

AI in the Central Banks of the Western Balkans: Adoption, Challenges, and Prospects

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Abstract

The changes in technological development driven by artificial intelligence (AI) are substantial and rapid, and central banks are not exempt. Implementing AI in the central banks of Western Balkan countries offers opportunities but also presents challenges and increases risks. That is why our aim is to analyze current advancements in the region's central banks regarding AI implementation, as well as possibilities for further growth. This review paper relies on relevant publications, including working papers, research outputs, and official announcements that reference AI and related concepts. The overall conclusion is that, while research and ideas are not necessarily lacking, implementation lags behind. It is hindered by numerous obstacles, particularly data quality and availability, followed by privacy issues, lack of human capital, and the difficulty of aligning the enduring mandates of central banks with rapidly evolving AI technologies. Nevertheless, the region's central banks have already begun the journey towards integrating AI, even if progress remains gradual.

Keywords: central banks, AI, Western Balkan

1. Introduction

The volatility of the times requires adapting analytical tools to handle large amounts of often unstructured data, which traditional analytical methods usually struggle to model. Machine learning (ML) and artificial intelligence (AI) are frequently able to capture the full depth and nonlinearity of economic relationships, both macroeconomic and financial ones, which is why they are emerging as key components of modern central-bank toolbox. ML techniques can process large datasets, identify hidden patterns, and produce forecasts, aiding in central banks' mandates to monitor inflation, assess financial stability risks, detect anomalies such as fraud or cyber threats, and evaluate macroprudential scenarios. Based on Araujo et al (2023), roughly 25% of central banks globally had already put AI and machine-learning models into full operational use, more than 60% of them reported either early-stage production applications or ongoing pilot projects, while only 12% of central banks worldwide experienced no involvement with AI or ML at all.

As central banks around the world increasingly experiment with ML-based nowcasting, text analytics, early-warning systems, and automated supervisory tools, our intention is to identify whether these and similar forms of the above-mentioned adjustments have taken root in the functioning of Western Balkan central banks. To achieve this aim, we rely on published working papers tackling AI/ML and its application. The need for a meta-theoretical study of this kind arises from the fact that only a few papers explore the use of these tools either within particular central bank or more broadly within central banks of WB region. Martin (2024), for example, argues that artificial intelligence (AI) and machine learning (ML) are increasingly being adopted by central banks globally as tools to improve decision-making, data analytics, forecasting, risk management, and operational efficiency. The paper reviews how major central banks have begun using AI for tasks such as macroeconomic forecasting, payment oversight, supervisory analysis, and compiling official statistics. Although the paper explores these issues

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in a broad, international context, it gives particular attention to the National Bank of Serbia, noting the instances in which the NBS uses ML. The paper that corresponds most closely to our research focus, such as Ivančević (2025), conducts a qualitative study to examine AI readiness in six central banks in the Western Balkans (excluding Kosovo, and including Croatia). The author utilized expert interviews with lead professionals in the mentioned institutions, aiming to determine their perspectives regarding strategic alignment, resources, knowledge, organizational culture, and data infrastructure. The paper finds that no institution demonstrates high preparedness in any of the five dimensions, with Serbia, Montenegro, and Croatia showing slightly better results. The main issues are identified as a lack of integration of AI into core values (institutional fragmentation and cultural issues regarding AI), poor and insufficient data, and a lack of a skilled workforce.

In order to present the achievements of the six analyzed central banks in applying AI/ML tools, we classify them into two groups. The first group consists of three countries (Albania, North Macedonia and Serbia) that have produced a visible research output, which we discuss in detail for each of these countries. The second group includes the remaining three countries (Montenegro, Bosnia and Herzegovina and Kosovo*) whose activities are mostly sporadic and declarative, and are therefore captured jointly and without extensive detail. Finally, in the concluding section, we briefly summarize our main observations and insights.

2. Central banks with visible research outputs

2.1. Albania

The Bank of Albania has published six articles that apply various ML techniques to topics of interest, mostly in macroeconomic analysis. Four of the articles deal with applications of artificial neural networks (one ANN and three LSTMs) to forecast Albania’s house-price dynamics, study Albania’s unemployment-output relationship, forecast USD/EUR exchange rates, and investigate whether monetary aggregates aid in forecasting prices. One article applies a semantic analysis of BoA’s communicative tone and investigates its correlation to macro/financial variables. One article proposes a data collection method using web-scraping to provide policymakers with timely information about Albania’s real estate market. All of the articles include a hands-on application of the mentioned ML models, with the aim of improving Bank of Albania’s existing approaches. The brief overviews of the articles in question and their applications are given below.

