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Evaluating the Impact of ESG on Regional Development in Kazakhstan: Empirical Analysis

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ABSTRACT

Environmental, social, and governance (ESG) principles have become increasingly vital for fostering sustainable regional development in emerging economies in recent years. This study assesses the relationship between ESG factors and regional economic performance using a panel dataset covering 18 regions from 2005 to 2023. The research used panel data econometric methods, including fixed effects (FE) and random effects (RE) models, to control for regional heterogeneity and estimate the impact of key ESG indicators. The Hausman test is used to determine the appropriate model specification, while regression analysis quantifies the relationships between solid and air pollutant emissions, R&D expenditure, labor force size, and regional GDP. The empirical results indicate that solid pollutant emissions have a significant adverse effect on regional GDP (FE coefficient = –17.94, RE coefficient = –18.57), while R&D expenditure (FE = 0.33, RE = 0.30) and labour force size (FE = 8.55, RE = 7.37) contribute positively and significantly to GDP growth. Regions with high R&D investment demonstrate up to 15% higher GDP growth, whereas variations in pollutant emissions account for a 20% gap in economic output. These findings suggest that regional ESG strategies require targeted policy interventions to mitigate environmental damage while fostering innovation-driven economic growth. Future research should investigate long-term causal mechanisms, sector-specific ESG influences, and qualitative governance factors to enhance regional sustainability frameworks.

KEYWORDS: Economy, Economic Development, Economic Stability, Environmental Sustainability, Social Equity, Governance, Sustainable Growth, Kazakhstan

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1. INTRODUCTION

ESG has emerged as the building block of sectoral growth for all countries. This influences policy architecture, investment patterns, and regional development initiatives. It represents a suite of interlinked dimensions: environmental stewardship, social justice, and good governance. The integrated model maps onto the economic growth, inadequate availability of resources, and societal inequality nexus. During recent years, the relevance of ESG integration has enlarged practically in advanced economies, while in developing and emerging economies, structural and regional disparities greatly amplify the degree of challenges to sustainability. Considering all these conditions, Kazakhstan can be regarded as an interesting case study, thanks to its resource-oriented economy and geographical diversity with unequal regional development.

These are supported by the significant variations evident in practically all key economic, environmental, and social indicators across different Kazakhstan regions, further underlining the need for locally tailored ESG practices. For instance, the striking per capita disparities in emissions of solid and air pollutants across the regions reflect the highly heterogeneous environmental problems generated by industrial activities and regulatory regimes. Similarly, gaps in gross domestic expenditure on R&D, labour force participation, and regional GDP growth manifest uneven economic capabilities and diverging social dynamics. Although the country has taken measures toward modernizing its economic infrastructure and adherence to international sustainability goals, ESG principal integration at the state level remains an under-explored area of study.

It makes the absence of profound studies that connect ESG metrics with regional development in Kazakhstan a serious challenge for policymakers. The completeness of national commitments to the UN SDGs and several government programs regarding economic diversification and ecological sustainability have not yet been transformed into the qualitative elaboration of region-specific ESG assessments. This inequality is even more striking in the environmental sphere, as the industrial regions of Karaganda and Pavlodar constantly have higher levels of pollutant emissions than other less industrialized regions. Moreover, unequal financing of research and development activity across the regions denotes the potential for underutilizing opportunities provided by innovation for ecologically oriented economic growth. These depend upon a strong and prospective data-driven analysis of ESG dynamics, emphasizing the interaction between environmental factors, economic performance, and social development.

Hence, the given study tries to bridge such a gap through an empirical analysis of ESG-related trends across the Kazakhstani regions for 2005-2023, based on a panel dataset with all essential indicators such as emission, air pollution per capita, R&D expenditure, labour force participation, GDP, and state survivor benefits. The paper, therefore, seeks to identify, using advanced econometric techniques, the spatial and temporal pattern of ESG metrics, unravel the relationships between the environmental, social, and economic variables, and assess the impact of governance and R&D investment on regional sustainability. These latter will be specified in terms of the associations of levels of environmental degradation and solid pollutant emissions- with economic indicators of regional development such as regional GDP growth, and also how the social variables like labour force participation rates and state benefits intervene in these associations.

Integrating ESG principles into regional policy and strategy may help overcome some of Kazakhstan's unique challenges. A high reliance on extractive industries has brought about environmental degradation and regional inequalities that put the long-term sustainability of the country's development at risk. At the same time, regions with high levels of investment in R&D and higher innovative potential, like Astana and Almaty, have

specific opportunities to develop best practices in the context of sustainable government and a diversified economy. Through tapping into such a dataset and carrying out a profound analysis of those dynamics, this research complements not just the vast, rapidly growing body of material on ESG but also provides very real policy guidance for the policymakers in the pursuit of aligning Kazakhstan's regional development to international standards of sustainability.

The most critical aspect of this study is its connectivity between theoretical ESG frameworks and actual applications within developing economies. Most international research currently focuses on the macroeconomic implications of ESG adoption and the neglect of regional variability. Everything from agrarian economies, like those in the regions of Turkistan, up to the heavily industrialized zones of Karaganda, are so different that ESG integration into Kazakhstan needs to be separate. Thus, this study explores a differentiated approach to underlining local ESG strategies with consideration of regional disparities for the sake of national cohesion.

It is relevant not only for purely academic purposes but also because, through an evidence-based analysis of ESG trends in Kazakhstan, the following report covers its country's strategic priorities embodied in national development programs, which are targeted, among others, at such development priorities as economic diversification, reduction of regional inequalities, and the SDGs. The foreseen outputs will endow policymakers with the knowledge required to devise interventions that address the causes of environmental and social disparities, thereby helping achieve inclusive economic growth. It is also expected to contribute to the broader discussion on ESG integration in emerging markets through an approach that could be replicated in other resource-dependent economies with related challenges.

This research is one more step toward understanding and helping to find solutions to the complex dynamics of ESG in the regional development of Kazakhstan. It attempts to provide a holistic assessment of progress by Kazakhstan regarding environmental, social, and governance integration into the country's development trajectory based on an analysis of extensive data from almost two decades. On the other hand, such insight from this study would not benefit only at the regional policy level but would also contribute to the global discussion on sustainable development across emerging economies. It is underlined that data analysis and practical policy recommendations are stressed, so this research shows the vast role of ESG in Kazakhstan's sustainable, equable future.

2. LITERATURE REVIEW

Various ESG factors have recently received considerable academic and policy-focused scrutiny for their role in promoting global, national, and regional sustainable development. Environmental degradation, social justice, and governance effectiveness are linked on so many levels that there is an obvious need to consider an all-inclusive, multidisciplinary method to conceptualize and address inequities at the regional level. While it has been discussed at large for developed economies, limited work emphasizes how it relates to emerging economies, such as resource-dependent ones like Kazakhstan. This literature review synthesizes existing knowledge on the main ESG principles, focusing mainly on those studies that may be relevant for setting the context for Kazakhstan.

The tendencies of ESG, rooted in CSR and sustainable development paradigms, significantly shape the nature of the international dialogue concerning it. Eccles et al. (2014) report that, over time, emphasis on ESG factors would shift from optional corporate pursuit to a keystone approach, which will be imperative for the long-term viability of business and stakeholder confidence building. Indeed, this institutes the proliferation of ESG metrics and reporting frameworks across industries. As Clark et al. (2015) highlighted, implementing ESG principles transcends organizational confines,

impacting regional and national development frameworks by incorporating environmental sustainability, social welfare, and governance accountability within the policy formulation process.

Environmental sustainability represents one of the core components of ESG criteria and has received significant interest in literature that evaluates its impact on economic and social outcomes. According to Stern (2007), the financial effects of poor environmental performance are an outcome of ecological degradation highly relevant to countries whose economies rely on extractive industries. This is reflected in current findings, as Doda (2014) stresses that pollution and resource depletion disproportionately affect developing areas. Therefore, considering the contribution of industrial activity to regional inequalities in environmental outcomes in Kazakhstan, ensuring the effective implementation of environmental policy is highly relevant. The actual level of air quality and, most importantly, emissions control remains relatively low, especially in such industrial cities as Karaganda and Pavlodar.

Social equity, one of the central elements of ESG, is closely related to workforce participation, educational access, and social welfare systems. These findings align with comprehensive studies undertaken by Stiglitz et al. (2010), which assert that social inequalities undermine economic resilience and act as a barrier to achieving sustainable development goals. Integrating social equity into ESG mechanisms is highly instrumental in addressing regional disparities, particularly in emerging economies with diverse socio-economic profiles.

Governance is the third aspect of ESG, which forms the substance for sound environmental and social policy implementation. According to Acemoglu and Robinson (2012), credible institutions are a source of prosperous, inclusive, and sustainable development because their existence forms a basis for the equitative distribution of resources, policy, and stakeholder engagement. In this respect, particular attention has been paid to governance challenges in several studies on Kazakhstan, including that by Pomfret (2019), which has especially called for more decentralization and transparency regarding regional policy setting. This would align the governance frameworks towards ESG-related concerns and address regional disparities for comprehensive development.

The role of R&D in realizing ESG goals has been underlined repeatedly in scholarly discourse. Freeman and Soete (2009) believe that with technological progress, innovation is a primary driving force of economic growth and sustainable development. In the case of Kazakhstan, Bekmagambetova et al. (2021) underline inequality in the distribution of R&D expenditures between its regions; such a situation hinders the country's capability to use innovation for sustainable development. The findings are thus consistent with international studies, including by Griliches, 1998 that indicate the role of selective research and development policies for regional competitiveness and environmental protection.

Various methodological approaches have been tried within regional development, from econometric analysis to case study research. According to Sachs (2015), applying the system approach is necessary while analyzing the interlinkage of environmental, social, and governance variables. In this respect, such methodological insights have special relevance for the case of Kazakhstan, where regional disparities require an advanced and evidence-based approach towards ESG assessment. Kazakhstan's recent policy initiatives highlight its commitment to sustainable development. The government's "Strategy of the Republic of Kazakhstan on Achieving Carbon Neutrality by 2060" underscores efforts to reduce greenhouse gas emissions through comprehensive ESG policies. In addition, Reuters (2024a) reported that Kazakhstan is making progress in decarbonization, particularly as the country restructures its energy and resource policies in line with global energy transitions (Reuters, 2024a).

The social and governance aspects of ESG in Kazakhstan are also receiving growing attention. A survey conducted by PwC Kazakhstan (2024) on "ESG Awareness in Eurasia" revealed that many Kazakh companies have implemented mature ESG strategies, with a majority incorporating robust sustainability practices into their operations (PwC Kazakhstan, 2024). In parallel, Aggarwal (2024) highlighted in an interview that enhanced sustainability reporting is crucial for building stakeholder trust and ensuring transparency in ESG practices (Aggarwal, 2024). Innovation and green finance are recognized as key drivers of ESG outcomes in Kazakhstan. Davidenko et al. (2024) examined the eco-branding of an industrial region in Kazakhstan, demonstrating that ESG transformation can stimulate sustainable economic growth by promoting clean production and green technology (Davidenko et al., 2024).

Recent studies underscore the growing significance of integrating ESG principles across diverse sectors in Kazakhstan to foster sustainable development and enhance economic resilience. Maralov et al. (2024) examined ESG practices in the telecommunications industry, revealing that although current strategies offer valuable insights through their cross-sectional design and semi-structured interviews, notable weaknesses affect overall company performance. In parallel, Nurgaliyeva et al. (2024) introduced innovative modelling methods that incorporate ESG criteria into risk management frameworks tailored to Kazakhstan's green economy, highlighting quantitative and qualitative approaches for assessing ESG risks and their influence on sustainable growth. Complementing these sector-specific findings, Kuandykova et al. (2023) explored the application of ESG principles in organic agriculture as a strategy to attract investment and stimulate rural development, offering a case study approach that provides policy recommendations to improve both environmental quality and socio-economic outcomes in rural regions. Collectively, these studies illustrate that effective ESG integration—whether in telecommunications, risk management, or agriculture—contributes to improved operational performance and drives broader sustainable development in Kazakhstan.

The importance of good ESG reporting stems from its potential to draw investment and support regional economic performance. Aggarwal (2024) believes that comprehensive sustainability disclosures are essential since they encourage transparency, enable comparability, and build stakeholder trust (Aggarwal, 2024). This perspective is also supported by the standards established by the International Sustainability Standards Board (ISSB), such as IFRS S2 Climate-related Disclosures, which provide a framework for evaluating and disclosing climate-related risks (Reuters, 2024b). The changing dynamics of ESG in Kazakhstan reflect more exhaustive regional efforts in Central Asia. For instance, the Eurasian Development Bank (EDB) has promoted green finance in the region through investments in renewable energy schemes (Eurasian Development Bank, 2024). Similarly, the Astana International Financial Centre (AIFC) has a central role in attracting sustainable investments and developing a strong financial system that supports ESG-related activity (Astana International Financial Centre, 2024).

In this regard, Kazakhstan's adherence to the UN SDGs presents a meaningful framework that could adequately introduce ESG considerations while developing regional policy. The studies by Kolk (2016) also highlight that most of Kazakhstan's national development programs are related to the SDGs and require a proper localized approach to regional differences. The literature concerning ESG has grown, but significant research gaps remain, notably regarding emerging markets such as Kazakhstan. Current literature mainly focuses on country-level analyses, often to the detriment of regional dynamics and their implications for ESG integration. Therefore, Therefore, the current paper tries to bridge these gaps by undertaking a detailed analysis of

ESG-related variables across regions in Kazakhstan, using a panel dataset for nearly two decades. It also attempts to draw operational messages from what existing literature states and contributes to the more considerable debate on sustainable regional development in emerging economies.

3. RESEARCH METHODS

Panel data analysis is one of the most applied statistical approaches. It allows us to study a dataset's time series and cross-sectional dimensions and, therefore, is apt for assessing regional and time-series changes concerning ESG factors. The panel data analysis underpins the following research that sought to investigate the relationship between ESG indicators and regional economic performance in Kazakhstan during the years from 2005 to 2023, especially concerning further differences in environmental pollution, distribution of social welfare, investments in research and development, the size of the labour force, and GDP. The dataset will include yearly observations over 20 regions, thus allowing a comprehensive study of the intra-region and inter-region dynamics for almost two decades.

This analysis is underpinned by the definition that economic growth, proxied by GDP, emanates from various mixes of environmental, social, and governance variables. Generally speaking, the econometric model for this study can be summarized according to the formula (1):

$$GDP_{it} = \beta_o + \beta_2 Emissions_{it} + \beta_2 AirPollutants_{it} + \beta_3 StateBenefits_{it} + \beta_4 RDExpenditure_{it} + \beta_5 LabourForce_{it} + a_i + \epsilon_{it} \quad (1)$$

where:

GDP_{it} – the gross domestic product of region *i* at time *t* (in million tenge);

$Emissions_{it}$ – total emissions of solid pollutants (in thousand tons);

$AirPollutants_{it}$ – air pollutant emissions per capita (in kilograms);

$StateBenefits_{it}$ – number of state survivor benefit recipients (serving as a proxy for social welfare);

$RDExpenditure_{it}$ – research and development expenditure (in million tenge);

$LaborForce_{it}$ – size of the labor force (in thousands);

α_i – a region-specific effect capturing unobserved heterogeneity;

ϵ_{it} – the idiosyncratic error term.

Including both the region-specific effect α_i and the error term ϵ it ensures that the model captures variations arising from time-invariant and time-variant factors, providing a nuanced understanding of how ESG-related variables impact regional economic performance.

The primary objective of this analysis is to evaluate the relationships between ESG factors and GDP while controlling for region-specific and time-specific unobserved characteristics. To ensure robustness, the study employs fixed effects (FE) and random (RE) estimations. The FE model, which eliminates time-invariant regional effects, is specified as formula (2):

$$(GDP_{it} - GDP_i) = \beta_1 (Emissions_{it} - Emissions_i) + \beta_2 (AirPollutants_{it} - AirPollutants_{ii}) + \ldots + (\epsilon_{it} + \epsilon_i) \quad (2)$$

Therefore, the FE model only considers the estimated coefficient's within-region variation, cleansing the potential effect of ESG factors on economic growth from spurious effects due to persistent regional characteristics. In contrast, the RE model assumes that the region-specific effects are uncorrelated with the explanatory variables, allowing one to consider jointly within- and between-region variations. For each of these, the appropriateness is ascertained using the Hausman test, which tests for a correlation between region-specific effects and independent variables. A statistically significant test should thus favour the FE model, indicating violations in assumptions set by the RE model. The variables used in the analysis indicate a holistic approach toward capturing ESG dimensions. Environmental factors include per capita

emissions of solid and air contaminants, by which high pollution levels are expected to affect GDP via health-related costs and reduced labour productivity negatively. The social aspects shown are the number of state survivor benefit recipients, whereby these variable proxies for welfare distribution and social cohesion. Governance elements in this model include expenses related to research and development and reflect investment into innovation and sustained economic competitiveness. The magnitude of the labour force-control variable involves the inevitable effect on economic production.

Such a dataset configuration, with yearly observations across 20 regions for almost twenty years, provides a rich basis for analyzing temporal and spatial dynamics. In this model specification, the control for time-fixed effects captures national-level shocks and trends, such as changes in macroeconomic policy or exogenous economic shocks. In contrast, regional fixed effects capture time-invariant characteristics of each region, such as natural resource endowments or geographical advantages. Clustering the standard errors of regressions at the regional level usually controls for most of these econometric problems: heteroscedasticity and/or serial correlation. The standard errors of such a model are robust to various failures regarding the assumptions of the classical linear regression model. Besides, this analysis checks the robustness of these findings by using different model specifications and excluding outliers from strongly polluted or highly research and development-intensive areas.

The model's suggested relationships are grounded on theoretical underpinning and empirical findings. This study expects that higher per capita emissions of solid and air pollutants will lower the GDP in tandem with various theories of environmental economics that indicate the probable trade-offs between economic development and environmental deterioration. On the other hand, increased research and development outlay is believed to have positive spill-over effects on GDP due to technological innovation and productivity improvement. The number of state survivor benefits is a proxy for social welfare and is also supposed to correlate positively with the GDP of a state since social stability will ensure economic growth. The size of the labour force is a control variable, which has a presumed positive relationship with GDP since the regions possessing more substantial labour forces will most likely contribute to high economic output. The empirical analysis will be based on the intrinsic values of panel data, giving more detailed insight into the dynamic relationships between ESG variables and regional economic performance in Kazakhstan. With the contribution of advanced econometric methods and a rich dataset, this paper will enrich the current debate on sustainable development. It will be of great usefulness for policymakers in the balancing act between economic growth, environmental concerns, and social equity.

4. FINDINGS AND DISCUSSION

These results provide a wide-based analysis of the interactive effects of ESG and regional successes in Kazakhstan's economy. Panel data from 2005-2023 looks at regional disparities in economic growth, environmental sustainability, and social parameters. The estimates underline significant relations to GDP with variables such as solid pollutant emissions, air pollution per capita, state survivor benefits, R&D expenditure, and labour force size. Indeed, the regions with higher R&D investments and larger labour forces show better economic performances, while the regions burdened by higher pollutant emissions face stagnation.

Figure 1 shows GDP trends across all regions.

The data illustrates the GDP trends across all regions of Kazakhstan from 2005 to 2023, capturing the regional disparities in economic growth over time. Almaty city and Astana city show the most considerable upward trends, respectively, showing that these are the financial hubs of Kazakhstan with consistently growing GDPs after 2015.

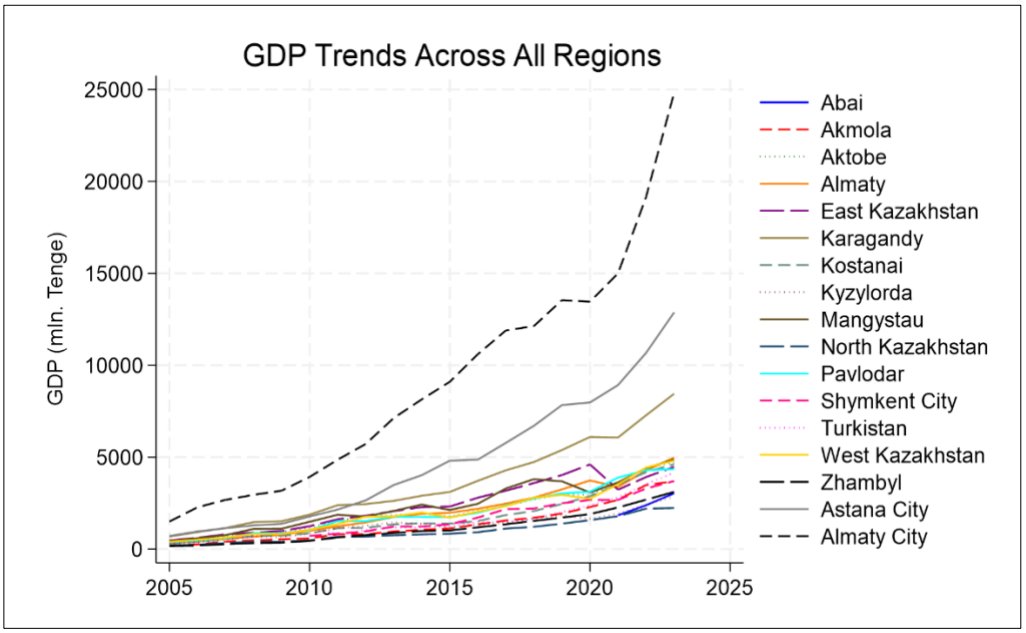

FIGURE 1. Respondents' familiarity with the concept of sustainable/conscious consumption

Note: compiled by authors

Other regions, such as Mangystau and Karaganda, have also been experiencing considerable upsurges, reflecting the implications of industrial and resource-based activities. On the other hand, Turkistan, Kyzylorda, and West Kazakhstan had relatively lower GDP growth rates, indicating a lower comparison rate with the other, more urbanized or industrialized regions in terms of economic development. The difference in this trend in economic development suggests structural differences and spontaneous agglomeration of economic activities in certain areas, entrenching the thought of special policy implementation for balanced and sustainable development.

Table 1 illustrates descriptive statistics of variables.

Table 1. Descriptive Statistics of Variables

Variable	Mean	Std. Dev.	Min	25%	50% (Median)	75%	Max	Skewness	Kurtosis
Emissions of solid pollutants	34.11	52.68	1.10	4.35	13.00	35.50	251.30	2.41	8.13
Emissions of air pollutants	163.77	220.92	8.00	39.05	98.05	149.60	1062.00	2.46	8.36
State survivor benefits	17607.38	9949.08	6325.00	11015.50	14057.00	20505.00	55085.00	1.76	5.99
R&D expenditure	3799.95	7920.78	46.80	353.70	1050.50	3420.10	77204.10	4.56	31.21
Labor force	522.52	226.11	188.50	344.45	437.30	704.55	1132.70	0.89	2.80
GDP	2698.24	3024.52	168.60	955.60	1780.60	3227.60	24828.70	3.21	16.94

Note: compiled by author

Table 1 shows descriptive statistics of all the variables studied in this research. It was noticed that, on average, the mission of solid pollutants was 34.11 thousand tons and was highly variable Std. Deviation 52.68, and with a highly positively skewed distribution, Skewness=2.41, implies that most data are at the lower measurements, while only some areas attain high levels of up to 251.30 thousand tons of pollutant emissions. The air pollutant emission data represent the mean of 163.77 kg per capita with an SD of 220.92 and a maximum value of 1062 kg per capita. A positively skewed value of 2.46 and a kurtosis value of 8.36 also indicate the presence of outliers and a long tail in the distribution. State Survivor Benefits can be used here as a proxy for social aid. The average beneficiaries are 17,607 beneficiaries with considerable variation Std. Dev. = 9949. It ranges from 6,325 to 55,085 beneficiaries, showing significant differences among regions. The mean value of R&D Expenditure, as one of the drivers of innovation, stands at 3799.95 mln. tenge and its distribution is very leptokurtic, with exceptionally high investments in some regions (Skewness = 4.56) up to 77,204.10 mln. tenge. It follows that R&D funding is unequally distributed among different regions, reflecting regional inequalities of innovation potential.

The Labor Force variable demonstrates a more symmetrical distribution (Skewness = 0.89) with an average workforce size of 522.52 thousand. The standard deviation of 226.11 indicates moderate variation across regions. Finally, GDP showcases an average regional output of 2698.24 million tenge, with a high standard deviation (3024.52) and considerable skewness (3.21). Some regions show high GDP values: Maximum = 24,828.70 million tenge, indicating that economic activities are concentrated in narrow areas. The kurtosis value of 16.94 also denotes that the distribution contains many extreme outliers. These scattered statistics denote that regional differences are widely marked in aspects related to economic, social, and environmental variables. This calls for the implementation of region-specific policies and targeted intervention programs.

Table 2 compares fixed effects (FE) and random effects (RE) model statistics.

Table 2. Comparison of Fixed Effects (FE) and Random Effects (RE) Model Statistics

Model Statistics	**Fixed Effects (FE)**	**Random Effects (RE)**
Number of observations	312	312
Number of groups	18	18
R-squared (Within)	0.6949	0.6884
R-squared (Between)	0.7268	0.7756
R-squared (Overall)	0.6399	0.6725
F/Wald Chi-squared	F (5, 289) = 131.64	Wald chi2 (5) = 607.60
P-value	0.000	0.000
Sigma_u (Variance due to u_i)	1911.872	834.333
Sigma_e (Residual Variance)	1316.435	1316.435
Rho (Variance due to u_i)	0.6784	0.2866

Note: compiled by author

Table 2 compares the available statistics for both FE and RE models. In each model, the total observation is 312, divided into 18 groups. Therefore, the data possesses a regional panel dimension. From the P-value of 0.000, the significance of the models is quite high; thus, both models possess high explanatory power. The R-squared within values indicate that both models explain a large part of the variation across time and space, with the FE model performing slightly better than the RE model, as its R-squared is 0.6949 against 0.6884 for the RE model. However, the R-squared Between value for the RE model is much higher than the FE model, 0.7756 and 0.7268, respectively, meaning that the RE model

captures more variance between regions. The overall R-squared captures the combined explanatory power within and between variances. The values stand at 0.6725 for RE and 0.6399 for FE. This would suggest that RE might be better for analyzing impacts brought about by the time-invariant and time-variant predictors.

The FE model has a higher value of Sigma_u (1911.872) and Rho (0.6784), reflecting that a more significant fraction of the overall variance is due to unobserved regional characteristics in this model. In turn, the RE model has a lower value of Sigma_u (834.333) and Rho (0.2866). Therefore, it attributes less variance to unobserved factors, as is indeed presumed by this model. Overall, the FE model is more robust in analyzing the time-variant predictors within regions because it controls for unobserved heterogeneity. In contrast, the RE model allows both time-variant and time-invariant factors, assuming the unobserved effects are uncorrelated with predictors. This comparison provides good insight into the trade-off among these models concerning the study's aims.

Table 3 shows a comparative analysis of the coefficients.

Table 3. A comparative analysis of the coefficients

Variable	FE Coefficient (SE)	RE Coefficient (SE)	P-value (FE)	P-value (RE)
Emissions of solid pollutants	-17.939 (5.663)	-18.567 (5.044)	0.002	0.000
Emissions of air pollutants	1.523 (1.393)	3.511 (1.222)	0.275	0.004
State survivor benefits	-0.229 (0.030)	-0.171 (0.025)	0.000	0.000
R&D expenditure	0.329 (0.020)	0.299 (0.019)	0.000	0.000
Labor force	8.552 (1.427)	7.368 (1.222)	0.000	0.000
Constant	1320.714 (655.377)	777.772 (507.181)	0.045	0.125

Note: compiled by author

Table 3 provides evidence of the role the variables of emission, public benefits, research and development expenditure, and the size of the labouring force play in shaping regional economic outputs. Both models present a considerable negative relationship between the emissions of solid pollutants, expressed in thousand tons, and GDP, with coefficients of -17.939 for the fixed effects model and -18.567 for the random effects model. This may denote unfavourable economic consequences from higher emissions of solid pollutants since these can interfere with productivity and sustainability. The results also differ between the two models regarding air pollutants, whose emissions are expressed in kilograms per capita. While FE exhibited a positive effect insignificantly related at P = 0.275, RE unveiled a statistically significant positive effect at P = 0.004 with a coefficient value 3.511. The difference in findings constitutes yet another signal about the sensitivity of results to model specifications and may relate to variation across regional air quality regulations or economic frameworks.

In both models, it was seen that state survivor benefits were in steady and strong negative correspondence with GDP: The FE model estimated a higher effect than the RE model, -0.229 versus -0.171, indicating some inefficiency related to the spending of more public resources on survivor benefits, which could otherwise be invested in growth-oriented projects. In models FE and RE, the coefficients are 0.329*** and 0.299***, respectively, which shows that the impact of R&D expenditure is positive and very significant in influencing GDP. This indicates the importance of innovation and technological development in nurturing economic growth. Another key factor strongly influencing GDP positively is the labour force ('000), showing 8.552*** and 7.368*** in the FE and RE estimations, respectively. The strong relevance of this variable underlines the crucial role that human capital has in economic outcomes,

where larger labour forces directly raise productivity and overall output.

In the FE model, the constant term is significant at P = 0.045, indicating that unobserved region-specific factors influence GDP. In the RE model, however, the constant is insignificant, P = 0.125, probably due to an assumption about uncorrelated individual effects with the explanatory variables. Both models have good explanatory power as witnessed by an R-squared within (FE: 0.6949, RE: 0.6884), between FE: 0.7268, RE: 0.7756, and overall, FE: 0.6399, RE: 0.6725. Wald chi-squared = 607.60 (P = 0.000) can be seen in the RE model, while for FE, the F-statistic is computed at F (5, 289) = 131.64 (P = 0.000), which justifies the joint significance of all the predictors used. These models capture the different components of the variance variably. Specifically, the share of variance contributed by unobserved heterogeneity, i.e., Rho, is way higher in FE (0.6784) than in RE (0.2866), which shows significant variations due to region-specific effects in the former model.

FE and RE models revealed that emission, R&D expenditure, and labour force have their bearing effects on regional GDP with peculiar magnitude and coefficient effects. In contrast, by controlling for unobserved heterogeneity, FE model results are richer effects from within-region variations, while RE generalizes across regions. Therefore, there is a dire need for clear empirical evidence that policymakers do need to strike a balance in the wheel of environmental sustainability, optimization of the labour force, and R&D investments towards improving regional economic performance.

5. CONCLUSIONS

In summary, based on nearly two decades of panel data from Kazakhstan, this study examines the linkage between ESG factors and regional economic performance. The analysis highlights significant regional disparities in economic, ecological, and social outcomes, underscoring the need to integrate ESG principles into regional development strategies. Employing both fixed effects and random effects models, the results indicate that higher emissions of solid pollutants generally harm GDP, suggesting an economic cost associated with environmental degradation. However, the evidence is not unequivocal; for example, under the random effects model, per capita air-pollutant emissions were found to have a positive relationship with GDP. This ambiguous finding may reflect the dual role of industrial activity—contributing both to economic output and to environmental pollution—as well as differences in regional industrial structures and evolving policy frameworks. Thus, while there is a clear call for stricter environmental policies and the development of greener industries, the complex relationship between pollution and economic growth necessitates further investigation into the underlying mechanisms.

Striking correlations in the data involve the social variables, state survivor benefits, and labor force size. The continued negative correlation of state survivor benefits with GDP points to a misallocation in social welfare spending that requires policy changes to enhance social expenditure's effectiveness. Labour is an important determinant of economic output, further underlining the importance of human capital for regional development. Hence, policies fostering labour market participation and productivity are key from the perspective of inclusive economic growth. The robust positive effect of R&D expenditure on GDP, irrespective of model specifications, underlines innovation and technological change's role in attaining sustainable economic growth. While it signals, at the same time, very significant differences in regional R&D investment, such could well be put against the general innovative potential of the country. The catching-up policies boost diffused R&D spending and local innovation systems to reduce disparities in regional performances for better national competitiveness.

The FE and RE models are important methodologically speaking. While the FE model provides detail concerning changes within regions due to control for unobserved heterogeneity, the RE model provides broader

generalization since it encompasses both the time-variant and time-invariant factors. From the results of the Hausman test, the appropriateness of the FE model to capture region-specific effects was realized, which again supports the importance of localized policy interventions according to regional contexts. This, therefore, places ESG principles at the forefront of shaping the regional economic landscape in Kazakhstan. Conclusions reached herein, therefore, underline the need for evidence-based, region-specific policymaking- a delicate balance between economic growth and environmental conservation coupled with social equity. Kazakhstan should include ESG principles within regional development strategy tools, using some of the valuable outputs of this research as input and as an instrument of sound compatibility with sustainable and inclusive growth in improving diverse regional challenges. The research also allows making a case for dialogue on ESG integration within emerging economies while constituting a tool that countries dependent on natural resources can apply to handle the complex paths of sustainable development better.

