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Specialized Audit in Public–Private Partnerships as a Tool to Strengthen the Public Audit Impact on National Resource Efficiency in the Digital Era

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ABSTRACT

Effective management of national resources is essential for ensuring sustainable development and improving societal welfare in the context of growing scarcity and increasing demands on public programs. This study aims to develop a comprehensive methodological approach for objectively assessing the efficiency, effectiveness, and economy of public resource management within the framework of public audit. The research hypothesizes that key obstacles—such as limited transparency in the use of public funds, inadequate data quality, and the absence of unified evaluation criteria—hinder accurate assessments and decision-making in public auditing. To address these issues, the study proposes the development and implementation of improved assessment tools, better data collection mechanisms, and greater institutional coordination. The methodology includes statistical analysis, Irwin's criterion, forecasting techniques, and structural-causal analysis, supported by a review of existing research and primary statistical data. The results highlight the need for enhanced transparency in government spending, the establishment of universal performance indicators, and stronger integration among public institutions. Forecast values for fixed capital consumption from 2024 to 2026 were calculated using a trend model, underlining the strategic importance of optimizing fixed capital

usage for sustainable economic growth. The findings confirm that a systematic approach to evaluating national re-source management contributes to more informed policy-making and reduces inefficiencies in budgetary spending. The study emphasizes the relevance of developing robust analytical tools to improve the quality of public audit and ensure the long-term resilience and competitiveness of the national economy.

INTRODUCTION

The issues of efficiency, effectiveness and cost-effectiveness of the use of national resources in the field of public audit are becoming more and more relevant and significant. Public audit plays a key role in ensuring transparency and effective management of public finances, as well as in assessing the achievement of goals and objectives.

In the context of accelerating digital transformation, public audit is becoming a critical instrument for ensuring the efficient use of national resources, requiring new methodological approaches and enhanced analytical capacity. Public–private partnerships (PPPs), as one of the most resource-intensive and strategically significant mechanisms for implementing infrastructure, social and innovative projects, demand strengthened oversight to mitigate fiscal risks, safeguard public interests and ensure long-term value creation. Specialized audit in the PPP sector, with its focus on evaluating contractual compliance, risk allocation, performance indicators and lifecycle efficiency, offers a powerful tool to expand the impact of public audit beyond traditional financial verification and towards assessing the real effectiveness of resource utilization.

1. RESEARCH BACKGROUND

Recent scholarship underscores that public audit is undergoing deep transformation driven by digital technologies and ecosystem-based reforms. Cordery & Hay (2025) argue that contemporary public audit is increasingly shaped by the principles of New Public Management (NPM), which shift audit institutions toward performance-oriented evaluation and create demand for auditing complex "products" such as public–private partnerships (PPPs). Their study highlights that the wider institutional environment and governance ecosystem significantly influence the effectiveness and credibility of public audit mechanisms. This aligns with Ulugbek (2025), who emphasizes that the efficiency and speed of public sector audits are strongly enhanced by modern audit techniques, including digital audit tools, forensic analytics and impact-evaluation methods, which collectively strengthen audit outcomes in rapidly reforming public sectors.

According to Yanuarisa et al. (2025), internal audit plays an essential role in enhancing the integrity and efficiency of public procurement governance; their systematic review demonstrates that robust internal audit practices help mitigate corruption risks, improve procedural compliance, and strengthen public value creation. Similar conclusions are drawn by Yener et al. (2025), whose comparative analysis of the Supreme Audit Institutions (SAIs) of Thailand and Türkiye demonstrates that digital transformation—particularly through AI-supported audit tools—significantly increases transparency and the value-added impact of audits in the public sector.

Empirical studies also highlight the strategic importance of performance and specialized audits. Leocadio et al. (2025) provide evidence from Portugal showing that AI-based audit technologies not only modernize public organizations but also strengthen auditor performance by enabling real-time data analysis and risk prediction. Their analysis suggests that digitalized PPP governance creates new demands for specialized forms of audit capable of assessing contractual compliance, value-for-money outcomes and long-term sustainability.

According to Moitshepi Moeng, Jacques De Jongh (2023) research, there is a positive relationship between higher levels of economic globalization and public debt, and in fact indicate noteworthy consequences associated with the limiting impact of the integration process regarding higher borrowing costs, increased external vulnerability and limited financial capacity in the context of improving social environment of the country. Thus, this process implies the need to apply international accounting standards and approaches to assessing national resources in order to reduce the level of public debt as one of the key macroeconomic indicators.