“Selecting a Neural Network Model with an Application to House Price Determinants in Albania” (Vika & Vika, 2024)

This article starts by describing the design, specification, and validation steps for neural-network models used in time-series forecasting, followed by an application of a Long Short-Term Memory (LSTM) neural network to forecast Albania’s house-price dynamics. The model selection relevant to macroprudential monitoring is beneficial, as it outlines real-world applications. The paper reinstates a conclusion from the growing empirical literature: choosing an LSTM architecture suitable for time-series analysis remains, in most cases, a trial-and-error exercise. The target variable is a real house-price index (RHP, in Albanian lek, seasonally adjusted and deflated), and potential predictors based on standard economic theory include real GDP per capita, bank real-estate lending, foreign purchases of real estate, house rentals, two-year government bond real yields, construction costs, and a measure combining urban population change and building permits. The authors model RHP as a function of its lags and these predictors, acknowledging that the housing market is complex and that relationships can

change over time. The authors construct 112 candidate LSTMs by varying input lags, hidden layers, and hidden nodes, and comparing forecast performance to a simple AR(1) model using RMSEs and Theil's U. Short lags dominate top-performing models, with a lag of 2 quarters being especially dominant, implying information from the past year is most informative for near-term house-price forecasting, with past house-price performance and real GDP per capita carrying most of the information about the price hikes. The authors conclude that neural networks can outperform simple linear benchmarks for medium-term house price forecasts, noting that additional work is needed to interpret machine predictions in alignment with economic fundamentals.

“Using Machine Learning Tools to Study the Unemployment and Output Relationship in Albania” (Vika et al, 2022)

The classical unemployment–output trade-off is analysed empirically using machine learning (ML) methods in this paper, particularly the LSTM. The authors' goal is to determine whether Albania's labor market exhibits an Okun-type relationship and whether advanced ML methods, such as LSTM, can detect nonlinear patterns that traditional econometric approaches miss. The paper states that this topic is central to macroeconomic analysis, as the unemployment–output nexus carries “an important predictive value for policy-making decisions”. The labor market indicators in Albania are prone to noise, structural breaks, and non-linear responses, rendering traditional analyses inadequate. The authors include the hysteresis concept in their analysis, questioning whether prolonged unemployment episodes generate long-lasting damage to the labor market. The LSTM models used are not purely predictive, as they are also used to identify structural relationships and compare them with baseline linear models. The authors' findings provide support for the existence of an unemployment–output trade-off in Albania. Some models suggest a stronger unemployment response during downturns, consistent with the international literature, which shows that job losses tend to be sharper in recessions than employment gains in recoveries. Additionally, the evidence indicates that Albania's labor market may exhibit forms of hysteresis, meaning that prolonged economic weakness can leave permanent or semi-permanent scars on employment. The interpretation of LSTM results is closely tied to policy relevance. Because the unemployment–output relationship is sensitive to the economy's structural characteristics, policies that support labor-market flexibility can strengthen the responsiveness of employment to growth. Labor-market interventions focused on retraining, education, and upskilling could ensure smoother transitions across jobs and industries. Similarly, because ML methods reveal nonlinearities, policymakers are encouraged to view downturns as disproportionately damaging, thereby justifying more aggressive countercyclical measures during contractions. The study also underscores the value of ML for forecasting and real-time assessment, thus helping policymakers anticipate turning points or detect early signs of hysteresis.

