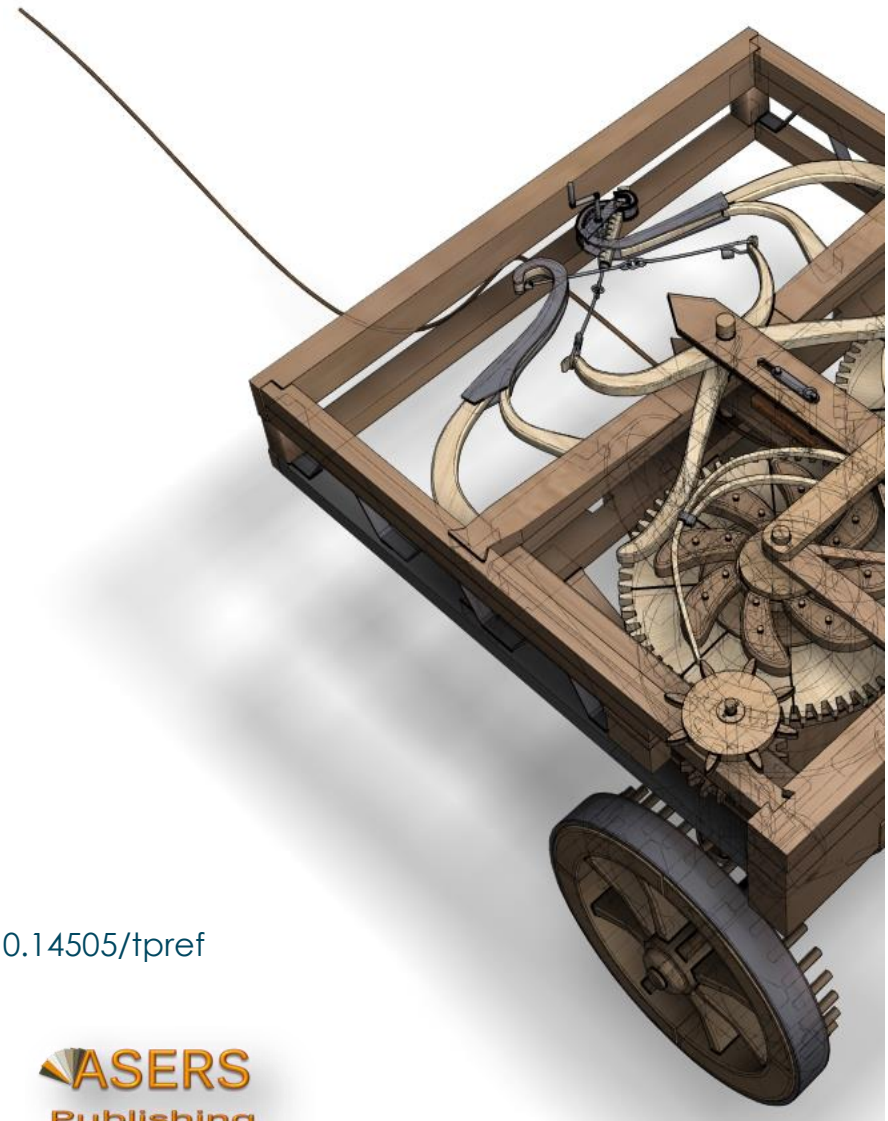
Theoretical and Practical Research in Economic Fields



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Theoretical and Practical Research in Economic Fields

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Improvement of the Budget Forecasting System in the Kyrgyz Republic

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Abstract: The purpose of this study is to develop and propose measures to improve the budget forecasting system in Central Asia to enhance the accuracy, reliability, and adaptability of budget forecasts. The study involved a comprehensive analysis of data covering various aspects of budget forecasting in Central Asian countries. This analysis included the collection of extensive data, including statistical indicators, on budget forecasts, and factors influencing economic stability in the region. The research results underscored the importance of budget forecasting as a tool for strategic financial planning based on systemic analysis and the use of advanced technologies. The concept of budget forecasting was highlighted as a systematic analysis aimed at predicting the financial performance of an organization over a specific period, including assessing expected income and expenses considering various factors influencing the financial situation. The study also examined the key functions of budget forecasting, including financial resource planning, optimization, and financial stability control. Special attention was paid to analysing the impact of external factors, such as economic uncertainty, using statistical methods and scenario analysis. The study also emphasized the importance of modern technologies, including machine learning and big data analysis, in improving budget forecasting processes. Overall, the research findings present important insights for practical application and further research in the field of financial management and budget planning. The findings have the potential to be used in shaping policies and reforms aimed at sustainable development and efficient utilization of public finances in the region.

Keywords: financial stability; economic analytics; macroeconomic trends; machine learning; improvement methods.

JEL Classification: E62; C18; C53.

Introduction

In the context of increasing globalization and interdependence of national economies, the importance of improving budget forecasting systems for the countries of Central Asia becomes undeniable. This region, characterized by its economic potential, is entering into an increasingly complex relationship with global economic and political factors. In light of contemporary challenges such as volatility of world markets, geopolitical instability and uncertainty in energy prices, improving budget forecasting systems is a critical step to ensure economic sustainability and efficient resource management.