According to E. Karabayev and T. Mukushev (2023), state audits aim to facilitate the successful implementation of economic policy and the effective use of the productive potential of the country, regions, industries, and spheres. Despite variations in management systems, independent supreme institutions of financial control (audit) aspire to promote transparency and efficiency in resource utilization for the benefit of the state and its citizens.
Consider the main differences in the public audit systems of different countries around the world, as shown in Table 1.

Table 1. Foreign experience of the main differences in the public audit system

Country	Main state audit	Legal and organizational status of the supreme audit authority	Purpose of audit	Number of instruments	Audit efficiency indicator
The USA	GAO	Authority with a hierarchical structure	Checking accounting reports	11	The ratio of funds returned to the amount of funds spent on 1 examination
Germany	Federal Office of Financial Supervision	Collegial authority		8	The amount of funds returned
Great Britain	National Audit Office	An authority with a hierarchical structure	Collecting evidence on the proper use and allocation of budget funds	4	The amount of fines after state financial inspections
France	Court of Accounts	An authority with a legal function	External financial control of the accounting statements' reliability	7	The amount of funds returned
Japan	The Accounting Chamber	Collegial authority	Determining the effectiveness of state funds usage	5	The cumulative socio-economic effect of the

	state programs' implementation

Source: Compiled on the basis of the source Bulkin, V. A. (2021). Foreign experience in organizing and conducting state financial control. *Young scientist, 51(393)*, 80-81

Gadzhiev et al. (2020) state that managing and assessing the quality of human capital should be focused on. Furthermore, Stryzhak (2019) notes that the quality of human capital affects a country's sustainable economic growth. In Kazakhstan, the share of human capital in the national wealth is currently low, at just over 40%. Additional investments are required in this area to enhance the quality of life of the population and boost their contribution to the country's economic development (Baidybekova and Sauranbay, 2022; Boykovskaya et al., 2022).

Foreign research highlights the investment in human capital as a key factor in the development and utilization of national resources in the new economy based on knowledge, information, ideas and innovation (Figure 1).

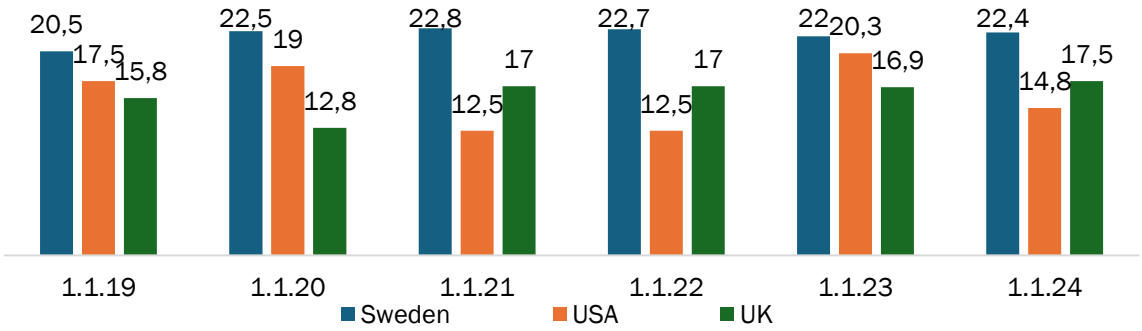

Figure 1. Development of investments in human capital in the world as a % of GDP.
Source: Compiled by the author based on the source https://gtmarket.ru/

In the final ranking, all states are ranked on the basis of HDI and classified into four categories in accordance with the accepted gradation:

- countries with very high HDI levels (more than 0.9);
- countries with high HDI levels (from 0.8 to 0.9);
- countries with medium HDI levels (from 0.5 to 0.8);
- countries with low HDI levels (less than 0.5) (Figure 2) (Joseph et al., 2025).