“The Usefulness of Artificial Neural Networks in Forecasting Exchange Rates” (Vika et al, 2015)

The paper investigates whether artificial neural networks (ANNs) can outperform traditional ARIMA models in forecasting the USD/EUR exchange rate. Exchange rates have historically

been extremely difficult to forecast, with many papers finding that even theoretically well-motivated models struggle to outperform simple random-walk predictions. Empirical models generally fail in out-of-sample forecasting tests, often performing no better than a naïve forecast that assumes no change from one period to the next. Exchange rates reflect a complex mixture of economic, political, and psychological influences, making it challenging to construct structural models with strong predictive power, as well as exhibiting volatility and nonlinearity, meaning that linear statistical models often misrepresent the underlying dynamics. The EUR/USD exchange rate is crucial for macroeconomic forecasting in small, open economies such as Albania. A growing literature advocates nonlinear or data-driven modeling approaches, including neural networks, which are flexible enough to learn nonlinear patterns without imposing a prior functional form. The authors compare two forecasting frameworks (ARIMA and NAR) using monthly USD/EUR exchange-rate data. For both models, the sample is split into an estimation period and an out-of-sample evaluation period. Forecasts from ARIMA, NAR, and a naïve random-walk model are compared visually and numerically. The neural-network forecasts are consistently closer to actual values, while ARIMA forecasts often lag turning points and overpredict the exchange rate (partly due to monetary-policy surprises related to the European Central Bank’s quantitative-easing signals). As the authors highlight, the neural network dramatically outperforms ARIMA on all metrics. ARIMA performs no better than the naïve model, while the NAR model beats both by a wide margin, with an average forecasting error of less than 1 cent, essentially eliminating systematic bias. The article concludes that neural networks, even in a modest application, show strong potential as forecasting tools for financial time series. Despite the popularity of ARIMA and the historical difficulty of beating a random walk, the study demonstrates that a carefully trained ANN can “consistently beat” both the traditional ARIMA model and the naïve forecast for the USD/EUR exchange rate. The authors emphasize that future research could integrate more complex architectures, incorporate economic fundamentals, or extend the horizon beyond one-month forecasts.

“Does Money Matter for Predicting Overall Prices in Albania? An Analysis with Recurrent Neural Network” (Vika et al, 2025)

The article investigates whether monetary aggregates contain useful information for forecasting overall price developments in Albania. Rather than relying on traditional econometric models, the authors employ a Long Short-Term Memory (LSTM) recurrent neural network. Their objective is to empirically re-evaluate the money–price nexus, especially in light of the dramatic monetary and price developments observed after the COVID-19 pandemic. The sharp monetary expansion during 2020–2022 has raised questions about the relevance of monetary indicators. The question posed is whether money growth provides predictive signals for price developments. Empirical studies show mixed evidence: money predicts inflation more strongly in high-inflation environments and less so in low-inflation regimes. Given Albania’s shift from modest pre-pandemic inflation to sharp post-pandemic price increases, the authors investigate whether the usefulness of money varies across regimes. The core inflation measure is the GDP deflator, which captures economy-wide prices rather than consumer prices alone. Monetary aggregates include base money, M1, M2, and M3. Descriptive statistics show strong regime

shifts: early-transition years exhibit extreme volatility, while the 2000s show greater stability, followed by renewed fluctuations after the pandemic. The first set of results compares a price-only model (univariate) against price + money models (bivariate). Base money is the *only* aggregate that consistently improves forecasts across most horizons. The usefulness of money is state-dependent: post-COVID inflationary conditions dramatically increase the predictive role of base money and M1, suggesting that in high-inflation regimes, monetary signals strengthen substantially. The authors conclude that money does matter for predicting overall price developments in Albania, particularly base money and narrow money M1, and especially during periods of elevated inflation. Given that modern policy frameworks often downplay money, the findings imply that monetary developments should regain attention, particularly for forecasting horizons of up to two years—the typical policy-relevant horizon. The article recommends further research using structural models combining monetary and real-economic indicators.

“Communicative Tone of Bank of Albania’s Monetary Policy Report: A Semantic Orientation Estimation” (Garo, 2024)

This article constructs and analyzes a time series indicator of the Bank of Albania’s monetary-policy communicative tone, with the intention to test whether the language used in the Bank’s quarterly Monetary Policy Reports signals future policy moves. The study builds a semantic orientation index (Tone Semantic Orientation Index) by counting “hawkish” (tightening) and “dovish” (easing) words and multi-word phrases in the English text of 86 quarterly reports spanning 2003–mid-2024. The final TSOI ranges from –1 to 1: positive values indicate hawkish reports, and negative values indicate dovish reports. Furthermore, the authors test the correlation between the TSOI and macro/financial variables, showing statistically significant relationships between the TSOI and macro/financial variables. TSOI tends to lead the policy interest rate, and TSOI correlates positively with GDP growth (lagged) and core inflation (two-quarter lag), while showing a negative correlation with the euro exchange rate. These findings suggest the Bank’s report language contains forward-looking signals that precede changes in monetary policy instruments. The paper and the applied methodology provide evidence that the Bank of Albania’s communication channel is informative and that forward guidance enacted since 2013 has increased its informativeness. The article closes by recommending TSOI’s use in future research and policy monitoring while acknowledging limits (English-only reports, dictionary choices, and potential misclassification).