AUTHOR CONTRIBUTION

Writing – original draft: Kuralay Nurgaliyeva.
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Software and supervisions: Kuralay Nurgaliyeva.
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Assessment of ESG Efficiency of the Oil and Gas Sector in Kazakhstan

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ABSTRACT

The oil and gas industry plays a key role in the global and national economy, necessitating the need to develop sustainable development strategies to ensure long-term growth and resource security. The purpose of the study is to provide a comprehensive analysis of the ESG (environmental, social, and governance) efficiency of oil and gas companies in Kazakhstan based on the developed methodological approaches. The research employs a combined approach integrating quantitative and qualitative methods. Quantitative analysis includes statistical methods, econometric modeling, and index assessment, while qualitative evaluation is based on expert reviews, best practice analysis, and corporate reports. Correlation and cluster analyses are used to examine ESG performance and classify companies into different sustainability categories. The study is based on data from the RAEX analytical agency and the Bureau of National Statistics, covering the period from 2013 to 2023. The findings reveal significant disparities in ESG efficiency among Kazakhstan's oil and gas enterprises. While leading companies demonstrate strengths in environmental sustainability (E-Rank = 6), they require improvements in social responsibility (S-Rank = 18) and governance (G-Rank=7). Correlation analysis indicates a strong relationship between industry wages and pollution levels, highlighting potential economic-environmental trade-offs. Achieving sustainable growth in Kazakhstan's oil and gas sector requires technological modernization, and enhanced collaboration between regulatory bodies and private enterprises. Future research should explore the long-term financial and operational impacts of ESG policies on industry competitiveness.

KEYWORDS: Economy, Economic Stability, Sustainable Development, Corporate Governance, Oil Production, Resource Management, Strategic Development, Kazakhstan

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1. INTRODUCTION

Kazakhstan's oil and gas industry plays a strategic role in the national economy, contributing significantly to GDP and being a significant source of export revenues. However, the industry faces new challenges in modern times, such as global trends towards decarbonization and increased demands for corporate social responsibility, as well as the need to adopt sustainable development principles. Environmental pollution remains one of the biggest problems in modern society, with air pollution significantly impacting climate, hydrology, human health, and agriculture. Therefore, assessing the ESG performance of the oil and gas sector becomes increasingly important as a key component of sustainable development.

Historically, the development of Kazakhstan's oil and gas industry has intensified since independence in 1991. The attraction of large international investors and the introduction of modern technologies have allowed the country to take significant positions in the global energy market. However, despite the successes achieved, the economy's dependence on hydrocarbon exports makes the industry vulnerable to changes in international climate and economic policies. In this context, adaptation to the new requirements of sustainable development, including ESG standards, is becoming essential for maintaining competitiveness and ensuring the long-term growth of Kazakhstan's oil and gas sector.

Scientific research confirms that effective ESG policies help reduce the environmental impact of businesses, increase social responsibility, and improve corporate governance (Fattouh et al., 2019; Giese et al., 2019; Bereznoi, 2021). International experience from developed countries shows that integrating ESG approaches leads to technological modernization, reduces production risks, and ensures long-term business sustainability (OECD, 2020). Companies focused on ESG principles also gain competitive advantages, access to cheaper financing, and strengthen their reputations.

However, in Kazakhstan, implementing ESG standards is accompanied by several difficulties, including underdeveloped institutional frameworks, dependence on traditional energy resources, and limited opportunities for introducing innovative technologies into industry. These factors lead to significant differences in ESG efficiency between companies in the oil and gas sector. This requires the development of objective tools for assessing sustainable development, such as ESG rankings, which allow quantifying companies' sustainable development based on environmental sustainability, social responsibility, and corporate governance parameters. The study of ESG rankings is necessary to identify trends in ESG practices and identify industry leaders and companies that need modernization. This, in turn, allows us to formulate targeted strategies to improve ESG indicators and contribute to the comparative analysis of Kazakhstan's oil and gas companies with their peers in other countries. This approach provides an opportunity to identify competitive advantages for the national industry and directions for necessary reforms to increase the sustainability of the oil and gas sector over the long term.

Thus, given the need to improve Kazakhstan's ESG efficiency for oil and gas enterprises and substantial differences in indicators of sustainable development among enterprises, a comprehensive review of existing methods for assessing ESG performance is required. This study aims to provide a comprehensive analysis of the ESG (environmental, social, and governance) efficiency of oil and gas companies in Kazakhstan based on the developed methodological approaches.

2. LITERATURE REVIEW

Many studies are devoted to the problems of ensuring sustainable growth of oil and gas industry enterprises due to their strategic importance for the economy and resource security (Gurvich, 2004; Perepelitsa &

Zhdanova, 2017). Sustainable growth refers to the ability of enterprises to maintain economic stability, adapt to changes in the external environment, and ensure long-term development while minimizing negative impacts (Pera, 2017). An analysis of the scientific literature shows that the steady growth of oil and gas enterprises is directly related to introducing innovations, increased operational efficiency, diversification of production processes, and resource management optimization (Kiseleva et al., 2020). The results of several empirical studies emphasize the importance of developing strategies aimed at reducing production risks and adapting to changes in global energy markets (Fattouh et al., 2019; Giese et al., 2019). This process is associated with economic benefits, such as job creation and industrial production growth and environmental challenges, including increased pollutant emissions and land-use changes.

Some scientists have extensively studied the process of achieving sustainable growth in the oil and gas sector by focusing on improved production performance and the optimization of industrial processes. Their research highlights the pivotal role of digitalization in transforming traditional operations (Ahmad et al., 2017; Lanshina et al., 2021; Akhunov et al., 2021). Companies can significantly reduce operational costs and enhance energy efficiency by leveraging advanced technologies such as automation, big data, and artificial intelligence. These advancements streamline production and support broader sustainability objectives by minimizing environmental impact. The results of these studies demonstrate that companies backed by regional governments and institutional frameworks tend to achieve more substantial progress in adopting digital and green technologies. This collaborative approach fosters the development of innovation-friendly ecosystems, accelerates the integration of cleaner technologies, and facilitates the shift toward a low-carbon economy (Noll et al., 2018; Deng, 2013). Moreover, such initiatives often lead to the establishment of industry benchmarks and regulatory frameworks that encourage broader participation in sustainability efforts (Okeke et al., 2022).

Several studies have highlighted how oil and gas companies adapt to new global challenges, such as transitioning to a low-carbon economy and strengthening environmental standards (Peng et al., 2019; Bereznoi, 2021). Thus, Peng et al. (2019) emphasized reallocating investments from traditional hydrocarbon extraction to renewable energy sources, such as solar and wind energy. In their study, Hastings and Smith (2020) assessed the role of the oil and gas sector in achieving net-zero greenhouse gas emissions. The authors concluded that the knowledge and expertise accumulated within the oil and gas industry are essential for developing and scaling carbon capture and storage (CCS) technologies. Bereznoi (2021) examined the adaptation of oil and gas companies to increasingly stringent environmental standards under the framework of EU climate initiatives. The study highlighted that successful adaptation requires significant investments in sustainable technologies and the integration of innovative approaches to meet evolving regulatory demands.

Several literary sources suggest that market sentiment plays a key role in ESG investing in oil markets (Dowling et al., 2016; Serafeim, 2020). For example, ESG studies claim that companies with strong and weak ESG indicators but with temporary social contradictions are perceived as weak and strong companies. In addition, in anticipation of low (high) incentives, investors ignore investing in companies that have strong (weak) ESG indicators but with a negative (positive) momentum of sentiment (Amel-Zadeh & Serafeim, 2018).

Other scientists have studied the role of attracting long-term investments, which have taken various forms, including those considering environmental and social aspects (Ferrat et al., 2022; Janicka & Sajnog, 2021). Studies have shown that ESG reversals, i.e., negative events related to companies'

activities, can weaken the positive impact of ESG factors on financial results (Aouadi & Marsat, 2018). Some scientists are studying the role of attracting long-term investments in infrastructure modernization and development, as well as the impact of ESG factors on the attractiveness of oil and gas companies to investors (Eccles et al., 2017; Brzeszczyński et al., 2019). This aspect is particularly relevant for industries such as the oil and gas industry, which is under intense public and investor scrutiny due to its high environmental impact (Brantley et al., 2014).

Current trends and practices of integrating ESG factors in the oil and gas industry are developing rapidly. Research shows that companies increasingly adopt ESG practices to reduce risks and improve overall operational efficiency (Aldowaish et al., 2022). The results of the Charfeddine et al. study (2020) showed that positive changes in oil prices are significant in all cases with an expected positive sign, which means that an increase in oil prices leads to an increase in real GDP.

Kazakhstani scientists have also investigated the issues of sustainable development of industrial enterprises. They claim that the oil and gas industry is essential for both global and national economic growth. It generates technological discoveries (Karabalin & Tukayev, 2019). Modern processes of geological exploration, production, transportation, and processing are all accompanied by extensive research using advanced methods from other sectors of the economy. Stable links between the oil and gas sector and other industries will enable the formation of industries that can develop early through service provision in the oil and gas field. In their work, Tleuzhanova and Dildebayeva (2024) showed that sustainable development requires environmentally friendly technology, strict environmental standards, and efficient resource management. Nevertheless, against the background of the practical results obtained due to the rational use of hydrocarbon resources by leading powers of the world, Kazakhstan, with such a powerful raw material base, still cannot declare itself a state whose oil and gas resources are used with high complexity. Therefore, the strategy for economic development of domestic oil and gas processing and petrochemical industries should be aimed at gaining the necessary momentum for progress shortly (Egorov et al., 2018).

Based on the literature review, it can be concluded that the strategic importance of sustainable development for enterprises in basic industries lies in their key role in economic stability. Many studies have highlighted the significance of innovation, improved operational efficiency, and digitalization in achieving sustainable growth. However, much of the current research focuses on international aspects of sustainability without considering the specifics of national contexts. The Kazakh scientific literature primarily focuses on oil and gas development from a national economic and technological perspective. Meanwhile, a combined approach considering environmental, social, and economic factors remains under-researched. Therefore, this study aims to address this gap in the literature. The study's results will contribute to the formulation of practical recommendations aimed at improving operational efficiency, minimising environmental risks, and achieving long-term sustainable growth.

3. RESEARCH METHODS

This paper attempts to evaluate the environmental, social, and governance (ESG) efficiency of oil and gas companies based on data from the analytical agency RAEX and the results of correlation analysis. The study seeks to identify key factors influencing sustainable development in the oil and gas sector, focusing on ESG aspects.

The primary data source is the official statistics of RAEX and Kazakhstan's Bureau of National Statistics, which provide quantitative assessments of parameters related to the development of oil and gas enterprises. The work follows five steps shown in Figure 1.

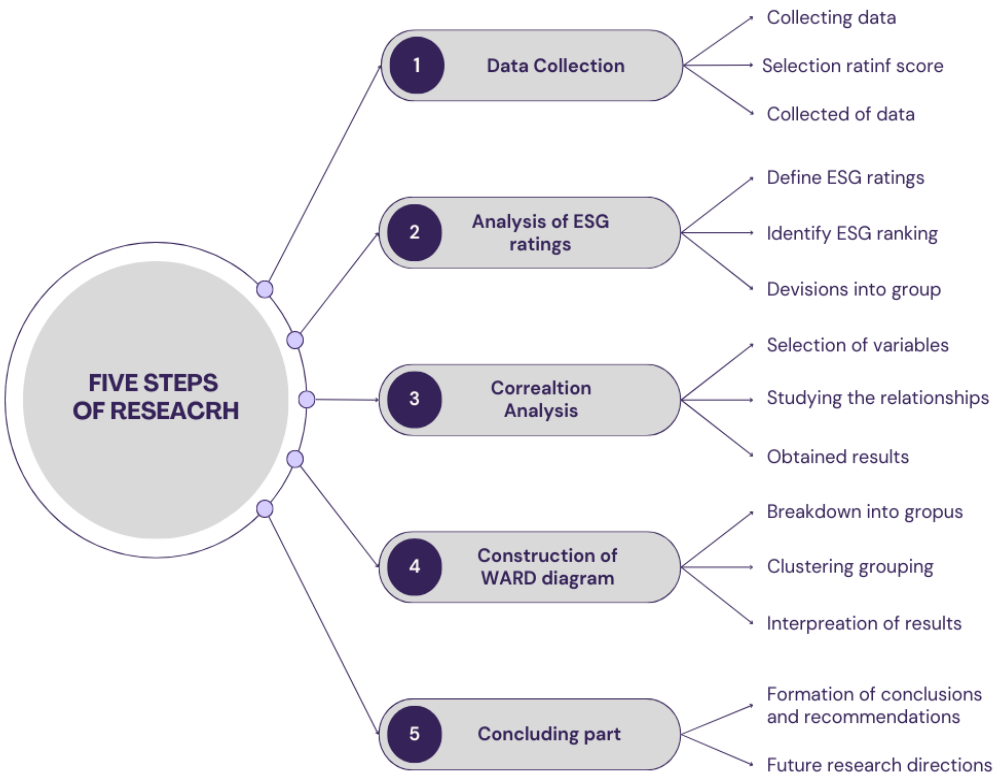

FIGURE 1. The scheme of the step-by-step stage of scientific research

According to the presented scheme, the research process was organised as a sequential execution of five key stages, each solving the tasks necessary for achieving a holistic result. At the initial stage, data was collected from official sources, emphasising its systematisation and the selection of indicators relevant to assessing companies' ESG ratings. Initial data was collected and used for further analysis, including information from annual collections of official statistics from the Bureau of National Statistics of Kazakhstan for the period 2013-2023.

The next step was to analyse ESG ratings, which allowed us to assess the competitive position of companies in the oil and gas industry and divide them into groups according to integral indicators. At this stage, the paper studied companies' operations' environmental, social, and managerial aspects. The companies' positions were evaluated based on ESG indicators, allowing us to group them according to integrated assessments (e.g., in categories with high, medium, and low scores).

Next, a correlation analysis was conducted in the third stage to study the relationships between selected variables. This stage allowed us to determine the level of linkages between various environmental, social, and managerial factors. Key variables for the analysis were selected (e.g., emissions, GDP, the oil and gas industry share, etc.), and a correlation matrix was constructed to identify the relationships among these indicators. In the fourth stage, cluster analysis was performed using the Ward method, which allowed us to form dendrograms to visualise the similarities among the study objects. Companies were divided into clusters that demonstrated their group characteristics, allowing them to be identified as homogeneous groups based on their key characteristics. The final stage included drawing conclusions, developing practical recommendations, and identifying

areas for further research. This step completed the combined assessment process.

The selection of variables for this analysis is critical to accurately assessing the effectiveness of ESG. Table 1 below provides a detailed explanation of the selected variables used in this study, which serve as the basis for the subsequent analytical processes. These variables cover a range of environmental, economic, and social indicators to provide a comprehensive view of the industry's sustainability dynamics.

TABLE 1. Explanation of the selected variables for the study

Code	Variable	Unit of measurement	Designation
Land_use_emissions	General emissions land use, land use change, and forestry	thousand tons	Y
Emissions_total	Per capita emissions of major pollutants	kg/person	X_1
Environmental_expenses	The volume of current expenditures on environmental protection	mln. tenge	X_2
Emissions_pol_per_capita	GDP per capita	mln. tenge	X_3
Oil_gas_gdp_share	Share of the oil and gas industry in GDP	%	X_4
Oil_profuction_dynamics	Dynamics of oil and gas condensate production,	mln. tons	X_5
Oil_gas_exports	Dynamics of oil and gas exports	billion dollars	X_6
Industry_avg_salary	Average wages in the industry	tenge	X_7

Note: compiled by authors

This dataset forms the basis for a structured analysis of ESG efficiency. It includes variables representing critical dimensions of sustainability, ranging from environmental impacts and economic contributions to social outcomes. By leveraging these indicators, the study aims to provide actionable insights into the ESG performance of Kazakhstan's oil and gas sector.

4. FINDINGS AND DISCUSSION

4.1 RESULTS OF ESG EFFICIENCY ASSESSMENT OF THE OIL AND GAS SECTOR

The international experience of structural and technological modernization shows that OECD countries with significant experience in ESG have achieved significant success in reducing their carbon footprint and minimizing environmental impact (OECD, 2021). In this context, the oil and gas sector play a key role in analyzing its approaches to structural reform and the implementation of ESG indicators. Additionally, the oil industry is a primary energy source and a significant contributor to economic growth in the region. Despite challenges like geopolitical instability and changes in global energy policies, the sector continues to grow. Cooperation between CIS countries in this field remains an essential factor for ensuring energy security, modernizing infrastructure, and developing new technologies.

Today, many rating agencies try to measure key criteria to help investors make appropriate decisions. At the same time, they use different approaches to assessing and defining criteria for each factor E, S, and G. Our paper attempts to compare the leading companies in Kazakhstan's and Russia's oil and gas sectors by their competitive positions in industry. The study uses data from RAEX, an analytical agency, which includes indicators such as E-rank, S-rank and G-rank (Table 2).

TABLE 2. ESG-ranking of companies in the oil and gas industry of Kazakhstan and Russia

Title of enterprise	Country	Industry	E-Rank	S-Rank	G-Rank
KazMunayGas	Kazakhstan	Oil and gas production	6	18	7
Tatneft Group	Russia	Integrated oil and gas companies	19	25	3
Rosneft	Russia	Integrated oil and gas companies	9	29	21
NOVATEK	Russia	Integrated oil and gas companies	16	8	48
LUKOIL	Russia	Integrated oil and gas companies	32	14	34
NC “QazaqGaz"	Kazakhstan	Oil and gas transportation	38	35	22
KazTransOil	Kazakhstan	Oil and gas transportation	55	23	20
Sakhalin Energy	Russia	Integrated oil and gas companies	26	34	79
Gazprom	Russia	Integrated oil and gas companies	36	50	52
Yakut Fuel and Energy Company (YATEK)	Russia	Integrated oil and gas companies	68	60	44

Note: compiled by authors based on RAEX (2024)

According to the data presented, companies in the oil and gas sector in Kazakhstan and Russia show significant differences in environmental, social, and managerial indicators, reflecting their current level of development and adaptation to the requirements for sustainable development. For example, Kazakh companies are distinguished by high environmental ratings, indicating active efforts to minimize environmental impact. However, they also need to develop corporate social responsibility further and improve management practices to increase efficiency and sustainability. By contrast, Russian companies have relatively high management performance, but their environmental and social aspects are less pronounced, underscoring the need to implement sustainable development principles.

In general, KazMunayGas has one of the best environmental indicators (E-Rank = 6), indicating a high environmental efficiency level. However, its social and managerial indicators are lower (S-Rank =18, G-Rank=7), which indicates the need to strengthen social responsibility and improve management processes. Russian companies, in turn, show more diverse results. For example, Tatneft has strong management indicators (G-Rank=3) but weaker environmental and social ratings (E-Rank =19, S-Rank =25), underscoring the need for improvement in these areas. Rosneft's environmental performance is balanced (E-Rank=9), while it's management and social performances remain average (G-Rank=21, S-Rank =29), reducing its competitiveness. The need for further integration of the principles of sustainable development remains relevant for Kazakhstan and Russia in order to increase the competitiveness and sustainability of their enterprises in the global market.

An important step in research is analyzing the Kazakh oil and gas industry in cooperation with Russian companies. Next, this paper focused on Kazakhstan's enterprises specializing in oil and gas upstream operations, such as exploration and production.

Table 3 ranks the oil and gas companies in Kazakhstan for 2022.

TABLE 3. ESG ranking of oil and gas enterprises in Kazakhstan

No.	Title of enterprise	Industry	E-Rank	S-Rank	G-Rank	Class
1	KazMunayGas	Integrated oil and gas companies	3	1	1	A
2	Karachaganak Petroleum Operating B.V.	Oil and gas exploration and production	2	2	5	B+
3	North Caspian Operating Company N.V. (NCOC)	Oil and gas exploration and production	1	3	7	B+
4	Nostrum (Zhaiykmunai LLP)	Oil and gas exploration and production	9	7	2	B+
5	Maten Petroleum	Oil and gas exploration and production	8	9	3	B+
6	Embamunaigas	Oil and gas exploration and production	4	4	6	B+
7	Mangistaumunaigas	Oil and gas exploration and production	5	6	4	B+
8	Kazakhoil Aktobe	Oil and gas exploration and production	6	5	7	B
9	Tengizchevroil	Oil and gas exploration and production	7	8	11	B
10	Kazakhturkmunai	Oil and gas exploration and production	10	10	12	B
11	Karazhanbasmunai	Oil and gas exploration and production	11	13	9	C
12	SNPS-Aktobemunaigas	Oil and gas exploration and production	12	11	14	C
13	KAZPETROLEUM GROUP	Oil and gas exploration and production	14	14	10	C

Note: compiled by authors based on RAEX (2024)

According to the data presented, Kazakh oil and gas companies demonstrate significant differences in environmental, social, and managerial aspects, reflecting their current level of development and willingness to implement the principles of sustainable development. According to the presented rating, the leader is KazMunayGas, which has received the highest integral rating of "A", indicating its strong position in all key ESG criteria. The second-ranking group, with a "B+" rating, includes such enterprises as Karachaganak Petroleum Operating BV, North Caspian Operating Company NV (NCOC), Nostrum (Zhaikmunai LLP), Maten Petroleum, and Embamunaigas. These industrial enterprises demonstrate stable results within the framework of individual ESG components, which reflects their importance for the oil and gas sector. However, their combined ratings indicate that there is room for improvement, especially in the areas of environmental responsibility and corporate governance.

The third group includes companies with a "B" rating, including Kazakhoil Aktobe, Tengizchevroil, and Kazakhturkmunai. These companies are located mainly in Kazakhstan's western and southern parts and have access to large hydrocarbon deposits. Despite the importance of their production activity, their compliance with ESG criteria remains limited, and their social activity remains relatively low.

Finally, a group of companies with a "C" rating shows the worst results according to the key ESG criteria. This group includes Karazhanbasmunai, SNPS-Aktobemunaigas, and KAZPETROLEUM GROUP. Low scores compared to the leaders in the ranking indicate the need for operations modernization and improvement of interaction with local

communities. The analysis reveals that these companies face problems, such as a low level of adoption of environmentally friendly technologies and a lack of attention to minimizing environmental harm. This is particularly noticeable against the backdrop of increasing demands for sustainable development and compliance with international environmental standards.

The global transition to sustainable development and the implementation of ESG principles brings the task of structural and technological modernization to the forefront for many states. For Kazakhstan, given its significant dependence on the raw materials sector and high carbon emissions, the problem of economic modernization is becoming extremely urgent. Increasing investment attractiveness, improving environmental sustainability, and growing companies' social responsibility require significant changes in resource management and use approaches.

4.2 RESULTS OF CORRELATION ANALYSIS

Kazakhstan's oil and gas industry plays a key role in shaping the national economy and influences various aspects of sustainable development. At the same time, the forms of sustainable growth have significantly transformed due to global challenges. In particular, the use of ESG approaches was driven by increased investor demand for more efficient use of information to make decisions about the profitability of enterprises.

Next, it is proposed to proceed to the results of correlation analysis, which allow us to study in detail the relationships between the studied variables (Figure 2).

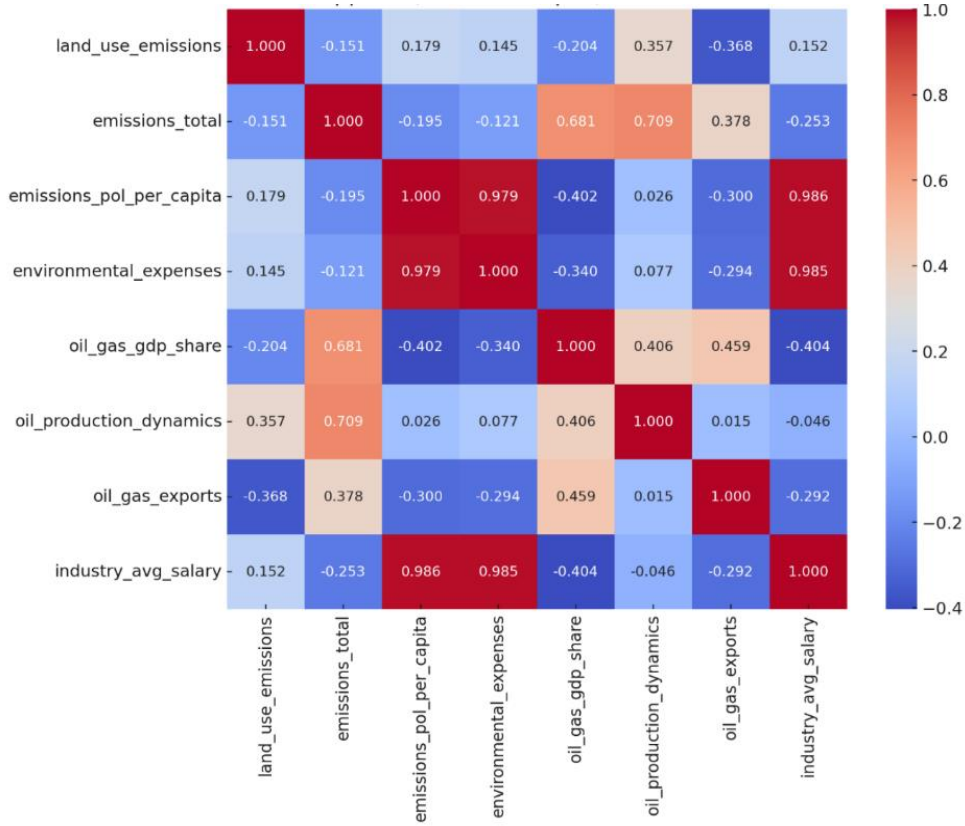

FIGURE 2. Matrix of correlation analysis

Note: compiled by authors based on Python

The oil and gas industry significantly impacts the environment: greenhouse gas emissions, water and soil pollution, and biodiversity loss. Moreover, the economy's reliance on fossil fuels may slow the transition to more sustainable and renewable energy sources. As a result, implementing ESG approaches is becoming a priority for most oil and gas companies. This trend is since the public, government, and investors demand specific actions in the field of ESG. Oil and gas companies that ignore the ESG agenda will be at a competitive disadvantage.

The results showed the presence of ambiguous relationships between the selected variables. The following results stand out in the group of the strongest positive correlations: the highest positive relationship was found between the emission of pollutants per capita and the average wage in the industry (0.986), which indicates a significant impact on income levels in the industrial sector on the environmental impact. A similar high positive relationship is observed between environmental costs and the average wage in the industry (0.985), which may indicate a redistribution of increasing incomes towards environmental programs. There is also a positive relationship between environmental costs and pollution emissions per capita (0.979), highlighting the growing costs of environmental measures with increasing pollution levels.

Next, we can identify a group of moderate positive correlations. Thus, there is a moderate correlation between the dynamics of oil production and the contribution of the oil and gas sector to GDP (0.406), which indicates a direct impact of production volumes on the economy's structure. Additionally, the positive relationship between oil production dynamics and pollution emissions (0.357) highlights the extractive sector's impact on the environment.

Finally, a group of strong negative correlations should be noted. Negative correlations have been found between the share of the oil and gas sector in GDP and the average wage in the industry (-0.404), which may indicate a redistribution of resources, in which a decrease in incomes in other industries accompanies an increase in the influence of the oil and gas sector. In addition, there is a negative relationship between the share of the oil and gas sector in GDP and pollution emissions per capita (-0.402), which may indicate a decrease in the economy's dependence on the oil and gas sector.

Hierarchical cluster analysis is used to visualize the identified relationships and their structure. This method allows for the grouping of variables based on their similarities and the identification of key patterns in the data.

Figure 3 is a dendrogram created from this analysis. It demonstrates which variables have the most substantial relationships and how they are grouped into clusters, reflecting the influence of economic, environmental, and social factors on the oil and gas sector.

The data shows a dendrogram obtained as a result of hierarchical cluster analysis using the Ward method, which reveals patterns in the dynamics of ESG efficiency in Kazakhstan's oil and gas sector for 2013-2023. Two main clusters were identified: 2014-2017 and 2021-2033. The first cluster includes 2009-12, which indicates relative stability in key ESG indicators. Corporate governance, environmental, and social sustainability showed minimal deviations, indicating the industry's stability, with minor regulatory and strategic management changes. The second cluster includes the period from 2018 to 2023, which is characterized by more pronounced fluctuations in ESG indicators. This consists of a subgroup from 2019 to 2102, where ESG efficiency is similar, which can be explained by stable industry trends such as strengthening environmental standards and a socially oriented transformation in corporate strategies. However, 2018 and 23 have separate development trajectories, likely due to institutional change, the influence of global economic factors, and the introduction of new ESG initiatives. A comparison of the distances between the clusters shows that 207 acts as a boundary between two stages in the evolution of ESG strategies for Kazakhstan's oil and gas sector.

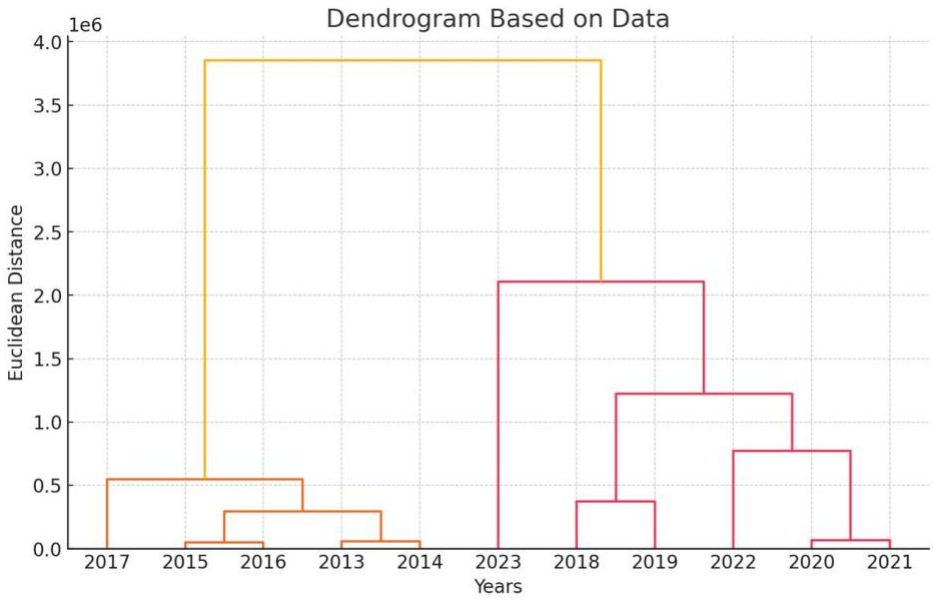

FIGURE 3. Dendrogram based on data

Note: compiled by authors based on Python

The significant difference in Euclidean distance between data groups before and after 27 indicates changes in corporate and regulatory practice that occurred during that period.

Thus, cluster analysis confirms that, since 2018, ESG-oriented initiatives have become more visible. At the same time, challenges remain related to the adaptation of companies to new standards for sustainable development. These findings emphasize the need for continued monitoring of the dynamics of ESG indicators and the development of strategies to enhance the effectiveness of the sustainable development of Kazakhstan's oil and gas industry.

5. CONCLUSIONS

The purpose of the study is to provide a comprehensive analysis of the ESG efficiency of oil and gas companies in Kazakhstan based on the developed methodological approaches. An analysis of existing research has shown that introducing ESG standards in the oil and gas sector is an important tool for increasing companies' competitiveness and sustainable development. Many scientific papers have shown the need to adapt the oil and gas industry to the global energy transition, strengthen environmental standards, and diversify activities through investments in renewable energy sources. However, in Kazakhstan, the process of implementing ESG approaches faces a number of barriers, including institutional and infrastructural constraints, dependence on traditional energy sources, and insufficient development of mechanisms.

Based on the conducted research, the following conclusions were obtained.

Firstly, the results of the ESG ranking of oil and gas companies in Kazakhstan demonstrated significant differences in the level of sustainable development between enterprises. Leading companies such as KazMunayGas have shown high environmental efficiency, which indicates implementing environmental protection measures and initiatives to reduce the carbon footprint. However, their positions in social

responsibility and corporate governance remain relatively low, indicating the need to improve domestic policy in these areas. Companies classified as having low ESG results, such as Kazakhoil Aktobe, Tengizchevroil, and Kazakhturkmunai, demonstrate an insufficient level of implementation of sustainable practices. A high environmental impact and a weak level of corporate governance characterize their activities.

Secondly, the study's results confirmed that the ESG efficiency of Kazakhstan's oil and gas companies varies significantly. The analysis showed that the leading enterprises demonstrate a high level of environmental sustainability, but their social responsibility and corporate governance remain relatively low. This indicates the need to find a balance between sustainable development and economic efficiency. Correlation analysis revealed a strong positive relationship between the industry's income level and the amount of environmental pollution, which indicates economic and environmental trade-offs. In addition, a link between environmental protection costs and emissions has been found, highlighting the need for more efficient use of environmental investments.