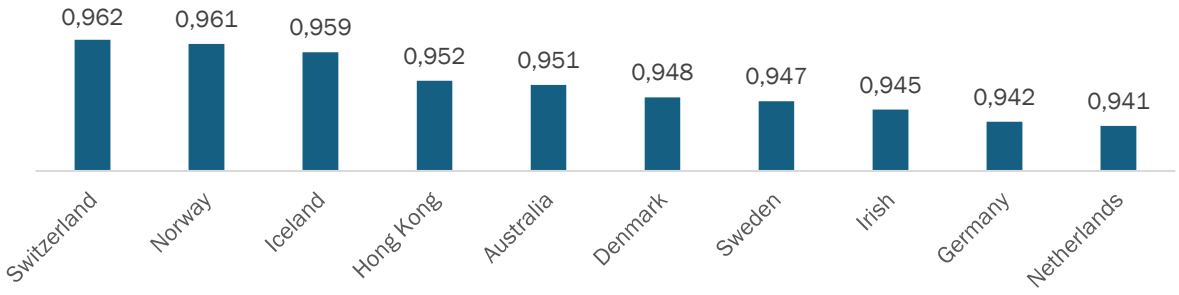

Figure 2. Ranking of the world's countries according to the Human Development Index for 2022-2024.

Source: Compiled by the author based on the source Gemmell, N., Kneller R., & Sanz, I. (2008). Fiscal Policy Impacts on Growth in the OECD: Are They Long-run? Available online: https://pdfs.semanticscholar.org/eca1/08deaf73c53bfec78c30e673a2b240b17a83.pdf

Human resource management penetrates all sectors of Kazakhstan's economy, including the state, quasi-state and private sectors, as well as organizations of all sizes and legal statuses When studying the state's participation in economic processes, it is worth noting that its role has ranged from minimal intervention in various spheres of human activity to a complete state monopoly on the production of all types of goods. At different stages of state development in various countries diverse economic policies have been implemented. The outcomes of these policies have not always been clear-cut, ranging from significant successes and economic prosperity to serious failures and social development crises. Gemmell N., Kneller R., Sanz I. (2008), and Barbiero O. (2013) have produced influential works in the fields of political economy and economic theory. Their research has focused on issues related to economic development, which aims to increase living standards while maintaining constant population growth.

In 2023, Voznyak, H. and Koval, V. (2023) proposed mechanisms to strengthen financial self-sufficiency. The financial stability and well-being of individuals can be achieved and strengthened through various means, as described in previous studies (Behrman et al., 2012; Stryzhak,2019; Gathergood, 2012; , Henager and Mauldin, 2015).

The New Public Management (NPM) movement is often considered a potential catalyst for the rise of PSA science (Almqvist et al., 2013; Steccolini, 2019). NPM relied heavily on accounting, budgeting, auditing, reporting, and performance measurement tools to increase efficiency and value for money (Gemmell, 2008).

It is noteworthy that public sector accounting (PSA), accountability, budgeting, performance measurement, auditing, and reporting have been studied separately by disciplinary and geographical communities. European and American traditions have developed on both sides of the Atlantic, but for different audiences and using different approaches (Van Helden et al., 2008).
Many authors address methodological questions about the need to promote and use mixed methods that would allow researchers to shed light on the effectiveness of existing practices, as well as the factors that provoked large-scale reforms in developing countries and the public accounting system of national resources (Van Helden, 2021; Kuruppu et al., 2021, Jayasinghe et al., 2021). Using the content analysis, scoring assessment system of information disclosure, and semi-structured interviews would enable them to demonstrate both existing practices and ongoing reforms. This provides a rationale for examining accounting, performance, and accountability issues in the context of public-private partnerships and other hybrid organizations that impact national resource development and welfare (Campanale et al., 2021; Caperchione et al., 2017; Grossi et al., 2022).

A review conducted by Grossi and Argento (2022) shows that the development of public administration, specifically networked, collaborative and digital governance, changes not only the way public services are delivered, but also the role of citizens and other social actors, resulting in the creation of public values (Grossi et al., 2023).

2. ANALYSIS AND RESULTS

Official national accounts data for Kazakhstan show that the economy has remained investment-intensive in the post-pandemic period, which directly conditions the pressure on national resources and the relevance of public audit. In 2023, gross domestic product (GDP) by final expenditure method amounted to 116.9 trillion TENGE, while gross capital formation (GCF) reached 33.6 trillion tenge, or 28.7% of GDP; within this, gross fixed capital formation (GFCF) was 29.8 trillion tenge, corresponding to 25.5% of GDP, with real growth of 17.1% year-on-year. In 2024, GDP by final expenditure method increased to 133.2 trillion tenge (real growth 5.0%), and gross capital formation rose to 37.5 trillion tenge, representing 28.1% of GDP. Gross fixed capital formation reached 33.5 trillion tenge, or 25.1% of GDP, with real growth of 6.5% compared with 2023. Thus, while the share of capital formation in GDP remained high and broadly stable, the growth rate of GFCF slowed, indicating a transition from a phase of rapid post-crisis catch-up investment in 2021–2023 to a more moderate but still resource-intensive investment path in 2024.