“Real-Time Obtained Real Estate Prices: The Web-Scrapping Methodology” (Garo, 2022)

The paper applies a data-collection procedure intended to help researchers and policymakers access timely and systematically processed information about Albania’s real-estate market. Because house-price data in emerging economies are often delayed or inconsistent (or non-existent), the authors propose the use of web-scraping (web data extraction) as an empirical solution to obtain real-time price information from online housing listings. Albania, like many Western Balkan economies, lacks a fully centralized, high-frequency database of real-estate transactions. Official statistics do exist, but are published at a lower frequency or as an aggregate of diverse market segments. Online property portals, by contrast, provide micro-level

data, including price, location, property type, size, as well as additional characteristics. Capturing these data in real time significantly broadens the analytical possibilities for policymakers monitoring macro-prudential risks. The authors give a clear, replicable overview of the “web scraping protocols” that guide the process. These procedures allow the constructed scraper to capture not only prices but also listing features. This method also poses challenges: inconsistent formats, incomplete data, missing fields, and dynamically loaded content. A critical, often under-reported challenge discussed in the article is data quality assurance. Raw scraped data typically includes duplicates, outdated listings, unconventional units of measurement, or non-numeric characters embedded in price or size fields, rendering some cleaning necessary. They stress that “data extraction needs continuous adjustments,” since website formats change and must be remapped over time. A high-frequency real-estate price dataset based on daily/weekly scraping routines is then constructed, taking all the mentioned restrictions into account. This dataset produces a timely indicator, including price indices segmented by region, property type, or structural features. Although the article does not provide long-run statistical results in the excerpt, it emphasizes that the method provides a granular and scalable basis for monitoring housing-market trends and informing macro-prudential policy. The authors argue the method represents a highly cost-effective approach to filling data gaps in Albania’s real-estate market and can serve as an important tool for central-bank analysis, housing-market surveillance, and early-warning systems.

2.2. North Macedonia

The National Bank of the Republic of North Macedonia (NBRSM) has published two articles regarding ML application in its research. One paper is a semantic study of NBRSM’s communication tone, and the other is on applying ML methods such as boosted trees and neural networks to optimize credit risk assessment. The overview of the two papers is given below.

“Understanding the Monetary Policy Communication in A Small and Open Economy Under an Exchange Rate Anchor: The Case of North Macedonia” (Ciunova-Shuleska et al, 2025)

The paper examines how the NBRSM communicates its monetary policy decisions and how the public perceives them. The authors focus on a key reasoning: communication has become an essential instrument of modern monetary policy, and central banks increasingly rely on speeches, reports, press releases, and other forms of public messaging to shape expectations and strengthen policy transmission. The study’s foundation is rooted in the idea that communication supports transparency and credibility, especially in small, open economies where expectations play a pivotal role. The authors emphasize that clear, consistent, and credible communication reduces information asymmetry, which helps financial markets, households, and firms make better decisions. The authors examine speeches delivered by the NBRSM Governor and analyze them using Latent Dirichlet Allocation (LDA), a machine-learning technique for topic modeling. LDA allows the identification of dominant themes, changes over time, and the relative importance of topics such as inflation, financial stability, external conditions, and policy decisions. The paper connects these communication themes to public reactions and economic indicators, assessing whether particular messages align with shifts in public interest. To capture public attention, the authors use Google Trends data as a

proxy for public interest in economic topics, a method increasingly used in empirical monetary policy literature. This allows them to study whether changes in topic emphasis correspond to changes in public search behavior. The results show that communication patterns adjust to economic cycles: specific topics dominate during periods of uncertainty, such as global shocks, inflationary pressures, or episodes of financial instability. In calmer periods, communication shifts toward structural themes, long-term expectations, and institutional credibility. The analysis also reveals that public attention reacts more strongly during periods when communication is more frequent and more focused. The authors argue that analytical tools like LDA can help central banks better understand how their messages are perceived and how they can be improved.

