least one type of artificial intelligence technology, with less than half applying five categories, indicating the potential for significant application of artificial intelligence. According to the same report, the use of artificial intelligence will generate over \$13 trillion in additional economic activity globally, accounting for 1.2% of additional annual GDP growth. When it comes to the financial sector, where customer and transaction data are the primary work resources, the application of artificial intelligence has enormous potential (Kruse et al., 2019). Kaya (2019) analyzed the influence of artificial intelligence on bank profitability and discovered that it had a double impact. First, artificial intelligence can automate repetitive jobs, reducing the demand for less skilled staff members and potentially increasing the efficiency of other bank employees' work. This move is critical, given that employee salaries account for a significant portion of a bank's total operating expenses. Second, the use of artificial intelligence can lead to higher revenue by developing new services for clients. The following section of the paper will discuss the challenges and risks of implementing artificial intelligence in central banks.

### **3. Opportunities, challenges, and implications of implementing artificial intelligence in central banks**

Artificial intelligence is the use of computer technologies to accomplish tasks that conventionally need the application of human complexity, according to a 2017 report by the Financial Stability Board. However, it's important to note other terms that are frequently used in conjunction with artificial intelligence. The term "big data" is frequently used to refer to the gathering and examination of substantial volumes of data. Machine learning, a subset of artificial intelligence, is the process of creating an algorithm—a sequence of instructions—that solves problems automatically by applying prior knowledge and performing optimization on

its own with little to no human involvement. When applying big data analytics—that is, applying vast amounts of data—machine learning can be utilized to identify patterns - Figure 1.



**Figure 1.** A schematic view of AI, machine learning and big data analytics

Source: Financial Stability Board - FSB (2017)

The opportunities of applying artificial intelligence are manifold and McMullen (2023) in his analysis, points out five benefits from the application of artificial intelligence in banks (Figure 2):

1. improved customer service - with the high expenses of running a call center, better customer service is reflected in increased operational efficiency in areas like calling the call center and waiting for the operator to answer. Conversational artificial intelligence, which uses data from social networks, the client's past, and present financial status to guide a conversation, is one way that artificial intelligence can help.
2. debt collection and recovery - artificial intelligence has several applications in the field of debt collection and recovery, particularly in uncertain economic times when customers frequently default on their payments. Artificial intelligence can be used in this field to provide early warning systems and predictive techniques that will boost debt collection.
3. risk assessment and maintaining - artificial intelligence has the potential to enhance risk assessment and compliance management, enabling the financial industry as a whole to more effectively evaluate risk and identify which customers are unsuitable to use particular goods and services.
4. streamlined underwriting process - machine learning models and robotic process automation can both be used to enhance the simplified underwriting procedure. By utilizing these procedures, the typical time for loan approval might be decreased in the area of online loan approval.
5. personalizing customer experience is crucial for retaining clients, which is why banks must offer individualized services to their clientele. Banks may more precisely forecast the demands and behavior of their current and potential customers by utilizing artificial intelligence.



**Figure 2.** AI in Finance — 5 Benefits for Better Banking

Source: McMullen (2023)

It is vital to comprehend which areas of central banking artificial intelligence can be applied to gain a better understanding of the challenges and risks associated with doing so. Araujo et al. (2024) have conducted an analysis that identifies four key areas of concern: (1) statistical data collection; (2) macroeconomic and financial analysis to support monetary policy implementation; (3) payment system supervision; and (4) supervision and financial stability. Central banks make extensive use of machine learning techniques to gather high-quality data at the micro level. Large-scale, granular data collection is made possible by this method, which is a feature of central banks. Macroeconomics and financial analysis are the next areas where artificial intelligence will be used to assist in the implementation of monetary policy. In this area, a neural network can be applied. It can, for instance, deconstruct headline inflation into its components and explain the portion of inflation linked to price increases, inflationary expectations, and prices from the global market. Another illustration would be real-time projections, or "nowcasts," which are useful for analyzing inflation expectations or summarizing the state of the economy over time. For the financial system to be stable, payment systems must operate effectively. In this context, distinguishing regular transactions from anomalous ones in high-frequency data with a wide distribution is a crucial challenge. Accurately identifying transactions that exhibit anomalies facilitates the prompt detection of possible financial crimes, cyberattacks, or bankruptcies. To detect suspicious transactions, one can employ graph neural networks, machine learning models, and unsupervised learning techniques. For central banks to successfully oversee financial institutions, supervision examines a lot of data. In the past few years, it has been increasingly crucial to examine the data pertaining to cyber and climate risks, as proper monitoring of these demands more thorough data than it does for traditional risks. Supervisory documents can be categorized using natural language processing (NLP) methods in conjunction with refined supervisory content models.