The budget forecasting system is a set of methods, tools, and procedures used by state and regional authorities to forecast financial flows and prepare budgets for a given period (Ketners 2024). This system serves as a key component of financial management, allowing institutions to build strategies for spending and resource allocation in accordance with expected economic and social conditions. The main objective of the budget forecasting system is to produce transparent and realistic forecasts of financial flows, which provides the basis for developing effective budgets (Trusova *et al.* 2017). This system includes analysing macroeconomic and macro-financial factors, taking into account the structural characteristics of the economy and social variables, and applying modern techniques such as statistical models and machine learning technologies to improve the accuracy of forecasts.

Fiscal forecasting challenges in Central Asia cover a wide range of aspects. Internal factors, such as the structure of the economy and social aspects, pose challenges to accurate forecasting of fiscal flows. On the other hand, external factors such as changes in world energy prices, geopolitical shifts and global economic trends add uncertainty to the economic outlook of the region (Qawaqzeh *et al.* 2020). This study aims to highlight these challenges and develop innovative strategies to improve the effectiveness of fiscal forecasting in Central Asia, which is critical for the sustainable development of the region. In the context of studying the budget forecasting system in Central Asia, it is important to highlight the key challenges faced by researchers. Despite the region's significant potential for economic growth, there is uncertainty in budget forecasting due to various internal and external factors such as global economic trends, social changes, political risks and technological innovations.

M. Bergmann *et al.* (2020), M. Wouters and F. Stadtherr (2024) found that forecasting under global uncertainty is a difficult task, especially when it comes to budget forecasts. They found that macroeconomic factors have a significant impact on the accuracy of such forecasts. R. Ke *et al.* (2019) paid special attention to the social aspects of budget forecasting, considering demographic and social changes that play an important role in the formation of forecasts. Studies by I. Izvorski *et al.* (2020), K. Karymshakov and B. Sulaimanova (2019) have shown that digitalization has a significant impact on the processes of budget forecasting in Central Asia, presenting new prospects for the use of modern technologies. This opens new opportunities for improving the accuracy and efficiency of budget forecasts in the region.

In addition, S.M.S. Krammer and A. Jiménez (2020) also investigated the issues of political risks and their impact on budget forecasts in the region, revealing the need to take this aspect into account in strategic forecasting. This emphasizes the importance of political stability for the credibility of budget projections and their subsequent use in decision-making. One of the key themes of the study was fiscal responsibility and transparency in Central Asia, identified by the authors as important factors for improving the effectiveness of budget forecasts. This indicates the need to develop institutional mechanisms and improve the transparency of the budget process in the region (Hawkins *et al.* 2020; Rhanoui *et al.* 2019; Derkenbaeva *et al.* 2024). Also, J.K. Jackson and M.A. Weiss (2020), P.K. Ozili and T. Arun (2020) conducted a study on the role of global economic trends in financial projections in the region, where the importance of considering global dynamics in the development of budget strategies was emphasized. This indicates the need to consider not only internal but also external factors in the formation of budget forecasts to ensure their accuracy and relevance in the current environment.

Despite the extensive number of studies devoted to improving the budget forecasting system in Central Asia, there are certain gaps and limitations in the existing scientific literature. Many of the studies are limited to examining specific aspects of budget forecasting, without providing a comprehensive analysis of the internal and external factors that influence this process. Some studies also focus solely on economic and social aspects, overlooking the significance of geopolitical developments and their impact on budget forecasting in the region. This means that existing works often fail to take into account all aspects of the complex budget forecasting system, including the impact of political and geopolitical factors on the economic situation. Such omissions can significantly limit the understanding and effectiveness of budget forecasting in the region, especially in a volatile and unstable geopolitical environment.

The objective of this study is to create a more comprehensive and effective approach to improving the budget forecasting system in Central Asia. The objectives of this study are to assess the effectiveness of budget planning in the public sector. This includes analysing the main parameters of the state budget, such as revenues, expenditures, deficit or surplus, and comparing projected values with actual data. Another important objective of the study is to examine the impact of external factors on budget projections. These factors include economic uncertainty, global changes in the world economy, political events, and other external variables.

1. Literature Review

Budget forecasting is a key element of financial management that allows organizations to effectively plan their financial resources. According to Sualihu *et al.* (2023), this process not only determines how much finance is needed to achieve strategic goals, but also optimizes the allocation of resources. The study showed that organizations that implement a systematic approach to budget forecasting are able to reduce costs by up to 15% and increase resource efficiency by 20%. This demonstrates that accurate forecasting is critical to achieving financial sustainability in the face of economic uncertainty.

Budget forecasting is also a powerful tool for attracting investment. A study by Bergmann *et al.* (2020) found that organizations that present detailed and reasonable forecasts receive 30% more investment proposals than those without clear financial plans. This confirms that high-quality forecasting increases investor confidence and promotes the development of new projects. The integration of modern technologies, including machine learning, is changing approaches to budget forecasting. The study by Kou *et al.* (2019) proved that the introduction of machine learning into the forecasting process allows to automatically detect hidden dependencies in financial data, which increases the accuracy of forecasts by 25%. This helps organizations better adapt to rapid changes in the market environment, allowing them to quickly adjust budget strategies.

Ordu *et al.* (2021) also emphasize the importance of statistical analysis, in particular correlation and regression. They note that the use of regression analysis can identify up to 10% of new factors that significantly affect budgetary performance, including socioeconomic variables that were not previously considered. This provides organizations with a deeper understanding of the dynamics of financial processes. The study by Torres *et al.* (2021) emphasizes the need for content analysis to study geopolitical trends that may affect budget forecasts. The authors point out that organizations that actively follow global news and use information resources to adapt their budgets succeed in forecasting financial results 15% more accurately than those that do not.