Table 2. Gross capital formation and gross fixed capital formation in Kazakhstan, 2023–2024

Indicator	2023	2024
GDP by final expenditure method, mln tenge	116,988,954.4	133,157,833.5
Gross capital formation, mln tenge	33,631,527.4	37,457,431.1
Gross capital formation, % of GDP	28.7%	28.1%
Gross fixed capital formation, mln tenge	29,811,815.9	33,469,209.9
Gross fixed capital formation, % of GDP	25.5%	25.1%
Real growth of GFCF, % to previous year	17.1%	6.5%

Source; compiled by the authors

From the perspective of national resource efficiency, the combination of a high GFCF share (≈25% of GDP) and decelerating real growth suggests that the marginal productivity of new investments becomes increasingly dependent on governance quality, project selection and contract management, rather than on mere volume expansion. This reinforces the argument that public audit – particularly specialized audit of PPPs – must move from ex post financial compliance towards performance-oriented and risk-sensitive assessment of how fixed capital contributes to long-term productive capacity and societal outcomes.

The PPP sector in Kazakhstan has expanded rapidly over the last decade and has become a major channel for mobilizing investment in infrastructure and social facilities, thereby concentrating substantial national resources and future fiscal obligations. According to the Kazakhstan Center for Public-Private Partnership, the PPP database contained about 1,357 projects as of mid-2022, of which 831 contracts had been signed, with total PPP capital expenditures reported at approximately 8.3 billion (in the Center's reporting currency).
By mid-2023, the number of concluded PPP contracts had increased to 1,085, with a total value exceeding 2.1 trillion tenge. As of 1 February 2024, 1,182 PPP contracts were in force, and the cumulative public obligations under these agreements were estimated at over 2.0 trillion TENGE, including availability payments and other long-term commitments. A UNECE assessment in late 2024 additionally notes that more than 750 small-scale PPP projects have already been implemented nationwide, primarily in health, education and municipal services.

Table 3. PPP portfolio in Kazakhstan and its relation to capital formation, 2019–2024

Year	PPP contracts concluded (cumulative)	Estimated PPP portfolio value, trln tenge	Selected characteristics
2019	717	≈1.5 (approx., mid-2019 estimate)	Rapid expansion of small social PPPs (schools, kindergartens, sports facilities).
2022	831	8.3 bn CAPEX (Center reporting)	Database of 1,357 PPP projects; transition to more complex regional projects.
2023	1,085	>2.1	Strong growth of obligations; increasing role of availability-payment PPPs.
2024	1,182	>2.0 (public obligations)	Over 750 implemented small-scale PPPs; digital project register and standard contracts.

Source: compiled by the authors

When compared with the volumes of gross fixed capital formation presented in Table 2, a number of important findings emerge:

First, the PPP portfolio (≈2.0–2.1 trillion tenge) is equivalent to around 6–7% of annual GFCF in 2023–2024 and represents a sizeable stock of long-term obligations relative to total fixed investment. This confirms that PPPs are no longer a marginal instrument but form a structurally significant segment of national resource allocation, especially in infrastructure and social sectors. Second, the growth of PPP commitments between 2019 and 2024 outpaces the growth of GFCF, indicating that an increasing share of new capital assets is being created through contractual arrangements that combine public and private financing, risk-sharing mechanisms and long-term tariff or budget payment schemes. In such a context, traditional financial or compliance audit is insufficient for capturing the full range of fiscal, economic and social risks.

Third, the proliferation of small-scale social PPPs (over 750 facilities by 2024) suggests a high degree of fragmentation of the PPP portfolio. This creates challenges for aggregate monitoring of national resource efficiency and increases the need for standardized digital tools, data aggregation and risk-based prioritization within specialized PPP audit.