Institutions have to track novel risks while implementing artificial intelligence. According to Milojević and Redzepagic (2021), using artificial intelligence and machine learning necessitates improving standard risk management, particularly in credit risk management. Wibisono et al. (2019) state that the primary problems of deploying artificial intelligence are handling big data and using big data. Handling big data is a resource-intensive activity, particularly in the domains of information gathering and access, which necessitates the employment of expensive

information technology and cutting-edge data security measures. Big microdata processing takes a significant amount of time, requiring the experience of diverse educational profiles such as data scientists, statisticians, and information technology professionals. Central bank statisticians face the task of making the best use of the available data, which necessitates extensive preparation as well as the implementation of proper accountability and control procedures. Using big data is also an issue in the field of artificial intelligence. This issue is particularly pronounced when vast amounts of data are processed, especially if the data is not adequately formatted. Big data sets frequently encompass the full population and have a lower sampling error than standard statistical surveys. The above-mentioned two issues are exacerbated by central bank features such as operational independence and the importance given to public trust. In the case of central banks, the need of precise data gathering is especially pronounced, down to the level of individual transactions, given that the acquired data will be utilized to make public-interest judgments. In addition, central banks make decisions that affect the financial system. There is thus a feedback loop between the financial big data collected and the precise measures implemented based on that data.

Cheatham et al. (2019) identify five major risks associated with artificial intelligence. The first is data difficulties, which refer to the greater challenge in entering, sorting, connecting, and effectively using data as a result of the increased volume of unstructured data from sources such as websites, mobile devices, and social networks. As a result of the foregoing, it is simple to fall into the trap of exploiting or disclosing sensitive information. Another risk is associated with technological troubles, which can have a negative impact on artificial intelligence. The next issue is security snags, which emerge as the ability for fraudsters to use supposedly sensitive financial, health, and marketing data that businesses acquire to build artificial intelligence systems. If security procedures are insufficient, the data can be exploited to build a fraudulent identity, causing harm to those companies. Model misbehavior is the next risk that arises when artificial intelligence models provide biased results, making those results unstable or contributing to incorrect conclusions. The fifth risk is interface concerns, which emerge when people engage with machines, posing a risk. Employees or external collaborators may violate a certain algorithm or use artificial intelligence incorrectly if strict protections are not in place. Artificial intelligence has a variety of effects on practically all economic participants. Artificial intelligence affects individuals through digital security, privacy, and reputation, whereas companies are affected by financial and non-financial performance, reputation, and corporate compliance. Artificial intelligence has an impact on society as a whole, both in terms of economic and political stability, and national security. In addition to the above, Ozili (2024) points to risks such as data privacy risk (this risk is linked to the possibility that artificial intelligence in central banks can lead to unintentional data leakage, which requires improvements in data privacy protection rules); using synthetic data to replicate real-world data (the aforementioned risk becomes greater if central banks depend more heavily on synthetic data generated by the algorithm than on real data. This can result in undesirable outcomes in an area like inflation forecast); the increased danger of embedded bias (occurs when central banks in the artificial intelligence system use unrepresentative data. If this occurs, it may result in poor monetary policy decisions); explaining artificial intelligence based central bank policy decisions is tricky (this risk is especially high when explaining the inputs and assumptions obtained from a network of interconnected artificial intelligence models) and vulnerable to cybersecurity risk (hackers can use sophisticated methods to access the artificial intelligence systems employed by the central bank and so impair the accuracy of artificial intelligence algorithms).