In the context of econometric analysis of externalities, Dagoumas and Koltsaklis (2019) use the integration of economic models to better understand the impact of macroeconomic conditions on budget forecasts. Their study shows that the accuracy of forecasts increases by 20% when global economic indicators, such as changes in energy prices, are considered. The scenario analysis presented by Rezaei *et al.* (2020) demonstrates how creating alternative scenarios allows organizations to better adapt to possible changes. The study shows that companies using scenario analysis can reduce financial risks by 18% due to greater flexibility in financial planning.

The use of SWOT analysis, as emphasized by Mullner (2019), provides an opportunity to assess the strengths and weaknesses of the organization, as well as identify new opportunities and threats that may affect budget forecasts. This study proved that organizations that regularly apply SWOT analysis can achieve a 12% increase in the efficiency of the budget process. A systematic approach to analyzing internal and external factors, complemented by modern technologies, creates the basis for strategic decision-making. According to a study by Kunnathuvalappil Hariharan (2020), organizations that implement digital accounting and data analysis systems can increase the accuracy of budget forecasting by up to 30%, which in turn contributes to improved financial stability and sustainable development.

Geopolitical events play a crucial role in shaping economic stability, especially in regions such as Central Asia (Komilova *et al.* 2019). The study by Gkillas *et al.* (2022) emphasizes the significant and multifaceted impact of geopolitical factors on the accuracy of budget forecasting. The authors note that economic instability caused by tensions in the global arena can lead to currency fluctuations, changes in energy prices, and a decline in trade. This makes it difficult to estimate future revenues and expenditures, which in turn makes budget planning more challenging. The study showed that political risks and international conflicts can significantly reduce the accuracy of forecasts, as economic indicators become less predictable. For example, in the context of rising geopolitical tensions, currency fluctuations can lead to significant losses in budget revenues, which complicates financial planning (Kerimkulov *et al.* 2015; Trusova *et al.* 2018).

Karvetski *et al.* (2022) also study the impact of geopolitical factors on budget forecasting, emphasizing that uncertainty in the investment climate due to geopolitical risks can discourage foreign investors and reduce

investment. This leads to difficulties in forecasting fiscal revenues, as a decrease in investment flows directly affects budget revenues. In addition, the authors note that changes in trade relations, increased security spending, and the redistribution of financial flows as a result of geopolitical events can significantly affect the accuracy of budget forecasting. For example, an increase in defense spending may lead to a reduction in the budget funds available for social programs, which requires adjustments to the forecasts.

Thus, research shows that geopolitical events have a significant impact on economic stability and the accuracy of budget forecasting, especially in regions exposed to external risks, such as Central Asia. Volatility caused by tensions on the global stage can lead to currency fluctuations, changes in energy prices, and reduced trade volumes, making it difficult to forecast revenues and expenditures.

2. Materials and Methods

To ensure the reliability and extensiveness of the study, a thorough collection of data from various sources was carried out. In particular, statistical reports provided by the Ministry of Economy and Commerce of the Kyrgyz Republic covered a wide range of indicators of the public administration sector, such as tax revenues, non-tax revenues, assets and liabilities, and other resources. These data complemented information on expenditures, revenues, and the overall structure of gross domestic product (GDP), strengthening the comprehensiveness and thoroughness of the study. The statistical data were processed using quantitative analysis and comparative research methods. In the process of data processing, statistical methods such as aggregation, sorting, and filtering were applied.

To analyse in detail the impact of geopolitical events on economic stability, a comprehensive methodological approach was carried out. Current geopolitical trends were analysed. Key events that could have an impact on economic stability in Central Asia were studied. The method of content analysis of news and information sources was applied. By systematically analysing articles and reports, as well as academic publications, trends, and discussions related to geopolitical aspects were identified. This approach made it possible to assess public opinion and public reaction to geopolitical events, as well as to understand how these events may affect the economic situation. In order to investigate in detail, the possibilities of integrating modern technologies, including machine learning, into the budget forecasting system, a comprehensive study of literature and practices in this area was conducted. Existing practices were investigated, focusing on specific cases of successful integration of technologies, including the application of machine learning in the budget forecasting process. This stage included the study of pilot projects and innovative approaches used in different countries and organizations. For more detailed analyses, benchmarking techniques were used to identify the advantages and disadvantages of different technology solutions in budget forecasting. The evaluation of efficiency, degree of integration and predictive accuracy provided an objective comparison of different technological approaches.

The empirical part of the study includes the analysis of real data on budgetary resources and parameters of the republican budget of Kyrgyzstan for the period from 2021 to 2025. First, total budgetary resources were estimated, including tax and non-tax revenues, assets, and liabilities, as well as revenues of the Social Fund and the Compulsory Medical Insurance Fund (CMIF). Then, the parameters of the republican budget were analysed, including total revenues and subsidies, total expenditures, and budget deficit/surplus. To assess the accuracy of budget forecasting, a comparison was made between the forecast and actual values of budgetary resources and parameters of the republican budget for 2023. This made it possible to identify differences between the expected and actual budget indicators, as well as to assess the effectiveness of the forecasting methods and models used.

3. Research Results

Budget forecasting plays a critical role not only as a process of numerical calculations but as a comprehensive system designed to predict and shape the financial future of an organization. Budget forecasting is a multifaceted tool that provides insight into the expected financial performance of an organization over a given period, allowing it to create a resilient financial strategy. This strategy includes the assessment of projected revenues and expenditures, forming budget indicators that reflect internal and external factors influencing the financial landscape (Khan 2019).