Figure 3 (conceptually) plots the dynamics of gross capital formation (% of GDP) and the cumulative PPP portfolio (trln tenge) for 2019–2024. It illustrates that, while the share of capital formation in GDP stabilizes around 26–29%, the PPP portfolio grows almost monotonically, thereby raising the relative weight of PPP-related commitments in the overall investment and debt structure of the state.

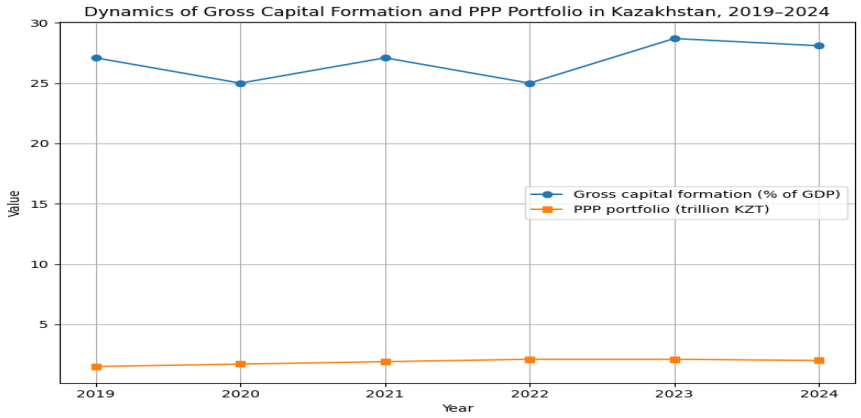

Figure 3. Dynamics of gross capital formation and PPP portfolio in Kazakhstan, 2019–2024
Source: The figure shows gross capital formation as a percentage of GDP (left axis) and the cumulative PPP portfolio in trillion TENGE (right axis), based on national accounts and Kazakhstan PPP Center data

In this case, Kazakhstan probably has a higher level of labor productivity compared to Malaysia, Bulgaria, Azerbaijan, Mongolia, Armenia, Uzbekistan and Kyrgyzstan due to a combination of the above factors. However, it still lags behind developed countries such as Australia and Chile on this indicator (Figure 4).