#### **4. Case studies of leading central banks using artificial intelligence**

Several leading central banks have begun to use artificial intelligence in various elements of their operations, with a focus on large cost reductions and increased business efficiency. We will use the example of prominent central banks to demonstrate how artificial intelligence can be applied in central bank operations.

In October 2022, the Bank of England, in collaboration with the Prudential Regulation Authority (PRA) and the Financial Conduct Authority (FCA), published a document titled "Artificial Intelligence and Machine Learning" to better understand how artificial intelligence can influence prudential supervision objectives and the implementation of supervision over financial system participants. This document is part of the PRA and FCA's attempts to assess the feasibility of artificial intelligence, and it comprises both the Artificial Intelligence Public-Private Forum (AIPPF) and the final report. The Bank of England and the FCA launched the AIPPF in October 2020 intending to foster a discussion between the public and business sectors to better understand the impact of artificial intelligence on financial services. The forum holds quarterly meetings and working group meetings covering topics such as data, risk management models, and governance. The final report, due out in February 2022, investigates the numerous barriers to adoption, risks, and risks across all three forum themes. The final report aims to improve collective understanding and promote future dialogue among practitioners, regulators, and academic community representatives in order to support the safe implementation of artificial intelligence in financial services.

The European Central Bank utilizes artificial intelligence in three areas. The first is data, which takes a long time to collect, prepare, and disseminate by statisticians because it comes from over ten million legal entities in Europe and is classed by institutional sectors (financial institutions, non-financial corporations, or the public sector). Machine learning techniques make it possible to automate the classification process, allowing European Central Bank staff members to focus on data evaluation and interpretation. The second domain is for the European Central Bank to have a better understanding of price fluctuations and inflation dynamics inside the European Union. Machine learning and web scraping can be used to collect and evaluate massive amounts of data on individual product pricing in real-time. One of the issues is that the collected data is largely unstructured and hence unsuitable for measuring inflation. For this reason, the European Central Bank, along with other eurozone member central banks, began applying artificial intelligence through the Price-Setting Microdata Analysis Network (PRISMA), which helps structure data and improves its accuracy. PRISMA was developed in 2018 by the European System of Central Banks to better understand price movements and inflation dynamics in the European Union, with a focus on essential elements of monetary policy transmission. The third area of artificial intelligence application is financial supervision, which necessitates the examination of enormous amounts of data from pertinent documents such as supervisory assessments, bank documents, and journalistic articles. The European Central Bank has developed the Athena platform, which assists supervisors in finding, processing, and comparing all of the data mentioned above. The Athena platform is intended to be used for data classification, dynamic topic modeling, sentiment analysis, and entity recognition. Supervisors may now combine collected data in seconds, allowing them to immediately comprehend key information rather than spending time searching for it. Heimdall, an artificial intelligence-based platform for assessing the accuracy of acquired data, is in use since June 2022. Heimdall reads bank statements automatically and supports automatic translation and process automation. This increases the quality of the report assessment while drastically saving manual labor. In addition to the aforementioned, the European Central Bank's supervision has developed SupTech, which allows for faster supervision of the complex

banking industry, as well as GABI (a big data analytics platform) and NAVI (a network analysis platform).