“Improving the Credit Analysis Process in Banks Through the Use of Machine Learning Methods” (Kalach, 2020)

The paper examines how machine learning (ML) methods can improve credit analysis and credit risk assessment in the banking sector, as growing credit volumes and the need for more accurate risk assessment have motivated institutions to explore advanced analytical techniques. The results show that boosted decision-tree models achieve the highest predictive accuracy, surpassing both classical linear models and neural networks. Macedonian financial institutions could significantly enhance credit-risk assessment by adopting modern ML methods and by refining existing models using richer loan-level datasets. The paper highlights the central role of the National Bank of the Republic of North Macedonia (NBRSM) in shaping the regulatory and supervisory framework within which Macedonian banks conduct credit-risk assessment, emphasizing that all banks must follow the methodology defined by NBRSM for classifying credit exposures, determining impairment and provisions, and evaluating repayment discipline, with categories and provisioning rules explicitly prescribed by the central bank’s regulations. NBRSM is one of the two key national institutions collecting data relevant for creditworthiness evaluation, maintaining the country’s official Credit Registry, which stores comprehensive information on all credit exposures of individuals and firms toward banks and savings houses, and represents one of the richest possible datasets for developing machine-learning-based credit-scoring models. The paper stresses that although such supervisory data are not publicly accessible for research, they could significantly enhance predictive performance, and that the same machine-learning methods evaluated in the study could support not only banks’ internal credit-analysis processes but also NBRSM’s broader supervisory oversight of credit risk, including systemwide monitoring of nonperforming loans. In addition to data and methodology, the paper cites several central bank policy interventions that materially affected the dynamics of NPLs and the environment in which credit-risk models operate, demonstrating that NBRSM’s decisions directly shape the statistical profile of bank portfolios. The paper presents NBRSM not only as the regulator that defines the rules of credit-risk management, but also as a crucial data steward whose registries, supervisory requirements, and policy decisions form the foundation for any advanced analytical approach (such as machine learning) applied to credit-risk assessment in North Macedonia.

2.3. Serbia

The National Bank of Serbia (NBS) has published four articles and one overview within the Annual Financial Stability Report regarding ML use in their methodology (National Bank of Serbia (2023)). The overview titled *Artificial intelligence in financial institutions and central banking* acknowledges the transformation of the global financial system over the past decade by improving efficiency and reducing operational costs, while questioning the introduced risks to financial stability through increased operational vulnerabilities related to security, data governance, privacy, and decision-making. The authors note that the National Bank of Serbia (NBS) already employs AI/ML early-warning systems for detecting problematic occurrences in banks, online-price-based inflation nowcasting, stress-test scenario validation, as an additional tool in projecting the reference guide when determining the countercyclical buffer rate, and detection of irregular flows in its instant-payment system. The overview underscores the NBS’s commitment to further developing its analytical frameworks in line with global best practices to strengthen forecasting, improve decision-making, and ensure that the adoption of AI/ML supports financial stability and regulatory effectiveness. The five papers deal with several different ML models, with three of them covering various forms of sentiment analysis: modeling inflation expectations based on news data, creating datasets based on automated classification of news topics, and constructing an inflationary pressures indicator based on news data. One paper showcases a web scraping approach to constructing an alternative inflation indicator, an online-price-based inflation nowcasting measure that has been used in the NBS since 2022. Finally, the fifth paper compares traditional econometric models to an LSTM approach to nowcast GDP. The brief summaries of the mentioned papers are given below.