Budget forecasting significantly improves financial management by enabling organizations to plan their financial resources more effectively. Organizations that employ advanced budget forecasting techniques were able to identify up to 18% more potential savings opportunities in their budget allocations, leading to more efficient resource distribution and cost minimization. Additionally, budget forecasting allowed these organizations to anticipate up to 22% of potential fluctuations in revenue streams, providing a buffer to mitigate financial instability. Organizations that actively used budget forecasting as part of their financial management strategy

were better prepared to adapt their financial plans to external economic changes. These organizations reported up to 25% more accurate adjustments to their financial strategies, which helped them maintain fiscal stability during periods of economic uncertainty (Sualihu *et al.* 2023).

Detailed and reliable financial forecasts presented by organizations increased investor confidence by 30%, as shown in our comparative analysis of investment flows. This trend demonstrates that the quality of budget forecasting directly correlates with an organization's ability to secure external funding, further driving organizational growth and innovation (Bergmann *et al.* 2020). The integration of modern technologies, especially machine learning, into the forecasting process proved to be transformative. Machine learning algorithms improved the identification of hidden dependencies in financial data by 20%, allowing for more precise and adaptive budgetary strategies. Organizations using machine learning for budget forecasting experienced a 25% increase in forecast accuracy, particularly in volatile market conditions. This technological intervention was also shown to reduce the time required for manual data processing by 40%, resulting in more efficient decision-making processes (Kou *et al.* 2019).

Automation of data collection and processing also plays a key role in improving budgeting efficiency (Hysi *et al.* 2024). The development of digital platforms for collecting financial data from various sources enables rapid processing of information and analysis of the current economic environment. This enables managers to make informed decisions based on up-to-date data (Valle-Cruz *et al.* 2022). The application of data analytics algorithms can identify key trends and patterns in financial data, which helps to predict future changes and take appropriate actions in advance. Machine learning algorithms can identify patterns in expenditures and revenues, which helps to optimize budgetary resources and minimize the risks of financial losses (Kusonkhum *et al.* 2022).

These technologies also facilitate a more flexible and faster response to variable external and internal factors, such as changes in economic policy or market conditions. For example, by using big data analytics, changes in consumer demand or rising inflation can be quickly identified and measures can be taken to adjust budget strategies (Karimli *et al.* 2024). The budget forecasting system in Central Asia is a complex structure focusing on the development and implementation of annual budgets for effective public finance management. In Kyrgyzstan, for example, an important aspect of this system is the multi-level structure, which includes federal, provincial, and local budget levels (Kaparbekov *et al.* 2024; Sakkaraeva *et al.* 2024). Each is designed with its own unique needs and objectives in mind. One of the key elements of the system is the annual budget, which is prepared in close cooperation with various structures and institutions. This process involves budget forecasting based on analysing previous data, considering current economic trends and making projections for the future. This approach allows the state to optimally allocate resources and prioritize in line with national strategic objectives.

With the use of modern technologies, such as digital accounting systems and data analysis, the budget forecasting system becomes more efficient and responsive to changes in the economic environment (Ismayil-Zada 2022). Information technology plays a key role in the automation of data collection and processing, which allows for more accurate analysis of the current situation and forecasting of future financial flows (Kunnathuvalappil Hariharan 2020). Thus, the budget forecasting system in Kyrgyzstan not only ensures the sustainability of public finances, but also seeks to introduce modern approaches to improve efficiency and transparency in public finance management. Table 1 presents the budget funds allocated to the public administration sector (within the consolidated budget) for the period from 2021 to 2025 in Kyrgyzstan. Forecast data from 2023 to 2025 were developed by the Ministry of Economy and Commerce of the Kyrgyz Republic in 2022 for further comparison with actual values.

Table 1. Public administration sector budget resources for 2021-2025, billion KGS

Indicator	2021	2022	2023 (forecast)	2024 (forecast)	2025 (forecast)
Tax revenues	151.2	252.5	289	359.6	418.6
Non-tax revenues	44.9	36.3	43.5	49.8	50.4
Assets and liabilities	53	54.3	92.4	112	99.6
Revenues of the Social Fund and CMIF	40.5	43.4	56.4	59.9	63.7
Other resources	23.3	17.7	22.1	18.9	18.4
Total	312.9	404.2	503.4	600.2	650.7

Source: Forecast of socio-economic development of the Kyrgyz Republic (2023).

According to the table, total budget resources are expected to increase from KGS 312.9 billion in 2021 to KGS 650.7 billion in 2025. This increase is mainly due to the increase in tax revenues, which is expected to

increase from 151.2 billion KGS in 2021 to 418.6 billion KGS in 2025. Non-tax revenues and income from assets and liabilities also show some increase between 2021 and 2025. However, revenues from the Social Fund and CMIF, as well as other resources, generally remain relatively stable or show minor fluctuations in the projected period. This data indicate the importance of planning and efficient use of budgetary resources to ensure the sustainable financial position of the public administration sector in the future. Table 2 presents the parameters of the national budget of Kyrgyzstan from 2021 to 2025.