A comprehensive reform of policies and management approaches is required to increase the ESG efficiency of Kazakhstan's oil and gas sector. First, national ESG standards adapted to the specifics of the Kazakh economy must be developed and implemented. Second, the government should strengthen the regulation of environmental activities by providing incentives to reduce its carbon footprint, including tax incentives and subsidies for investments in green technologies.

Future research should focus on developing methods to assess the long-term impact of ESG policies on the operating results of oil and gas companies and explore the possibilities of integrating renewable energy sources into the oil and gas sector. In addition, it is necessary to conduct an in-depth analysis of international experience in the field of corporate governance and its adaptation to the conditions of Kazakhstan, which will increase the sustainability and competitiveness of the industry.

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RESEARCH ARTICLE
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Econometric Analysis of Key Factors Affecting Domestic Tourism Development in Kazakhstan

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ABSTRACT

Today, tourism plays a crucial role in Kazakhstan's economic diversification and regional development, especially in the post-pandemic era. This study aims to identify and quantify the key economic and infrastructural factors influencing tourism development in Kazakhstan. The research employs multiple regression analysis based on econometric modeling of macroeconomic indicators from 2013 to 2024. Based on the study of time series and correlation dependencies of indicators, a close relationship was found between the number of tourists and such variables as gross domestic product, the share of tourism in GDP, the number of organizations in the tourism sector, and income from accommodation facilities. The results indicate a strong positive relationship between domestic tourism growth and GDP per capita ($\beta = 0.0508$, $p < 0.01$) as well as the share of tourism in GDP ($\beta = 447{,}484$, $p < 0.05$). The number of tourism-related organizations also demonstrates a positive, though weaker, effect ($\beta = 637.8$, $p<0.1$). However, accommodation revenue and hotel occupancy were found to be statistically insignificant. Using methods and SWOT analysis, the strengths and weaknesses of the industry were identified, and opportunities and threats influencing its sustainable development were determined. The article proposes strategic measures to improve the competitiveness of the tourism industry, including the development of regional tourism, diversification of tourism products, the introduction of digital technologies, and environmentally responsible practices. These findings offer valuable insights for policymakers and industry stakeholders to support long-term tourism growth in Kazakhstan.

KEYWORDS: Economy, Economic Strategy, Tourism, Tourism Infrastructure, Tourism Policy, Business Opportunities, Kazakhstan

SCSTI: 06.71.07

JEL Code: L83, O18, R11, R58

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1. INTRODUCTION

In the context of global turbulence caused by the pandemic and external economic changes, focusing on domestic tourism has become a strategic priority for many countries, including Kazakhstan. The development of domestic tourism in Kazakhstan is a pressing issue in the context of global changes caused by the COVID-19 pandemic, restrictions on international travel, and changes in tourist preferences. Despite the presence of unique natural and cultural resources, Kazakhstan remains an undervalued destination in both the global and domestic tourism markets. At the same time, the lack of a systematic approach to infrastructure development and promotion of local routes leads to a decrease in the industry's competitiveness.

Several studies examining issues of tourism infrastructure and their economic analysis, such as Song and Li, highlighted that tourism demand is driven by macroeconomic conditions, including GDP, income levels, and employment rate (Song & Li, 2008). The study of Poghosyan and Tovmasyan also demonstrated that economic factors play a crucial role in shaping trends in domestic tourism development in the context of transition economies (Poghosyan & Tovmasyan, 2021). Other studies further emphasized the role of government support and investments in infrastructural and regional development for fostering domestic tourism (Murima & Shereni, 2023; Tovmasyan, 2023).

While these studies provide valuable insights, the specific relationship between regional characteristics, economic factors, and tourist flows remains insufficiently explored. This gap in the literature necessitates a comprehensive econometric analysis to identify the key determinants and constraints of domestic tourism growth in Kazakhstan. Although extensive research has been conducted on international tourism trends, the dynamics of domestic tourism remain underexplored. This study seeks to address this gap by conducting an econometric analysis of macroeconomic and infrastructural factors influencing the development of domestic tourism in Kazakhstan.

The study employs a mixed-methods approach, integrating both quantitative techniques (correlation and regression analysis) to quantify relationships between key variables and qualitative methods (SWOT analysis) to assess the strengths and weaknesses of the tourism industry. Unlike previous studies that rely predominantly on descriptive statistics or conceptual analysis, this research adopts a rigorous econometric approach, allowing for a more precise estimation of macroeconomic and infrastructural determinants of domestic tourism.

Another key contribution of this study is its focus on post-pandemic tourism trends in Kazakhstan. The COVID-19 pandemic has significantly reshaped travel patterns, leading to a marked shift from outbound to domestic tourism. However, empirical research on this transformation remains limited. The findings of this study will provide valuable insights for policymakers and industry stakeholders, facilitating the development of strategic initiatives aimed at improving infrastructure, diversifying tourism products, and promoting regional destinations.

This study aims to identify and assess the impact of key economic and infrastructural factors on domestic tourism development in Kazakhstan using an econometric analysis of data from 2013 to 2024. To guide this study, the following research questions are formulated:

RQ1. What are the key economic and infrastructural factors influence domestic tourism development in Kazakhstan?

RQ2. What is the impact of GDP growth on the number of domestic tourists?

RQ3. What is the role of accommodation revenue and hotel occupancy in shaping domestic tourism?

Based on these research questions, the study tests the following hypotheses:

H1: GDP growth positively influences domestic tourism.

H2: The number of tourism-related organizations significantly affects the number of domestic tourists.

2. LITERATURE REVIEW

There has been a noticeable increase in interest in domestic tourism in recent years, but there is still no consensus on its definition. Scholars have examined various factors, including economic, infrastructural, psychological as determinants of tourism demand. This section provides a comprehensive discussion of the extant literature on key theoretical models and the role of infrastructure in shaping domestic tourism trends.

2.1 Definition and key determinants of domestic tourism

Research on domestic tourism presents numerous definitions of the term. Llorca-Rodríguez et al. (2020) describe domestic tourism as a subjective concept that can be interpreted and applied differently depending on the circumstances and approaches of the researchers. Kabote et al. (2019), highlighted that the lack of generally accepted definitions makes it difficult to track the movement of domestic tourists, making this form of tourism, to some extent, an "invisible" part of overall tourism activity.

Over the years, researchers have proposed various definitions of domestic tourism, which often contradict each other. According to Bakari (2021), the concepts of "usual environment" and "second home" may overlap, making it difficult to include activities such as visiting relatives and friends as tourism activities. However, all definitions agree on one thing: domestic tourism refers to the movement of people within their country. some definitions focus on the distance traveled from one's usual place of residence, including same-day visitors, or exclude them (Ngondo et al., 2024). Other definitions limit domestic tourism to movements outside the "usual habitat" (Aggarwal et al., 2024), excluding visits to relatives and friends (VFR). Some researchers include all movements within the country (Apriyanti et al., 2024).

According to Song and Li, tourism demand can define as the quantity of tourism products consumed over a given period under different conditions (Song & Li, 2008). Echoing this the study of Stabler et al. (2010) also note the economic nature of tourism demand, whereby tourism demand depends on income, preferences, and prices. Moreover, psychological and social factors also play a role in shaping demand.

Quantitative methods dominate in conducting analysis and forecasting tourism demand. (Song et al., 2010) divide analysis and forecasting methods into the following groups: time series models and econometric models. Time series models analyze historical data and are cost-effective but lack causal relationships, while econometric models are excellent at examining interdependencies and providing policy recommendations. Several studies (Sarwoko et al., 2020; Taupikurrahman, 2022) confirm that econometric models are practical tools for understanding tourism demand.

The literature identifies various factors that influence tourism demand, which are broadly grouped into economic, social, psychological, and environmental factors. According to the literature, socio-economic determinants include income levels, demographic trends, urbanization and vacation timing (Song et al., 2010; Tovmasyan, 2023). Further, economic variables such as income, prices, and transport costs are key to shaping demand. For example, income elasticity of demand has been shown to significantly impact tourist arrivals and tourism receipts.

2.2 The role of infrastructure in domestic tourism

Tourism infrastructure is a fundamental determinant of domestic tourism development. According to the findings of Apriyanti et al. (2024), a well-developed tourism infrastructure, including transportation networks, lodging establishments, and tourist attractions, is critical in attracting domestic tourists. Bakari (2021) emphasizes that the

quality of the infrastructure directly affects tourist satisfaction and the competitiveness of a tourism destination. At the same time, Kabote et al. (2019) indicate that seasonality and uneven tourism distribution limit tourism development in many regions. These disparities often lead to overcrowding in popular destinations and underutilization of resources in less developed regions, further exacerbating regional imbalances.

Later studies by Poghosyan and Tovmasyan (2021) found that a lack of investment in tourism infrastructure remains a significant constraint to domestic tourism expansion in developing countries. Similarly, Murima and Shereni (2023) emphasized that insufficient infrastructure funding hinders sustainable tourism growth and limits the industry's potential. They argue that infrastructure investments should be regionally balanced to promote sustainable tourism growth.

2.3 Economic factors and tourism growth

Several studies have researched the relationship between macroeconomic factors and tourism demand. Song et al. (2010) categorize forecasting methods into time series models and econometric models. Time series models are intended to analyze historical data and trends, but they often lack exploring causal relationships. Econometric models are called to examine interdependencies between tourism and economic indicators, which makes them suitable for formulating policy recommendations (Sarwoko et al., 2020; Taupikurrahman, 2022).

The existing body of literature has consistently indicated that economic growth, measured by GDP, significantly impacts domestic tourism. Oladele et al. (2018) found that growth in GDP per capita increases disposable income, enabling higher spending on tourism activities. However, affordability remains a challenge. Murima and Shereni (2023) highlight that the high costs of tourism services often restrict residents from participating in domestic tourism. Similarly, Bakari (2021) emphasizes that accommodation expenses present a significant barrier, particularly in developing countries.

3. RESEARCH METHODS

This paper uses a quantitative approach using econometric modeling based on assessing the key determinants (factors) affecting the development of domestic tourism in Kazakhstan. In addition, for the reliability of the analysis, other methods were used, including SWOT analysis, to assess the strengths and weaknesses, opportunities and threats shaping the tourism industry.

The scientific work is generally based on panel data obtained from official sources of the Bureau of National Statistics of the Republic of Kazakhstan. In particular, annual statistical reports on tourism, economic indicators and industry specifics of the tourism industry were also used. The panel data set covers the period from 2013 to 2024, which allows for a long-term assessment of domestic tourism trends over the past twelve years.

Data processing and analysis are performed using Excel for data structuring and visualization. Additionally, the Gretl tool was used for correlation and regression modeling and trend analysis. It is noteworthy that the paper uses a structured econometric approach that begins with identifying key economic and infrastructural variables that affect tourist flows, followed by the formulation of hypotheses that suggest the impact of macroeconomic indicators such as GDP, the share of tourism in GDP, the number of tourism-related organizations, and the profitability of accommodation on tourist flows. development of the tourism sector.

This methodological framework combines quantitative and qualitative methods to comprehensively assess the factors determining domestic tourism. It offers empirical evidence that contributes to developing effective tourism development policies and strategies.

So, the steps of the study are shown in Figure 1.

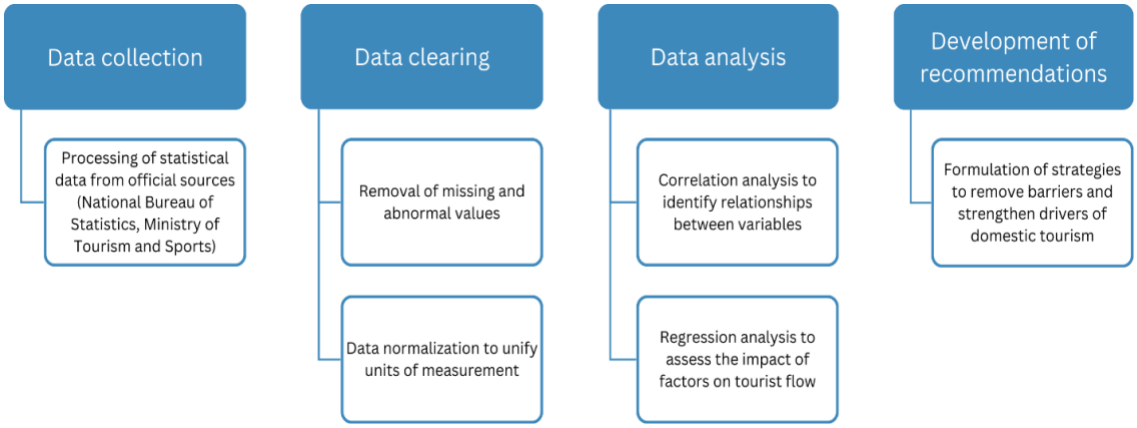


FIGURE 1. Research stages

Note: compiled by authors

The quantitative research methods used include correlation analysis, which identifies the degree of connection between independent variables (such as the number of accommodation facilities) and the dependent variable (tourist flow), and regression analysis, which constructs a model of the dependence of tourist flow on infrastructure factors, seasonality, and employment.

The multiple regression model formulated in the study has the following appearance by formula (1):

$$Tourists = \beta 0 + \beta 1 \times \text{GDP} + \beta 2 * \text{Share\_of\_Tourism\_GDP} + \beta 3 \times \text{Organizations} + \beta 4 \times \text{Accom\_Revenue} + \beta 5 \times \text{Hotel\_Occup} + \epsilon \quad (1)$$

where:

Tourists – the dependent variable that reflects the number of domestic tourists (in thousands of people);

β0 – the constant or free term of the regression that describes the level of the number of tourists at zero values of all explanatory variables;

β1, β2, β3, β4, β5 – coefficients for explanatory variables showing the strength and direction of the influence of each variable on the number of tourists;

ϵ – random error of the model, which includes factors not considered in the model.

The study combines quantitative and qualitative methods to provide a comprehensive analysis of domestic tourism. The chosen methodology ensures the representativeness and reliability of the findings, which allows the offer of practically applicable recommendations for the sustainable development of domestic tourism in Kazakhstan.

4. RESULTS AND DISCUSSION

The study involved constructing an econometric model to identify and quantify the key factors influencing the number of domestic tourists. The model was estimated using the ordinary least squares (OLS) method based on data from 2013–2024. The econometric analysis included an estimate of the regression coefficients (Table 1), an analysis of their statistical significance, and a test of the model for autocorrelation (Table 2). Additionally, graphs were constructed to demonstrate the trends of the variables under study (Figure 2) and time series (Figure 3).

In Table 1, there are results for least squares model.

TABLE 1. Least squares model, observations from 2013-2024

Predictors	Coefficient	St. error	-statistics	p-value
const	-4.98584e+06	1.96140e+06	-2.542	0.0440
GDP	0.0508075	0.0117957	4.307	0.0051
Share_of_tourism_GDP	447484	170463	2.625	0.0393
Organizations	637.838	277.987	2.294	0.0616
Accommodation_Revenue	-0.00481190	0.00592297	-0.8124	0.4476
Hotel_Occupancy	115301	69385.9	1.662	0.1476

Note: compiled by authors

The model estimates the influence of various factors on the dependent variable. Significant predictors ($p < 0.05$) include GDP ($\beta = 0.0508$, $p = 0.0051$) and the share of tourism in GDP ($\beta = 447484$, $p = 0.0393$), which indicates a statistically significant influence of these factors. The number of organizations also has an impact ($p = 0.0616$), but it is borderline significant. Revenue from accommodation ($p = 0.4476$) and hotel occupancy ($p = 0.1476$) had a considerable effect.

In Table 2, there are results for multiple linear regression model.

TABLE 2. Results of the analysis of the multiple linear regression model

Category	Metric	Value
Model Fit	R-squared	0.978973
	Adjusted R-squared	0.961450
	F-statistic (5,6)	55.86861
	P-value (F-statistic)	0.000060
Error Statistics	Sum of squared residuals	4.78e+11
	Standard error of the model	282,306.1
	Standard error of weighted variable	1,437,830
Model Selection Criteria	Log-likelihood	-163.4773
	Akaike Information Criterion (AIC)	338.9547
	Schwarz Criterion (BIC)	341.8641
	Hannan-Quinn Criterion	337.8775
	Durbin-Watson statistic	2.554366

Note: compiled by authors

The average value of the dependent variable is 4,560,958 (thousand tourists), while the standard deviation of the dependent variable is 1,437,830. R-square: 0.978973, which indicates that the selected independent variables explain 97.9% of the variability in the number of tourists. The corrected R-squared is 0.961450, which confirms the high explanatory power of the model, even considering the number of factors included. F-statistic: 55.86861 with a p-value of 0.000060 indicates the significance of the overall model. Checking the model problems - Durbin -Watson statistics ($DW = 2.554366$): a value close to 2 indicates the absence of autocorrelation of the residuals, confirming the model's reliability.

In Table 3, there are presented results for coefficient analysis.

TABLE 3. Interpretation of coefficients

Variable	Coefficient	Interpretation	P-value	Significance
Const (constant)	-4,985,840	Base value of the number of tourists (in thousands) if all independent variables are 0.	-	-
GDP	0.0508075	A 1 million tenge increase in GDP per capita is associated with an increase in tourists by ~50,808 people.	0.0051	Significant at 1% (very strong)

Share_of_ tourism_ GDP	447,484	A 1% increase in the share of tourism in GDP is associated with an increase of 447,484 tourists.	0.0393	Significant at 5% (strong)
Organization	637.838	Each additional tourism service organization is associated with ~638 more tourists.	0.0616	Significant at 10% (weak)
Accom_ Revenue	0.00481190	A 1,000 tenge increase in accommodation revenue is linked to a decrease of 4.81 tourists (not statistically significant).	0.4476	Not significant
Hotel_ Occupancy	115,301	A 1% increase in hotel occupancy is associated with 115,301 more tourists (not statistically significant).	0.1476	Not significant

Note: authors' elaboration

Thus, the key factors influencing the number of tourists are GDP per capita and the share of tourism in GDP. Less significant are the number of organizations and the indicators of income of accommodation facilities and hotel occupancy, which are statistically insignificant. Next, the paper analyzed the relationships between the number of tourists (Tourists) and key economic and tourism indicators (Figure 2).

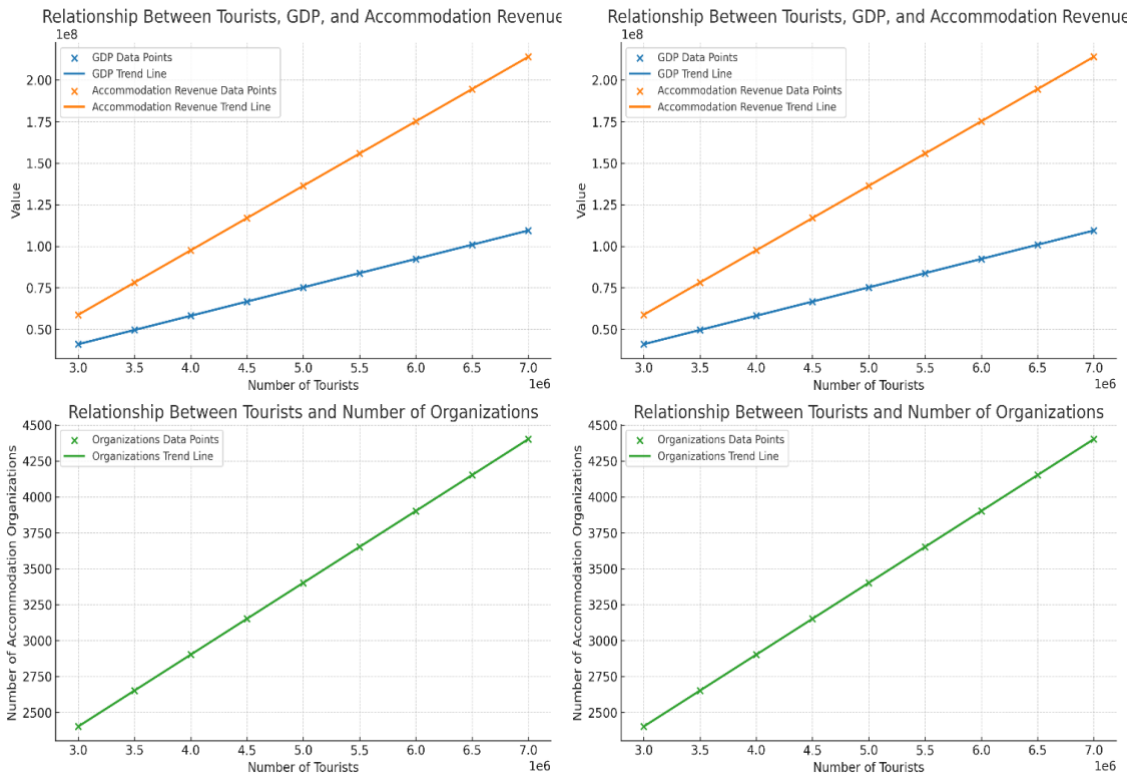


FIGURE 2. Tourism and economic growth: analysis of key factors

Note: authors' elaboration

1. *Number of tourists and GDP (GDP)* – this graph demonstrates a clear positive correlation between the number of tourists and the gross domestic product (GDP). The higher the GDP,

the more tourists. This indicates that the country's economic development stimulates the growth of tourist activity. Thus, GDP growth reflects an improvement in the economic situation, an increase in the population's income and investment in tourism infrastructure. In addition, GDP is an indicator of business activity that affects inbound tourism (for example, business tourism). Thus, GDP is an important factor in the growth of tourist numbers. Sustainable economic growth contributes to the increase of both domestic and inbound tourism.

2. *Number of tourists and the share of tourism in GDP (Share_of_Tourism_GDP)* - the graph shows a weak positive correlation between the number of tourists and the share of tourism in GDP. Although there are observations on the chart that deviate greatly from the general trend (probably periods of crisis or extreme growth), the overall relationship remains positive. The share of tourism in GDP increases, the growth in the number of tourists slows down. This may indicate a saturation effect: if the tourism sector becomes a significant part of the economy, its growth may be limited by internal factors (e.g., infrastructure limitations). At the same time, a decrease in the share of tourism during crises may not mean a drop in the number of tourists, but rather a relative decrease in the contribution of tourism against the background of growth in other sectors. Even though tourism and its share in GDP are closely related, sustainable growth requires measures to improve infrastructure and increase the share of high-income tourism (e.g., luxury or business).

3. *The number of tourists and the number of accommodation organizations (Organization)* – demonstrate a strong positive relationship when, with an increase in the number of accommodation organizations, the number of tourists also increases. This is logical since a more significant number of hotels and accommodation facilities allows for more tourists to be served. That is, an increase in the number of accommodation organizations indicates the development of tourism infrastructure. At the same time, a direct relationship confirms that the growth of the hotel industry stimulates tourism, providing tourists with a more significant number and variety of accommodation options. However, the concentration of organizations in certain regions can limit tourist flows to less developed areas. Consequently, for further growth of tourism, it is necessary to increase the number of accommodation organizations and evenly distribute facilities across regions.

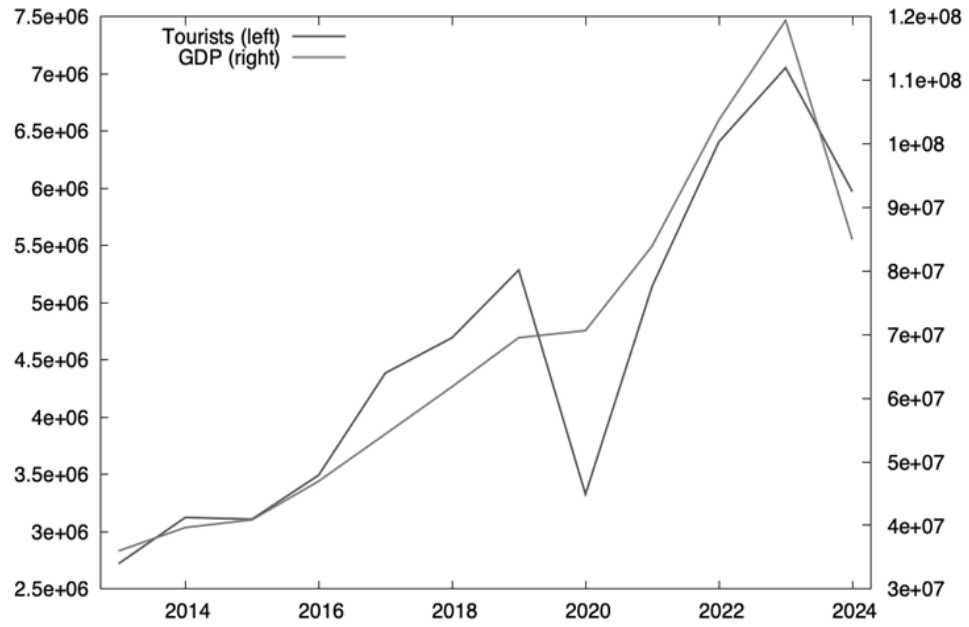
4. *Number of tourists and accommodation revenue (Accom_Revenue)* – in this case, the graph shows a moderate positive correlation: as accommodation revenue increases, the number of tourists increases. However, certain deviations may be due to the influence of seasonality and the level of accommodation prices. The income of accommodation facilities depends on the number of tourists and the average accommodation cost. This explains the imperfect correlation: high revenues can be observed with a smaller number of tourists due to an increase in the cost of accommodation. Significant deviations from the general trend may also indicate periods when revenue growth occurred due to higher prices rather than increased tourists. It is necessary to increase the tourist flow and ensure the availability of quality offers on the mass market to achieve sustainable growth in the income of accommodation facilities.

5. *Number of tourists and hotel occupancy (Hotel_Occupancy)* – the correlation between the number of tourists and hotel occupancy is observed but not very strong. An increase in the number of tourists does not always lead to an increase in hotel occupancy, as tourists may choose alternative accommodation options. It is necessary to consider seasonal fluctuations and develop strategies to attract tourists during the low season and increase hotel occupancy.

The key factors for tourism growth include economic development (GDP), which plays a significant role in increasing tourist flow; the development of tourism infrastructure and the increase in the number of hotels also stimulate tourism. Constraining factors include seasonality and uneven distribution of tourism infrastructure. Individual indicators, such as

the share of tourism in GDP or hotel occupancy, require an integrated approach to improve efficiency. To ensure stable growth, developing tourism in less-developed regions and supporting market segments associated with high incomes (e.g., business or elite tourism) is important.

Next, Table 3 presents a time series analysis for key tourism indicators.



Note: authors' elaboration

These graphs allow for an in-depth analysis of each trend, a more accurate assessment of the situation, and identifying key aspects influencing tourism development.

1. *The number of tourists (Tourists)* has had a clear positive trend since 2013, and key trends have been identified. Between 2013 and 2019, there was gradual and stable growth in the number of tourists, which is associated with developing tourism infrastructure and improving the economic situation. 2020, a sharp decline can be attributed to the COVID-19 pandemic and the introduction of travel restrictions between 2021–2024: post-crisis recovery. Since 2022, tourist numbers have exceeded pre-crisis levels, with a significant recovery in the tourism industry driven by increased domestic tourism and the lifting of restrictions.

2. *Gross domestic product (GDP)* has shown steady growth throughout the analyzed period, wherein the period from 2013 to 2019 there was steady growth, which reflects the stable development of the economy, then 2020 with a slowdown in growth rates during the pandemic, and finally in 2021 to 2024 there is accelerated GDP growth, which is associated with the recovery of the economy after the crisis, the implementation of anti-crisis measures and an increase in business activity. GDP growth creates opportunities for increasing public and private investment in tourism. The positive trend of GDP indicates favourable conditions for tourism development. Economic growth can become a platform for large-scale investment projects in the tourism industry.

3. *The share of tourism in GDP* fluctuated from 2013 to 2018. Then, from 2019 to 2021, there was a decline associated with the pandemic and a reduction in the volume of tourism activities. From 2022 to 2024, a gradual recovery in the share of tourism was noted, but not yet to the level of 2018. The

decline in the share of tourism in GDP, especially in 2020, was affected by the reduction in tourist flows despite the overall growth of GDP. Recovery is possible only if conditions are created for domestic and inbound tourism growth.

4. *Number of accommodation organizations (Organization)* - the dynamics show a stable growth in the number of accommodation organizations during 2013–2024. The increase in growth rates after 2020 is likely due to investments in the development of domestic tourism. A steady increase in hotels and other accommodation facilities improves the infrastructure for receiving tourists. However, growth in 2021–2024 may be uneven, with new accommodation facilities concentrated only in the most popular regions. The increase in the number of accommodation establishments creates a solid basis for tourism growth but requires support in the form of an even distribution of investment across regions.

5. *Accommodation revenue (Accom_ Revenue)* is growing but fluctuating sharply, with steady growth from 2013 to 2019 due to increased tourists and improved infrastructure. Then, in 2020, there was a sharp decline in revenue due to the pandemic, with a recovery period from 2021–2024. Seasonality of demand and external factors such as the pandemic significantly affect the sector's profitability. Insufficient attention to the development of off-peak tourism may limit further growth. Against such fluctuations attention must be paid to the diversification of tourism products to smooth out seasonal fluctuations and minimize the risks from external shocks.

6. Signficant fluctuations also characterize *Hotel occupancy (Hotel_Occupancy)*. Before the pandemic, there was a slight increase (2013-2019), indicating the development of the sector; then a sharp decline due to the pandemic (2020) and a gradual recovery (2021-2024), but the occupancy level remains unstable. The identified fluctuations indicate problems in demand management: the tourist infrastructure is used unevenly. Seasonal factors have a strong influence and thus, it is necessary to develop measures to stimulate tourism during the low season, such as special promotions and new tourist services.

To develop strategic measures for the tourism industry's sustainable development, we should assess its strengths, weaknesses, threats, and opportunities.

In Table 4, there is presented SWOT matrix and justify the proposals.

TABLE 4. SWOT analysis of the tourism industry of the Republic of Kazakhstan

Strengths	Weaknesses
GDP growth and positive correlation with tourism: – economic development promotes growth of tourism activity; – high GDP stimulates investments in tourism infrastructure and improves purchasing power of the domestic population. Increase in the number of accommodation organizations: – the growing number of hotels and other accommodation facilities makes it possible to serve a larger number of tourists, improving the offer and quality of services; – stable income from accommodation revenue; – accommodation revenues show steady growth, indicating active development of the tourism sector and increased demand for accommodation. Development of tourism infrastructure: the number of accommodation facilities and investment	Uneven distribution of tourism infrastructure: – tourism infrastructure is concentrated in certain regions, which limits the development of tourism in peripheral and rural areas. Seasonality of tourist demand: – hotel occupancy and accommodation revenues are highly dependent on seasonal fluctuations, which reduces the stability of the industry. Restrictions in the high-margin tourism segment: – the prevalence of mass tourism may reduce the profitability of the industry. the luxury, business and cultural tourism segments remain underdeveloped. Weak adaptation to external crises: unpredictable external factors (pandemics,

in infrastructure indicate progress, especially in developed regions.	economic crises) can have a strong impact on tourism, as recent events have shown.
Possibilities	**Threats**
Development of domestic tourism: – growing interest in domestic tourism creates opportunities to improve regional infrastructure and promote national cultural attractions. Innovation and digitalization: – the introduction of digital technologies (online booking, virtual tours, demand management systems) can increase the convenience and attractiveness of tourism services. Diversification of tourism products: – the development of ecotourism, agrotourism, cultural and event tourism will attract new categories of tourists. Government support: – subsidies, tax incentives and tourism development programs can increase the attractiveness of the industry to investors and stimulate its development.	External economic and political factors: – economic sanctions, currency fluctuations, inflation and political instability can negatively impact the tourism industry. Competition from international tourism: – lower prices for overseas travel could divert domestic demand, especially among high-income tourists. Environmental issues: – mass tourism can have negative impacts on the environment, especially in popular tourist destinations. Shortage of qualified personnel: – the growth of the sector requires more skilled workers, and a lack of professional training may limit development; – strategic measures for sustainable development.

Note: compiled by authors

Based on the SWOT analysis, the following measures are proposed:

1. Development of regional tourism, with a focus on tourism infrastructure in peripheral regions, including improving transport accessibility, developing hotels, promoting local attractions. The implementation of this measure will reduce the burden on popular destinations, increase the influx of tourists to remote areas and ensure more uniform development of the industry.

2. Diversification of the tourism product by creating and promoting new tourism products, such as agrotourism, ecotourism, cultural and historical tourism, event tourism (festivals, conferences). This activity will help attract different categories of tourists, reduce dependence on seasonality and increase the competitiveness of domestic tourism.

3. Development of elite and business tourism, creation of conditions for attracting high-income tourists through investments in elite hotels, conference halls, premium resorts. These measures will increase the profitability of the industry, raise the international status of tourist destinations and strengthen the economy.