The Federal Reserve System, the United States' banking regulator, has explored the expanding role of artificial intelligence. When it comes to the usage of artificial intelligence tools, the Federal Reserve System has issued several regulations, recommendations, and supervisory measures. First, in April 2011, the document "Guidance on Model Risk Management" was published, emphasizing the significance of critical analysis during the development, implementation, and usage of models containing complicated algorithms, such as artificial intelligence. Second, guidance on vendor risk management was issued in December 2013, coupled with rules for prudential regulators for technological service providers, emphasizing the proper selection of enterprises expected to deploy artificial intelligence capabilities. These documents guide how to select and conclude a contract with an external company, as well as assuring business continuity and unforeseen events before contract termination. Third, emphasize the necessity of comprehending the instructions in the context of the individual risk and application. Thus, the supervisors encourage financial market participants to pay close attention to the application of artificial intelligence, which can be used to make critical choices or have a significant impact on financial service customers. In March 2021, the Federal Reserve Board of Governors, the Federal Deposit Insurance Corporation, the Office of the Comptroller of the Currency (OCC), the National Credit Union Administration, and the Consumer Financial Protection Bureau issued a request for information (RFI) to better understand current and future banking practices in the new technology environment. Their efforts will increase with the advancement of artificial intelligence. It should be highlighted that the US financial sector is still incorporating artificial intelligence into its operations and supervisors are optimistic about the technology's potential benefits.

The incorporation of artificial intelligence into central bank activities will result in more decision-making automation. However, any changes in this area must be thoroughly considered and reviewed by regulators and decision-makers.

## **5. Artificial intelligence in the Serbian banking sector**

The Strategy for the Development of Artificial Intelligence in the Republic of Serbia for the Period 2020–2025 was adopted by the Republic of Serbia in December 2019. Its objectives are to enhance public services, attain greater economic growth, improve the quality of scientific personnel, and cultivate future-ready skills. In addition, by putting the Strategy into practice, the Republic of Serbia must guarantee that artificial intelligence is developed very safely and in compliance with internationally recognized ethical principles, all with the goal of enhancing people's lives and places of employment as well as society at large. Oxford Insights and the International Development Research Centre established the Government Artificial Intelligence Readiness Index in order to provide an approximate similar indication for a large number of nations worldwide (195). Three pillars are used in the calculation of the index: government (which includes vision; government and ethics; digital capacity and adaptability), technology sector (which includes maturity; innovation capacity and human capital) and data and infrastructure (which includes infrastructure; data availability and data representativeness). Based on 2023 statistics, the Republic of Serbia is rated 57<sup>th</sup> overall with a total score of 55.57 (government: 74.29, technology sector: 37.13, and data and infrastructure: 55.30) - Table 1. Slovenia, Hungary, and Bulgaria are placed higher than Serbia, whereas Romania, Croatia, Montenegro, and North Macedonia, are ranked lower, along with Albania and Bosnia and Herzegovina.



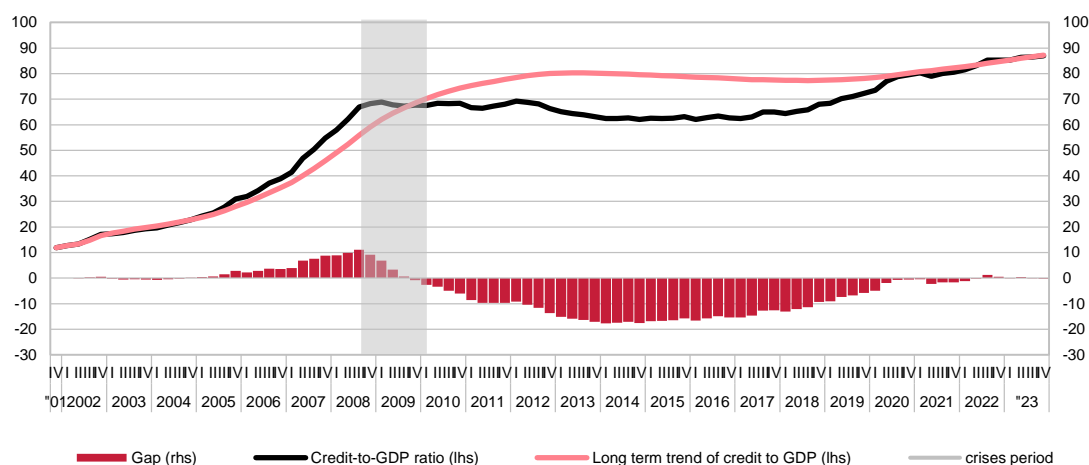
**Table 1.** Regional Government Artificial Intelligence Readiness Index for 2023