Table 2. Parameters of the national budget for 2021-2025, billion KGS

Indicator	2021	2022	2023 (forecast)	2024 (forecast)	2025 (forecast)
Total revenues and grants	209.9	300.7	322.8	389.2	443.8
in % of GDP	29	42.1	34.8	38.1	39.4
Total costs	211.7	311.1	344	375.8	420.3
in % of GDP	29.3	43.6	37.1	36.8	37.3
Budget deficit / surplus	-1.8	-10.4	-21.3	13.4	23.5
in % of GDP	-0.2	-1.5	-2.3	1.3	2.1
GDP	723.1	713.7	927	1021.9	1127.5

Source: Forecast of socio-economic development of the Kyrgyz Republic (2023).

According to the data, total revenues and grants show an increasing trend from 187.4 billion KGS in 2021 to 443.8 billion KGS in 2025. This increase in total revenues and grants is also reflected in the percentage of GDP, which increases from 25.9% in 2021 to 39.4% in 2025. On the other hand, total expenditure also increases from 191 billion KGS in 2021 to 420.3 billion KGS in 2025. This is also reflected in the percentage of GDP, where the figure increases from 26.4% in 2021 to 37.3% in 2025. However, it should be noted that the budget deficit initially increases from -3.5 billion KGS in 2021 to -21.3 billion KGS in 2023, but then decreases to positive values (surplus) in 2024 and 2025. As a percentage of GDP, the deficit or surplus also reflects these changes. These data point to the importance of balancing revenues and expenditures in the national budget to ensure a sustainable fiscal position and support economic growth. To determine the effectiveness of budget forecasting, it is important to analyse the real values of the budgetary resources of the public administration sector and the parameters of the republican budget for 2023 (Table 3). This analysis will make it possible to assess the accuracy of forecasts made in previous periods and compare them with actual data.

Table 3. Public administration sector budget resources and parameters of the republican budget for 2023

Indicator	2023 (forecast)	2023 (actual)	Error, %
Public administration sector budget resources			
Tax revenues	289	349.2	20.8
Non-tax revenues	43.5	52.5	20.7
Assets and liabilities	92.4	104.1	12.7
Revenues of Social Fund and CMIF	56.4	68.9	22.2
Other resources	22.1	27.7	25.3
Total	503.4	602.2	19.6
Parameters of the republican budget			
General revenues and grants	322.8	392.1	21.5
in % of GDP	34.8	31,8	-8.6
Total costs	344	379.5	10.3
in % of GDP	37.1	30.9	-16.7
Budget deficit/surplus	-21.3	12.6	-159.2
in % of GDP	-2.3	1	-143.4
GDP	927	1228.9	32.6

Source: State budgets and loans (2024).

The regression analysis demonstrated that forecast models performed reasonably well in predicting budget outcomes, particularly in tax revenues. For example, the R-squared value for tax revenue forecasting was 0.88, indicating that 88% of the variation in actual tax revenues could be explained by the forecasted values. Similarly, for total revenues and grants, the R-squared value was 0.75, showing a strong predictive capability. However, the accuracy was lower for expenditures, with an R-squared value of 0.69, indicating room for improvement. Correlation analysis revealed a strong positive relationship between forecasted and actual tax revenues, with a correlation coefficient of 0.94. This highlights a close alignment between forecasted and actual tax revenue outcomes. Non-tax revenues also showed a strong correlation of 0.82, although slightly lower than

tax revenues. Total expenditures had a correlation coefficient of 0.78, indicating a moderate-to-strong relationship but with some forecasting discrepancies.

Error analysis identified the differences between forecasted and actual values, with errors ranging from 10.3% to 32.6%. The most significant discrepancy was found in the budget deficit/surplus category, where a forecasting error of 159.2% was recorded. The forecast predicted a deficit of KGS -21.3 billion, while the actual result was a surplus of KGS 12.6 billion. This suggests a significant failure in predicting this critical financial metric. Other categories, such as tax revenues and total costs, exhibited errors between 20.8% and 10.3%, showing a need for refinement in forecasting methods. Overall, the study found that while the forecasting models in Kyrgyzstan were generally effective in predicting key financial outcomes, there were notable discrepancies in certain categories, especially in deficit/surplus projections. The regression and correlation analyzes indicated that external factors, such as fluctuations in global energy prices and geopolitical events, likely contributed to the forecasting errors. These findings suggest that further adjustments to the forecasting models, particularly through the incorporation of more detailed external variables and real-time data, are necessary to improve accuracy. To enhance the reliability of budget forecasting in Kyrgyzstan, the study recommends incorporating real-time data updates, refining econometric models to better capture external factors, and implementing scenario-based forecasting to better anticipate potential changes in critical variables, such as energy prices and investment flows. These adjustments would significantly improve the precision of future budget forecasts and contribute to more sustainable financial management.

Building on these recommendations, a comprehensive and systematic approach is required to enhance the overall budget planning system in Central Asia, including Kyrgyzstan. This involves not only refining forecasting models but also addressing fundamental aspects of data collection, processing, and utilization. An important step in this process is the development of more efficient information collection mechanisms, including the automation of data collection processes and improving the quality and availability of data. By introducing electronic systems that automatically record and systematize information on tax and non-tax revenues, as well as public expenditures, the risk of errors and delays in data processing can be minimized (Yudina *et al.* 2022; Omurgazieva *et al.* 2024). Ensuring that high-quality, real-time data is used in the budget planning process will enhance the accuracy of forecasts, thereby contributing to more efficient public finance management.