4. The introduction of digital technologies based on the creation of digital platforms for tourism management, including booking systems, mobile applications for tourists, and the promotion of virtual tours, will increase the convenience of trip planning, improve the tourist experience, and attract more youth audiences.

5. State support and sustainable development will contribute to tourism development (e.g. through tax incentives for hotels, subsidies for infrastructure development, and personnel training programs). Measures for environmentally responsible tourism are also needed through the introduction of eco-certificates, development, and application of sustainable practices. Government support will encourage investment, while sustainable tourism will reduce environmental threats and improve the country's image.

6. Anti-crisis strategies, including the creation of reserve programs to support the tourism industry in the event of economic or external crises. This measure will help mitigate the impact of unpredictable factors and maintain the sustainability of the industry. Sustainable development of the tourism

industry requires a diversified approach, including strengthening regional tourism, creating new tourism products, digitalization and introducing environmentally responsible practices. Support from the state and business initiatives will ensure not only an increase in the number of tourists, but also an increase in the industry's profitability, its resilience to external threats and contribution to the country's economic development.

Thus, based on the obtained results, the following conclusions can be made: firstly, an increase in GDP per capita and the share of tourism in GDP are the main drivers of growth in the number of tourists; secondly, an increase in the number of organizations providing tourist services also has a positive effect, but weaker. At the same time, the income of accommodation places (Accommodation_ Revenue) and hotel occupancy (Hotel_ Occupancy) do not have a statistically significant effect on the number of tourists in this model. As a recommendation for increasing the number of tourists, emphasis should be placed on economic growth and an increase in the contribution of tourism to GDP. Hotel accommodation revenue and occupancy rates may be better considered in separate models that focus on the economic performance of the hotel business.

Economic factors have a significant impact on tourism development - GDP growth has a direct and significant impact on attracting tourists. This suggests that improving the overall economic situation in the country stimulates tourism. Improving the income level of the population also increases domestic travel. Share of Tourism in GDP is an indicator of the importance of the industry for the economy. An increase in this share has a positive effect on the number of tourists.

The role of tourism infrastructure:

Number of organizations (Organizations) in the tourism sector, including hotels, recreation centers, and other facilities, has a positive effect on the influx of tourists. An increase in the number of such organizations stimulates the development of tourism by improving the availability of services.

Despite weak statistical significance, variables such as Accommodation Revenue and Hotel Occupancy rates still reflect the state of the infrastructure and can be important for improving the overall level of comfort and quality of services.

1. Potential of domestic tourism. Hotel occupancy rates in recent years (23-27 % on average) and growth in accommodation revenues indicate that domestic tourism already plays an important role in the economy. However, low rates during periods of crisis (e.g. 2020) show the vulnerability of the industry to external economic shocks and pandemics.

2. Weaknesses of the current model: Weak statistical significance of the indicators Accommodation Revenue and Hotel Occupancy may indicate insufficient development of infrastructure or that domestic tourism is not yet sufficiently supported at the state level.

As a result of the conducted research, the following recommendations for the development of domestic tourism can be formulated:

1. Priority areas in the development of tourism infrastructure:

- Expansion and improvement of accessibility of tourist sites at the expense of increasing the number of tourism organizations such as hotels, hostels, recreation centers, campsites, and other infrastructure facilities ; and investing in the construction of modern middle- and economy-class hotels to attract broad sections of the population, as well as the development of unique tourism products (for example, ethno-tourism, eco-tourism, cultural and historical routes), which will increase interest in domestic tourism.

- Modernization of transport infrastructure, improvement of accessibility of tourist areas through construction and repair of roads, railways and airports, development of the network of domestic air and rail communications to reduce the time and cost of travel.

- Digitalization of tourism infrastructure by way with the creation and promotion of online

platforms and applications that will allow tourists to book accommodation services, buy tickets and find information about tourist routes, as well as the implementation of digital solutions for assessing tourist feedback (for example, tourist ratings, reviews of accommodation and holiday destinations).

2. Economic policy to support domestic tourism:

- State subsidies and tax incentives - provision of tax preferences for the hotel business and tour operators working with domestic tourists, with subsidies for the development of new tourist infrastructure facilities in remote regions.
- Stimulating domestic tourism by means of from creating cashback programs for domestic tourists (for example, returning part of the cost of accommodation or transportation), to organizing marketing campaigns to popularize domestic tourist destinations.
- Support for small and medium-sized businesses in the tourism sector at the expense of preferential lending for small hotels, campsites, cafes and restaurants operating in tourist areas, and the introduction of a training and certification program for local staff in the hospitality industry.

3. Improving the quality of services provided:

- Personnel training and certification – development programs for advanced training for workers in the tourism sector to ensure high quality service and hospitality, the creation of public or private training centers for training guides, hotel managers, and restaurant workers.
- Improving service standards by implementing national quality standards in the tourism sector (for example, standards for hotels, restaurants, tourist routes), conducting regular audits and monitoring the quality of service to tourists.

4. Development of new tourist destinations - inclusion in domestic tourism programs of regions with unique nature, historical or cultural heritage (for example, Altai, the Caspian Sea, Tien Shan), promotion of ecological and active tourism (for example, trekking, mountaineering, trips to nature reserves), creation of complex tourist routes with an emphasis on cultural and historical heritage.

5. CONCLUSIONS

The tourism industry is one of the key sectors of the economy that contributes to strengthening regional development, increasing employment, and stimulating social integration. The study examined key economic indicators that influence the development of domestic tourism and the dynamics of their changes based on time series and correlation analysis.

As a result of the study, the following factors significantly impact the development of domestic tourism: economic factors, such as the growth of GDP per capita and an increase in the share of tourism in the economy, stimulate the growth of tourist flows; and infrastructure factors, such as an increase in the number of tourism organizations, expand the availability of tourism services. At the same time, certain aspects were identified that require further attention. For example, variables such as accommodation revenues and hotel occupancy showed weak statistical significance.

The following proposals for changing scientific knowledge and practice are formulated based on the analysis: The need for a systemic approach to developing tourism infrastructure is substantiated. The growth in the number of tourism organizations and the improvement in services provided are directly related to the increase in tourist flows. This conclusion confirms the importance of long-term investment in infrastructure.

The impact of economic policy on the development of domestic tourism has been established. The tourism industry is susceptible to economic shocks and supportive measures from the state, emphasizing the importance of fiscal and administrative initiatives such as tax incentives and subsidies. The development of domestic tourism should take into account regional characteristics and potential, such as

historical and cultural heritage, natural attractions, and the economic activity of the population. The results contribute to the scientific understanding of the factors influencing tourism development in transition economies such as Kazakhstan. A comprehensive combination of economic incentives, infrastructure investments, and government support programs can increase the importance of domestic tourism in the national economy.

The study identified several promising areas for future research: an analysis of the impact of the quality of transport infrastructure and accessibility on the development of domestic tourism and a study of the behavioural factors and preferences of domestic tourists for a more accurate assessment of demand, and the development and testing of sustainable tourism models taking into account the environmental and cultural characteristics of the regions of Kazakhstan. Thus, this study's results provide a basis for further empirical and applied research and for the development of effective public policy strategies in the field of tourism.

Kazakhstan must balance infrastructure investment and economic support to develop domestic tourism effectively. Demand stimulation programs such as cashback, marketing, and preferential lending will complement long-term infrastructure and personnel training investments. Only a comprehensive approach will increase tourist flow, enhance the industry's economic importance, and stimulate the country's economic growth. The research confirms that domestic tourism development is a significant factor in the growth of the national economy.

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Resources: Zarina Toleubayeva.
Software and supervisions: Kamshat Mussina.
Data collection, analysis and interpretation: Kamshat Mussina.
Visualization: Zarina Toleubayeva.
Writing review and editing research: Kamshat Mussina.

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Econometric Analysis of the Tourist Flow in Kazakhstan: Trends, Factors and Forecasts

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ABSTRACT

Tourism is an important economic sector that has a multiplier effect on employment, investment, and infrastructure development. However, tourist flows are subject to significant fluctuations caused by external and internal factors. This study aims to analyze the dynamics of tourist flow in Kazakhstan, identify key factors influencing the sector's profitability, and forecast its future development. Research methods include econometric analysis, studying the elasticity of demand, the sensitivity of tourism revenues to various factors, and forecasting the future state of the industry using the Markov model. The results showed that the tourist flow in Kazakhstan is characterized by high variability. The elasticity analysis revealed that a 1% decrease in air ticket prices increases the number of tourists by 0.75-11.3% over the years. Elasticity analysis showed that changes in airfare prices affect the number of tourists, and income sensitivity helped to identify which parameters – the number of tourists, the cost of accommodation, or the number of international flights – have the most significant impact on the financial sustainability of the industry. The forecast showed a 73.5% probability of tourism growth in 2024-2025 but a possible decrease after 2026. The results showed that the tourist flow in Kazakhstan is characterized by high variability, is subject to seasonal and crisis fluctuations, and requires a systematic approach to management. Future research may focus on developing strategies to reduce tourism's dependence on external crises and create mechanisms to ensure its sustainable development.

KEYWORDS: Tourism, International Tourism, Tourism Business, Seasonal Fluctuation, Global Economy, Economic Growth

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1. INTRODUCTION

Tourism is one of the leading sectors of the global economy, ranking third among the most significant export categories after fuel and chemical products. Its contribution to global GDP in the pre-COVID period was 10.4%, and international tourist flows reached 1.5 billion people. Tourism is an important sector of the economy worldwide, contributing to GDP growth, job creation, and infrastructure development. It is essential for developing countries, where tourism provides an influx of foreign currency and contributes to economic growth, but its potential has not yet been fully realized.

Tourism has a multiplier effect on related industries such as transport, hospitality, and retail. One of tourism's most important aspects is its environmental impact. High energy consumption levels, CO2 emissions, and an increase in anthropogenic load accompany tourism activity. Research shows that tourism is directly related to greenhouse gas emissions: it accounts for about 5% of global CO2 emissions, 75% for transport and 50% for air travel. However, implementing sustainable tourism practices can reduce negative environmental impacts, as studies in several countries confirmed. Tourism plays a vital role in the economies of many countries, providing jobs, stimulating investment, and developing infrastructure. According to the World Tourism Organization (UNWTO), before the COVID-19 pandemic, tourism accounted for about 10% of global GDP, and the industry provided every tenth job. However, after the pandemic, the tourism sector faced sharp fluctuations. In 2021, the number of international trips remained 71% below 2019. However, a partial market recovery was observed in 2022, and 2023 is predicted to mark a return to pre-crisis levels.

In many countries, tourist flow management has become integral to public policy. For example, Spain actively uses Big Data and artificial intelligence technologies to forecast demand, manage seasonal fluctuations, and distribute tourists by region. France has introduced methods for analyzing social networks and online platforms to assess traveler preferences and adjust marketing strategies. Thailand uses econometric models to forecast tourism revenues and optimize air traffic, while the UAE and Japan use cluster analysis and dynamic pricing to manage the load on tourism infrastructure. Tourism development is also of strategic importance for Kazakhstan. With unique natural resources, cultural heritage, and potential for developing eco- and adventure tourism, the country can significantly increase its industry contribution to the economy.

In the current context, special attention is paid to the issues of the industry's recovery after the pandemic and the potential of sustainable tourism models as a tool for economic growth and poverty reduction, especially in developing countries. However, one of the key problems remains the high variability of tourist flow, dependence on international air travel, and seasonal fluctuations in demand. This study aims to analyze the dynamics of tourist flow in Kazakhstan, identify key factors influencing the sector's profitability, and forecast its future development.

2. LITERATURE REVIEW

Tourism plays a key role in economic development (Akbar et al., 2017), but its impact depends on many factors, including income levels, quality of infrastructure and government policies. Tourism is a source of long-term growth, stimulating the economy by increasing the inflow of foreign investment, creating jobs and helping to revive consumer demand. Moreover, low-income countries find it more difficult to exploit the tourism potential due to a lack of infrastructure and institutional constraints.

The impact of tourism depends on the degree of its integration into the country's economy (Pablo-Romero & Molina, 2013). Thus, in economies mainly focused on service exports, the contribution of tourism is higher than in countries with diversified economies.

Jucan and Jucan (2013) examined the experience of Romania, where tourism became one of the most critical drivers of recovery after the 2008 economic crisis and identified tourism as a factor in economic recovery after crises. Therefore, the impact of tourism on GDP growth varies depending on a country's infrastructure level and macroeconomic policies.

Tourism significantly impacts GDP growth, with a 10% increase in international tourist expenditure leading to a 0.4% increase in GDP (Fayissa et al., 2008). However, Du et al. (2014) found that although tourism has a positive impact on the economy in most cases, it is not always a sufficient growth driver. They noted that economic determinants such as investment levels and human capital levels play an equally important role. Therefore, the social and financial status of the population translated into income increase, which results in tourists seeking more unique and environmentally sustainable places to travel, leading to increased competition among countries for tourist flows (Dwyer, 2015). Thus, it is worth considering tourism development's economic benefits and social and institutional aspects. Goffi et al. (2018) and Rahman et al. (2022) noted that environmental and social factors directly affect the attractiveness of the tourism sector in developing countries. Countries implementing sustainable practices have a competitive advantage, as modern tourists increasingly choose environmentally friendly destinations. Li et al. (2018) identify several ways tourism contributes to growth: capital accumulation, poverty reduction, improvement of quality of life, and infrastructure development. However, in countries with unstable economies, tourism can exacerbate social inequality.

In addition to affecting the overall tourist flow, economic instability has a powerful impact on business tourism, which is more sensitive to crises. Tsui et al. (2017) identified four key determinants of business tourism flows: the New Zealand Economic Uncertainty Performance (EPU) index and the volume of bilateral trade, and two non-economic factors, flight distance and the number of direct flights. Summing up, active trade relations between the countries contribute to an increase in the flow of business tourists. At the same time, long distances reduce the intensity of travel, and direct flights increase the convenience of travel and contribute to the growth of business tourism.

Unexpected non-economic factors (terrorist attacks, natural disasters, and military conflicts) significantly impact stock markets. However, the nature of the response varies depending on the type of event and the region (Zopiatis et al., 2019). Thus, economic crises have a heterogeneous impact on tourist flows: inflationary crises have the most negative impact on international tourism, reducing it in receiving and sending countries (Khalid et al., 2019; Kyrylov et al., 2020). However, sovereign debt crises increased international tourist arrivals in host countries as currency devaluations made tourism more affordable (Duan et al., 2022). Banking crises mainly reduced tourist flows in the Americas and Latin America but had virtually no impact on tourism in Asia and the Middle East. Thus, using the example of European countries, Palazzo et al. (2022) showed that countries' income level is an important factor in determining the extent of recovery since, although tourism partially began to recover from the pandemic, the recovery was uneven.

The tourism industry is vulnerable to external economic shocks related to changes in energy prices, which affect the demand for air travel, accommodation, and tourist spending. In addition, rising fuel costs significantly reduce the number of international tourists, especially from long-distance destinations, as higher airfares reduce the affordability of travel. Furthermore, Becken and Lennox (2012) showed that tourists' responses to price changes vary depending on distance, travel motivation, and income. Peng et al. (2014) showed that tourists from different regions respond differently to income changes, with the highest elasticity observed for European tourists (3.419) and the lowest for African tourists (1.147). In addition, long trips have a

higher income elasticity than short trips, suggesting that rising wealth encourages longer and more frequent trips. Seetaram et al. (2016) investigated the elasticity of outbound tourism demand. They found that the real exchange rate yields a very low elasticity (-0.002), while the price competitiveness index more accurately reflects tourists' sensitivity to price changes (-1.07). Thus, to accurately forecast tourism demand, it is necessary to consider not only macroeconomic indicators but also the specific characteristics of price competitiveness in each market. Morlotti et al. (2017) found that the elasticity of demand varies significantly depending on various factors that affect the decision-making behavior for traveling.

The most common factors include route type, season, and booking time. Moreover, low-competitive routes exhibit lower elasticity since consumers have fewer alternative options. Therefore, low-cost airlines can flexibly manage prices, stimulating demand depending on the season, competitive environment, and passenger type. Balcilar et al. (2020) found that short-term economic shocks, such as financial crises, can sharply reduce outbound tourism demand while the sector's recovery is slow. Matsuura and Saito (2022) confirmed that in the post-COVID-19 period, the government's travel support program stimulated domestic tourism. However, the effect of subsidies depends on the level of perceived risk: in regions with high COVID-19 infection rates, even subsidies failed to significantly increase travel. In addition, tourism is influenced not only by macroeconomic indicators but also by social factors such as the level of trust in the economy and the availability of tourism offers. Stråle (2022) found that households with low tourism expenditures show the highest elasticity, meaning that their travel habits are more sensitive to changes in income. At the same time, wealthier households are less elastic, indicating that their travel behavior remains relatively stable regardless of the economic situation.

Before the pandemic, hotel room prices were determined mainly by seasonality and significant events, but the COVID-19 crisis has seen a considerable drop in prices (Wu et al., 2020). However, demand seasonality appears to be much more pronounced than price seasonality, indicating the important role of pricing policy in mitigating demand fluctuations (Lozano et al., 2020). Korinth (2022) noted that countries with high tourism dependence experienced the most significant financial losses, while developed economies were able to adapt more quickly by diversifying their tourism products and supporting the sector. At the same time, developing countries faced a prolonged downturn, as their recovery depended on external factors such as the resumption of international flights. Perić et al. (2022) found that increased tourist arrivals pressure accommodation prices, especially in regions with high tourist facilities. However, they also found that the development of the hotel sector can partially offset this effect, as the growth of hotels reduces the demand for short-term rental housing, stabilising prices. Thus, governments seeking to develop tourism should consider its impact on the real estate market and provide mechanisms to maintain housing affordability.

An analysis of the literature shows that tourism plays a vital role in economic development. However, its impact is determined by many factors, including the macroeconomic situation, the population's income level, investments in infrastructure, and government policy. The contribution of tourism to a country's GDP is exceptionally high in those focused on exporting services. However, its effect on economic growth is not universal and depends on factors such as investment and human capital. Social and environmental aspects are also becoming increasingly important. Modern tourists prefer environmentally sustainable destinations, which creates competitive advantages for countries implementing “green” practices. At the same time, tourism can exacerbate social inequality in unstable economies.

Analysis of existing studies has shown that several factors, including the key roles of tourist flow, the dynamics of accommodation

prices, and air travel, significantly influence tourism development. These indicators form the basis for assessing the sustainability of tourism and its susceptibility to macroeconomic and social changes. It is important to consider that tourism is subject to external shocks, such as economic crises, changes in energy prices and pandemics, which require constant monitoring of its sustainability. In addition, differences in the elasticity of tourism demand depending on the region and socio-economic status of the population emphasize the need for a detailed analysis of the factors influencing tourism activity. The review of existing studies allowed us to highlight following factors which are regarded as main factors of tourism development: tourist flow, price change for accommodation and flights. Therefore, it is important to analyse the sustainability of tourism and its sensitivity to external factors.

3. RESEARCH METHODS

The study uses quantitative analysis methods to identify key factors influencing the dynamics of the tourist flow in Kazakhstan. The main focus is assessing the elasticity of demand for tourism services, the sensitivity of industry revenues to changes in the external environment, and forecasting possible scenarios for the development of the sector. To achieve these goals, econometric tools were used, including the analysis of demand elasticity, modeling the sensitivity of income to price and infrastructural changes, as well as forecasting the dynamics of tourist flow using the Markov chain model. First of all, the elasticity of demand for tourism was calculated, which makes it possible to determine the degree of dependence of the number of tourists on changes in the cost of air travel. The demand for tourist trips, especially in the international segment, directly depends on the prices of air tickets. The elasticity analysis makes it possible to assess the sensitivity of the tourist flow to price changes, which is a key indicator for further research.

Next, the analysis of the sensitivity of tourism income to the primary factors, such as the number of tourists, the cost of accommodation, and the number of international flights, was carried out. The variables that have the most significant impact on the industry's financial stability have been identified, taking into account the revealed patterns of changes in the tourist flow. At the final stage, a forecast of the future dynamics of the tourist flow was carried out, allowing it to fix existing trends and determine the likely scenarios for further development. The probability of various industry conditions, including growth, recession, and stability, is estimated. This analysis is especially important for strategic planning: a high probability of recession requires the development of measures to support the industry, while steady growth opens up opportunities for its scaling.

The leading indicators used in the analysis of the tourism sector of Kazakhstan are presented in Table 1.

TABLE 1. Indicators of tourism in Kazakhstan

Indicator	Description	Applied analysis
International tourists (mln)	Total number of foreign visitors to Kazakhstan	Elasticity & Forecasting
Domestic tourists (mln)	Total number of Kazakhstani citizens traveling domestically	Trend Analysis
Revenue from international tourism (bln tenge)	Total revenue generated from inbound tourism	Revenue Sensitivity Analysis
Number of international flights	Total number of incoming international flights	Revenue Sensitivity & Forecasting
Average airfare price (tenge)	Average price of international airfare to Kazakhstan	Elasticity Analysis
Average hotel price (tenge/day)	The average daily cost of a hotel stay	Revenue Sensitivity Analysis

Note: compiled by authors

Thus, this paper aims to gain a deeper understanding of the dependence of the tourism sector on price and economic factors, as well as assess the prospects for its sustainable development. An integrated approach, including analysis of elasticity, income sensitivity, and forecasting, allowed us to obtain a holistic view of the mechanism for the formation of the tourist flow and its role in the economy of Kazakhstan. A sensitivity analysis of tourism income was used to assess the impact of key factors on the industry's profitability, which made it possible to determine which parameters have the most significant impact. Sensitivity was calculated using the formula (1):

$$S = \frac{\%\Delta D}{\%\Delta X} \qquad (1)$$

where:

S – revenue sensitivity;

$\%\Delta D$ – percentage change in tourism revenues;

$\%\Delta X$ – percentage change in one of the factors (number of tourists, average accommodation cost, or number of international flights).

To assess the elasticity of tourism demand, the following formula (2) was used:

$$E = \frac{\%\Delta T}{\%\Delta P} \qquad (2)$$

where:

E – demand elasticity;

$\%\Delta T$– percentage change in the number of tourists;

$\%\Delta P$– percentage change in airfare prices.

Future tourism flow forecasting was conducted using Markov chain modeling. A transition matrix was constructed based on historical data, representing the probabilities of shifting from one tourism state (growth, decline, or stability) to another. The forecasted probabilities were determined using the following formula (3):

$$S_{t+1} = S_s \times T \qquad (3)$$

where:

S_{t+1}– current tourism flow state;

T– transition probability matrix;

S_s – predicted distribution of tourism state probabilities for the following year.

The developed approach for the analysis based on the sequence of elasticity → income sensitivity, → forecast allowed us to provide a logical structure for the study, moving from demand fundamentals to economic implications and possible future scenarios.

The use of an integrated approach to analyzing the tourism sector of Kazakhstan is due to the need to consider both macroeconomic and behavioural determinants. Income sensitivity analysis allows us to identify key factors that influence the industry's financial sustainability, and assessing the elasticity of demand helps determine how much changes in price and income affect tourist flows.

The Markov chain model is used to forecast tourism development, which allows for determining the probabilities of transition from one state to another (growth, stability, decline). The method's main advantage is the ability to take into account historical data and analyze the stability of trends over time. The Markov transition matrix is calculated based on changes in tourist flow over previous years and then used to model probable scenarios for the future state of the industry. This allows for assessing the sustainability of growth or identifying the risks of a possible decline, which is of practical importance for developing tourism regulation strategies.

A gradation system of changes was used based on relative growth rates to assess the dynamics of the tourist flow. If the change in the flow compared to the previous year did not exceed 5%, it was assigned the value "0" (stability); if the growth exceeded 5% - "1" (increase in flow); if the decline was higher than 5% - "-1" (decline). This approach is based on macroeconomic logic, according to which minor fluctuations within 5% are considered a

statistical norm and do not significantly impact the industry. This method allows us to identify critical changes and conduct more accurate forecasting based on the Markov model.

4. FINDINGS AND DISCUSSIONS

The data analysis made it possible to identify key patterns in the dynamics of the tourist flow in Kazakhstan, assess the impact of price and infrastructure factors on the industry, and predict possible scenarios for its development. This section presents the research results, including calculating the elasticity of demand for travel services, analyzing the sensitivity of tourism industry revenues to changes in airfare, cost of accommodation, and number of international flights, and predicting future trends using the Markov chain model.

One of the key aspects of the study was the study of the elasticity of demand, which makes it possible to determine how much the change in the cost of air travel affects the number of tourists arriving. The calculated elasticity indicators demonstrate the degree of sensitivity of the tourist flow to price changes and make it possible to identify periods when this factor had the most significant impact on the industry.

The main results of the analysis of the dynamics of the tourist flow and calculations of the elasticity of demand are presented in Table 2.

TABLE 2. Dynamics of changes in tourist flow and elasticity of demand

Year	Number of foreign tourists visiting Kazakhstan	The average price of air tickets for international flights	The elasticity of demand for tourism
2014	-7,42581	1,699381	-4,36972
2015	1,53166	1,670984	0,916621
2016	1,228616	1,64607	0,746394
2017	18,3131	1,616906	11,32602
2018	14,12804	1,591178	8,878977
2019	-7,66868	1,566256	-4,89618
2020	-74,923	1,542103	-48,5849
2021	966,3391	1,518683	636,3006
2022	16,12826	1,495964	10,78118
2023	-63,4918	1,473915	-43,077

Note: compiled by authors

The calculated values show that the demand for tourism in Kazakhstan varies significantly depending on external conditions and is sensitive to external changes. In some periods, changes in air ticket prices were accompanied by a significant increase or decrease in the number of tourists, while in other years, the impact of price fluctuations was minimal. During periods of economic growth and active development of the tourism sector, elasticity exceeded one. Demand was sensitive to changes in air ticket prices: when prices decreased, the tourist flow increased significantly, and when prices increased, a decline was observed. This situation is typical for 2017 and 2018, when there was active growth in international tourism in Kazakhstan. During this period, the impact of air ticket prices was especially noticeable. On the contrary, during years of economic instability and crises (2014, 2019, and 2023, when external factors such as global economic problems or changes in tourist preferences dominated demand), elasticity decreased sharply, sometimes acquiring a negative value. Moreover, even with a decrease in airfare prices, the flow of tourists did not increase; on the contrary, it decreased.

Particular attention should be paid to 2020-2021, when the tourism industry experienced unprecedented shocks due to the COVID-19 pandemic. In 2020, the elasticity of demand

took a negative value, which means that even a decrease in airfare did not lead to an increase in tourist flow. Strict restrictions were introduced, where strict sanitary measures and restrictions on movement affected international travel, border closures, and decreased population mobility.

In 2021, on the contrary, there was a sharp jump in elasticity when tourism demand recovered immediately after the restrictions were lifted. During this period, even a slight change in airfare led to a significant change in the flow of tourists. This effect was caused by deferred demand - people who could not travel in 2020 began actively booking trips immediately after the borders opened. The analysis shows that in addition to airfare prices, tourism demand in Kazakhstan depends on many external factors, including economic crises, global events such as the COVID-19 pandemic, the country's tourist attractiveness growth, marketing strategies, and government support for tourism. The elasticity results are presented separately in Figure 1, which shows the dynamics of the elasticity of demand for tourism by year.

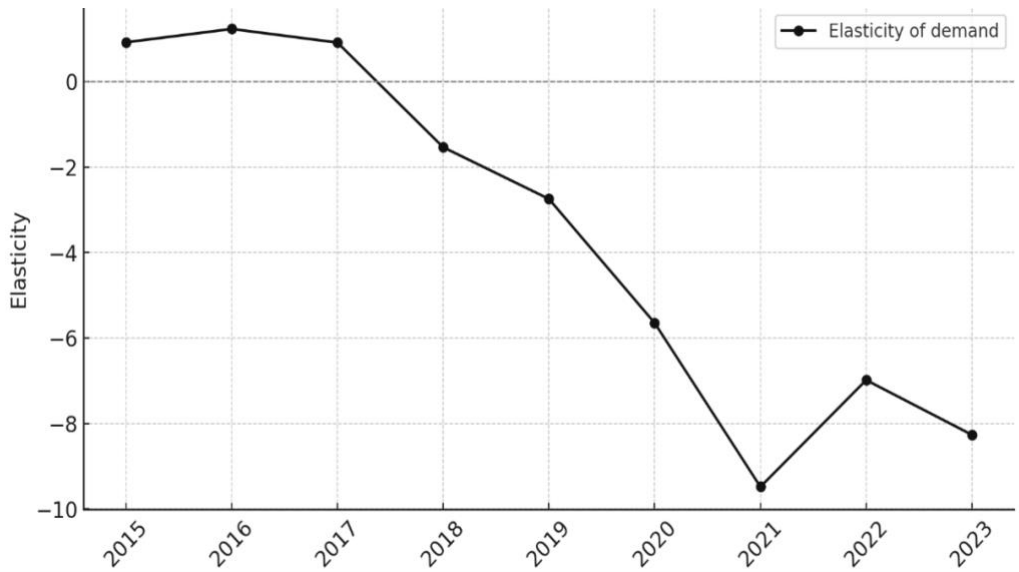

FIGURE 1. Results of correlation analysis

Note: compiled by authors

Figure 1 illustrates the dynamics of the elasticity of demand for tourism in Kazakhstan, demonstrating when elasticity was significantly higher than one, indicating a significant impact of price factors on the flow of foreign tourists. According to the results, a sharp jump in 2021 is observed, which can be associated with the industry's recovery after the COVID-19 pandemic. During periods of stable growth, such as 2017-2018, elasticity is high; in crisis years, for example, 2014, 2019, and 2023, negative values are observed, and in 2020, the pandemic sharply reduced tourism despite a possible price decrease. In 2021, there was an abnormal jump in elasticity due to the recovery of demand. Thus, the analysis of the elasticity of demand for tourism demonstrates that the cost of air tickets is a significant but not the only factor influencing the flow of tourists.

An analysis of income sensitivity to key factors was conducted to assess the tourism industry's resilience to external changes. Detailed data reflecting income sensitivity is presented in Table 3.

TABLE 3. Sensitivity of tourism revenue to key factors

Year	Number of foreign tourists visiting Kazakhstan		The average cost of hotel accommodation		International flights arriving in Kazakhstan	
	Million	Sensitivity	Tenge/per night	Sensitivity	Number	Sensitivity
2013	6,841	34,96565	5000	0,04784	4,25	56,28235
2014	6,333	37,54934	5200	0,045731	4,62	51,47186
2015	6,43	36,76516	5408	0,043713	4,98	47,46988
2016	6,509	36,10386	5624	0,041785	5,35	43,92523
2017	7,701	30,33372	5849	0,039938	5,71	40,91068
2018	8,789	26,43077	6083	0,038188	6,08	38,20724
2019	8,115	28,4658	6327	0,03651	6,45	35,81395
2020	2,035	45,40541	6580	0,014043	6,82	13,54839
2021	21,7	6,387097	8400	0,0165	7,19	19,27677
2022	25,19983	7,150841	9500	0,018968	7,54	23,8992
2023	9,2	24,34783	14400	0,015556	7,9	28,35443

Note: compiled by authors

The intercept, as shown in table 2, means that when all independent variables (soil surface temperature, producer price index, sown area, and employment) are zero, then the expected value of the dependent variable would be 301.99. This is the baseline level of agricultural productivity not explained by the other factors in the model. A 1-degree increase in the soil surface temperature is associated with an increase of 0.84 units in agricultural productivity, holding other variables constant. However, since the p-value is only 0.07, being slightly above 0.05, this relationship cannot be said to be statistically significant at the 5% level, although it is at the 10% level. The wide confidence interval is from -0.06 to 1.73, which might indicate some uncertainty regarding exactly how productivity is affected by temperature. Each 1-point rise in the agricultural product producer price index decreases agricultural productivity by 1.95 units, assuming all other variables are held constant. The negative coefficient would suggest that higher prices of the agricultural product could reduce productivity because either the higher price increases input costs or reduces market demand. This relation is highly significant because of the p-value of 0.00, meaning it is very unlikely to have occurred by chance. Holding all other variables constant, agricultural productivity decreases by 0.01 units with every additional unit area sown. This result is somewhat counterintuitive because one might expect a positive relationship between the sown area and agricultural output. The increase in agricultural productivity is very slight, 0.01 units, for every additional 1,000 persons in total employment, assuming other conditions remain constant. The results seem to indicate that the variables of producer prices and sown area are stronger predictors of agricultural productivity, and at the same time, the employment and temperature variables may not strongly determine agricultural productivity in this specific context. It may be further explored for what reasons larger sown areas and higher producer prices act to depress productivity.