“Topic classification of economic newspaper articles in a highly inflectional language – the case of Serbia” (Đukić, 2024)

The paper examines how modern text-analysis techniques can be applied to large collections of economic news in Serbian, a language characterized by extensive morphological variation, in order to extract topic structures that can be used for economic analysis, particularly for understanding and predicting inflation expectations. The author notes that news articles represent a rich source of qualitative information that can, when processed with machine-learning models such as Latent Dirichlet Allocation (LDA), produce quantitative indicators reflecting the state of the economy. Because Serbian is a highly inflected language in which a single word may appear in many different forms, the paper emphasizes the importance of careful linguistic preprocessing. After preparing the dataset, which consists of 25,248 economic-news articles from the Serbian newspaper *Politika* over the period 2006–2023, the author applies LDA topic modeling to extract forty coherent topics, each identified by its most frequent and most informative terms. These topics cover a broad range of economic themes, including prices, inflation, wages, enterprises, banking, fuel markets, trade, agriculture, public finance, fiscal policy, and international developments. To determine whether changes in media content help explain movements in inflation expectations, the author estimates a LASSO regression model in which the dependent variable is an empirical measure of inflation expectations and the independent variables are the topic shares extracted from the news corpus. LASSO is chosen because it performs variable selection and is particularly suitable when

dealing with a large number of potentially correlated predictors. The results show that seventeen of the forty topics have statistically significant explanatory power, indicating that shifts in the content of economic news are associated with changes in public inflation expectations, and suggesting that the media environment may contain valuable high-frequency signals relevant for central-bank analysis. The paper highlights that news-based indicators could complement traditional surveys of expectations, especially in periods of heightened uncertainty, and that the approach is scalable and adaptable to other languages and contexts, provided that suitable linguistic preprocessing tools are available. The author concludes that machine-learning methods represent a promising direction for modern central-bank research, offering new ways to quantify the informational content of media narratives and to better understand expectation formation, while also acknowledging challenges related to language complexity and model interpretability.

“News article analysis using Naïve Bayes classifier” (Vujović, 2025)

Similar to the previous article, this paper presents an analysis of how a classic machine-learning method, the Naïve Bayes classifier (NBC), can be used for thematic classification of news-text data. The author starts from the premise that text-processing and natural language processing (NLP) have gained prominence in economics, especially after the COVID-19 pandemic. This is partly due to the fact that traditional economic indicators and statistics often suffer from lag or lack of granularity, while publicly available text sources (news articles, social-media commentary) provide high-frequency data reflecting real-time developments. In the empirical part of the study, the author applied the Naïve Bayes classifier to a sample of 2,225 news texts (from the BBC website, in five categories) and tested whether the classifier could reliably assign each text to predefined thematic categories. After training and testing, the results indicate that the classifier performs with high predictive accuracy in thematic classification, even with relatively simple assumptions and a limited dataset, validating the feasibility of using Naïve Bayes for economic-text analysis in contexts where data are abundant but structured datasets may be lacking. The author argues that this finding opens space for further application of NBC (and similar text-classification models) in the domain of economic research: constructing sentiment indicators, monitoring economic or financial instability via media content, or detecting shifts in public discourse relevant for monetary and financial policy. The paper highlights that, while central banks (or other institutions) could benefit from such low-cost text analytics tools, text data analysis depends heavily on preprocessing quality (cleaning, normalization, feature extraction), and the assumptions underlying Naïve Bayes (feature independence) may not always hold in natural-language data. In conclusion, the author demonstrates that even relatively simple machine-learning classifiers like Naïve Bayes can serve as effective tools for thematic classification of economic news texts, offering central banks and economic researchers an additional instrument for capturing high-frequency, qualitative signals. This finding is useful for real-time monitoring of economic sentiment, inflation pressures, or financial-sector developments.

“Assessment of inflationary pressures using newspaper text analysis” (Đukić, 2022)

Following the previous two papers, this article poses the question of whether publicly available economic news from four leading Serbian daily newspapers can be used to construct a reliable indicator of inflationary pressures that complements traditional price statistics. The author compiles a large corpus of 117,113 articles, then applies a dictionary-based (lexicon) text-analysis approach by defining two lists of phrases and words related to price increases and price decreases, and counts both the frequency of such expressions and the number of articles containing them to build several measures they call “news-based inflation sentiment.” Comparing these sentiment measures with official inflation data yields several conclusions: during periods of high and volatile inflation, the constructed news-sentiment indicators are highly correlated with observed inflation and tend to lead or anticipate inflation peaks; in contrast, during stable low-inflation periods, the correlation is much weaker. The author estimates forecasting models and finds that including the news-sentiment variable improves out-of-sample inflation prediction compared with simple autoregressive models, suggesting that media-based sentiment measures provide real predictive value when inflation dynamics are challenging. The paper argues that, since news articles are high-frequency, freely available data, a “news index” can serve as a low-cost, timely complementary tool for central banks and policymakers, offering early signals of changing inflationary pressures ahead of official CPI releases. The methodology is transparent and relatively simple, thus easy to update and replicate, although the author notes limitations: news coverage may be biased, the list of price-related expressions might omit relevant terms, and the sentiment index may not fully capture structural drivers of inflation, which requires caution and possibly combining it with other data sources. The paper provides empirical evidence that sentiment extracted from media content can be an informative proxy for inflationary pressure in Serbia, particularly during turbulent periods, and recommends that central banks consider integrating such media-based indicators into their analytical toolkits.