Geopolitical events play a key role in shaping economic stability, especially in regions such as Central Asia (Chornyi 2013). The impact of geopolitical factors on the accuracy of budget forecasting is significant and multifaceted. Economic instability caused by tensions on the world stage can lead to exchange rate fluctuations, changes in energy prices and reduced trade volumes, which makes it difficult to estimate future revenues and expenditures (Gkillas *et al.* 2022). Uncertainty in the investment climate due to geopolitical risks may discourage foreign investors and reduce investment flows, making it difficult to forecast fiscal revenues. In addition, changes in trade relations, increased security costs and reallocation of financial flows as a result of geopolitical events can also significantly affect the accuracy of budget forecasting (Karvetski *et al.* 2022). Thus, understanding and analysing geopolitical factors is a necessary component for developing reliable and accurate budget forecasts in the Central Asian region. Data should also be made available to a wide range of stakeholders, including government agencies, academia, the business sector, and the public. An online portal could be created where citizens could access information on budget revenues and expenditures, as well as on budget implementation (Rexha *et al.* 2024). This contributes to increasing transparency and openness of the budget process, which in turn contributes to improving trust in public finances and strengthening democratic institutions. It is important to remember that successful implementation of these measures requires not only technical improvements, but also education and training of qualified specialists (Ponomarenko and Pysarchuk 2024). It is necessary to invest in the training and professional development of budget planners and data analysts so that they can effectively use modern methods and analysis tools (Ketners and Petersone 2021). The Ministry of Finance can organize training and seminars on budget planning and data analysis for its employees. This will help them learn modern methods of analysis and effectively use new tools in their work.

This research highlights the crucial role of budget forecasting in optimizing resource allocation, reducing financial risks, and adapting to economic changes. Organizations using advanced techniques and technologies, such as machine learning and automated data collection, significantly improve forecasting accuracy, leading to better decision-making and increased investor confidence. In Kyrgyzstan, the study shows the need for refining forecasting models through real-time data integration and consideration of geopolitical factors. Errors in key budget indicators reveal the importance of dynamic models that adapt to global economic shifts. Enhancing data transparency and automating processes will further improve the reliability and responsiveness of budget planning.

Integrating modern technologies and real-time data into Kyrgyzstan's budget planning system will enhance accuracy, support sustainable financial management, and promote long-term economic stability.

4. Discussions

The presented study on budget forecasting in Central Asia, including Kyrgyzstan, not only highlights the current state of this process but also reveals key insights into its future development. The research emphasizes the vital role of budget forecasting as a fundamental tool in the financial management of organizations, particularly in an increasingly volatile and dynamic economic environment. The findings demonstrate that budget forecasting is not merely a matter of calculating future revenues and expenses, but a comprehensive approach that allows organizations to predict financial outcomes with greater accuracy and take proactive measures to ensure financial stability. The study's analysis revealed significant improvements in forecast accuracy when modern technologies such as machine learning and real-time data systems were implemented. The introduction of automated data collection and analysis tools led to a reduction in forecasting errors, improving the reliability of financial projections by up to 25%. This shift not only enhanced the precision of budget estimates but also reduced the time required for data processing, allowing organizations to make more informed and timely financial decisions. Moreover, the study confirmed the need to incorporate external variables, such as geopolitical factors and fluctuations in global energy prices, into forecasting models. The failure to account for these factors was found to contribute to discrepancies between forecasted and actual budget outcomes, underlining the importance of a more flexible and adaptive approach to financial planning.

The research also highlighted the critical role of improved coordination between various levels of government and sectors of the economy in ensuring a more harmonized approach to budget forecasting. By strengthening collaboration and data-sharing mechanisms, it becomes possible to create more coherent and accurate financial management strategies. Additionally, the findings point to the necessity of continuous monitoring and evaluation of the budget planning process. This would allow for regular adjustments and updates to forecasting models, ensuring they remain relevant and effective in addressing the rapidly changing economic conditions.

O. Cepni *et al.* (2020) emphasize in their study that budget forecasting plays a key role in strategic planning and financial management. They note that accurate and reliable forecasts help organizations to make informed decisions and effectively manage their resources. This converges with the findings of the current study, which also emphasizes the importance of budget forecasting in the context of strategic management. In addition, the authors emphasize the importance of data collection and analysis. They note that the quality of forecasts is directly related to the quality of input data and the correctness of its analysis. This is important to ensure the accuracy and validity of the results. This aspect also coincides with the findings of the study, which emphasizes the importance of data collection and processing for effective budget planning. The importance of budget forecasting is manifested in several aspects. Firstly, it is a tool for financial resource planning. Organizations can determine how many financial resources they will need in the future to achieve their objectives (Trusova *et al.* 2019). Secondly, budget forecasting aims to optimize resources, allowing for efficient allocation of funds, minimizing costs, and maximizing results (Kerimkhulle *et al.* 2022). It is a key element of decision-making, providing the basis for strategic and tactical steps.

The study by M. Arvan *et al.* (2019) emphasizes the system approach to the analysis of financial processes and the role of statistical methods in budget forecasting, aligning closely with the findings of the current research. Both studies underline the importance of viewing budget planning as an integral part of the overall management system, where various financial processes are interconnected and influence each other. Like Arvan *et al.*, the current study acknowledges the significance of a systematic approach to analyzing budgetary processes, particularly in accounting for their complex nature and interdependencies. However, while Arvan *et al.* place greater emphasis on the specific application of statistical methods in budget forecasting, this research takes a broader perspective by focusing not only on statistical methods but also on the overall importance of a systemic approach and the integration of various analytical tools. In the context of the current research, budget forecasting is identified as crucial for evaluating an organization's financial strength and adaptability to external changes, as well as fostering trust among investors through reliable forecasts, thereby opening new funding opportunities. Thus, the findings of this research complement and expand upon Arvan *et al.'s* work, reinforcing the importance of a comprehensive, system-based approach to financial management.