The calculation results demonstrate how much changes in various factors affect international tourism revenues in Kazakhstan. Sensitivity shows how much revenues change when one of the factors changes by 1%. First of all, it is worth noting that the sensitivity of revenues to the number of foreign tourists remains positive and high in most years.

Based on this analysis, weights for the Integral Index Weights are made. The absolute value of coefficients of regression is taken and applied to the data below (Table 4).

TABLE 4. Key Indicators of Agricultural Development Across Regions of Kazakhstan

Region	Soil surface temperature	Producer price index for agricultural products	Employed in the economy	Total adjusted sown area
Abay	7,26	103,30	292,5	767,18
Akmola	6,17	93,30	407,1	5 360,03
Aktobe	8,40	104,60	434,9	743,56
Almaty	13,59	105,40	704,8	442,72
Atyrau	14,82	110,50	335,1	7,78
East Kazakhstan	7,41	100,50	368,8	631,98
Zhambyl	14,86	105,30	543,7	745,18
Zhetysu	10,84	106,60	309,3	509,65
West Kazakhstan	9,95	103,90	333,3	620,78
Karaganda	7,54	99,10	535,8	1 225,52
Kostanay	6,56	90,00	449,5	5 576,76
Kyzylorda	16,27	106,80	331,5	190,58
Mangistau	16,07	105,00	336,7	0,97
Pavlodar	7,12	101,70	385,2	1 631,30
North Kazakhstan	5,34	94,40	274,5	4 458,02
Turkestan	17,15	103,00	800,6	863,39
Ulytau	9,46	116,50	100,9	32,77
Almaty city	11,85	105,40	1 045,5	0,49
Astana city	7,63	106,60	658,7	1,41
Shymkent city	15,88	103,30	433,5	27,00

Note: compiled by authors

Thus, an increase in the number of tourists directly contributes to the rise in revenues. However, in crisis years, for example, in 2020, there was a sharp jump in values, which is associated with the COVID-19 pandemic: the number of tourists decreased, but the impact of their number on profitability changed due to the specific conditions of that period.

Another critical factor is the average cost of staying in hotels. In the early years (2013-2019), the influence of this factor was relatively stable, but since 2020, the sensitivity has increased significantly. This is due to a sharp decrease in hotel service prices during the pandemic when tour operators and hotels tried to retain customers by reducing room rates. However, in 2021–2023, there was a slight recovery, and the sensitivity of accommodation prices decreased slightly. As for the number of international flights, the impact on revenues has proven to be the most unstable. Until 2019, the number of flights was declining. However, tourism revenues remained relatively stable, indicating a possible increase in the average tourist check or the share of domestic travelers. However, in 2020, when the number of flights fell sharply, the sensitivity increased sharply, indicating this factor's critical importance in the crisis. In 2021–2023, there was a gradual increase in the number of flights, which was accompanied by a gradual recovery in tourism revenues.

Figure 2 shows the dynamics of the sensitivity of tourism revenues in Kazakhstan to the primary factors (the number of tourists, the average cost of accommodation, and the number of international flights).

The graph shows how the influence of each factor on the formation of tourism sector revenues changed in different years. The most noticeable fluctuations were observed in 2020. The consequences of the measures taken during the COVID-19 pandemic led to a sharp change in the structure of tourism demand and the availability of travel. The sensitivity of revenues to the number of foreign tourists remains high in most years, confirming the key role of traveler flow in forming industry revenues caused by the global decline in tourism traffic and border closures. After 2021, the sensitivity gradually stabilizes.

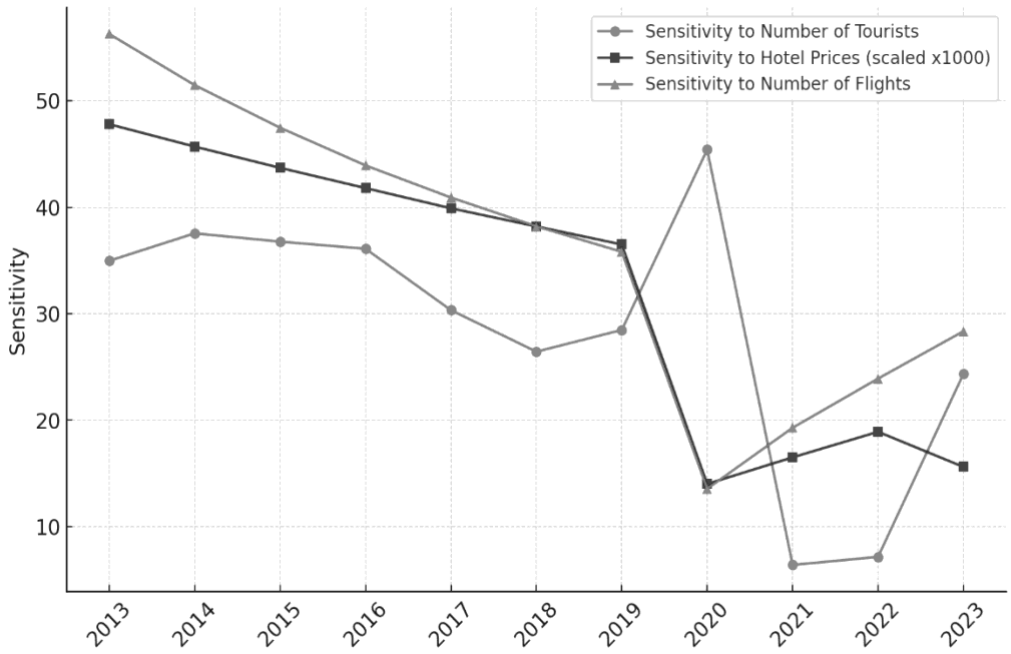

FIGURE 2. Sensitivity of tourism revenue to key factors in Kazakhstan for 2013-2024

Note: compiled by authors

The number of international flights (red graph) plays a critical role in times of crisis. Until 2019, this factor's influence declined, indicating a possible increase in domestic tourism or diversification of travel modes. Despite improvements, the sector's profitability was affected by a considerable decline in international flights in the next year. Therefore, Kazakhstan's tourism depends on the availability of air travel, especially in times of crisis.

The graph also shows that the recovery of the tourism sector after the pandemic was accompanied by a gradual decrease in sensitivity to each factor, indicating a return to traditional revenue generation mechanisms. In 2021-2023, the impact of the cost of accommodation and the number of flights gradually weakened, and sensitivity to the number of tourists returned to more stable values. The flow of tourists and the accommodation cost significantly impact profitability, and the number of international flights becomes critical in periods of instability. Thus, the sensitivity analysis of tourism revenues shows that the number of tourists and accommodation costs significantly impact profitability. The sector's recovery after the pandemic is accompanied by the normalization of sensitivity values, which indicates a return to traditional income generation models.

The analysis of the presented data shows that during the period under review, there were significant fluctuations in the number of tourists, indicating the instability of Kazakhstan's tourism market. There is a predominantly positive trend in the first half of the period (2013-2018): the number of foreign tourists increased annually, especially in 2017 and 2018, when the growth was 1.192 million and 1.088 million people, respectively. However, in 2019, the first decline was observed when the number of foreign tourists decreased by 0.674 million people.

Thus, Table 4 presents an analysis of the dynamics of tourist flow in Kazakhstan from 2013 to 2023.

TABLE 4. Dynamics of the tourist flow in Kazakhstan for 2013–2023

Year	Foreign tourists (visitors)			Local tourists (citizens)		
	Million	Change	State	Million	Change	State
2013	6,841	-	-	4,7	-	
2014	6,333	-0,508	-1	5	0,3	1
2015	6,43	0,097	1	5,3	0,3	1
2016	6,509	0,079	1	5,7	0,4	1
2017	7,701	1,192	1	6	0,3	1
2018	8,789	1,088	1	6,7	0,7	1
2019	8,115	-0,674	-1	6,7	0	0
2020	2,035	-6,08	-1	4,5	-2,2	-1
2021	21,7	19,665	1	4,8	0,3	1
2022	25,19983	3,499833	1	5,4	0,6	1
2023	9,2	-15,9998	-1	9,7	4,3	1

Note: compiled by authors

The most significant decline was observed in 2020 when the number of foreign tourists decreased by 6.08 million people. In 2021, the number of foreign tourists rebounded sharply by 19.665 million, driven by the resumption of air traffic and high demand for international travel. In 2022, growth continues but at a more moderate level (3.5 million tourists), which indicates a gradual normalization of the situation. In 2023, a significant decrease in the number of foreign tourists by 15.99 million people is again recorded, which may be due to several factors, including economic instability, rising airfare prices, and changing tourist preferences.

As for domestic tourists, their dynamics are more stable. Unlike the international flow, domestic tourism grew in almost all years, except in 2020, when the decline was 2.2 million people due to the pandemic. The recovery of domestic tourism was faster, and in 2023, it reached the highest value of 9.7 million tourists, which may indicate an increased interest in domestic travel. Figure 3 visualizes the dynamics of the tourist flow in Kazakhstan in 2013–2023.

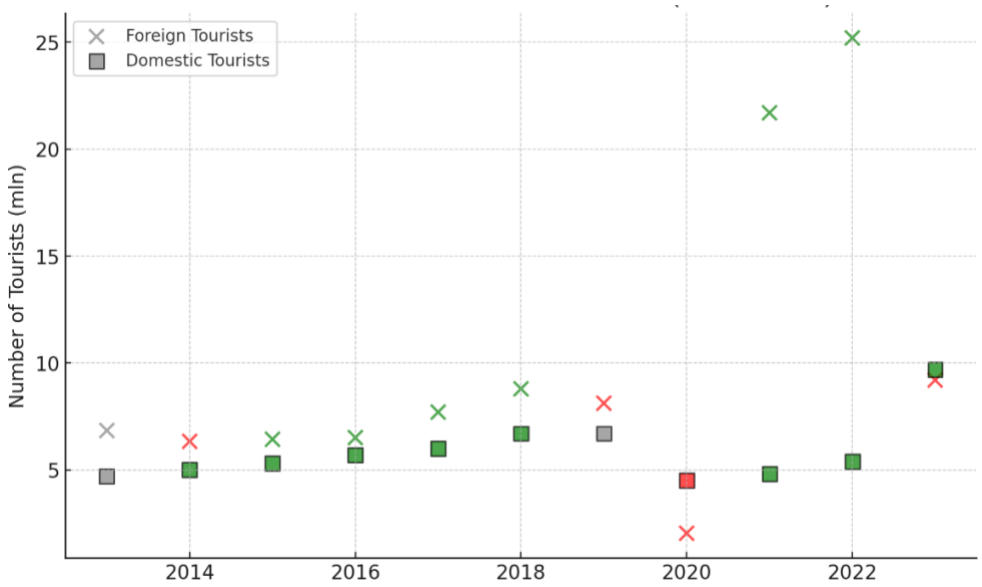

FIGURE 3. Tourism flow trends in Kazakhstan for 2013-2023

Note: compiled by authors

There are visible periods of growth, decline, and stability. In the early years, there was a predominantly positive trend, especially among foreign tourists, which may be due to the development of tourism infrastructure and marketing campaigns. However, in 2019, a decline began, and 2020 became a crisis year due to the COVID-19 pandemic, when the number of foreign tourists dropped sharply. Domestic tourism also declined, but not as significantly. In 2021-2022, rapid growth is seen, especially among foreign tourists, which is associated with recovery from the pandemic and deferred demand. However, in 2023, there is again a decline in international flow, possibly due to external economic and geopolitical factors. Surprisingly, domestic tourism continued to grow in 2023, while international tourism in Kazakhstan is subject to significant fluctuations, and domestic tourism remains more stable.

Figure 4 visualizes the tourism state transition matrix, demonstrating the probability of changing its dynamics.

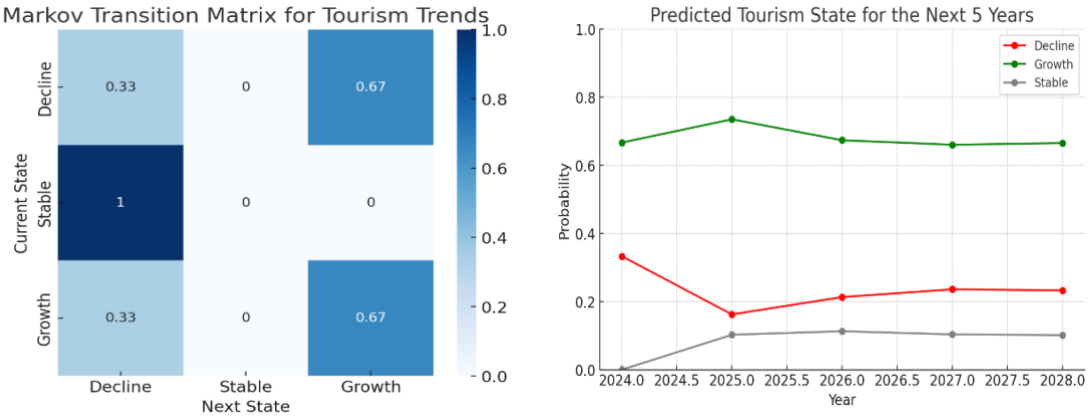

FIGURE 4. Analysis and forecast of the dynamics of tourist flow based on the Markov model

Note: compiled by authors

The results of the state transition matrix of the tourist flow in Kazakhstan show that the most probable scenario is continued tourism growth. It provides data on the number of foreign and domestic tourists and calculates changes in the number of tourists compared to the previous year. Based on these data, the states of tourist flow are determined, where the values “1” mean growth, “0” - stability, and “-1” - a decrease in the number of tourists. This approach allows us to identify patterns in changes in tourist flow and assess periods of active growth or decline in the tourism industry.

Based on data for 2013-2023, it was found that in most cases, an increase in the number of tourists leads to further growth, but there is still a possibility of a transition to a decline, especially after sharp increases. There is instability in the industry, which is influenced by external factors. However, the probability of long-term stabilization remains low, indicating the sector's high dynamism. Forecasts based on the transition matrix showed the following results. In 2024-2025, growth probability remains predominant and reaches 73.5%, confirming positive industry recovery trends. However, starting from 2026, the probability of a decline gradually increases, which may indicate possible fluctuations in tourism development in the long term. The lack of a high probability of stability emphasizes the need for strategic management and adaptation to possible changes in demand.

To formalize strategic decisions in the tourism sector, binary coding, where 1 means that the strategy is applied and 0 means that it is not applied, is proposed. This approach

allows the systematization of possible measures and comparisons with similar initiatives in neighbouring countries, which will help forecast regional tourism development. Next, a comparative analysis with neighboring countries describes Table 5.

TABLE 5. Binary coding of tourism management strategies in Kazakhstan and comparative analysis with neighboring countries

Strategy	Kazakhstan	Uzbekistan	Kyrgyzstan	Russia
Increase marketing expenditures	1	1	0	1
Development of sustainable tourism	0	1	1	0
Expansion of the hotel sector	1	1	0	1
Subsidizing domestic travel	0	1	1	1
International promotion of tourism	1	1	0	1
Introduction of digital tourism services	1	1	0	1
Liberalization of the visa regime	1	1	1	0
Support for ecotourism	0	1	1	0

Note: compiled by authors

A review of strategic approaches in Central Asian countries and Russia allows us to identify key areas where Kazakhstan needs to strengthen its position to increase the competitiveness of its tourism industry.

First, Kazakhstan actively invests in marketing and international promotion, similar to Uzbekistan and Russia, which helps attract foreign tourists. However, unlike Uzbekistan and Kyrgyzstan, Kazakhstan has not yet focused on developing sustainable tourism. Introducing targeted ecotourism initiatives can help diversify the tourism product, which is especially important given the growing demand for ecotourism among young people.

Second, Kazakhstan is already implementing programs to expand the hotel sector, which positively affects the accommodation sector. However, countries in the region, such as Uzbekistan, additionally subsidize domestic tourism, stimulating demand during low seasons. In this regard, Kazakhstan could consider support measures for domestic tourists, especially in post-pandemic recovery.

Digital tourism services is an important area for Kazakhstan for development and keep up with Uzbekistan and Russia. However, Kyrgyzstan is still lagging in this area, which could become a competitive advantage for Kazakhstan in attracting tourists focused on the convenience of online services.

Kazakhstan's most notable difference is its liberalization of the visa regime for citizens of many countries. This makes Kazakhstan a more accessible destination than Russia but is on par with Uzbekistan and Kyrgyzstan, which are also actively developing tourism diplomacy.

Finally, support for ecotourism remains underdeveloped in Kazakhstan, unlike Uzbekistan and Kyrgyzstan, which implement programs to protect natural attractions and promote sustainable routes. This direction is promising for Kazakhstan, especially given its unique natural resources, such as the Charyn Canyon, Kolsay Lakes and Altyn-Emel.

Using binary coding of strategies allows us to identify Kazakhstan's key competitive positions in the tourism sector and identify areas that require improvement. The analysis shows that Kazakhstan is a leader in international promotion, visa liberalization and digitalization of tourism but lags behind neighbouring countries in developing ecotourism and domestic tourism. Introducing support measures for local travellers and focusing on sustainable tourism initiatives can increase Kazakhstan's attractiveness among travellers and diversify industry revenues.

5. CONCLUSIONS

The study aimed to analyze the dynamics of the tourist flow in Kazakhstan from 2013 to 2017, considering both foreign and domestic

tourists. Special attention was paid to identifying trends and changes in the number of tourists and assessing the stability of the sector's growth. The literature review shows that tourism is vital to the country's socio-economic development, contributing to increased employment and infrastructure development and expanding the region's attractiveness for investors. Research confirms that domestic and inbound tourism are important components of the national economy, and their growth requires comprehensive measures, including government support, improved logistics, the development of the hotel business, and increased service levels.

Moreover, the number of tourists and the cost of accommodation have the most significant impact, resulting in the sector's financial stability, making them key factors that determine the financial sustainability of the tourism sector. The more tourists come to the country and the higher the accommodation cost, the more income the hotel and transport business receives. The reduction of international flights during crises leads to a decrease in the number of foreign tourists, resulting in a restriction of income for the hotel business, transport, restaurants, and other relevant industries, increasing the inflow of investment into the country's GDP.

Forecasting the further development of the industry showed that positive dynamics of growth in tourist flow are expected in the coming years, which can contribute to an increase in income in related sectors of the economy. However, the results of tourism sensitivity revealed its high dependence on external factors, such as global economic crises, exchange rate changes, and political stability. This highlights the need for adaptive management and strategic planning to diversify the tourism offer, develop infrastructure, and increase the sector's resilience to external shocks.

Kazakhstan demonstrates strong positions in international marketing and visa liberalization but lags behind neighboring countries in developing sustainable tourism and supporting the domestic market. Additional incentives for domestic tourism, the creation of environmentally sustainable routes, and digitalising tourism services are key factors for long-term growth.

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Kazakhstan's Banking Sector: Between Domestic Regulation and Macroeconomic Trends

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ABSTRACT

The banking sector plays a fundamental role in economic stability and development by facilitating financial intermediation, credit allocation, and liquidity management. In emerging economies such as Kazakhstan, the financial system is characterized by high market concentration, limited competition, and a weak connection between banking activity and macroeconomic growth, which can affect financial stability and economic development. The goal of current study is to analyze the impact of bank profitability, market concentration, and macroeconomic factors on the stability of Kazakhstan's banking sector. The research follows a four-stage methodology, including descriptive statistical analysis, data visualization using Raincloud Plots, multivariate and univariate statistical tests, and Q-Q plots. The analysis evaluates how income influences net profitability and taxation, how market concentration affects credit and deposit allocation, and how macroeconomic conditions interact with banking performance. Findings indicate that bank profitability has a significant impact on net profit and taxation, reinforcing the role of internal financial management in determining banking stability. Market concentration directly influences the allocation of loans and deposits, highlighting the dominant role of a few major banks in shaping financial flows. However, macroeconomic variables, including GDP and inflation, do not show a statistically significant direct effect on banking sector dynamics, suggesting that Kazakhstan's banking system operates largely independently of economic fluctuations. The results reflected the importance of monitoring market concentration, ensuring competitive financial conditions, and reconsidering regulatory mechanisms to enhance banking efficiency and economic integration.

KEYWORDS: Bank, Banking Sector, Bank Regulation, Economic Growth, Credit Allocation, Market Concentration, Financial Stability, Risk Management

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1. INTRODUCTION

The banking system is central to redistributing financial resources, providing loans to businesses and individuals, liquidity management and financial stability. The efficiency of the banking sector contributes to sustainable economic growth, investment activity and financial inclusion. The main challenge remains structural problems, such as high capital concentration, profitability instability, or poor connection with macroeconomic indicators, which can lead to crises, reduced availability of credit, and a slowdown in economic development.

In current economics, countries have encountered problems in the banking sector. The shadow economy has become a central problem in the banking system, including financial institutions providing banking services without proper regulation and supervision. Due to this, crucial systemic risks arise. Moreover, financial institutions tend to circumvent established regulations, increasing the likelihood of economic crises. Different countries have different experiences. Nevertheless, shadow banking was a key factor in the 2007 subprime mortgage crisis in developed countries like the United States. The consequences affected and escalated into the global financial crisis. Another condition in developing countries is insufficient transparency and weak institutional structures. Vietnam is an acceptable illustration of that. Challenges such as low penetration of banking services, the predominance of cash payments, and insufficient transparency of loan portfolios limit the population's access to financial services and reduce lending effectiveness. In addition, in the context of global instability, such as the COVID-19 pandemic, the banking systems of many countries have experienced significant stress. The decline in economic activity, the growth of non-performing loans and the need for additional reserves have threatened the financial stability of banks, especially in economies with a transition structure. In this context, special attention should be paid to emerging economies such as Kazakhstan.

Before the COVID-19 pandemic burst and restrictions were imposed, Kazakhstan's banking sector demonstrated stable growth, supporting economic development. However, with the onset of the pandemic in 2020, Kazakhstan's economy faced serious challenges, including a 3% contraction in GDP, the first decline since the late 1990s (World Bank, 2020). The banking sector faced downfalls in the loan portfolio quality and increased reserves for problem loans to 3% in 2020. Banks maintaining capital demonstrated a positive return on assets at 2.5% in March 2021 (World Bank, 2021). Over the past five years, Kazakhstan's banking sector has undergone significant changes, demonstrating growth in overall profitability. However, despite the positive dynamics, challenges related to high capital concentration, limited diversification of financial instruments and dependence on consumer lending remain. As of the end of 2024, banking sector assets reached 59.2 trillion tenge, and lending to the economy increased by 17.9%, indicating the expansion of financial activity (Ratel, 2023; Halyk Finance, 2024). However, 43.6% of all loans are consumer loans, which may indicate the risks of financial instability during economic downturns. At the same time, the banking system remains highly concentrated, as a significant part of assets is concentrated in a few large banks, creating the possibility for limited competition and the availability of financial resources for small and medium-sized businesses (Government of Kazakhstan, 2024). In the context of such imbalances, studying the factors that determine the stability of the banking sector in Kazakhstan is of particular importance.

The research aims to determine the impact of bank profitability, capital concentration, and macroeconomic factors on the banking sector's stability and assess the degree of its integration into the country's economic development in Kazakhstan. The banking sector's profitability depends on internal and external factors. In developed and post-Soviet countries, the size of assets plays a key role, but its impact varies depending on the market structure. At the same

time, systemic risks arising in the banking sector require a new approach to regulation since traditional methods do not always prevent financial shocks. Therefore, it is important to understand to what extent internal operational factors, such as asset management and lending, and macroeconomic dynamics impact the financial stability of banks and determine the banking sector's profitability.

2. LITERATURE REVIEW

Banks play a central role in shaping economic conditions rather than simply adapting to them. Changing the structure of financial regulation and reforms in the banking system affects the availability of credit and the formation of the deposit base in developing economies. Banks create the money supply and actively participate in the economic cycle. The level of development of the financial sector directly affects the efficiency of resource redistribution in the economy. Aderibigbe (2004) noted that combining financial reforms with measures to maintain the banking system's stability is necessary. The banking system does not simply redistribute existing resources. Banks generate liquidity through lending, making it an important driver of economic growth. In other words, the quality of regulation and the structure of the banking system directly impact the financial system's stability (Bossone, 2001). Automation and digitalisation can improve the efficiency of operations and reduce costs. Davamanirajan et al. (2006) found that banks that actively implement digital technologies gain an advantage in the competitive environment and demonstrate higher profitability. Okorie and Uwaleke (2010) noted that reforms such as credit market liberalisation led to increased lending but were accompanied by increased financial risks and bank instability. As a result, the regulatory process is only concerned with stimulating growth. Therefore, it is necessary to consider the creation of crisis prevention mechanisms. Forcadell and Aracil (2017) expanded the concepts of banking efficiency. They noted that financial indicators and social impact are becoming increasingly relevant in the context of the global transformation of financial markets. Thus, banks that invest in sustainable development not only increase the level of trust from customers but also receive long-term economic benefits. However, it is worth noting that an important task remains the regulation of emerging or new forms of financial intermediation. Nersisyan and Dantas (2017) distinguished between the concepts of "real" and "fictitious" liquidity. They showed that the modern financial system functions as a hierarchy of financial obligations, where different institutions create liquidity at different levels.

Modern research has shown that there is no single set of factors affecting bank profitability; their importance depends on the country's economic structure, the level of regulation, and global financial conditions. Menicucci and Paolucci (2016) emphasised in their work that bank size and capitalisation significantly impact profitability and that better-capitalized banks are more resilient to financial shocks. Larger banks have advantages in the form of economies of scale, but a high share of problem loans negatively affects profitability. If banks increase lending without properly assessing the quality of borrowers, this leads to increased risks of default. In such conditions, the growth of the loan portfolio does not mean an improvement in the financial position of banks but, on the contrary, can signal market overheating and the formation of a debt "bubble". Thus, the loan portfolio size and banks' income sources significantly impact their sustainability and profitability (Yüksel et al., 2018). Adelopo et al. (2018) divided the factors into bank-specific and macroeconomic ones. They found that the largest banks are less susceptible to crisis shocks due to more diversified sources of income and better access to capital. That is, bank size, cost management and liquidity significantly impact profitability, while capitalisation, credit risks and economic growth are more sensitive to macroeconomic conditions. Yao et al. (2018) divided the factors into positive and negative ones and introduced additional variables considering banks'

structural and operational characteristics. They include asset size, financial structure, labour productivity and market power as positive ones, and credit quality, operational efficiency and bank concentration as negative ones. Raza et al. (2019) focus on the balance between credit expansion and capitalisation and consider the impact of lending and capitalisation on different indicators of bank profitability. Therefore, lending positively affects profitability since an increase in the volume of loans issued brings interest income to the bank, increasing its overall profitability. Thus, banks with a high level of capital can issue loans with lower risks, contributing to the stability of interest income. At the same time, excess capital can reduce the efficiency of banking operations since the bank is forced to maintain reserve assets that do not always bring high income. General trends in the development of the banking sector show that effective management of capital, credit risks and sources of income plays a decisive role in ensuring the banking system's stability.

The concentration of the banking market and the degree of competition significantly impact financial stability. On the other hand, the relationship between competition and stability is ambiguous and depends on the market structure. Increased competition can destabilise the financial system by increasing the risk of bank failures, but with adequate regulation, it is possible to benefit from increased competition without compromising financial stability (Canoy et al., 2001). The limited liability of banks and the negative externalities of bank failures can encourage excessive risk-taking. Acharya (2009) found that traditional regulatory mechanisms such as capital adequacy and bank closure policies are ineffective in reducing systemic risk. In a competitive environment, banks can reduce lending rates, reducing the likelihood of borrower defaults, which can stabilise the banking system (Jiménez et al., 2013). Langfield & Pagano (2016) noted that the European financial structure is at risk due to excessive expansion of bank lending during asset growth and their deficit during falling prices. As a solution, the authors proposed an approach that includes reducing regulatory preferences for banks and supporting the development of securities markets.

Competition in the banking sector significantly changes the structure of banks' functioning. Leroy and Lucotte (2017) noted that weak competition increases the correlation of risky decisions between banks. Thus, individual banking risk increases, but at the same time, competition reduces systemic risk. In parallel, macroeconomic factors have a significant impact. Thus, Morina and Osmani (2019) found that both economic crises and changes in interest rates affect strongly the level of deposits, indicating a high sensitivity of the banking sector to macroeconomic conditions. However, Feghali et al. (2021) noted that increased access to payment and savings services positively impacts financial stability, but access to credit can weaken stability, mainly if credit growth occurs without considering borrowers' solvency.

Kazakhstani studies have analysed Kazakhstan's banking system's sustainability and examined different aspects of this process. The works assess the effectiveness of banking risk regulation, consider internal asset management strategies, analyse the impact of digitalisation on competition, and examine the structure of deposits and its impact on banking operations (Ybrayev,2022). Kazbekova et al. (2022) concluded that despite introducing new risk management mechanisms, the level of financial sustainability of banks in Kazakhstan remains vulnerable due to the persistently high share of problem loans. The Kazakh banking regulatory system is approaching international standards, but it remains less stringent in some respects, which may create additional risks in the face of economic shocks. Buzaubayeva et al. (2024) find that banks focused on consumer lending show higher short-term profitability but remain more vulnerable to macroeconomic shocks. Therefore, risk management and bank internal policies are more important for sustainability than macroeconomic conditions (Sarkambayeva & Sailaubekov, 2024). However, Kan et al. (2024) showed that

corporate deposits are banks' primary liquidity source, while retail deposits and securities transactions play a secondary role. Begimkulov and Kuti (2024) examine the impact of digitalisation on competition and bank profitability in Kazakhstan and Kyrgyzstan. The authors found that in Kyrgyzstan, digitalisation has led to increased competition among banks, an increase in their profitability, and an expansion of their customer base. However, in Kazakhstan, the impact of digital technologies was limited due to the high concentration of capital in the largest banks. Thus, technological innovations may not have the expected impact on financial systems with high monopolization.

Based on the literature review, it is possible to identify the leading indicators of the interaction of macroeconomic factors, bank concentration and financial stability for forming an effective banking system. The impact of macroeconomic factors on banking systems remains ambiguous. To test the impact of bank profitability, concentration and macroeconomic factors on the financial stability of the banking sector of Kazakhstan, the following hypotheses were formulated:

Hypothesis 1 (H_1): Bank profitability significantly impacts net income and tax burden, determining the financial stability of the banking sector.

Hypothesis 2 (H_2): Bank capital concentration affects the structure of deposits and lending, determining the level of market power and competitive conditions in the banking system.

Hypothesis 3 (H_3): Macroeconomic conditions, such as GDP, inflation and employment levels, affect the assets, loan portfolio and deposit base of banks.

These hypotheses allow us to empirically test the mechanisms of interaction between profitability, concentration and macroeconomic factors, which will provide a comprehensive understanding of the functioning of the banking sector in Kazakhstan.

3. METHODOLOGY

The methodological approach of the study is aimed at analyzing the factors affecting the stability of the banking sector in Kazakhstan. To achieve these goals, a step-by-step analysis is used, including statistical methods, data visualization and evaluation of their distribution. This approach makes it possible to determine the relationship between bank profits, capital concentration and macroeconomic conditions, as well as to identify the structural features of the banking system. The research methodology was based on the literature review and includes four main stages of the research.

Table 1 details the main stages of the analysis, methods, and relevant references to the works, confirming their choice.

TABLE 2. Indicators

Category	Variable	Role in analysis	Description
Profitability	1_IncR	Independent Variable	Income (remuneration)
Profitability	1_NetR	Dependent Variable	Net income (remuneration)
Profitability	1_NetA	Dependent Variable	Net income after taxation
Profitability	1_Tax	Dependent Variable	Tax expenses
Concentration	2_Top5A	Independent Variable	Share of the top 5 banks (assets)
Concentration	2_Top5L	Dependent Variable	Share of the top 5 banks (loans)
Concentration	2_Top5D	Dependent Variable	Share of the top 5 banks (deposits)
Economy	3_GDP	Independent Variable	GDP (billion tenge)
Economy	3_ActGDP	Dependent Variable	Assets / GDP
Economy	3_LoanGDP	Dependent Variable	Loans / GDP
Economy	3_DepGDP	Dependent Variable	Deposits / GDP

Note: compiled by authors

Based on the literature review, key indicators reflecting the performance of the banking sector were selected, based on previous studies. Profitability indicators (1_IncR, 1_NetR, 1_NetA, 1_Tax) were included in the study based on the works of Menicucci & Paolucci (2016), Acharya (2009), which showed that profitability is one of the key factors in the stability of the banking system. Studies of European banks have confirmed that banks with high profitability are more resilient to economic shocks and can accumulate capital reserves, minimizing credit risks. In addition, in the context of developing economies, the tax burden analysis (1_Tax) is important since taxation can pressure banks' financial performance and ability to lend to the real sector (Acharya, 2009).