“Nowcasting inflation using prices from the web” (Đukić et al, 2023)

This paper presents a methodology developed by NBS for producing real-time estimates of inflation based on web-scraped online price data. The authors argue that automatic collection and processing of online prices can act as a complementary indicator to official consumer price indexes (CPI), giving monetary policy makers earlier insight into inflation trends, instead of waiting for official statistics. The method attempts to cover a large share of the CPI basket (at the time of writing, about 90% of the CPI components) by scraping prices not only for goods sold online, but also for regulated prices, service tariffs, etc., displayed online. This broad coverage distinguishes the NBS approach from many other “nowcasting” studies, which often focus on limited sub-categories (e.g., food prices only). Empirical results are encouraging: during the first year of application, the “internet-price inflation” nowcasts closely tracked the official inflation figures, even in a period of high and volatile inflation. Because the data come from the web and can be updated frequently (potentially weekly or daily), this methodology gives NBS a timely, low-cost, and flexible tool to monitor price dynamics in near real time — useful for both monetary policy and macroeconomic forecasting. However, the authors

acknowledge certain limitations: web-scraped data depend on the continued availability and quality of online sources; changes in website structure or the removal of price information may disrupt data collection. Moreover, for some categories of goods and services (especially those with regulated prices or limited online presence), data may be missing or not representative, requiring imputation or exclusion. Hence, the web-based index is proposed not as a replacement for the official CPI, but rather as a complementary indicator that can offer early signals ahead of official releases. The paper demonstrates how a central bank (NBS) can leverage big-data tools to enhance its inflation-monitoring capabilities, making monetary policy decisions better informed and more responsive to real-time developments. The methodology shows promise, especially for economies where timely and granular inflation data matter for stable policy.

A comparison of using MIDAS and LSTM models for GDP nowcasting (Glišić, 2024)

This paper explores the use of both classical econometric and modern machine-learning methods to produce “nowcasts” of Gross Domestic Product (GDP) in Serbia: estimates of current GDP growth before official statistics become available. This information is particularly valuable in periods of economic volatility when timely information is critical. The author compares a mixed-frequency regression model (based on the MIDAS model) with a recurrent neural network model using long short-term memory (LSTM), with the goal of determining which approach yields more accurate and timely estimates when combining official data with high-frequency and alternative (big-data) indicators such as Google Trends, electricity consumption, and other variables that are released more frequently than quarterly GDP statistics. The results show that while both models improve on traditional lagged-statistics approaches, the LSTM model consistently delivers higher precision and lower forecast errors. Nonetheless, the author points out that the MIDAS model retains particular strengths because its parametric structure allows for more transparent interpretation, making it easier to decompose the contributions of individual indicators to GDP dynamics, and thus remains a useful decision-support tool for policymakers. The paper also emphasizes that the inclusion of high-frequency alternative indicators substantially improves forecast quality for both models, underscoring the growing relevance of “big data” sources and machine-learning methods in macroeconomic nowcasting, especially under conditions of high uncertainty or when traditional data release schedules are lagged. At the same time, the author acknowledges the limitations: both models face challenges related to overfitting due to relatively small samples, potential data-quality issues arising from alternative indicators, and difficulties in interpreting complex model outputs, especially in the case of deep-learning models. The paper concludes that while LSTM-based nowcasting shows strong potential, a hybrid approach combining the interpretability of MIDAS with the flexibility and accuracy of machine learning may offer the best path forward for central banks and statistical agencies seeking timely and reliable assessments of economic activity.