Country	Rank	Score
Slovenia	39	62.63
Hungary	45	60.66
Bulgaria	51	58.64
<b>Serbia</b>	<b>57</b>	<b>55.57</b>
Romania	64	52.32
Croatia	70	49.34
Montenegro	78	47.15
North Macedonia	83	45.40
Albania	89	43.26
Bosnia and Herzegovina	117	36.49

Source: Oxford Insights and the International Development Research Centre, Available at: <https://oxfordinsights.com/ai-readiness/ai-readiness-index/>

The Republic of Serbia's financial sector is extremely bank-centric; in fact, data from the third quarter of 2023 indicates that 81% of the financial sector's total assets are related to banks. By the end of the third quarter of 2023, there were 20 banks in operation in Serbia, 16 of which were foreign-owned, two were state-owned and two were local private banks. Italy (23.1%), Austria (18.0%), Hungary (12.6%), Slovenia (9.0%) and Greece (5.1%) are the countries with the highest percentage of foreign owners. As to the announcement made by the National Bank of Serbia in June 2023, five banks in the country have plans to introduce artificial intelligence, while ten institutions are currently employing it. Furthermore, six banks intend to enhance the integration of artificial intelligence into their business procedures, on top of the current implementation. Seven banks in Serbia utilize predictive analytics, six use robotic process automation, four use machine learning, and three use real-time analytics as specialized uses of artificial intelligence.

The National Bank of Serbia uses artificial intelligence extensively in its operational procedures and analyzes the riskiness of banks from the perspective of the chance of a problematic scenario developing by using machine learning techniques. In addition, the machine learning approach is employed for projecting a reference indication for validating scenarios during stress testing for the banking sector, evaluating the countercyclical capital buffer and for evaluating the macroeconomic environment. Macroprudential stress tests are used by the National Bank of Serbia to evaluate the banking sector's resiliency and vulnerability as well as the effects of macroeconomic factors on the system's stability and on specific financial institutions. These tests, which use network modeling, the liquidity stress test, and the solvency stress test, have been conducted on a quarterly basis since 2012. The National Bank of Serbia implemented Basel III in June 2017, introducing four capital buffers: countercyclical capital buffer, capital conservation buffer, a capital buffer for a systemically important bank, and a systemic risk buffer. A bank maintains an additional buffer of Common Equity Tier 1 (CET 1) capital above the prescribed regulatory minimum applied to domestic exposures, which can be set higher if cyclical risks are judged to be high. This buffer is known as the countercyclical capital buffer, and it is a macroprudential tool used to mitigate the procyclicality of the financial system (Martin, 2022). Based on an expert evaluation that combines reference indicator analysis with additional optional indicator analysis, the countercyclical capital buffer rate is established. The percentage of the credit gap in GDP serves as the primary indication of excessive credit activity (Martin, 2021) – Figure 3.



**Figure 3.** Credit-to-GDP ratio and its long run trend

Source: National Bank of Serbia

The primary objective of the National Bank of Serbia is to maintain and attain price stability, and the consumer price index's growth rate serves as the primary inflation indicator. For this reason, the National Bank is creating a web scraping model that automatically gathers prices from online retailers. The Republic Institute of Statistics releases its official inflation report on the 12<sup>th</sup> of the month for the previous month, however the model allows for the creation of an insight into the direction of inflation even before this official publication. This methodology, which has been in use since March 2022, is based on monitoring more than 30,000 product prices across more than 130 websites. Approximately 90% of the consumer price index basket was covered by the National Bank of Serbia using this methodology. Because data is automatically gathered and analyzed, daily and weekly monitoring of inflation is possible. The aforementioned not only highlights the significance of integrating artificial intelligence into all significant business activities of the National Bank of Serbia, but it also creates more room for additional applications of this technology. In this context, an evaluation of the potential positive and negative aspects of artificial intelligence implementation is vital, as is the risk profile associated with its use.