The capital concentration indicators (2_Top5A, 2_Top5L, 2_Top5D) were selected based on the studies of Allen & Gale (2004) and Boyd & De Nicoló (2005), which analye how market concentration affects the stability of the banking sector. On the one hand, high concentration can reduce the likelihood of systemic banking crises since large banks have better financial stability and liquidity (Allen & Gale, 2004). However, other studies show that excessive concentration can limit competition, increase interest rates on loans and reduce the availability of financial resources for small and medium-sized businesses (Boyd & De Nicoló, 2005). Thus, the analysis of these indicators allows us to identify the balance between the stability of the banking system and the level of competition.

Macroeconomic indicators (3_GDP, 3_ActGDP, 3_LoanGDP, 3_DepGDP) were included in the analysis based on the works of Mare (2015), Jiménez et al. (2013), which show that the banking system is closely related to the dynamics of GDP and economic cycles. Research confirms that GDP growth is usually accompanied by an increase in lending and an improvement in the financial stability of banks (Mare, 2015). However, suppose the volume of loans issued grows faster than GDP. In that case, this may indicate the risks of economic overheating and a possible deterioration in the quality of the loan portfolio, which is confirmed by the analysis of banking crises in different countries (Jiménez et al., 2013).

Thus, the choice of study indicators is based on scientific works confirming their importance for analyzing banking stability

4. FINDINGS AND DISCUSSIONS

The analysis of Kazakhstan's banking sector requires a comprehensive approach that takes into account both internal financial indicators and external macroeconomic conditions. In conditions of high concentration of capital, limited competition, and unstable connection with macroeconomic growth, it is necessary to identify the key factors affecting the banking system's stability. This study is aimed at identifying the relationship between bank profitability, capital concentration and macroeconomic conditions, which will allow assessing the degree of integration of the banking sector into the economic development of the country. The methodology used includes statistical analysis, data visualization, and an assessment of the normality of the distribution, which provides an integrated approach to studying the stability of the banking system.

To properly select indicators, descriptive analysis was conducted. The results are shown in Table 3.

TABLE 3. Descriptive analysis results

Variable	Valid	Mis-sing	Median	Mean	Std. Deviation	Min.	Max.	Percentile		
								25th	50th	75th
1_IncR	11	0	2010.10	2343.909	1153.558	1161.70	5182.90	1713.65	2010.10	2435.00
1_ExpR	11	0	1071.90	1185.664	592.081	574.70	2684.50	851.10	1071.90	1226.75
1_NetR	11	0	952.60	1158.264	569.865	587.00	2498.40	838.55	952.60	1269.05
1_IncN	11	0	26804.60	33457.58	28835.693	2644.30	106006.7	19393.7	26804.6	35784.9
1_ExpN	11	0	27635.90	33795.93	28819.109	2954.90	106345.5	19705.1	27635.9	36139.9
1_NetN	11	0	-310.60	-338.345	220.400	-831.30	-53.00	-452.80	-310.60	-185.55
1_NetB	11	0	718.90	819.809	674.128	121.30	2292.40	279.25	1128.65	279.25

1_Tax	11	0	116.20	135.118	74.824	39.90	283.80	79.45	175.30	79.450
1_Net A	11	0	603.30	684.836	604.951	12.60	2008.60	223.65	954.20	223.65
2_Top 5A%	11	0	62.60	61.045	4.612	53.80	66.30	57.15	64.75	57.15
2_Top 5L%	11	0	62.70	64.436	6.521	54.40	74.40	61.05	68.40	61.05
2_Top 5D%	11	0	65.50	62.936	6.028	52.20	70.80	59.50	66.60	59.50
3_GDP %	11	0	58242.90	62454.82	25145.931	34291.0	113824.5	42831.0	72371.5	42831.0
3_Act GDP%	11	0	45.10	42.904	15.148	0.44	57.90	42.95	49.45	42.95
3_Loa nGDP %	11	0	25.20	25.363	10.147	0.39	37.20	22.75	31.80	22.75
3_Dep GDP%	11	0	30.00	29.035	10.301	0.280	39.500	29.15	34.30	29.15

Note: compiled by authors

An analysis of the descriptive statistics for profitability reveals key trends and variations in the data. The mean profitability value (1_IncR = 2343.91) exceeds the median (2010.1), indicating a possible distribution asymmetry towards higher values. A similar situation is observed for net profit after tax (1_NetA: Mean = 684.84, Median = 603.3). Net profit excluding fees (1_NetN) has a negative mean (-338.35), indicating possible losses in this category. The high standard deviation of profitability (SD = 1153.56) and net profit (SD = 604.95) confirms a significant spread of values, which may be due to differences in profitability among the properties. Of particular note is the 1_NetN category, where the standard deviation (SD = 220.4) also confirms instability. The range of values varies from 1161.7 to 5182.9 for 1_IncR and from 12.6 to 2008.6 for 1_NetA, indicating significant differentiation in profitability and income. Tax payments (1_Tax) fluctuate from 39.9 to 283.8, indicating a heterogeneous tax burden.

As part of further analysis, it is proposed to use the 1_IncR indicator as an independent variable in Raincloud Plots and consider 1_NetR (net income), 1_NetA (net income after tax), and 1_Tax (taxes) as dependent variables. This choice will allow us to visualise the distribution of net income depending on the level of profitability and identify possible patterns in the tax burden. This analysis identifies key differences and assesses profitability's impact on financial indicators.

Based on these criteria, 1_IncR (income) was selected as the independent variable for visual analysis in Raincloud Plots, and 1_NetR (net income), 1_NetA (net income after tax), and 1_Tax (taxes) were selected as the dependent variables. This choice allows us to assess the impact of profitability on the final financial indicators and identify possible patterns in the distribution of profit and tax burden.

In Figure 1, the results of Hypothesis 1 are presented.

The analysis of the distribution of net income (1_NetR) shows a significant variation in values, with the bulk of the data concentrated below 1,500. The distribution over the years is not uniform, which may indicate the influence of temporary factors on the level of net income. Values above 2000 are less common, which may indicate the presence of emissions associated with high incomes of individual banks.

The distribution of net income after taxes (1_NetA) shows a similar pattern to 1_NetR, however, in some cases, net income decreases significantly more after taxes. This may indicate a differentiated tax burden, which disproportionately reduces the income of individual banks. The analysis of tax expenditures (1_Tax) shows that the tax burden increases with increasing income, but its distribution remains uneven.

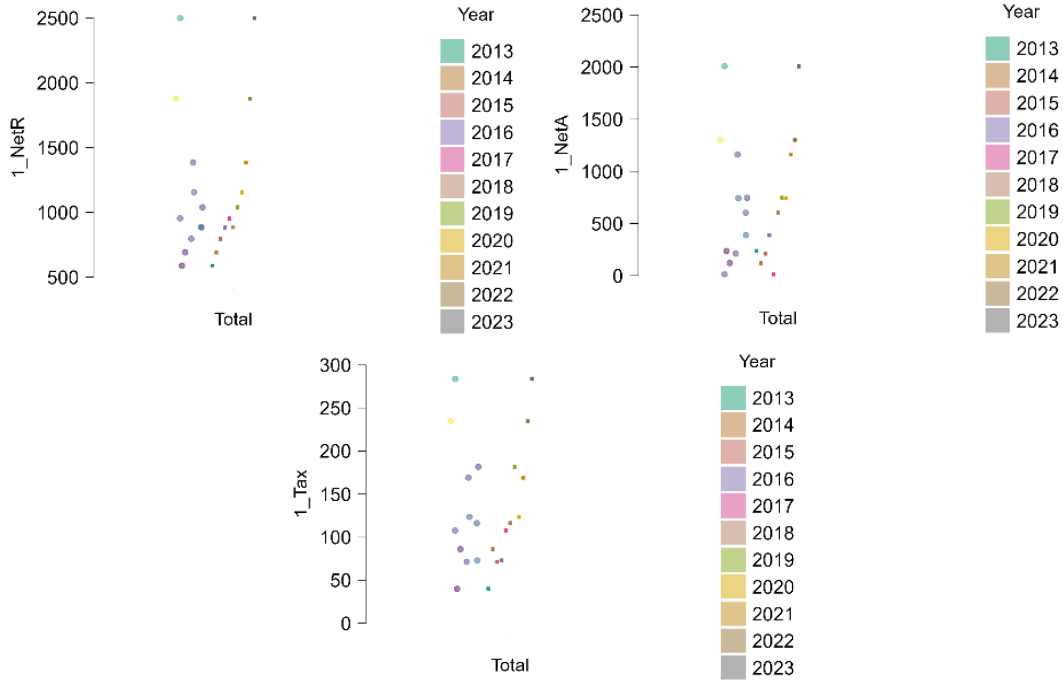

FIGURE 1. Hypothesis 1

Note: compiled by authors

Most of the values do not exceed 200, but some observations exceed 250, which may be due to differences in tax conditions in different years. Visual analysis confirms the existence of a positive relationship between profitability (1_IncR) and net income (1_NetR, 1_NetA) and tax expenses (1_Tax), which indicates an increase in net profit and tax burden with increasing income. However, significant dispersion of data and the presence of outliers may indicate the influence of additional factors, such as tax incentives or macroeconomic changes.

Figure 2 shows the results confirming the second hypothesis.

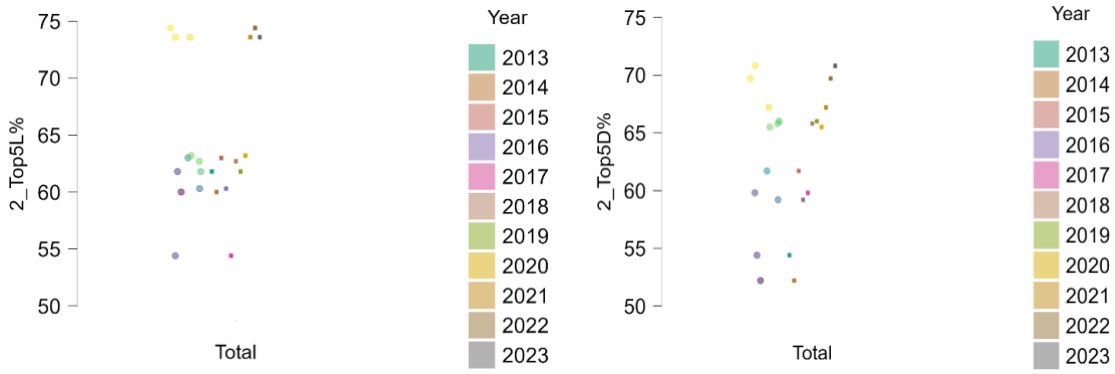

FIGURE 2. Hypothesis 2

Note: compiled by authors

An analysis of the Raincloud Plots results shows that the distribution of loans among the largest banks (2_Top5L%) varies between 55-70%. However, in some years, values exceeding 70% are observed. This indicates a high concentration of loan portfolios in a small number of large banks. The distribution of deposits (2_Top5D%) shows a similar trend but with a more even distribution.

The values of 2_Top5D% follow the same trends, but with a lower variance, which may indicate a more stable deposit structure compared to loans.

The results obtained confirm a stable positive relationship between the concentration of assets (2_Top5A%) and the share of the largest banks in lending (2_Top5L%) and deposits (2_Top5D%). This means that a small number of the largest banks control a significant part of the credit and deposit markets. However, in some years, emissions have been observed, which may be due to external economic factors, banking reforms, or crisis phenomena.

Figure 3 shows the results confirming the third hypothesis.

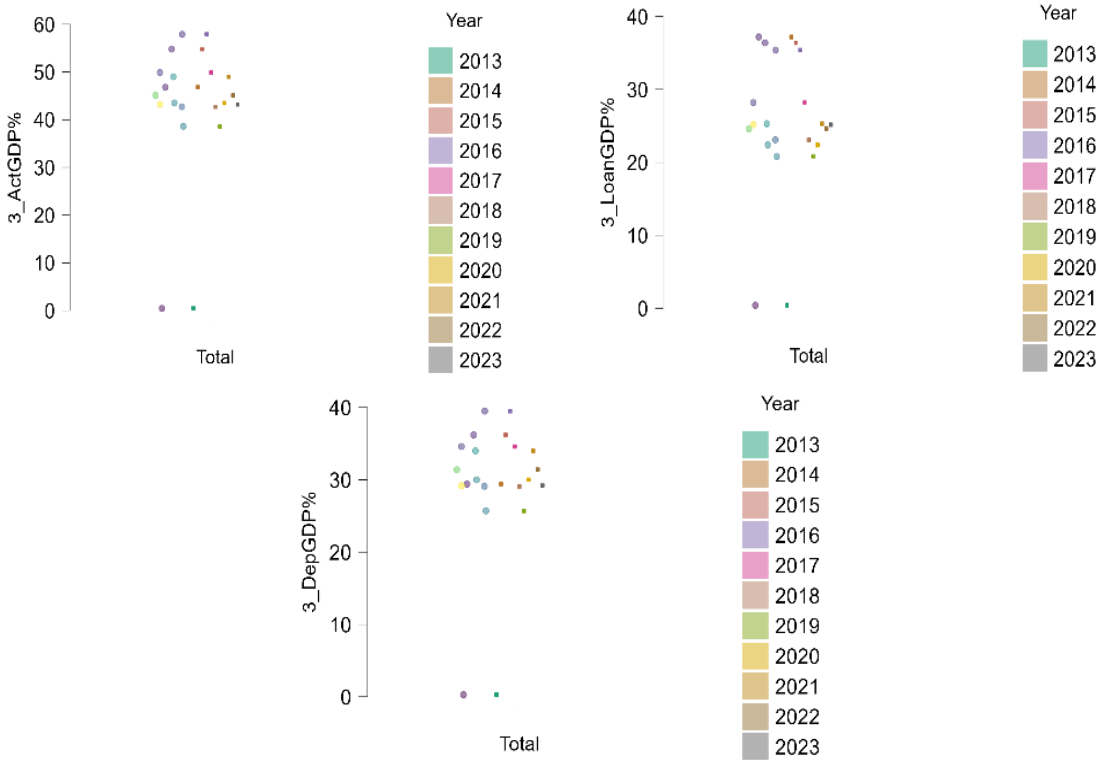

FIGURE 3. Hypothesis 3

Note: compiled by authors

An analysis of the ratio of banking assets to GDP (3_ActGDP%) shows that most of the values are concentrated in the range of 40-55%, but extremely low indicators (about 5-10%) are found, which may indicate periods of economic instability affecting the banking system. The dynamics over the years demonstrate the relative stability of the share of assets of the largest banks in GDP, but in some years, there have been deviations.

The credit-to-GDP ratio (3_LoanGDP%) reflects a similar picture, ranging from 20-35%, but with individual emissions below 10%, which may indicate crisis phenomena, for example, a reduction in lending in certain years. The distribution of deposits to GDP

(3_DepGDP%) is also concentrated in the range of 20-35%, while emissions similar to 3_LoanGDP% are observed, which confirms the presence of sharp fluctuations in deposits during certain periods associated with economic shocks.

Thus, the data indicate a significant relationship between the dynamics of GDP and banking indicators, which is reflected in the similar nature of changes in assets, loans, and deposits. The identified abnormal emissions may be related to periods of instability or structural changes in the economy. In conditions of economic growth, banks increase lending, while during periods of recession, they reduce their activity.

Table 4 shows the results of a multidimensional analysis confirming the identified relationships

TABLE 4. Multivariate tests

Dependent variable	Test	value	F	df1	df2	p
1_IncR	Pillai's Trace	0.989	202	3	7	<.001
	Wilks' Lambda	0.0114	202	3	7	<.001
	Hotelling's Trace	86.7	202	3	7	<.001
	Roy's Largest Root	86.7	202	3	7	<.001
2_Top5A%	Pillai's Trace	0.971	135	2	8	<.001
	Wilks' Lambda	0.0287	135	2	8	<.001
	Hotelling's Trace	33.8	135	2	8	<.001
	Roy's Largest Root	33.8	135	2	8	<.001
3_GDP%	Pillai's Trace	0.316	1.08	3	7	0.419
	Wilks' Lambda	0.684	1.08	3	7	0.419
	Hotelling's Trace	0.462	1.08	3	7	0.419
	Roy's Largest Root	0.462	1.08	3	7	0.419

Note: compiled by authors

The results of the multivariate analysis demonstrate a significant impact of profitability (1_IncR) and concentration of banking assets (2_Top5A%) on financial indicators, which is confirmed by high values of Pillai's Trace, Wilks' Lambda, Hotelling's Trace and Roy's Largest Root with $p < 0.001$. This indicates a stable dependence of net income and tax burden on the structure of the banking sector.

At the same time, the impact of the macroeconomic factor (3_GDP%) turned out to be statistically insignificant ($p = 0.419$), which indicates that the GDP level does not have a direct impact on banking indicators in this model. This may be because internal mechanisms regulate the banking sector and do not always synchronously reflect macroeconomic changes.

The results of the multivariate analysis showed that bank profitability has a significant impact on net income (1_NetR, 1_NetA) and tax burden (1_Tax), which is confirmed by high values of F-statistics ($F = 50.0–593.8$, $p < 0.001$), confirming the relationship between profitability and financial stability of banks (Hypothesis 1 is confirmed). Analysis of capital concentration of the largest banks (2_Top5A%) revealed a significant impact on the distribution of deposits (2_Top5D%, $F = 163.7$, $p < 0.001$) and loans (2_Top5L%, $F = 16.4$, $p = 0.003$), which confirms the role of market concentration in the redistribution of financial resources (Hypothesis 2 is confirmed).

In Table 5, the results for univariate tests are presented.

However, macroeconomic factors (3_GDP%) did not have a statistically significant impact on banking indicators (3_ActGDP%, 3_LoanGDP%, 3_DepGDP%) since $p > 0.05$, which may indicate a weak direct dependence on the banking system of Kazakhstan on economic growth or the presence of a time lag in their relationship (Hypothesis 3 is not confirmed).

TABLE 5. Univariate Tests

Dependent variable	Predictors	Sum of Sq.	df	Mean Sq.	F	p
1_IncR	1_Tax	47449	1	47449	50.0	<.001
	1_NetA	3.09e+6	1	3.09e+6	48.7	<.001
	1_NetR	3.20e+6	1	3.20e+6	593.8	<.001
	1_Tax	8538	9	949		
	1_NetA	570768	9	63419		
	1_NetR	48489	9	5388		
2_Top5A%	2_Top5D%	344.4	1	344.45	163.7	<.001
	2_Top5L%	274.4	1	274.38	16.4	0.003
	2_Top5D%	18.9	9	2.10		
	2_Top5L%	150.9	9	16.76		
3_GDP%	3_ActGDP%	62.50	1	62.50	0.2520	0.628
	3_LoanGDP%	1.71	1	1.71	0.0150	0.905
	3_DepGDP%	42.80	1	42.80	0.3782	0.554
Residuals	3_ActGDP%	2232.20	9	248.02		
	3_LoanGDP%	1027.99	9	114.22		
	3_DepGDP%	1018.34	9	113.15		

Note: compiled by authors

In general, the analysis shows that the banking system of Kazakhstan depends to a greater extent on internal financial factors, such as profitability and capital concentration, than on macroeconomic conditions, which emphasizes the need to regulate the capital structure and profitability management mechanisms to ensure the sustainability of the financial sector.

In Table 6, the results of the assumptions check are presented.

TABLE 6. Shapiro-Wilk multivariate normality test

Model	W	p
1_IncR	0.856	0.052
2_Top5A%	0.842	0.034
3_GDP%	0.573	<.001

Note: compiled by authors

Testing the assumptions using the Shapiro-Wilk test showed that the profitability variable (1_IncR) is close to a normal distribution ($W = 0.856$, $p = 0.052$), while asset concentration (2_Top5A%) has minor deviations ($W = 0.842$, $p = 0.034$). A significant deviation from normality is observed for the macroeconomic indicator (3_GDP%, $W = 0.573$, $p < 0.001$), which indicates the possible influence of structural factors or high GDP variability across years. These results confirm that banking indicators depend more on the internal mechanisms of the sector. At the same time, the influence of macroeconomic factors may be more complex and require taking into account time lags or other analytical methods. The first hypothesis about the impact of profitability (1_IncR) on the tax burden and net income is confirmed, which indicates a strong dependence on banks' financial indicators on their profitability. The results of the multivariate analysis (MANCOVA) show that profitability has a significant impact on tax expenses (1_Tax), net income (1_NetA) and net income before tax (1_NetR), which is confirmed by high values of Pillai's Trace, Wilks' Lambda and Hotelling's Trace with $p < 0.001$. In other words, the banking sector in Kazakhstan primarily focuses on internal profitability and profitability indicators. Therefore, the results reflect that macroeconomic factors are less dependent. It is important to note that profitability growth is accompanied by increased net profit and tax

burden. Moreover, this explains the increase in lending and managing of assets. Thus, during economic downturns, individual banks continue demonstrating stable indicators, maintaining their financial stability due to internal management mechanisms.

The second hypothesis about the impact of the concentration of bank assets (2_Top5A%) on lending and deposit processes is also confirmed. The data show that the largest banks have a significant impact on the share of deposits (2_Top5D%) and the volume of lending (2_Top5L%), which is reflected in high F-criterion values (163.7 and 16.4, $p < 0.001$ and $p = 0.003$, respectively). We conclude that there is a high concentration of capital, with a small number of banks controlling the bulk of credit and deposit flows in Kazakhstan's banking system. The influence of macroeconomic factors on this process was less significant. This may explain why changes in the banking sector do not always reflect the overall macroeconomic trend during periods of economic instability since key players can regulate their activity regardless of changes in GDP. The third hypothesis about the impact of GDP (3_GDP%) on banking indicators is not confirmed since the analysis did not reveal a statistically significant relationship between the GDP level and such indicators as assets (3_ActGDP%), loans (3_LoanGDP%) and deposits (3_DepGDP%), which is confirmed by high p-values ($p = 0.628$, $p = 0.905$, $p = 0.554$). This means that the banking system of Kazakhstan does not demonstrate the expected linear effect of dependence on macroeconomic conditions. This result can be explained by several reasons: the possible presence of a lagged effect, in which changes in GDP begin to affect the banking system only after several years, or the fact that banks adjust their policies based on internal strategies and not macroeconomic conditions. Another explanation may be that the impact of GDP on banking indicators is manifested indirectly but through other factors, such as inflation, interest rates or government policy in financial regulation. This confirms that Kazakhstan's banking system is more dependent on internal governance mechanisms than macroeconomic changes, which requires further study using more complex econometric models.

In Figure 4, the Q-Q plot results are presented.

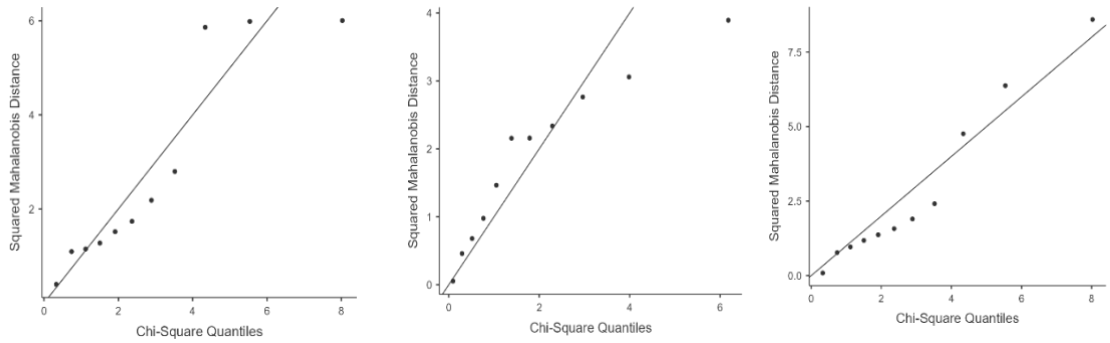

FIGURE 4. Q-Q Plot Assessing Multivariate Normality H1, H 2 and H3

Note: compiled by authors

The quantile-quantile plot for the first hypothesis, which assesses the impact of profitability (1_IncR) on net income and tax burden, shows that the data distribution generally corresponds to the theoretical chi-square distribution, as the points are located along the diagonal line. This means that in Kazakhstan, when banks increase their profitability (for example, by increasing interest rates on loans or the volume of operations), they naturally increase their net profit and tax payments. A statistically

significant result shows that such a relationship exists and is not a coincidence. For example, if a bank increases interest rates on loans, its profitability (1_IncR) grows, which leads to an increase in net profit (1_NetR and 1_NetA), but also to an increase in tax payments (1_Tax). This confirms that Kazakhstani banks first focus on maximising their profit, and the tax burden is a consequence of this process. In the second hypothesis, which analyses the effect of concentration (2_Top5A%) on the share of deposits and loans, the Q-Q plot shows minor deviations from the diagonal line, especially in the upper part, which may indicate the presence of outliers. However, the overall distribution remains close to normal, which allows us to consider the analysis reliable. The results confirming the significant effect of bank concentration on the distribution of deposit and loan flows remain valid, despite possible minor deviations in the data distribution. This means that a small group of the largest banks determines how financial resources are distributed in the economy. For example, if the five largest banks increase lending, this may increase the availability of borrowed capital for businesses and the population. If these banks tighten lending conditions or reduce deposit volumes, this may slow economic growth, since businesses and individuals have fewer options for financing. In Kazakhstan, the banking sector is highly concentrated, and the analysis results confirm that the policies of these largest players determine the dynamics of the entire financial system. For example, if leading banks increase their reserves instead of actively lending, this may lead to stagnation of the economy, even if other macroeconomic factors

The quantile-quantile plot for the third hypothesis, assessing the impact of macroeconomic factors (3_GDP%) on bank indicators, shows the most significant deviation from the diagonal, indicating that the data distribution is significantly different from normal. This is consistent with the statistical analysis results, which show that the impact of GDP on bank indicators is not statistically significant. This may mean that GDP affects the banking system indirectly but through complex mechanisms that are not immediately apparent. For example, if the economy grows, businesses expand and take out more loans, but this process takes time - perhaps several years. As a result, banks may not show an increase in assets and loan issuance, but this effect will become apparent in two or three years. Another example is when, during an economic crisis, the government may introduce anti-crisis measures, such as state support for banks or loan subsidy programs. In this case, even with a decline in GDP, banks can maintain a stable level of lending through these programs. Such a mechanism will not be visible when analyzing data for only one year but may appear when considering long-term trends.

This suggests that even if the economy of Kazakhstan is growing, this does not automatically mean that the banking sector is growing. Banks can increase or decrease lending depending on their internal strategies, not the overall economic situation. For example, in conditions of high economic growth, banks can remain cautious and not increase lending if they believe that the risks of loan defaults remain high. On the other hand, during periods of crisis, banks can receive support from the state or the National Bank, which allows them to continue lending even when GDP declines. This explains why the banking system of Kazakhstan does not demonstrate a clear correlation with economic growth - large banks make decisions based on their strategies, not only on overall macroeconomic conditions.

5. CONCLUSIONS

Internal factors determine the financial stability of Kazakhstan's banking sector, while macroeconomic indicators insignificantly impact banking indicators. The dispersion analysis confirmed that the growth of bank profitability leads to an increase in net profit and tax burden, which means that banks are focused on maximising their profitability rather than supporting economic growth through expanding business lending.

High capital concentration in the largest banks significantly impacts the lending structure and deposit distribution. A change in the deposit structure and loan portfolio has a considerable impact on the share of the largest banks, which is explained by the financial sector's dependence on the decisions of a limited number of participants. Therefore, if several of the largest banks adopt a conservative lending strategy, access to financing may decrease sharply, especially for small and medium-sized businesses. The analysis also showed the absence of a significant relationship between macroeconomic indicators and the banking system, which suggests that Kazakhstani banks do not respond proportionally to changes in GDP.

Thus, the results show that Kazakhstan has a strict system of regulation of the banking sector, which reduces the dependence of banks on economic cycles but, at the same time, limits their ability to support the economy during periods of growth or crisis. That is, the banking system operates in a closed mode, focusing more on its profitability than on the dynamics of the economy. Banks do not respond to GDP growth as expected, which may indicate insufficient involvement of the banking sector in financing the real sector of the economy. Thus, the problem lies in the limited integration of the banking system into economic growth, which reduces its role as an engine of development. If the regulatory policy does not actively stimulate banks to finance businesses, this may slow down investment and modernisation of key industries.

For businesses, access to credit resources is sensitive to changes in investment activity and entrepreneurship, which is especially crucial for small- and medium-sized enterprises.

For the population, the priority development of consumer lending may increase the debt burden among citizens, increasing the risks of financial instability for households. For the economy as a whole - the banking system does not act as an active driver of economic growth, which may slow down the modernisation of key industries since the real sector does not receive enough funding.

An active policy is needed to stimulate competition in the banking sector and mechanisms to ensure more balanced lending, including support for the corporate segment. The concentration of capital in a small number of banks increases systemic risks and limits the effectiveness of redistributing financial resources - implications for banks. Hence, internal management strategies determine profitability. Attention to consumer loans and business financing is necessary to improve sustainability, diversify income sources, and develop a balanced credit policy.

The banking system of Kazakhstan does not actively participate in the development of the economy, which may lead to the fact that even under favorable macroeconomic conditions, the development of the real sector will be constrained by the lack of available financing. To unleash the country's economic potential, it is necessary to review the mechanisms of banking regulation and encourage banks to participate more actively in investment processes.

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The Impact of Digitalization and Investment on Agricultural Development in Kazakhstan

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ABSTRACT

Today, digitalization and investment are becoming key drivers of agricultural transformation, but their impact on the agro-industrial sector remains controversial. The study aims to determine how investments in fixed assets, digital literacy, and Internet penetration affect the volume of gross agricultural output in Kazakhstan. The initial data includes panel data from the Bureau of National Statistics of the Republic of Kazakhstan for 2010-2023. The study uses multidimensional linear regression to assess the contribution of each factor (investments in fixed assets, the level of digital literacy, Internet penetration, and the use of mobile phones and computers) to the formation of gross agricultural output. The findings indicate that investments in fixed agricultural assets exhibit a positive but statistically insignificant relationship with agrarian production ($\beta = 4.4474$, $p = 0.2221$). Similarly, mobile phone use and Internet penetration in rural areas do not show a significant correlation with the growth of the agricultural sector. In addition, negative coefficients for digital literacy and Internet activity in rural areas have been identified, which may indicate barriers to introducing digital technologies into the agro-industrial complex. The novelty of this research lies in its empirical evaluation of digitalization's role in agricultural development within a transitional economy, emphasizing the need for targeted policy interventions. The results suggest that investment efficiency, digital skills training, and improved technological adoption should be prioritized to maximize agricultural productivity. Further research is needed to explore long-term investment effects and sector-specific impacts to refine policy recommendations.

KEYWORDS: Agricultural Investment, Agricultural Development, Agribusiness, Digital Economy, Internet Penetration, Digital Literacy

SCSTI: 06.77.35

JEL Code: Q10, Q18, R11

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1. INTRODUCTION

The modern agro-industrial complex is one of the main sectors of the economy that ensures food security and sustainable development in rural areas. In 2022, agriculture contributed 4.5% of Kazakhstan's GDP, and the number of people employed in the industry amounted to more than 1.2 million (World Bank, 2023). However, traditional agricultural practices face some challenges, including climate change, lack of skilled labor, declining soil fertility, and increasing demands for product quality and safety. For example, according to the World Bank, global food demand will increase by 60% by 2050, requiring new approaches to agricultural management (FAO, 2021). Under these conditions, digitalization becomes a strategic tool to improve agribusiness efficiency, sustainability, and competitiveness. According to the Ministry of Agriculture of Kazakhstan, the industry's digitalization level in 2023 was 30%, with a target of at least 50% by 2025.

Digitalization of agribusiness involves introducing innovative technologies such as artificial intelligence, big data, the Internet of Things (IoT), blockchain, and drone technologies. Such tools enable optimizing processes at all stages of agricultural production - from soil preparation and sowing to harvesting, logistics, and product sales. With their help, it becomes possible to predict yields more accurately, reduce resource costs, improve product quality control, and minimize negative environmental impact (Klerkx & Rose, 2020).

One of the main aspects of digitalization in agribusiness is the application of precision farming technologies. According to FAO (2022), precision farming can increase crop yields by 10-15% and reduce fertilizer and water costs by 20-30%. Through drones, satellite monitoring, and sensor systems, farmers can get up-to-date information on field conditions, soil moisture levels, and fertilizer needs, increasing yields and reducing losses due to adverse weather conditions or misallocating resources.

In addition, digitalization contributes to the transformation of business models in agriculture. Kazakhstan has already launched over 20 digital platforms, such as AgroHub, Smartek, Qoldau, which bring together farmers, suppliers, processors and consumers (Tsoy & Nurbatsin, 2024). The development of agricultural platforms and marketplaces facilitates interaction between producers, suppliers, distributors, and end consumers. Blockchain enables supply chain transparency, while smart contracts automate transaction and settlement processes, reducing transaction costs, increasing trust between market participants, and improving access to international markets (Treiblmaier, 2018).