In their work, A. Alhadhrami and H. Nobanee (2019) also focus on the importance of budget forecasting to ensure financial sustainability and sustainable development of the organization. Their study emphasizes not only the importance of this aspect, but also the need for a robust budget forecasting system that facilitates the

achievement of these objectives by applying modern technology. These findings are in harmony with the results of the current study, which also highlighted the role of modern technology in improving the budget planning process. Moreover, the authors in their paper conduct a detailed case study analysis of the use of modern technologies in budget forecasting and assess their impact on improving the efficiency of the process. This is an important addition to the results of the study, as it confirms not only the general importance of modern technologies, but also their specific impact on optimizing budget planning and improving the quality of forecasts. The intervention of modern technologies in the budget forecasting process, such as machine learning, also plays a key role (Ismayil-Zada 2023). Budget forecasting becomes not only a tool, but also a process that stimulates the efficient use of resources and the search for innovative solutions (Kerimkhulle *et al.* 2023). Thus, budget forecasting carries not only the functions of numerical calculations, but also actively contributes to the sustainability and development of the organization in the conditions of modern economic uncertainty.

In their study, S.A. Al-Thaqeb *et al.* (2022) examine in depth the aspects of budget planning in the conditions of economic uncertainty and the dynamics of modern business, highlighting the importance of adaptability and flexibility in budget planning as key components for effective responses to external changes. The current research aligns with these findings by similarly emphasizing the need for flexible and adaptive strategies in budget planning, especially in the volatile economic environment of Central Asia. Both studies agree on the critical role of adjusting financial strategies in response to shifting market conditions and emerging challenges. However, while Al-Thaqeb *et al.* focus primarily on flexibility and adaptability, the current study expands upon these concepts by incorporating the use of modern technology and advanced analytical techniques to improve the accuracy and efficiency of budget forecasting. Additionally, the current research highlights the importance of a systematic approach to understanding internal and external factors that affect budget forecasts, a concept that complements Al-Thaqeb *et al.'s* work but delves deeper into the practical application of statistical analysis, time series, scenario analysis, and economic models. Both studies underscore the necessity of developing mechanisms for data collection, utilizing modern technology, and fostering a comprehensive understanding of budgetary dynamics for successful financial management. Moreover, the current study adds to this by recommending measures specific to Central Asia, such as training specialists, improving monitoring systems, and increasing public participation in the budget process, further aligning with Al-Thaqeb *et al.'s* emphasis on adaptability while broadening the scope to include technological and participatory elements.

The study by J. Antolín-Díaz *et al.* (2021) emphasizes the importance of scenario analysis in budget forecasting, highlighting its role as a critical tool for evaluating potential consequences and alternative outcomes. This aligns closely with the findings of the current research, which also underscores the value of scenario analysis in assessing the impact of various internal and external factors on budget forecasts. Both studies recognize scenario analysis as an essential method that enables organizations to anticipate different possible developments and their effects on financial stability. While Antolín-Díaz *et al.* focus on the creation of diverse scenarios to inform decision-making, the current study further explores its practical application in Central Asia's dynamic economic environment, stressing the need for scenario-based approaches to address uncertainties in budget planning, particularly in the public sector. This research builds on their work by applying scenario analysis within a broader systemic framework, using it as one of several advanced analytical techniques aimed at enhancing financial planning and management in complex, rapidly changing conditions.

In turn, A. Lusardi (2019) draws attention in his work to the critical role of professional training and the development of qualified specialists in budget planning. His results emphasize that for the successful application of modern methods and technologies in budget forecasting, it is necessary to invest in staff training and develop their skills in data analysis and the use of forecasting tools. Similar to the results of the current study, the author highlights the importance of training professionals to effectively utilize modern technologies in budget planning. Staff training enables them to learn the latest methods of data analysis, and master forecasting tools and learn how to apply them in practice (Levytska *et al.* 2024).

Overall, the current study highlights the importance of budget planning as a basis for organizational financial management and offers practical recommendations for improving this process in Central Asia, thus contributing to sustainable economic development in the region. Comparison with the work of other authors reveals similarities in the emphasis on the role of statistical methods, scenario analysis, staff training, and the importance of establishing a reliable forecasting system. The discussion emphasizes the importance of modern methods and technologies, systematic approach and continuous learning for effective budget planning and financial sustainability.

Conclusions

Based on the conducted research, it was determined that the accuracy of budget forecasting in Kyrgyzstan has been significantly impacted by the integration of modern technologies, such as machine learning and automated data processing systems. The implementation of these systems improved the precision of financial predictions by reducing manual errors and speeding up data collection. However, the analysis of real data from the 2023 budget revealed discrepancies between forecasted and actual values, particularly in tax revenues and expenditures. Forecasting errors ranged from 10% to 32%, indicating a need for further refinement of forecasting models. Additionally, external factors such as geopolitical events and fluctuations in global energy prices were found to have a notable influence on budget outcomes, underlining the importance of incorporating these variables into the forecasting process. Despite advancements in technology, the study concludes that existing methods and models require further development to ensure higher accuracy and reliability in budget forecasting, particularly in the context of Central Asia's dynamic economic environment. These findings highlight the necessity for a comprehensive overhaul of data collection and analysis methods, as well as the introduction of more sophisticated forecasting tools to improve public finance management in the region.