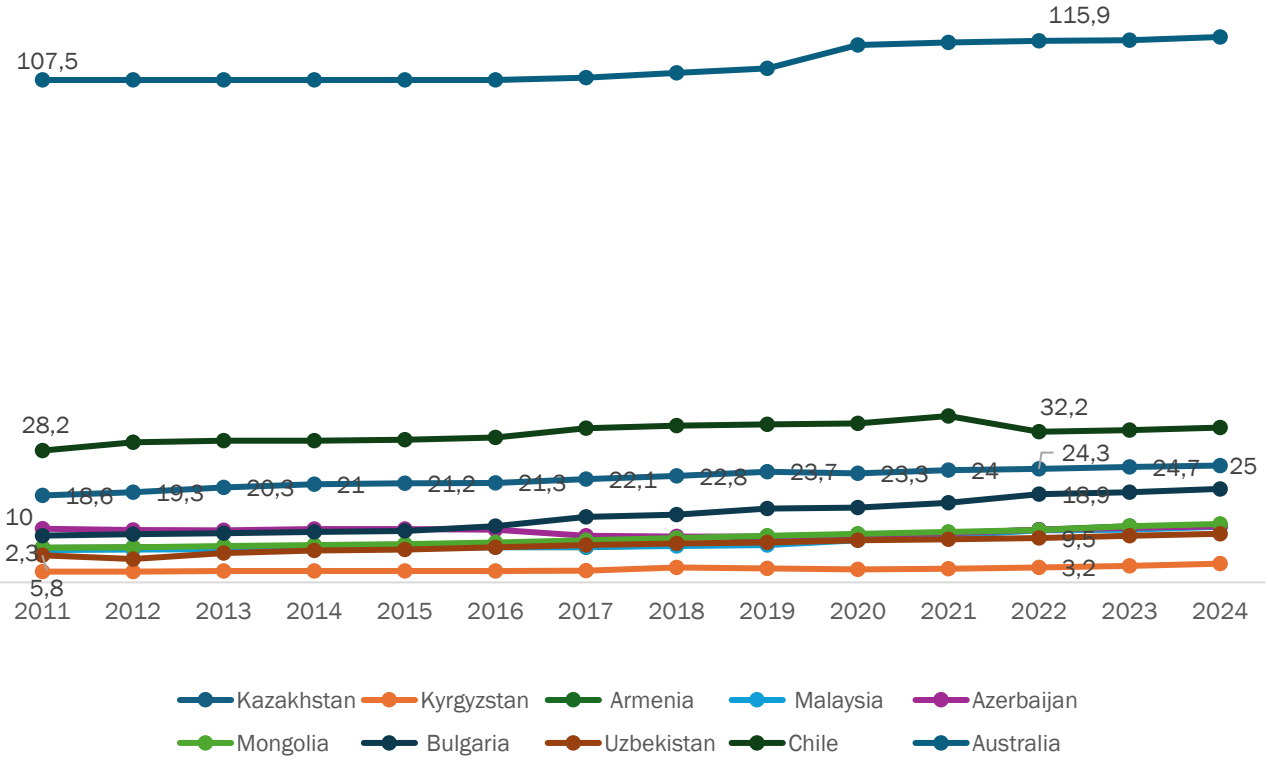

Figure 4. Labour productivity of Kazakhstan and other countries, thousand US dollars
Source: Compiled on the basis of the source https://gtmarket.ru/

The consumption of fixed capital in the Republic of Kazakhstan is directly related to its national resources. Fixed capital includes buildings, structures, equipment, vehicles and other tangible assets used to produce goods and services. This process of fixed capital consumption determines

the efficient utilization of national resources, such as natural resources, human capital, and financial resources. For instance, infrastructure development, industrial facility construction, and production facility modernization, necessitates substantial investment in fixed capital. This, in turn, requires the use of national resources, including construction materials, energy, labour resources, and financial investment.

In the process of building the trend model the following stages were performed:

1. Checking the time series for the presence of anomalous observations. For this purpose, Irwin's criterion was used (Table 4).

Table 4. Checking the presence of anomalous observations in the time series.

Year	Observed value of Irwin's criterion	Calculation formulas
2014	-	Observed value of Irwin's criterion $\lambda_t = \frac{\lvert y_t - y_{t-1} \rvert}{\sigma_y},\ t = \overline{2,11}$ Critical value of Irwin's criterion $\lambda_{0,05} = 1{,}5$
2015	0.943	
2016	0.815	
2017	0.889	
2018	0.610	
2019	0.351	
2020	0.029	
2022	0.109	
2023	1.474	

Source: Compiled on the basis of calculations made

The initial time series with a probability of 95% does not contain anomalous observations, since all observed values of Irwin's criterion are less than critical.

2. Using the criterion of "ascending" and "descending" series, it was found that the time series under consideration contains a trend component (Table 4).

Table 5. Checking the presence of a trend

General view of the criterion of "ascending" and "descending" series (violation of at least one inequality is sufficient for the presence of a trend) Calculated values with probability of error	Estimated values with probability of error $0{,}05 < \alpha < 0{,}0975$
$\nu(n) > \left[\frac{2n-1}{3} - 1{,}96\sqrt{\frac{16n-29}{90}} \right]$	3 < 4
$K_{\max} < [K_0(n)]$	6 > 5

Source: Compiled on the basis of calculations made

3. The approximation of the raw data was done using a first degree polynomial:

$y_t = a_0 + a_1 t + \varepsilon_t$ (1)

4. Quality assessment of the obtained model was carried out in two directions: adequacy check and assessment of model accuracy.

To check the adequacy of the model, a series of residuals, i.e., the discrepancy between the levels calculated by the model and actual observations, was investigated. The most important

properties of the residual component are: equality of mathematical expectation to zero, randomness of residuals and their conformity to the normal distribution law. The results of the analysis of the residuals series in order to check the model for adequacy are shown in Table 6.

Table 6. Checking the adequacy of the model.

Checked property	Statistics used Name, calculation formula	Received value	Boundary	Conclusion
Randomness	The criterion of "peaks" (turning points) $p > \left[\frac{2}{3}(n-2) - 1{,}96\sqrt{\frac{16n-29}{90}}\right]$	6	3	Adequate
Normality	RS- criterion $RS = \frac{e_{\max} - e_{\min}}{S}$	9	2,80-3,91	Adequate
Equality of the mathematical expectation of the levels of the residual series to zero	Student's t-statistic $t_{observ.} = \frac{\mid \bar{e} \mid}{S}\sqrt{n}$	0,99	2,23	Adequate

Source: Compiled on the basis of calculations made

To assess the accuracy of the model, the mean relative error of approximation was calculated:

$$E_{rel.} = \frac{1}{n}\sum_{i=1}^{n}\frac{|e_t|}{y_t} \cdot 100\% = 0.73\%,$$

value, which indicates a good level of accuracy of the model.