Another important direction is the development of agricultural robotic systems and automated production, which will increase the efficiency of agricultural processes, reduce labor costs, and minimize the human factor in the management of agro-industrial complexes. McKinsey (2021) predicts that using robots in agriculture could reduce labor costs by 30-50%. Unmanned tractors, harvesters, and drones for applying fertilizers or pesticides can reduce labor costs, improve the accuracy of operations, and reduce environmental impact. Kazakhstan has already introduced more than 50 unmanned tractors and about 200 drones for fertilizer and pesticide application, reducing chemical consumption by 20-25% and improving operational accuracy (Gabdualiyeva et al., 2024). Artificial intelligence and machine learning help analyze large amounts of data and make optimal decisions, which is especially important in climate variability and population growth (Wolfert et al., 2017).

However, successful implementation of these technologies is impossible without industry professionals' appropriate skills and knowledge. Digital literacy is becoming a significant factor in effectively using robotic systems and automated processes. According to OECD research (OECD, 2022), only 40% of farmers in developing countries have a

sufficient level of digital literacy to work with new technologies. In Kazakhstan, about 65% of the rural population has access to the Internet, but the level of digital literacy in agribusiness remains insufficient (Dauliyeva et al., 2022). Lack of knowledge in working with digital tools can be a serious barrier for farmers and agricultural enterprises. In this context, an important aspect is not only the mastery of digital technologies but also the general level of literacy of the rural population, which determines the ability to adapt to new technological realities, perceive innovations, and increase productivity. Lack of knowledge of digital tools can be a serious barrier for farmers and agricultural enterprises. In this context, an important aspect is not only digital skills but also the general literacy level of the rural population. It determines the ability to adapt to new technological realities, perceive innovations, and increase labor productivity.

Additional indicators of agro-industrial complex digitalization are the level of automation of processes, the degree of integration of digital platforms in agriculture, and the availability of digital infrastructure in rural areas. High levels of automation minimize human error and increase productivity, while digital platforms provide access to analytical tools, trading platforms and logistics services. The availability of digital infrastructure, including broadband internet and mobile technology, is fundamental to successfully implementing digital solutions in agriculture.

However, despite the apparent advantages, agribusiness's digitalization presents several challenges. These include the high cost of technology adoption, the need for staff training, the risks of cyber threats, and the lack of infrastructure in rural areas. It is also important to consider the possible social consequences, such as reducing traditional jobs and the need for farmers to adapt to new farming conditions. Government support, investment in research and development of innovations, and the development of educational programs are becoming critical factors in the successful digital transformation of the agribusiness sector.

Thus, the digitalization of the agro-industrial complex is a powerful driver of its development, ensuring increased production efficiency, cost reduction, and improved environmental sustainability. However, the successful implementation of digital technologies requires a comprehensive approach, including infrastructure modernization, government and business support, and the active development of educational and research initiatives. The following sections of this study will discuss key areas of digital transformation of the agro-industrial complex, examples of successful implementation of technologies in different countries, and possible strategies for adapting to the conditions of national agriculture.

The study aims to investigate the impact of economic (investment) and digital (internet, digital literacy, use of technology) factors on agricultural development. Hypotheses were formulated:

H0: The listed factors have no statistically significant effect on the gross output of agriculture.

H1: Rural internet penetration and digital literacy have a meaningful impact on the growth of agricultural production.

H2: Fixed capital investment in agriculture is the primary driver of the increase in gross output.

H3: Use of cell phones and computers in rural areas contributes to the development of the agricultural sector.

2. LITERATURE REVIEW

The introduction of digital technologies and investment in fixed capital is an important direction of agricultural development. However, their impact on the growth of agricultural production remains a subject of academic debate. This review explores the relationship between investment, digital literacy, internet penetration, and agricultural sector development.

Investment in fixed capital is one of the factors that increase agricultural productivity. Studies by Gollin et al. (2002) and Mogues et

al. (2012) show that increased investment in the agricultural sector contributes to infrastructure modernization, adoption of innovative technologies, and yield growth. However, the impact of investment depends on its focus: funds invested in technology and equipment have a more significant impact on productivity than investments in traditional farming practices. Ali et al. (2022) found that digitalization and automation of the agricultural sector contribute to reducing CO_2 emissions through resource efficiency, confirming the need to modernize agriculture through investment.

Digital literacy is becoming one of the main drivers of economic and social development today. The agro-industrial complex s crucial in increasing productivity, optimizing resource management, and enhancing market access for farmers and agrarian enterprises (Kosasih & Sulaiman, 2024). This review explores the significance of digital literacy in agriculture, analyzing its impact on precision farming, access to financial services, knowledge dissemination, and sustainable development. Empirical studies and theoretical approaches are reviewed, illustrating both the benefits and challenges of digital transformation in agribusiness.

One of the main factors influencing the successful implementation of digital technologies in the agricultural sector is farmers' level of digital literacy. Studies by Gong et al. (2024) examine the impact of digital literacy on the efficiency of green production in agriculture. Their study found that farmers with high digital skills are likelier to use digital tools to monitor soil health, manage water resources, and optimize fertilizer application. As a result, their farming operations are more sustainable, reducing the burden on the environment. In addition, the successful implementation of digital solutions requires their availability and the active participation of farmers in the digitalization process. In particular, research shows that those with access to educational resources and government support adapt to new technologies much faster and use them more effectively in their work (Engås et al., 2023).

Precision farming is based on the use of digital tools such as geographic information systems (GIS), remote sensing, and the Internet of Things (IoT) sensors to help optimize agricultural processes (Klerkx & Rose, 2020). In addition, Chang et al. (2023) examined the impact of social media on fertilizer management among farmers in Shaanxi Province of China. They found that digital platforms such as WeChat and Douyin (the Chinese equivalent of TikTok) allow farmers to access up-to-date information on best farming practices, which helps to reduce excessive use of chemical fertilizers and improve soil fertility. The study found that farmers who actively use digital platforms exhibit more environmentally conscious behavior and are willing to adopt innovative agricultural resource management practices.

Also, farmers with high levels of digital literacy are more willing to adopt innovative technologies, which leads to higher yields and reduced negative environmental impact (Wolfert et al., 2017). In Kazakhstan, the issues of digitalization of agriculture are also the focus of scientists' attention. According to a study by Abdullaev et al. (2020), the level of adoption of precision agriculture in Kazakhstan remains insufficient, mainly due to the lack of qualified personnel and limited availability of technology in remote regions. However, government initiatives such as the Digital Kazakhstan program have gradually increased the adoption of innovative agro-technologies.

In addition to adopting precision farming, digital literacy is important in making financial services accessible to agriculture. Mobile banking, digital credit platforms, and blockchain technology make it easier for farmers to obtain finance, facilitating the modernization of production and adopting sustainable practices (Ye et al., 2022). Studies in Kazakhstan show that farmers with basic skills in digital financial instruments are less likely to face credit problems (Dauletkhanova et al., 2023). However, insufficient financial literacy and poor development of digital

infrastructure in rural areas hinder the full utilization of digital payment systems and online lending.

Another important aspect of digitalization is disseminating knowledge and innovation in agriculture. The Internet and mobile applications have radically changed the process of information transfer, providing farmers with up-to-date data on weather conditions, pest control, and best farming practices (Abiri et al., 2023). Kazakhstan is actively developing educational programs to improve the digital literacy of agrarians. According to a study by Myrzakhmetova et al. (2021), the introduction of online courses and webinars has significantly increased the level of digital knowledge of farmers. However, there is an urgent need to localize content into Kazakh and adapt educational programs to the specific conditions of agriculture in the country.

Despite the apparent benefits of digital technologies, their diffusion in the agricultural sector faces many challenges. Key barriers include lack of internet accessibility, lack of educational programs on digital literacy, and farmers' wariness of new technologies (Eastwood et al., 2019). Together, these factors inhibit the digital transformation of agribusiness, reducing the effectiveness of agribusiness modernization. Overcoming these barriers requires a comprehensive approach that includes infrastructure development, educational initiatives, and support for digital solutions at the state level.

In Kazakhstan, a study by Dauliyeva et al. (2022) found that the main barriers to the digitalization of agriculture are the high equipment cost, low training level, and lack of specialized digital solutions for local agrarian conditions. Researchers emphasize that state subsidies and tax incentives are needed to support the digitalization of farms.

Analysis of scientific research shows that digital literacy, internet penetration, and investment in agriculture are key factors in the modernization of the agro-industrial complex. However, their impact depends on the quality of infrastructure, the level of training of farmers, and the availability of financial resources. In Kazakhstan, despite increased investment and internet penetration, the effect of digitalization remains limited due to low levels of digital literacy and poorly developed digital infrastructure. Future research should consider the impact of long-term investments and the need to develop educational programs focused on farmers and the rural population.

3. RESEARCH METHODS

The study uses a quantitative approach to analyze the impact of investment, internet penetration, digital literacy, and digital technologies in rural areas on the volume of gross agricultural output in Kazakhstan. Using a quantitative method allows for an objective assessment of the existing relationships between variables and the identification of significant factors influencing the development of the agricultural sector. The study is based on secondary data collected from official statistical sources, including the Bureau of National Statistics of the Republic of Kazakhstan. The analysis covers the period from 2013 to 2023, which allows for assessing long-term trends, identifying stable relationships, and identifying possible structural changes in the industry.

Python, which provides powerful statistical and visualization tools, was used to analyze the data and build regression models. In particular, the following libraries were used.

The research methodology includes several stages, shown in Figure 1.

Description of the research stages:

Stage 1. Descriptive analysis of macro-economic indicators The first stage of the study includes an analysis of the main macroeconomic indicators of the agro-industrial complex of Kazakhstan. During this stage, the share of agriculture in the gross domestic product and gross value added is considered, which makes it possible to determine the importance of the industry in the country's economy. The gross agricultural output is also analyzed, covering both crop production and animal husbandry.

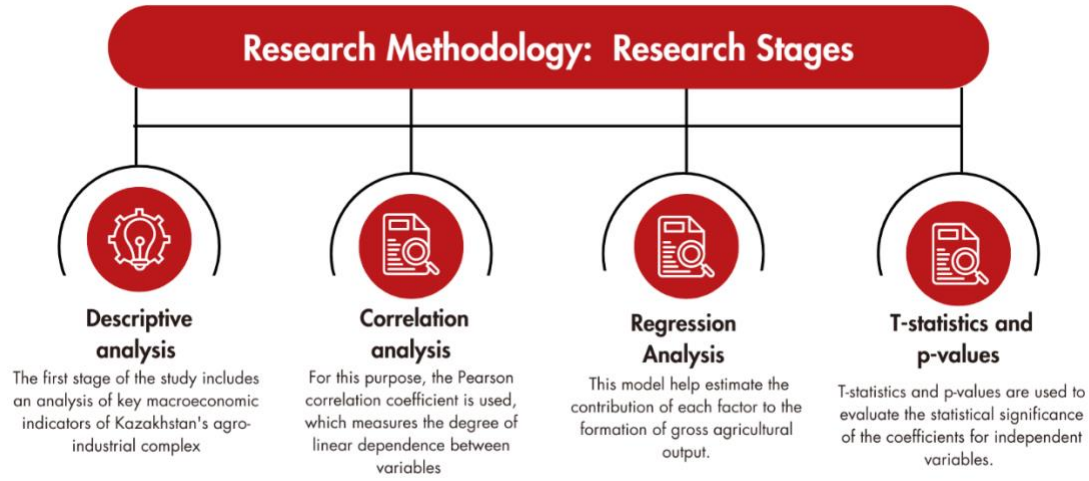

FIGURE 1. The steps of analysis

Note: compiled by authors

Another important aspect is the level of investment in fixed assets of agriculture, which reflects the scale of financing of the industry and the potential for its further development. This analysis helps identify the main trends related to agricultural production and determine the sector's structure.

Stage 2. Correlation analysis determines the strength and direction of the relationship between the dependent and independent variables at this stage. For this purpose, the Pearson correlation coefficient is used, which measures the degree of linear dependence between variables (see Table 1).

TABLE 1. Indicators for analysis

Code	Indicator	Category
Dependent variable		
GO_AP	Gross output of agricultural products (services), mln KZT	The economic factor
Independent variables		
Inv_AP	Investments in fixed assets, mln KZT	The economic factor
Mob_us_r	Percentage of mobile phone users in rural areas, %	The digitalization factor
%_Com	Percentage of computer users aged 6-74 years, %	The digitalization factor
Hh_Int	Share of rural households with Internet access from home, %	The digitalization factor
Dig_lit	The level of digital literacy of the population, %	The digitalization factor
Int_us_r	Percentage of Internet users aged 6-74 in rural areas, %	The digitalization factor

Note: compiled by authors

Correlation analysis reveals the degree of relationship between gross agricultural output and key economic and digital factors, which contributes to a deeper understanding of the impact of digitalization and investment on the development of Kazakhstan's agro-industrial complex.

Stage 3. Multiple regression model, to analyze the relationship between variables. This model help estimate the contribution of

each factor to the formation of gross agricultural output.

The regression model is specified as follows formula (1):

$$GO\_AP = \beta 0 + \sum_{i-1}^{6} \beta_i X_i + \epsilon \qquad (1)$$

where:

β0 – the free term of the equation;

βi – regression coefficients for each independent variable;

Xi – vector of independent variable;

ϵ – accidental model error.

This regression model captures the linear relationship between agricultural output and key economic and digitalization-related factors. The main purpose of the model is to determine which of these factors have a statistically significant impact on agricultural production and to what extent. Stage 4. T-statistics and p-values are used to evaluate the statistical significance of the coefficients for independent variables. F-statistics help to determine whether the model explains a significant part of the variation in the dependent variable. Confidence intervals (95%) are used to assess the reliability of regression coefficients.

The proposed methodology provides a comprehensive analysis of the factors influencing the development of agriculture in Kazakhstan. The applied research approach allows us to obtain objective and reliable results that can serve as a basis for developing recommendations on the digitalization and modernization of the country's agro-industrial complex.

4. FINDINGS AND DISCUSSIONS

Kazakhstan has significant agricultural potential, contributing to developing a more diversified and inclusive economy. The key advantage of the country's agricultural sector is its vast territory with low population density and a large amount of agricultural land. The total area of agricultural land reaches about 217 million hectares, of which about 35 million hectares is arable land, and fallow land is about 13 million hectares. Due to geographical peculiarities and uneven distribution of land resources, the agrarian specialization of the regions varies significantly. Thus, crop production is predominantly developed in the north of the country, as well as in the east and south. The central regions are oriented towards extensive livestock farming, while in the south-eastern part of the country, a mixed type of agriculture prevails.

Figure 2 shows that the share of agriculture in the GDP structure varies between 4.3 and 5.4%, demonstrating relative stability with small fluctuations.

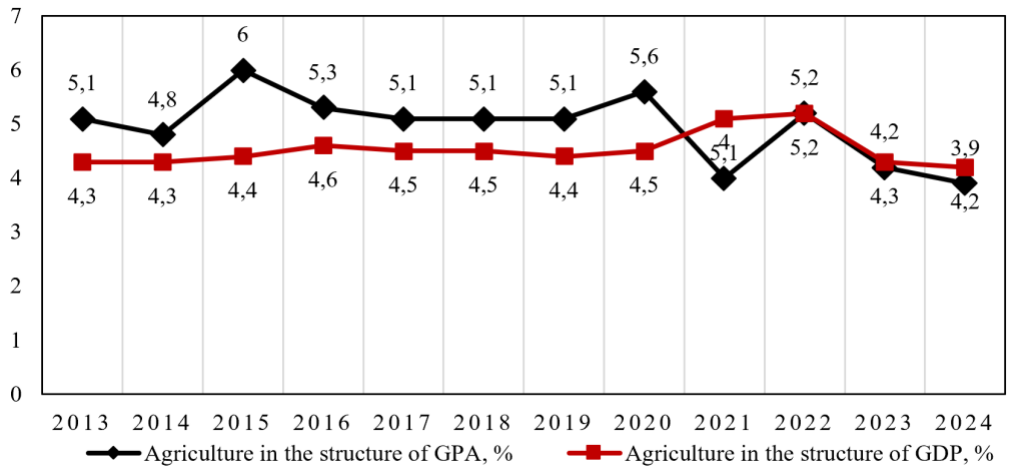

FIGURE 2. Agriculture in the structure of GDP and GVA, %

Note: compiled by authors

The highest value was noted in 2020, and amounted to 5.4%, and in 2024 there was a decrease to 4.2%. And the share of agriculture in the structure of gross value added (GVA, %), in contrast to GDP, had more pronounced fluctuations. In 2015, it reached 6%, then there was a decrease to 5.1% in 2019, but in 2020 there was an increase to 5.6%. However, after 2022, the value dropped to 3.9% in 2024, indicating a drop in agriculture's contribution to total value added. The general trend shows a decrease in the importance of agriculture in the economy in recent years, especially after 2020. The reason may be related to labor productivity in agriculture, as outdated machinery is used in Kazakhstan, and there is a shortage of qualified personnel.

Figure 3 reflects the dynamics of Kazakhstan's agricultural sector over the period 2013-2023, demonstrating changes in gross output, as well as in the structure of the industry, where crop production and animal husbandry occupy different shares.

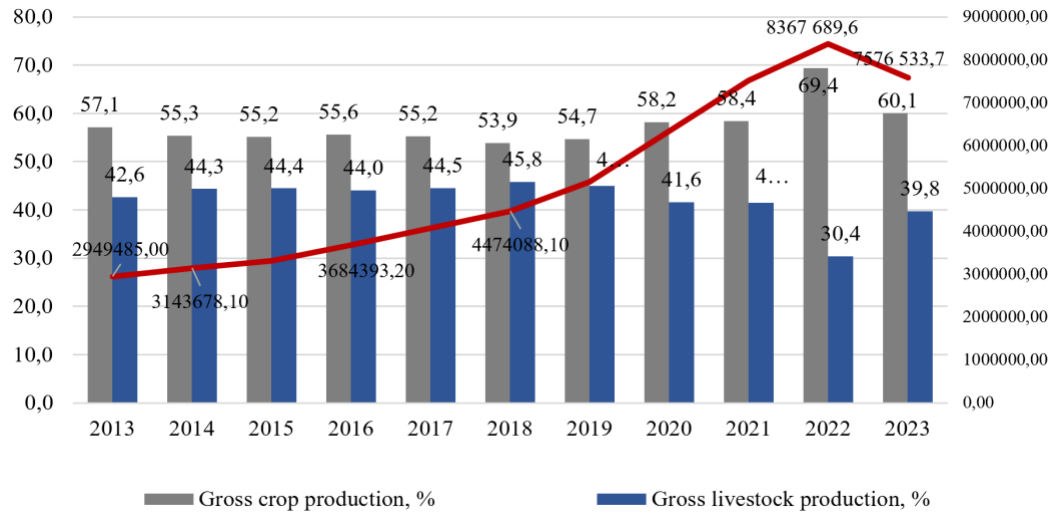

FIGURE 3. Gross agricultural product in the context of animal husbandry and crop production

Note: compiled by authors

In general, there is a steady increase in gross agricultural production: if in 2013 the volume amounted to 2.94 trillion tenge, then by 2022 it reached 8.37 trillion tenge, which indicates a more than twofold increase. However, in 2023, there was a decrease to 7.58 trillion tenge, which may be due to a number of factors, such as worsening weather conditions, price fluctuations on world markets or changes in the agricultural policy of the state. In addition to the general growth of agricultural production, there is a significant change in its structure. The share of crop production, which was 57.1% in 2013, has shown a downward trend over the following years, reaching 39.8% in 2023. This reduction is especially noticeable after 2022, when the share of crop production fell sharply from 69.4% to 39.8%, due to changes in acreage, dry periods, falling yields or rising production costs. At the same time, animal husbandry shows relative stability, maintaining a share of 41-45% until 2021, but in 2022 it decreased to 30.4%, and in 2023 it increased sharply to 60.1%, indicating possible crisis phenomena such as feed shortages, epidemiological threats, rising prices for livestock products, this could lead to temporary difficulties in the sector, and then to its recovery.

Thus, the agricultural sector continues to show growth in value terms, but its structure is significantly transformed. The decline in the

share of crop production combined with the instability of the livestock sector may indicate structural problems requiring intervention.

Figure 4 shows the dynamics of investments in fixed assets of agriculture for the period 2013-2023.

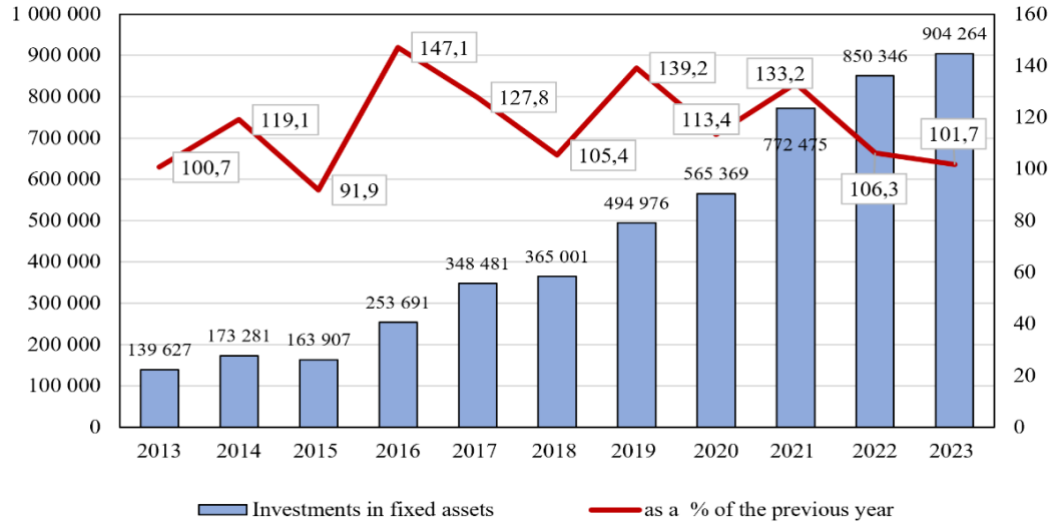

FIGURE 4. Investments in fixed capital of agriculture, mln. KZT

Note: compiled by authors

In general, there is a tendency towards an increase in investment volumes, which indicates a gradual increase in investments in the agricultural sector. If in 2013 the volume of investments amounted to 139.6 billion tenge, by 2023 this figure has increased more than sixfold, reaching 904.2 billion tenge, which indicates the increasing role of investments in the development of agriculture. However, the dynamics of investment growth is uneven, which is reflected in the percentage change compared to the previous year. In 2014, there was a significant increase in investments (119.1% compared to 2013), but in 2015 the growth rate decreased to 91.9%, indicating possible financial or institutional constraints. In 2017, there was a sharp jump in investment, amounting to 147.1% compared to the previous year, which may be due to government support programs, the introduction of new technologies and increased investor interest. However, the following years were characterized by volatility, where, despite the growth in absolute investment values, the growth rate showed fluctuations.

In 2019, investment growth was 139.2%, but then decreased to 113.4% in 2020, which could be due to the impact of the COVID-19 pandemic, disruption of supply chains and a decrease in business activity. In 2021, a significant increase in investments was recorded, reaching 772.4 billion tenge, but in 2022 the rate of increase slowed to 106.3%, which may indicate that the existing mechanisms for supporting the sector are approaching the limit of effectiveness. Despite a slight decrease in growth rates in 2022-2023, the total volume of investments continues to grow, which indicates continued interest in agricultural development and strengthening of its investment base.

The agricultural sector demonstrates a steady increase in investments in fixed assets, but their growth is cyclical, due to changes in macroeconomic conditions, the availability of credit resources, government support programs and the level of technological modernization. Fluctuations in investment growth reflect changes in the sector's financing strategy, including the impact of external factors such as

climate conditions, global economic crises, and changes in agricultural policy. In the long term, maintaining positive investment dynamics will be crucial for increasing agricultural productivity, introducing innovative technologies, and increasing the competitiveness of the agricultural sector.

Summing up the analysis, Kazakhstan's agro-industrial complex is showing growth, but is facing a number of structural challenges. The share of agriculture in GDP is declining, reaching 4.2% in 2024, reflecting its slowdown. Although the gross output of agricultural products more than doubled from 2013 to 2022, in 2023 it decreased to 7.58 trillion tenge due to unfavorable conditions and price instability. Structural changes are manifested in a decrease in the share of crop production to 39.8% in 2023, while livestock production, after a recession in 2022, increased to 60.1%. Investments in fixed assets have increased more than sixfold in a decade, but their pace remains unstable. Technological modernization, qualified personnel and effective government support are needed to ensure the sustainable development of the sector.

Next, a correlation analysis was performed, presented in the form of a heat map, which demonstrates the degree of relationship between the various indicators.

Figure 5 describes the indicators which have strong positive relationships, which is confirmed by high correlation values, 0.91 and higher, respectively.

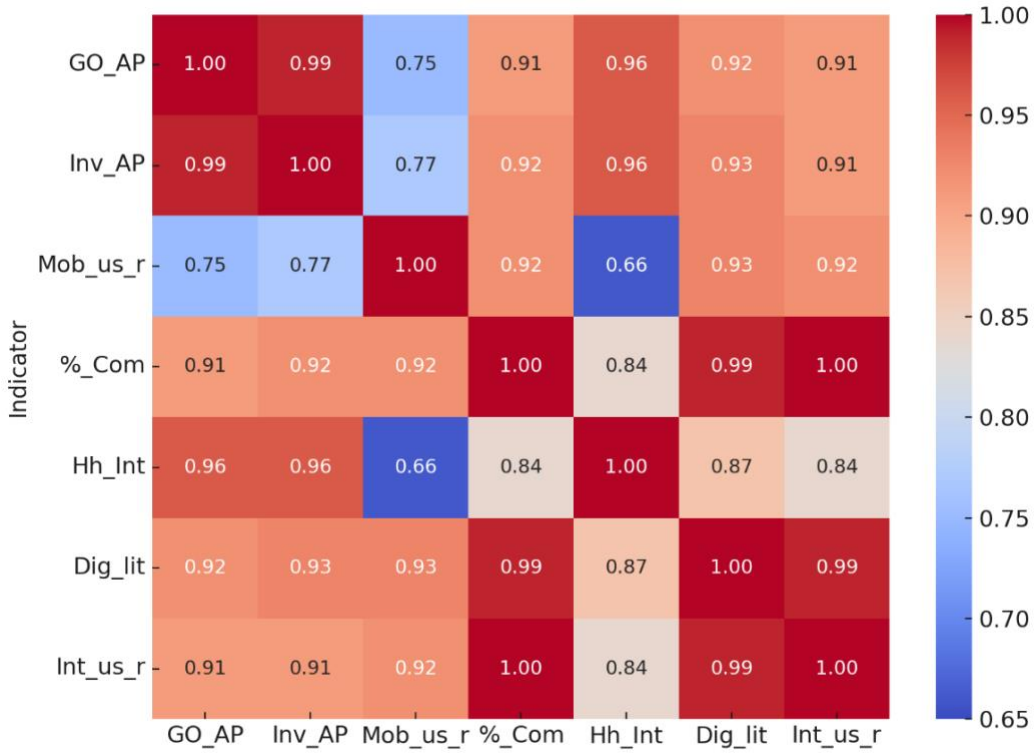

FIGURE 5. Correlation matrix

Note: compiled by authors

Thus, GO_AP and Inv_AP show an almost complete correlation (0.99), which may indicate a close relationship between the level of investment in agriculture and its gross output. Indicators such as the proportion of mobile phone users in rural areas (Mob_us_r) and the proportion of rural households with Internet access from home (Hh_Int) have less

pronounced connectivity (0.66), which may indicate the presence of additional factors affecting their relationship. It can also be noted that digital literacy (Dig_lit) and the level of Internet access (Int_us_r) are almost identical in terms of the degree of connection with other variables, reflecting the high level of digital integration and dependence on infrastructure. In addition, %_Com (the proportion of computer users) shows a significant correlation (over 0.99) with digital literacy and Internet users, which underscores the importance of digital technologies in economic activity. In general, the presented analysis indicates a high degree of interconnectedness between investments, digital skills and infrastructure development, which confirms the need for an integrated approach to their development.

Table 2 shows the results of regression analysis, which demonstrate the absence of a statistically significant influence of the studied factors on the dependent variable, which is confirmed by the high P-values of all independent variables (above 0.05) .

TABLE 2. Regression analysis result

Variable	Coefficient	Standard Error	t-Statistic	P-Value	95% CI (Lower)	95% CI (Upper)
Intercept	-12,371,360	23,395,370	-0.5288	0.6249	-77,327,310	52,584,590
Inv_AP	4.4474	3.0785	1.4446	0.2221	-4.10	12.99
Mob_us_r	18,417.85	40,214.20	0.4580	0.6707	-93,234.66	130,070.4
%_Com	371,529.4	563,178.5	0.6597	0.5455	-1,192,105	1,935,164
Hh_Int	122,363.2	80,007.7	1.5294	0.2009	-99,773.8	344,500.2
Dig_lit	-217,847.4	248,059.2	-0.8782	0.4294	-906,570.2	470,875.5
Int_us_r	-122,229.5	417,590.0	-0.2927	0.7843	-1,281,645	1,037,186

Note: compiled by authors

Although investments in agriculture (Inv_AP), rural mobile users (Mob_us_r), and household Internet access (Hh_Int) have positive coefficients, their impact remains statistically insignificant. The highest coefficient (371.529.4) is observed for a variable reflecting the proportion of computer users (%_Com), but its P-value (0.5455) indicates a weak relationship. At the same time, digital literacy (Dig_lit) and the share of rural Internet users (Int_us_r) show negative coefficients, but their high P-values (0.4294) and (0.7843). The high uncertainty of the estimates and wide confidence intervals, for example, for %_Com from -1,192,105 to 1,935,164, indicate possible model problems such as multicollinearity or insufficient number of observations.

Table 3 shows the results of hypothesis testing.

TABLE 3. Hypothesis testing results

Hypothesis	Expected Effect	Coefficient	t-Statistic	P-Value	Result
H1	Positive	-217,847.4 (Digital Literacy) -122,229.5 (Internet Usage in Rural Areas)	-0.8782 -0.2927	0.4294 0.7843	Rejected (P > 0.05)
H2	Positive	4.4474	1.4446	0.2221	Rejected (P > 0.05)
H3	Positive	18,417.85 (Mobile Usage in Rural Areas) 371,529.4 (Computer Usage)	0.4580 0.6597	0.6707 0.5455	Rejected (P > 0.05)
H0	No effect	-			Not Rejected (All P-values > 0.05)

Note: compiled by authors

Based on the regression results, none of the independent variables showed a statistically significant effect on agricultural output (all p-values > 0.05). This suggests that internet penetration, digital literacy, mobile and computer usage, and investment in fixed assets do not strongly influence agricultural production growth in the analyzed data. The null hypothesis (H0) is not rejected, meaning no statistical evidence supports the alternative hypotheses (H1, H2, and H3).

4. DISCUSSION

The regression analysis results indicate that investments in fixed agricultural assets, internet penetration, digital literacy, and the use of digital technologies in rural areas do not have a statistically significant impact on agricultural output in Kazakhstan. This finding contrasts with numerous studies that emphasize the transformative role of digitalization and capital investment in agriculture. However, it aligns with research suggesting that the effectiveness of these factors is contingent on additional conditions, such as the level of infrastructure development, the efficiency of policy implementation, and the capacity of farmers to adopt and utilize new technologies effectively.

Empirical studies by Gollin et al. (2002) and Mogues et al. (2012) underscore the crucial role of capital investment in enhancing agricultural productivity, particularly in developing economies. Contrary to these findings, the present study reveals no significant relationship between investment in fixed agricultural assets and agricultural output, which may suggest that either the level of investment remains insufficient to drive substantial productivity gains or that financial resources are not being effectively allocated to key productivity-enhancing assets such as modern machinery, irrigation systems, and precision farming technologies. Moreover, in Kazakhstan, where large-scale agribusiness enterprises coexist with smallholder farms, it is plausible that investments are disproportionately concentrated in specific subsectors, thereby limiting their overall contribution to the agricultural sector's growth.

Similarly, despite the theoretical advantages of digitalization, the study does not confirm a statistically significant impact of internet penetration and digital literacy on agricultural output. While research by Engås et al. (2023) suggested that access to digital technologies in rural areas can improve market access, reduce transaction costs, and enhance productivity, these benefits may not yet be fully realized in Kazakhstan's agricultural sector. One possible explanation is that, although internet penetration is increasing, its application for agricultural purposes remains limited. Many farmers may not actively utilize digital tools for market monitoring, financial management, or precision farming, constraining the anticipated productivity gains. Furthermore, Kosasih and Sulaiman (2024) highlighted the persistence of the digital divide in rural regions, where older farmers demonstrate lower levels of technology adoption, which may further explain the insignificant impact observed in this study.