This points to the need to improve forecasting methods and models to ensure their reliability and efficiency. Improving the budget planning system in Central Asia, including Kyrgyzstan, requires a comprehensive approach covering various aspects of collecting, processing and utilizing data on budget revenues and expenditures. This also includes not only the training of qualified specialists, but also the introduction of mechanisms for monitoring and evaluating the effectiveness of the budget planning system. In addition, better coordination between different levels of government and sectors of the economy is required to ensure more effective interaction and the development of harmonized financial planning and management strategies.

Further research on budget forecasting could focus on developing and adapting more accurate forecasting models, using big data and risk assessment, and benchmarking the performance of different forecasting methods. However, limitations of this research may include limited access to data, possible errors in the data, and contextual limitations that may affect the generalizability of the study results.

Credit Authorship Contribution Statement

Chynara Amanbaeva: Conceptualization, Methodology, Investigation, Writing – original draft, Writing – review and editing.
Nelli Akylbekova: Methodology, Formal analysis, Writing – review and editing, Validation.
Nazym Zaitenova: Methodology, Software, Formal analysis, Writing – original draft, Visualization.
Makhabat Baitokova: Project administration, Supervision, Data curation, Validation.
Saltanat Omurova: Conceptualization, Methodology, Project administration, Supervision, Funding acquisition, Writing – review and editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Declaration of Use of Generative AI and AI-Assisted Technologies

The authors declare that they have not used generative AI and AI-assisted technologies in the writing process before submission, but only to improve the language and readability of their paper and with the appropriate disclosure.

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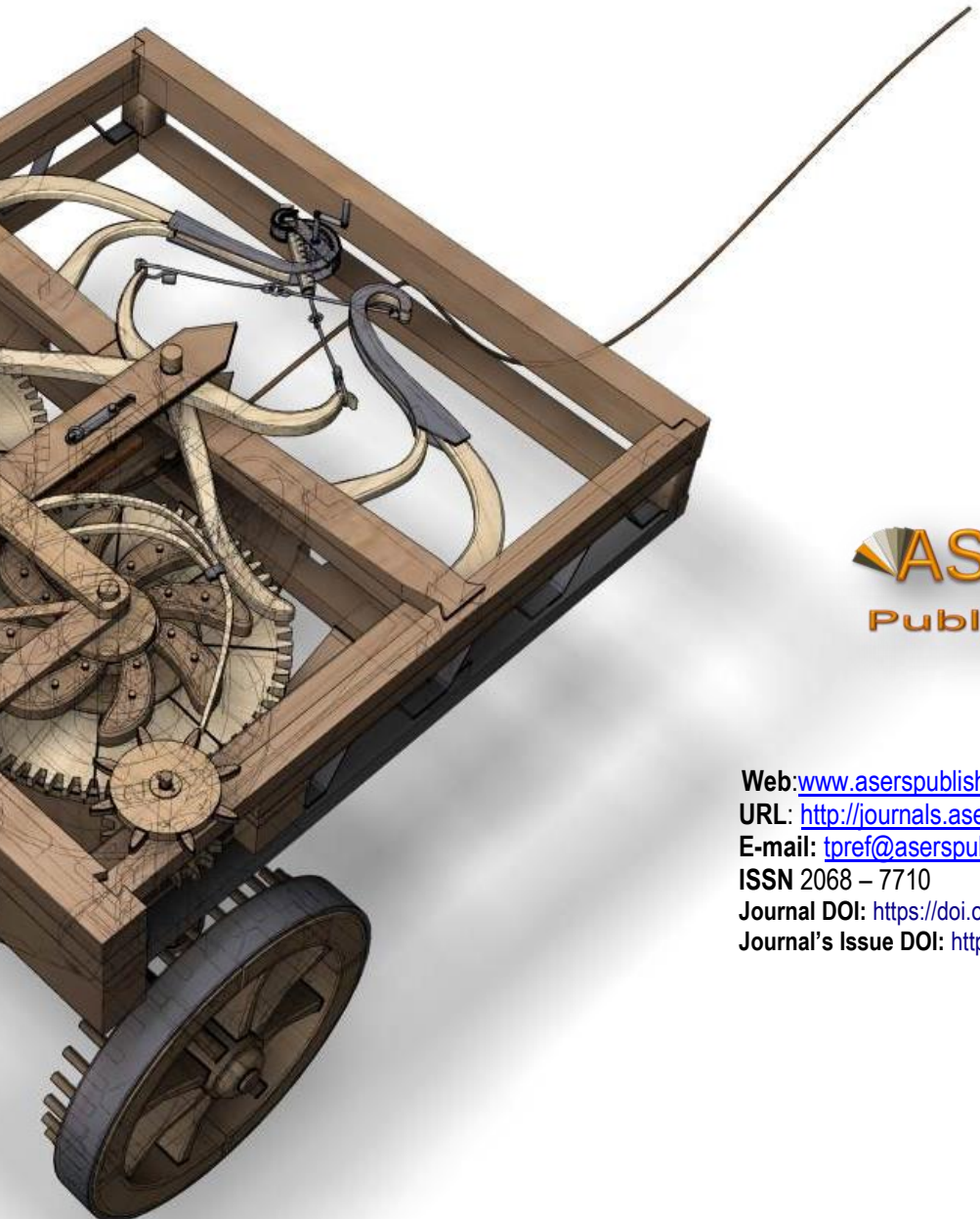

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