3. Central banks with limited or sporadic engagement

There are currently no working papers regarding AI/ML implementation in the central banks of Bosnia and Herzegovina, Montenegro, or Kosovo*.

There is a public announcement from CBCG (Central Bank of Montenegro, 2022) about a project titled “Detection of misuse of bank cards based on artificial intelligence”. According to CBCG, the project aims to develop an AI-based approach to detect fraud in bank-card transactions, to be applied in existing payment-system infrastructure and the future instant-payments system. Additionally, there are two working papers published in the Central Bank of Montenegro Journal, but they discuss AI/ML and fintech from a general banking-sector perspective, and not applications within the institution. Vučinić & Luburić (2024) argue that rapid advances in artificial intelligence (AI) and fintech are reshaping the financial industry, and that central banks must adapt to maintain monetary and financial stability mandates. The authors examine how AI-driven innovations (including generative AI) can transform payments, credit, risk management, and data analytics, offering gains in efficiency and broader access to financial services. The paper calls for central banks to strengthen regulatory frameworks, build institutional capacity, and modernize supervisory infrastructures, with a recommendation to policymakers to adopt human-centric, transparent, and resilient AI governance. Similarly, Milojević & Redzepagic (2021) review the potential for AI/ML, deep learning, and big-data analytics to improve banking risk-management. The authors argue that traditional statistical methods are often inadequate in the current data-rich environment, especially after the global financial crisis and during periods of economic turbulence (e.g., the COVID-19 pandemic). By contrast, ML models can better handle complex, nonlinear relationships, large datasets, and alternative data sources, thus improving risk-assessment accuracy, early-warning capabilities, and overall resilience. The paper also carefully highlights limitations and challenges: data quality, explainability (“black box” nature), regulatory and ethical concerns, and the danger of model over-reliance. The conclusion encourages a cautious but proactive adoption of AI/ML, especially if combined with deep domain knowledge and robust data governance.

The Central Bank of Kosovo* (CBK) recently adopted a formal regulation titled “Regulation on Information Systems and Cyber Risk Management”, whose text explicitly includes a section on Artificial Intelligence (AI) models and technology risk management (Bank of Kosovo, 2025). That regulation defines minimum standards and procedures for using AI, cloud computing, data security, model-governance, and cyber-risk oversight in financial institutions supervised by CBK, but no explicit mention of integrating AI/ML in their operations.

The Governor of the Central Bank of Bosnia and Herzegovina mentioned exploring the possibilities of introducing AI models for data analysis in one of her public speeches (Central Bank of Bosnia and Herzegovina, 2025). She further emphasized public and private sector cooperation, saying that only when both sectors, each in its own area, take initiative, contribute, and begin to cooperate, can tangible results be expected.

4. Concluding Remarks

Although machine learning and artificial intelligence offer new ways to analyze complex data and support timely and informed policy decisions, they have yet to find a permanent spot in the central banks of the Western Balkan countries (Albania, Bosnia and Herzegovina, Kosovo*, Montenegro, North Macedonia, and Serbia). The integration of AI and ML into central banks of the region remains at a very early stage, i.e. the progress is visible in the form of exploratory advances. These efforts are still fragmented and far from being fully embedded in the day-to-day analytical, supervisory, or operational frameworks. Most institutions remain in the experimentation phase, relying primarily on traditional econometric tools while testing AI-based methods only in limited contexts. The gap between aspiration and implementation persists, and closing it will require investment, cooperation, and long-term planning. The authors of the working papers outlined above mention several constraints when it comes to use of AI/ML methods in central banking, such as dataset sizes, potential legal restrictions, and

ethical considerations. However, as OECD (2025) states, support for the development and adoption of AI in the private sector is gaining traction across the Western Balkans. There are innovation funds in Montenegro, North Macedonia and Serbia providing financial support and non-financial assistance, with Serbia establishing a Research and Development Institute for Artificial Intelligence. As AI becomes more widespread in the region, the public sector and central banking involvement will no longer be optional. It is more than recommended for institutions to get ahead of the curve - ensuring that the necessary regulatory frameworks, data-governance standards, and technical capacities are in place, which will help central banks safeguard financial stability, promote responsible innovation, and avoid a situation in which supervisory expectations lag behind technological realities.

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