## 6. Conclusion

Central banks study a wide range of data in order to achieve their major goals more efficiently, which are price and financial stability. The growing the number of data, particularly in light of emerging dangers to the financial sector, such as climate and cyber risks, poses a substantial problem. As a result, artificial intelligence is rapidly being used in many functions of central banks. Central banks should offer training programs covering the fundamentals of artificial intelligence, data analysis, and the instruments utilized in this field. This would allow employees to comprehend the fundamentals of artificial intelligence and how to apply them to daily jobs. Recruiting professionals in artificial intelligence with specific skills can boost central bank staff and be critical for the successful adoption of these technologies. It is essential to provide transparency in artificial intelligence-based decision-making.

Central banks should foster an environment of creativity and adaptation among their staff, but it is also critical to establish clear goals and expectations for the use of artificial intelligence within central banks. This enables more effective targeting of resources in specific areas such as data analysis, risk reduction, and monetary and financial stability. Collaboration with universities and research institutes would provide access to cutting-edge research and

technology advancements in artificial intelligence. This collaboration has the potential to spark the development of novel ideas and technology solutions for central banking.

Finally, it is widely acknowledged that artificial intelligence is unlikely to replace supervisors and regulators in central banking because the human factor is required when making critical decisions in an uncertain environment. The only use of artificial intelligence in decision-making has a high risk, and the human factor is required to thoroughly examine all variables in order to meet central banks' primary goals-price and financial stability.

## References

- Araujo, D., Doerr, S., Gambacorta, L. & Tissot, B. (2024). Artificial intelligence in central banking, *Bank for International Settlement, BIS Bulletin No 84*, 1-9.
- Cheatham, B., Javanmardian, K. & Samandari, H. (2019). Confronting the risks of artificial intelligence, *McKinsey Quarterly*, 1-9.
- Da Costa, S. (2018). How Artificial Intelligence is changing the banking sector? *La Rochelle Business School*, 1-90.
- Dirican, C. (2015). The Impacts of Robotics, Artificial Intelligence on Business and Economics. *Procedia - Social and Behavioral Sciences*, 195 (2015), 564 – 573.
- Dzhaparov, P. (2020). Application of blockchain and artificial intelligence in bank risk management. *Economics and Management*, 17(1), 43-57.
- FSB - Financial Stability Board (2017). Artificial intelligence and machine learning in financial services: Market developments and financial stability implications, Available at: <https://www.fsb.org/wp-content/uploads/P011117.pdf> (04.03.2024.)
- Ghandour, A. (2021). Opportunities and Challenges of Artificial Intelligence in Banking: Systematic Literature Review. *Technology, Education, Management, Informatics (TAM) Journal*, 10(4), 1581-1587. <https://doi.org/10.18421/TEM104-12>  
<https://nbs.rs/en/scripts/showcontent/index.html?id=18981> (13.03.2024.)  
<https://www.bankingsupervision.europa.eu/press/interviews/date/2024/html/ssm.in240226~c6f7fc9251.en.html> (12.03.2024.)  
[https://www.bankingsupervision.europa.eu/press/publications/newsletter/2023/html/ssm.nl231115\\_2.en.html](https://www.bankingsupervision.europa.eu/press/publications/newsletter/2023/html/ssm.nl231115_2.en.html) (12.03.2024.)  
<https://www.bankofengland.co.uk/prudential-regulation/publication/2023/october/artificial-intelligence-and-machine-learning> (12.03.2024.)  
<https://www.ecb.europa.eu/press/blog/date/2023/html/ecb.blog230928~3f76d57cce.en.html> (12.03.2024.)  
<https://www.federalreserve.gov/newsevents/speech/cook20230922a.htm> (11.03.2024.)  
<https://www.mckinsey.com/featured-insights/artificial-intelligence/notes-from-the-ai-frontier-modeling-the-impact-of-ai-on-the-world-economy> (06.03.2024.)  
<https://www.minneapolisfed.org/article/2023/across-the-fed-a-mindful-exploration-of-ai-is-underway> (11.03.2024.)
- Kaya, O. (2019). Artificial intelligence in banking: A lever for profitability with limited implementation to date. *Deutsche Bank Research*, 1-9.
- Khan, A. & Malaika, M. (2021). Central Bank Risk Management, Fintech, and Cybersecurity. *International Monetary Fund, IMF Working Paper WP/21/105*, 1-76.
- Kruse, L., Wunderlich, N. & Beck, R. (2019). Artificial Intelligence for the Financial Services Industry: What Challenges Organizations to Succeed. *Proceedings of the 52<sup>nd</sup> Hawaii International Conference on System Sciences*, 6408-6417.
- Martin, V. (2021). Analysis of capital buffers in Serbia. *Annals, Faculty of Economics in Subotica, University of Novi Sad*, 57(46), 73-87. <https://doi.org/10.5937/AnEkSub2146073M>