Thus, the model is qualitative and can be used for forecasting.

5) To calculate the point forecast, the corresponding values of the variable were substituted into the constructed model. To construct the interval forecast, the confidence interval was determined at the significance level of.

The results of point and interval forecasts for 2024-2026 are presented in Table 5.

Table 7. Point and interval forecasts of the indicator “Consumption of fixed capital” for 2024-2026.

Year	Spot forecast, TENGE million	Interval forecast, tenge million	
		Lower boundary	Upper boundary
2025	13,200,000	12,500,000	13,900,000
2026	14,100,000	13,300,000	14,900,000
2027	15,000,000	14,100,000	15,900,000

Source: Compiled on the basis of calculations made

The results of the forecasting of the indicator “Consumption of fixed capital” for 2025-2027 are graphically presented in Figure 7.

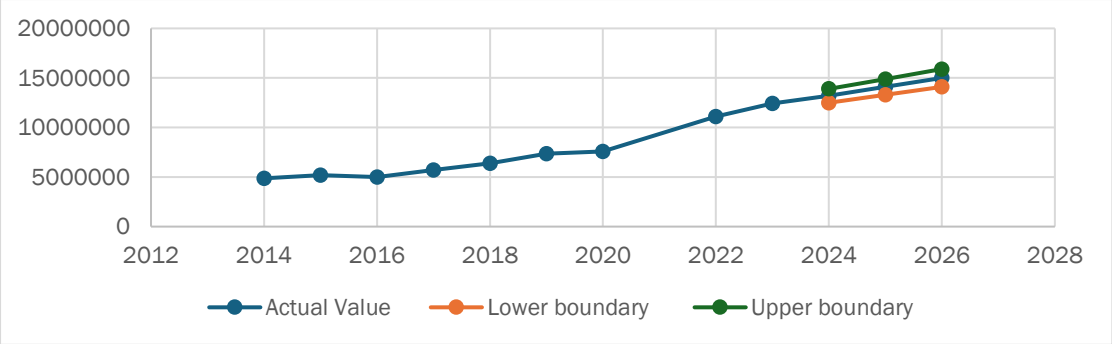

Figure 7. Point and interval forecasts of the indicator “Consumption of fixed capital” for 2025-2027, mln. tenge

Source: Compiled on the basis of calculations made.

3. DISCUSSION

Fixed capital consumption, that is, the depreciation and decrease in the value of productive assets, directly affects the economy's production capacity and competitiveness. Effectively managing and optimizing this process is crucial for achieving economic objectives and sustained growth in national welfare. Maintaining an appropriate level of investment in fixed assets, their renewal, and modernization enables a more efficient use of resources, increasing labor productivity and the competitiveness of enterprises in the global market.

Increased consumption of fixed capital contributes to the renewal of the production base and improvement of production efficiency. This allows companies to use modern equipment and technology, which in turn increases labor productivity, reduces production costs and improves the quality of products or services. More efficient use of fixed assets also contributes to market competitiveness by reducing the cost of production and improving the supply of goods or services. In addition, increased consumption of fixed capital can stimulate investment in the development of new technologies and innovation, which contributes to long-term growth and development of the economy.

Thus, proper management of fixed capital can promote stable economic growth and improvement of the population’s living standards.

CONCLUSION

Understanding projected consumption of fixed capital can help government auditors develop more accurate recommendations and strategies for improving national resource management. For instance, if low consumption of fixed assets is predicted, this may encourage auditors to consider investment efficiency and asset management issues. It is necessary to improve mechanisms for collecting, analyzing and publishing data on public expenditures and results of programs and projects. This allows to improve openness and transparency in the management of national resources and ensure a more objective assessment of their effectiveness. It is recommended to develop more accurate and universal criteria and indicators for assessing the effectiveness of the use of national resources, taking into account the diversity of goals and objectives of state programs and projects. There is a need to improve the interaction between different state agencies and levels of government to work together to assess the effectiveness of resource use and develop appropriate strategies and improvement measures. Training and professional development of

government auditors and resource efficiency evaluation specialists is recommended to ensure a high level of professionalism and quality in the audits conducted.

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