- Martin, V. (2022). Countercyclical Capital Buffer Analysis in Serbia. *Ekonomski vidici, Society of economists Belgrade*, 1(2), 1-21.
- Mcmullen, M. (2023). AI in Finance — 5 Benefits for Better Banking. Towards AWS, Available at: <https://towardsaws.com/ai-in-finance-5-benefits-for-better-banking-70cbaae31911> (04.03.2024.)
- Mi Alnaser, F., Rahi, S., Alghizzawi, M. & Hafaz Ngah, A. (2023). Does artificial intelligence (AI) boost digital banking user satisfaction? Integration of expectation confirmation model and antecedents of artificial intelligence enabled digital banking. *Heliyon*, 9(2023), 1-14. <https://doi.org/10.1016/j.heliyon.2023.e18930>
- Milojević, N. & Redzepagic, S. (2021). Prospects of Artificial Intelligence and Machine Learning Application in Banking Risk Management. *Journal of Central Banking Theory and Practice*, 3(2021), 41-57. <https://doi.org/10.2478/jcbtp-2021-0023>
- Mullin, J. (2023). Artificial Intelligence and Bank Supervision. *Econ Focus, Federal Reserve Bank of Richmond*, 23(2Q), 8-11.
- Oxford Insights and the International Development Research Centre*, Available at: <https://oxfordinsights.com/ai-readiness/ai-readiness-index/> (14.03.2024.)
- Ozili, P. K. (2024). Artificial Intelligence in Central Banking: Benefits and Risks of AI for Central Banks. *Industrial Applications of Big Data, AI, and Blockchain*, 70-82. <https://doi.org/10.4018/979-8-3693-1046-5.ch004>
- Piotrowski, D. & Orzeszko, W. (2023). Artificial intelligence and customers' intention to use robo-advisory in banking services. *Equilibrium. Quarterly Journal of Economics and Economic Policy*, 18(4), 967–1007. <https://doi.org/10.24136/eq.2023.031>
- Strategy for the Development of Artificial Intelligence in the Republic of Serbia for the period 2020-2025*, Available at: <https://www.srbija.gov.rs/tekst/437277/strategija-razvoja-vestacke-inteligencije-u-republici-srbiji-za-period-20202025-godine.php> (14.03.2024.)
- Sugiharto, B., Simanungkalit, R., Siregar, I. & Andriani, M. (2023). Artificial Intelligence (AI) Architecture for Integrated Smart Digital Banking System. *Journal Penelitian Pendidikan IPA*, 9(10), 876–882. <https://doi.org/10.29303/jppipa.v9i10.4645>
- Wibisono, O., Dhini Ari, H., Widjanarti, A., Andhika Zulen, A. & Tissot, B. (2019). The use of big data analytics and artificial intelligence in central banking. *International Finance Corporation, IFC Bulletin No 50*, 1-20.
- Yadav, N., Sharma, L. & Dhake, U. (2024). Artificial Intelligence: The Future. *International Journal of Scientific Research in Engineering and Management*, 8(1), 1-6. <https://doi.org/10.55041/IJSREM27796>
- Yamaoka, H. (2023). The Future of Central Banking. *The Journal of Accounting, Economics, and Law*, 13(2), 103-132. <https://doi.org/10.1515/ael-2019-0003>

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