Additionally, the findings do not support the hypothesis that the use of mobile phones and computers in rural areas significantly contributes to agricultural development. While previous highlights the role of mobile technologies in facilitating access to market information and financial services, thereby increasing efficiency, the results of this study suggest that, in Kazakhstan, mobile phone usage in rural areas may still be predominantly limited to communication purposes rather than business-oriented applications. Furthermore, low digital literacy levels, particularly among older generations, maybe a barrier to effectively utilizing digital tools in agricultural operations, further limiting their potential impact.

Several factors may explain the lack of statistically significant results. First, investments in agriculture typically exhibit a time lag before yielding measurable

productivity gains. The observed period of analysis may not fully capture the long-term effects of capital investments, and future studies could benefit from applying lagged models to address this limitation. Second, while internet penetration continues to expand, insufficient training, inadequate digital infrastructure, and resistance to technology adoption may hinder its effective integration into agricultural processes. Policymakers should, therefore, not only focus on increasing internet accessibility but also prioritize initiatives to enhance digital skills and provide targeted incentives for farmers to integrate technological innovations into their production activities.

Furthermore, the structural characteristics of Kazakhstan's agricultural sector may also influence the effectiveness of investments and digitalization. The sector is characterized by a dual structure comprising large agro-industrial enterprises alongside smallholder farms. The impact of technological advancements and capital investment may vary significantly between these groups, with larger enterprises having greater capacity to adopt and implement modern agricultural technologies. At the same time, small-scale farmers may face barriers related to financial constraints and limited access to resources. Future research should, therefore, consider heterogeneous effects, particularly by analyzing whether digitalization and investment policies disproportionately benefit large-scale farms over smallholders.

In light of these findings, policymakers should focus on improving the efficiency of investment allocation in agriculture, ensuring that resources are directed toward productivity-enhancing assets and technological advancements. Moreover, digitalization efforts must extend beyond increasing internet access to fostering a comprehensive digital transformation strategy that includes training programs, targeted incentives, and infrastructural development. While previous studies emphasize the potential of digitalization and investment in driving agricultural growth, the results of this study indicate that, in the case of Kazakhstan, these factors have not yet yielded statistically significant effects, highlighting the need for complementary measures to unlock their potential fully.

5. CONCLUSION

This study was aimed at analyzing the impact of economic and digital factors on the development of agriculture in Kazakhstan, where the main focus was on investments in fixed assets, digitalization and their potential contribution to the formation of gross agricultural product. The literature review revealed that investments in agriculture are traditionally considered as a key factor in increasing productivity, but their effectiveness depends on the direction of investments. Research shows that the most significant effect is achieved by financing technological innovations, upgrading infrastructure, and training personnel, whereas a simple increase in capital investment does not always lead to an increase in agricultural production.

The empirical results of the study, based on data from 2013-2023, revealed that investments in fixed assets did not have a statistically significant impact on agricultural production, which may be explained by the long-term nature of their impact, uneven resource allocation and possible inefficiency of their use. The penetration of the Internet and the level of digital literacy also did not demonstrate a significant relationship with the growth of agricultural production, which indicates that access to digital technologies alone does not guarantee their effective use in the agricultural sector. In addition, the use of mobile phones and computers in rural areas did not turn out to be a significant growth factor, which is probably due to insufficient digital involvement of farmers and the underdeveloped ecosystem of digital services in agriculture.

The results obtained allow us to conclude that a simple increase in investments and the spread of digital technologies without parallel development of infrastructure and educational initiatives does not lead to the expected effect.

In this regard, it is necessary to reconsider approaches to the development of agriculture and the digitalization of the agricultural sector, ensuring a more targeted use of resources. Main recommendations include improving investment efficiency through priority financing of technological modernization and productivity improvement, developing digital literacy of farmers through the introduction of educational programs, improving the digital infrastructure of rural areas with an emphasis on providing broadband Internet and affordable digital services, creating financial incentives for the introduction of digital technologies in the agricultural sector, including subsidies, tax incentives and grants, as well as monitoring and evaluating the effectiveness of government initiatives in this area.

Given these findings, policymakers should adopt a more comprehensive approach to agricultural development by ensuring that investments are effectively allocated to productivity-enhancing assets such as modern machinery, irrigation, and precision farming technologies. Additionally, digitalization efforts should focus on expanding internet access, improving digital literacy, and promoting the practical application of technology in agricultural production. Future research should explore the long-term effects of investment, sector-specific impacts, and the interaction between digitalization, investment, and government policies. By addressing these challenges, Kazakhstan can better leverage its agricultural potential to enhance economic diversification and sustainable rural development.

Limitations

The study's limitations stem from data constraints. The short observation period may not fully reflect the effects of long-term investment and digitalization. Structural differences within the agricultural sector were not considered, potentially masking varying impacts. Additionally, unobserved factors like regional policies and financial access could influence results. Future research should address these gaps for a more comprehensive analysis.

AUTHOR CONTRIBUTION

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Software and supervisions: Assel Bekbossinova, Raigul D. Doszhan.
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The Influence of Economic and Environmental Factors on the Adoption of Responsible Production Standards

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ABSTRACT

In the context of global sustainability challenges, understanding the determinants of environmental management standard adoption has become increasingly relevant. This study aims to investigate the impact of economic and ecological factors on the adoption of ISO 14001 certifications in five selected countries: China, Germany, Japan, Sweden, and the United States. Utilizing a fixed-effects panel regression model, the research analyzes longitudinal data from five countries over the period 2012–2022. Data were sourced from the World Bank, International Energy Agency, Global Carbon Atlas, and ISO survey reports. The results indicate that GDP per capita positively impacts the number of certifications ($p < 0.01$), suggesting that higher economic resources are associated with an increase in the adoption of environmental standards. Additionally, CO2 emissions show a strong positive correlation ($p < 0.01$), indicating that more significant environmental pressure encourages the adoption of certification. The proportion of renewable energy demonstrates a conditionally significant effect ($p < 0.05$), highlighting the need for further research. These findings confirm that environmental concerns and economic capacity contribute to adopting sustainable production practices. The study emphasizes the crucial role of economic affluence and environmental priorities in promoting responsible production standards. Future research should extend the analysis by incorporating institutional variables, policy incentives, and sector-specific dynamics to deepen understanding of ISO 14001 diffusion in heterogeneous economic environments.

KEYWORDS: Responsible Production, Environmental Sustainability, Sustainable Development, Renewable Energy, Green Economy, Economic Growth

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1. INTRODUCTION

Responsible production, considering minimal negative environmental impacts, is an increasingly important component in the sustainable development of the global economy. During an era of growing environmental concern and increased environmental awareness, international standards like ISO 14001 are instrumental to businesses seeking to improve their environmental performance. ISO 14001 is an internationally recognized standard developed by the International Organization for Standardization (ISO) that aims to establish effective environmental management systems and improve the environmental performance of companies (ISO, 2024).

Various factors are influential in implementing standards, such as ISO 14001. Economic factors, such as GDP per capita, become important since a country with a higher income can invest more in environment-friendly technologies and standards. More developed economies can establish conditions to effectively enforce environmental standards and promote sustainable production (Delmas & Montes-Sancho, 2011). Apart from economic factors, environmental performance significantly influences the adoption of responsible production standards. Countries with high greenhouse gas emissions are under pressure from international organizations and domestic legislation to implement standards to reduce environmental impacts. Additionally, using renewable energy is a crucial indicator of environmental sustainability, affecting the implementation of ISO 14001. However, while many studies have focused on adopting ISO 14001 in specific countries or industries, limited attention has been given to comparative, cross-country analysis of the factors that drive ISO 14001 certification on a global scale. The existing literature does not comprehensively understand how economic and environmental factors interact across countries with different economic structures and environmental policies. This study aims to fill this gap by conducting a cross-country analysis, examining developed and developing economies to understand the global drivers of responsible manufacturing standards (Daddi et al., 2015; Casadesús et al., 2008).

The selected countries - China, Germany, Japan, Sweden, and the United States - are world leaders in industrial and environmental initiatives, making them ideal for exploring the adoption of responsible production standards such as ISO 14001. Each country demonstrates a different approach to balancing economic growth with environmental responsibility. Developed economies such as Germany, Sweden, and Japan have a long history of implementing strict environmental regulations and promoting corporate sustainability. China faces growing environmental challenges as a rapidly industrializing country but has made significant strides in adopting responsible production practices in recent years. The United States, although home to many forward-thinking companies, has varying levels of commitment to environmental standards influenced by regional policies and industrial sectors. This diverse context allows for a broad study of how economic and environmental factors contribute to adopting ISO 14001 in different regions.

This study aims to investigate the influence of economic and environmental factors on the number of ISO 14001 certifications in different countries. Implementing the ISO 14001 standard in various countries allows for examining the connection between economic growth, environmental accountability, and sustainable production. Thus, this study seeks to improve comprehension of how economic and environmental factors affect the progression of responsible production worldwide.

Thus, the research questions (RQ) are as follows:

RQ1: How do country-specific economic and environmental factors impact the adoption of ISO 14001 standards?

RQ2: To what extent do GDP per capita, renewable energy use, and greenhouse gas emissions drive the number of ISO 14001 certifications globally?

2. LITERATURE REVIEW

Recent literature highlights the growing importance of responsible production (RP) in manufacturing, emphasizing its role in minimizing negative environmental impacts while maintaining economic viability (Liu et al., 2021). Key factors influencing the successful implementation of RP practices include social responsiveness, legislation compliance, and economic performance (Yusup et al., 2014). Research on RP has seen significant growth, particularly in developing countries like China, with an increasing focus on its financial implications (Ziegler & Rennings, 2004). Studies generally indicate a positive correlation between environmental and economic performance. Environmental regulations have been found to improve environmental outcomes without necessarily compromising economic performance, though more research is needed to generalize these findings across different sectors and policy types (Dechezleprêtre et al., 2019). The literature emphasizes the importance of sustainable supply chains, consumer behavior, and Industry 4.0 in realizing RP principles (Liu et al., 2021).The implementation of responsible manufacturing standards, such as ISO 14001, has been widely studied in the context of sustainable development. ISO 14001, part of the ISO 14000 family, is the most prominent international standard for environmental management systems (EMS). It provides a framework for companies to manage their environmental responsibilities systematically (ISO, 2024).

2.1 Economic factors and ISO 14001 certification

Economic development is a key determinant in the adoption of responsible manufacturing standards. Higher-income levels generally allow countries to invest in new technologies, research and development (R&D), and more sustainable production practices. Casadesús et al. (2008) found that countries with higher GDP per capita tend to have more ISO 14001 certifications, suggesting a direct relationship between economic affluence and environmental responsibility. Daddi et al. (2015) found that firms in countries with higher GDP were more likely to pursue ISO 14001 certification.

The review indicates that ISO 14001 certification positively correlates with national economic factors and corporate performance. Studies have found that GDP per capita, foreign direct investment, and exports to Europe and Japan are positively associated with ISO 14001 adoption rates across countries (Neves et al., 2017). At the organizational level, ISO 14001 implementation has been linked to improved financial performance, with certified companies showing higher sales returns than non-certified counterparts. The standard appears to significantly impact globally oriented firms significantly, enhancing their innovation capabilities and environmental commitment (Grandic, 2017). Additionally, research suggests that national macroeconomic indicators, particularly GDP, influence the number of ISO 14001 certifications within EU member states (Črv, 2021). These findings highlight the interconnected relationship between economic factors, environmental management systems, and corporate performance in the context of ISO 14001 implementation.

However, economic growth has not been found to be a driver of adopting ISO 14001. A study by Sarkis et al. (2010) discovered that in as much as economic resources play an important role, governments' policies and institutional frameworks can also play equally important roles. In those countries where the governments offer incentives, tax breaks, or subsidies for adopting sustainable practices, the rating of ISO 14001 certifications turns out higher, regardless of the nation's GDP per capita.

2.2 Environmental factors and ISO 14001 certification

Research shows that environmental factors are most influential in ISO 14001 certification.

Environmental pressures such as CO2 emissions and fossil fuel consumption have been considered the driving factors for introducing ISO 14001 in the American continent (Hikichi et al., 2017). Internalization of ISO 14001 acts as a mediating agent between certification and environmental performance, and internal motivation is the crucial driving force for this process (Qi et al., 2012). Companies' decision to pursue ISO 14001 certification is frequently driven by ethical and competitive motivations (Benito & González-Benito, 2005). In developing countries, environmental pressures and trade openness positively impact the adoption of ISO 14001, although the relationship varies across regions (Liu et al., 2019). These findings highlight the complex interactions between environmental factors, economic considerations, and ISO 14001 certification, underscoring the standard's importance in addressing environmental issues and encouraging sustainable practices across various contexts.

Various studies exist on the relationship between renewable energy and ISO 14001 certification. ISO 14001 certification reduces CO2 emissions in SAARC nations and renewable energy consumption (Ikram et al., 2020). In addition, in the BRICS, MINT, and G7 economies, ISO 14001 has the potential for greener growth, while renewable energy cleans carbon emissions in most blocs (Ofori et al., 2024). The integration of ISO 50001 (energy management) with ISO 14001 (environmental management) can be beneficial for companies, as there are strong compatibilities between the two standards (Uriarte-Romero et al., 2017). This integration can lead to energy savings and improved environmental performance. Furthermore, ISO 14001 has been found to support sustainable development, particularly in contexts where legal enforcement mechanisms are weak (Fortuński, 2008).

Environmental factors, especially the proportion of renewable energy in a country's total energy consumption, significantly influence the adoption of ISO 14001 standards (Daddi et al., 2015). Countries investing heavily in renewable energy tend to show a stronger commitment to sustainability, which is evident in their industrial practices. Renewable energy reflects a nation's overall environmental priorities and can promote the adoption of responsible manufacturing standards as part of a comprehensive sustainability agenda.

Besides the positive impact on reducing greenhouse gas emissions, renewable energy favours an environment where industries can align with international environmental standards. Delmas and Montes-Sancho (2011) also said that "environmental regulation, along with a high level of production of renewable energies, is positively correlated to the adoption of ISO 14001, as this acts as a market inducement for industries to align themselves according to environmental standards".

The literature review confirmed that economic and environmental factors are crucial in implementing environmentally sound manufacturing standards, such as ISO 14001. It has been confirmed in prior research that GDP per capita positively correlates with the number of certifications since more developed economies have a greater capacity to invest in environmental standards. The impact of renewable energy on the implementation of standards is conditionally significant and requires further analysis. Additionally, high levels of greenhouse gas emissions compel companies and governments to implement green standards.

Despite recent scientific advances, knowledge gaps regarding cross-country differences and the long-term effects of such factors exist. This study aims to bridge this gap by providing a comprehensive quantitative analysis of how economic and environmental factors influence the adoption of ISO 14001 and, in doing so, to gain further insights into the mechanisms of responsible production in various economic and institutional contexts.

3. RESEARCH METHODS

A panel regression analysis was conducted to examine the factors influencing the number of ISO 14001 certifications across five

countries such as China, Germany, Japan, Sweden, and the United State, during the period 2012–2022. The data were obtained from the World Bank (GDP per capita), the International Energy Agency (IEA) (share of renewable energy in total energy consumption), the Global Carbon Atlas (CO2 emissions), and the International Organization for Standardization (ISO) (number of ISO 14001 certifications). These countries were chosen due to their significance in the global economy and diverse environmental responsibility approaches. They represent varying levels of economic development and energy consumption patterns, encompassing developed economies with high GDP per capita (e.g., Germany, Japan, USA) and emerging economies like China.

Additionally, the sample includes countries with different shares of renewable energy sources, allowing for an investigation into the impact of environmental policies and greenhouse gas emission levels on ISO 14001 certification. This approach ensures the study's representativeness and contributes to more generalized conclusions about the relationship between economic and environmental factors and the level of implementation of environmental standards.

Based on the research objective and analysis, three hypotheses have been formulated:

H1: GDP per capita positively affects the number of ISO 14001 certifications.

Previous studies confirm a positive relationship between GDP per capita and the number of ISO 14001 certifications. More developed countries are more likely to adopt environmental management standards because of their ability to invest in environmental technologies and growing environmental awareness (Neumayer & Perkins, 2004; Sam & Song, 2022). Economic development is also increasing pressure from civil society and environmentally oriented export markets to increase the adoption of standards (McGuire, 2014).

H2: The increasing share of renewable energy in total energy consumption contributes to the growing number of ISO 14001 certifications.

Studies show that an increasing share of renewable energy positively impacts adopting ISO 14001 certification (Ikram et al., 2020; Ofori et al., 2024). The shift to renewable energy contributes to the broader adoption of environmental management standards, especially in developed countries where support for sustainable practices is more pronounced (Garrido et al., 2020). These results emphasize the role of renewable energy in promoting responsible production and sustainable development.

H3: Higher greenhouse gas (CO2) emissions lead to more ISO 14001 certifications.

It has been revealed that high levels of CO2 emissions encourage the adoption of ISO 14001 as a measure to reduce environmental impacts. Sam and Song (2022) found that ISO 14001 certification significantly reduced carbon dioxide emissions among certified manufacturing companies in South Korea. McGuire (2014) also observed a methane and CO2 emissions reduction due to certification. However, Garrido et al. (2020) emphasize that the effect of ISO 14001 implementation varies according to national conditions, with a stronger impact in countries with high levels of ethical behavior of companies.

The analysis used data from reliable sources to cover economic and environmental indicators for China, Germany, Japan, Sweden, and the United States from 2012 to 2022.

The selection of variables was based on their significance in evaluating economic and environmental factors' influence on adopting ISO 14001 standards. GDP per capita is a critical economic indicator, as nations with higher GDP have more resources to invest in sustainable technologies and enforce environmental standards (Casadesús et al., 2008). The proportion of renewable energy

showcases a nation's dedication to environmental sustainability, and its growth contributes to an uptick in environmental certifications (Daddi et al., 2015). Greenhouse gas emissions are a crucial indicator of environmental pressures, and elevated emission levels prompt the implementation of standards to alleviate their impact (Testa et al., 2014).

The GDP per capita information was obtained from the World Bank and consists of countries' current and historical data. The share of renewable energies in total energy consumption emanates from the International Energy Agency data on energy sources, as well as the share that is renewable in electricity generation. GHG emissions include CO2 obtained from the Global Carbon Atlas database. Data on ISO 14001 certifications were obtained from ISO annual reports. These provide information on the number of ISO 14001 certifications issued in every country during each reporting period.

The main variables used in the study and their descriptive statistics are given in Table 1.

TABLE 1. Descriptive statistics

Variable	Obs. number	Mean	Std.dev.	Min	Max
Y, ISO 14001 certification number	55	36723.7	60960.1	2783.0	295501.0
X1, GDP per capita	55	42478.4	18944.1	6300.5	77246.6
X2, Share of renewable energy in total energy consumption	55	30.0	17.3	9.4	68.4
X3, GHG (CO_2) emissions	55	4014321.7	4622359.5	37850.0	12942868.0

Note: compiled by authors

Table 1 is the core of the study, as it indicates the main variables used in the regression analysis. It illustrates how various economic and environmental variables (independent variables) influence the adoption of responsible production standards, which is captured through the number of ISO 14001 certifications (dependent variable). The presented data also shows the descriptive statistics of the main variables included in the study: mean, standard deviation, and minimum and maximum values. This provides an overview of the general characteristics and distribution of data.

To ensure the robustness of the cross-country analysis, a comparative approach was employed in this study, analyzing the relationships between selected variables across five countries. The analysis was conducted to understand how economic and environmental factors, such as GDP per capita, the share of renewable energy, and CO2 emissions, affect the adoption of ISO 14001 certifications in China, Germany, Japan, Sweden, and the United States. The relevant data were collected for each country from 2012-2022, ensuring continuity and comparability of variables.

Background factors, including each country's level of industrialization, regulatory frameworks, and key environmental policies, were included to provide context for the quantitative findings. The study examined the differences and similarities in the economic and environmental contexts by employing panel regression analysis, providing insights into the dynamics specific to each country.

4. FINDINGS AND DISCUSSIONS

This section presents the key findings of a study examining economic and environmental factors impact on adopting responsible manufacturing standards (ISO 14001) across various countries. The first part presents a cross-country comparative analysis that examines the differences in regulatory frameworks, the level of ISO 14001 implementation, and the specifics of responsible manufacturing in the United States, Japan, China, Germany, and Sweden. The second part presents the results of a quantitative

analysis based on a panel regression model that assesses the impact of GDP per capita, the share of renewable energy, and CO_2 emissions on the number of ISO 14001 certifications. This approach helps identify patterns and determine the key factors contributing to responsible manufacturing standards' global adoption.

Table 2 illustrates the influence of national regulatory environments and innovative policies on adopting ISO 14001 in different countries.

TABLE 2. Results of the cross-country analysis

Country	Environmental regulations	ISO 14001 adoption	Key responsible production practices
USA	National Environmental Policy Act (1969), Energy Policy Act (2005)	Varies by state, with more substantial adoption in regions with stricter laws	GE focuses on energy efficiency, and Tesla integrates ISO 14001 in EV production
Japan	Act on the Promotion of Efficient Use of Resources (2000), Green Purchasing Act (2001)	High adoption in technology and sustainability sectors	Toyota and Sony use ISO 14001 to improve resource efficiency and reduce emissions
China	Environmental Protection Law (2020), Circular Economy Promotion Law (2018)	Rapid increase due to government policies	Huawei and Sinopec implement ISO 14001 for supply chain sustainability
Germany	Circular Economy Act (KrWG, 2021), Renewable Energy Sources Act (EEG)	One of the global leaders, broad adoption in energy-intensive sectors	BASF and Siemens integrate ISO 14001 to reduce environmental impact
Sweden	Environmental Code (1999), Circular Economy Strategy (2016)	High adoption, supported by strong government commitment	IKEA and Volvo focus on sustainable materials and energy-efficient production

Note: compiled by authors

The most significant level of ISO 14001 adoption is seen in Germany and Sweden, for which sustainable development is a national policy priority. China has shown rapid certification development, which is driven by government policy and prompted by international pressure. Countries with strong regulatory support and sustainability-focused industries demonstrate higher ISO 14001 adoption rates, indicating a global shift toward environmentally responsible manufacturing.

Figure 1 shows a comparison of the number of ISO environmental standard certifications and per capita GDP for selected countries.

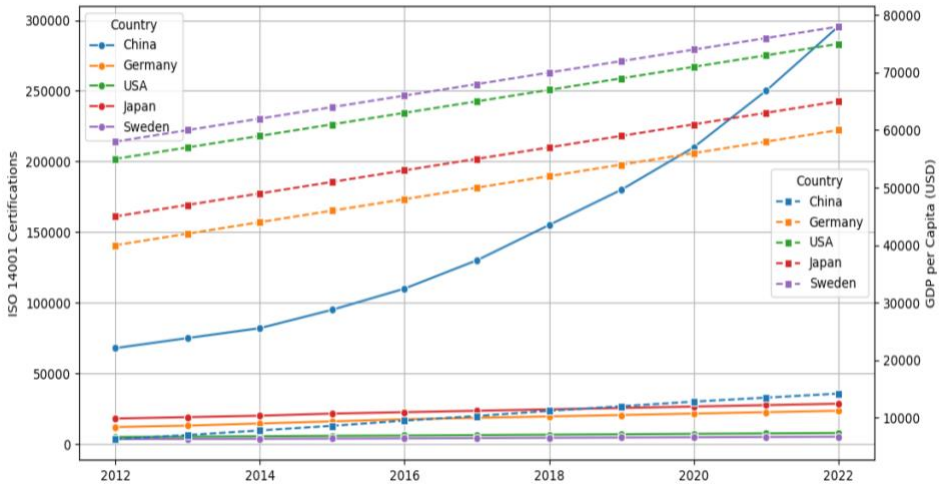

FIGURE 1. ISO 14001 certifications and GDP per capita

Note: compiled by authors based on calculations

According to the data presented, the dynamics of the number of ISO 14001 certifications varies significantly between countries, especially in the context of their level of economic development. The most noticeable growth is observed in China, which may indicate an increasing attention to environmental management issues in the context of industrial growth. For developed countries such as Germany, the USA, Japan and Sweden, the growth rate of certifications remains more moderate. This may be due to the high level of environmental standards already achieved and fewer new enterprises requiring certification. In addition, a high GDP can facilitate stricter regulation and compliance with standards without the need for formal certifications.

Furthermore, Figure 2 shows a comparison of the renewable energy share and CO2 emissions for selected countrie

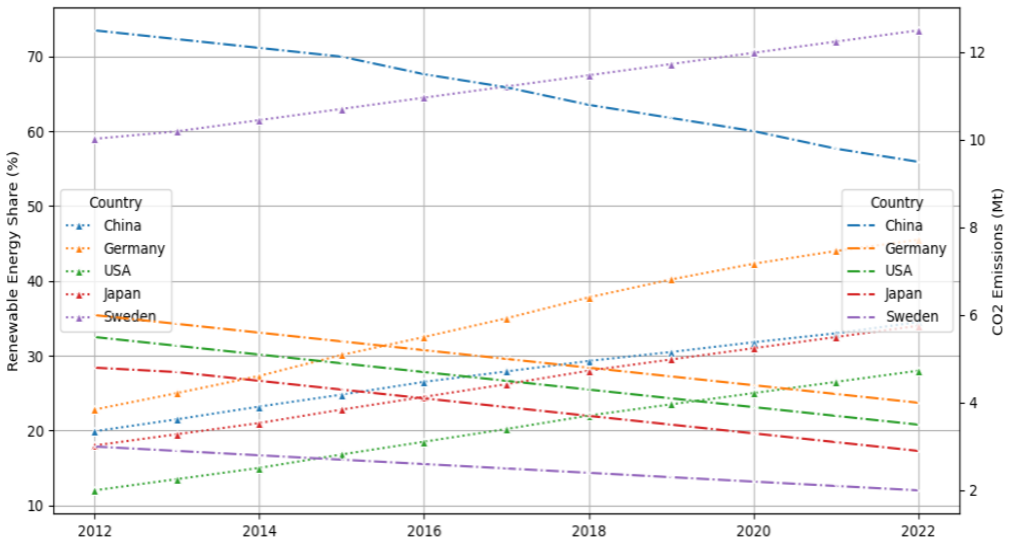

FIGURE 2. Renewable energy share and CO2 emissions

Note: compiled by authors based on calculations

As can be seen from Figure 1 and Figure 2, China has seen a dramatic increase in ISO 14001 certifications over 11 years, rising from 67 874 certifications in 2012 to 295 501 in 2022. This dramatic growth suggests that China's policy measures and economic shift towards sustainability have had a significant impact. Other countries, including Germany, Japan, Sweden, and the US, show a more stable trend in the number of certifications, indicating either a maturing market or more moderate growth in adopting environmental management standards. Germany consistently has about 7000 to 13000 certifications, Japan has between 18000 and 27000, and Sweden and the US have less than 5000 certifications yearly.

GDP per capita data provides context for each country's economic development. China shows significant GDP growth, from $6300 per capita in 2012 to over $12600 in 2022, reflecting its rapid economic development. Meanwhile, developed economies such as Germany, Japan, Sweden, and the US show higher and more stable levels of GDP per capita. The US shows the highest levels, peaking at $77246 in 2022. Sweden also shows strong growth in GDP per capita, from $58037 in 2012 to $56299 in 2022, despite slight fluctuations over the period.

Renewable energy share data reflects countries' commitment to transition to cleaner energy sources. Sweden leads the way, with its

share of renewable energy increasing from 59% in 2012 to around 68.3% in 2022, remaining consistently high throughout the period. Germany's renewable energy share has increased significantly from 22.8% in 2012 to 43.3% in 2022, demonstrating the success of its initiatives to transition to renewable energy. China and the US, although starting from lower levels, have shown steady growth, with China increasing from 19.9% to 29.7% and the US increasing from 12% to 21.3% over the period.

China's CO2 emissions remain significantly higher than in other countries, reflecting its position as a global manufacturing center despite the growth of renewable energy. China's emissions peaked in 2020 at more than 12.9 million metric tons but declined slightly by 2022. In contrast, Germany, Japan, Sweden, and the US show much lower emissions, with Sweden maintaining the lowest levels (around 37850 in 2022) due to its reliance on renewables. The US shows a significant decline in emissions, from over 6 million metric tons in 2012 to 4.85 million in 2022, reflecting a shift to cleaner energy.

Based on the data presented, it is clear that countries with a higher share of renewable energy, such as Sweden and Germany, have made consistent progress in their sustainability efforts, as evidenced by the growing number of ISO 14001 certifications. Despite its higher emissions, China's rapid growth in certifications indicates its increasing focus on environmental management, driven by economic growth and policy changes. Meanwhile, countries such as the US and Japan are showing more moderate progress with stable levels of renewable energy adoption and certification numbers. These trends highlight the approaches and outcomes of adopting responsible production standards in different economic and environmental contexts.

Before building the regression model, a test for multicollinearity between the explanatory variables was conducted. The results of the correlation analysis are presented in Table 3.

TABLE 3. Correlation matrix of independent variables

Variable	x1	x2	x3
x1	1	0.243	-0.692
x2	0.243	1	-0.402
x3	-0.692	-0.402	1

Note: compiled by authors based on calculations

As shown in Table 3, variables x1 (GDP per capita) and x3 (GHG (CO2)) have a notable negative correlation (-0.692). This indicates that countries with higher GDP per capita tend to have lower GHG emissions. Meanwhile, there is a negative correlation (-0.402) between variable x2 (share of renewable energy in total energy consumption) and emissions x3 (GHG (CO2)), which also confirms the relationship between increasing the share of renewable energy and reducing emissions.

A panel regression analysis employing fixed effects was utilized to examine the influence of economic and environmental factors on the quantity of ISO 14001 certifications. The Hausman test demonstrated that the fixed effects model is more suitable than the random effects model due to a correlation between individual country effects and explanatory variables.

GDP per capita, the share of renewable energy, and the level of greenhouse gas emissions were independent variables. Results of fixed effects regression analysis are presented in Table 4.

Almost all variables have significant coefficients at the 1% level, except GDP per capita in the random effects model, which lacked statistical significance. The Hausman test confirmed the fixed effects model is preferred due to correlation between country effects and explanatory variables. A positive coefficient for the share of renewable energy indicates that an increase in the share of renewable energy leads to an increase in the number of ISO 14001 certifications.

TABLE 4. Results of the panel data analysis

Variable	Fixed-effect	Random-effect
x1	2,128*** (0,781)	-1,51*** (0,298)
x2	1348,139** (679,786)	588,755** (256,125)
x3	0,054*** (0,010)	0,007*** (0,001)
Constant	-312445,6*** (61111,77)	54865,89*** (19677,45)
Number of observations	55	55
Number of groups	5	5
R^2	0,567	0,773
Test for significance	F (3, 47) = 11,58 [0,0000]	Wald chi2 (3) = 173,33 [0,0000]
, * - significance of coefficients at 5% and 1% levels, respectively		

Note: compiled by authors based on calculations

The positive and significant coefficient for CO_2 emissions in the fixed effects model confirms the importance of environmental pressure in adopting ISO 14001 standards.

In the fixed effects model, the coefficient for GDP per capita is 2.13. It is significant at the 1% level, indicating a positive effect of economic growth on the number of ISO 14001 certifications. The coefficient for the share of renewable energy in the fixed effects model is 1348.14 and is conditionally significant at the 5% level, which confirms its positive impact. CO_2 emissions also have positive and statistically significant coefficients at the 1% level, indicating that high emissions contribute to an increase in ISO 14001 certifications. The constant is significant at the 1% level in the fixed effects model.

The high R^2 value and Fisher's test results confirm the model's overall statistical significance, indicating its good explanatory power. The results confirm the important role of economic and environmental factors in promoting responsible production standards. The main conclusions from the regression analysis are as follows in Table 5.

TABLE 5. Hypotheses and results

Hypothesis	Result
H1: GDP per capita positively affects the number of ISO 14001 certifications.	Justified
H2: The increasing share of renewable energy in total energy consumption contributes to the growing number of ISO 14001 certifications.	Conditionally justified
H3: Higher greenhouse gas (CO_2) emissions lead to more ISO 14001 certifications.	Justified

Note: compiled by authors

H1: GDP per capita positively affects the number of ISO 14001 certifications.

The coefficient for the GDP per capita variable was 2.13 and is statistically significant at the 1% level (p = 0.009). This supports hypothesis H1, showing that economic growth contributes to an increase in the number of ISO 14001 certifications. The GDP per capita growth stimulates enterprises and governments to pay more attention to implementing environmental responsibility standards.

H2: The increasing share of renewable energy in total energy consumption contributes to the growing number of ISO 14001 certifications.

The coefficient for the share of renewable energy was 1348.14 with a p-value of 0.05 making it significant at the 5% level. Although a positive effect of renewable energy share on the number of ISO 14001 certifications is observed, the significance level requires further confirmation. Hypothesis H2 can be tentatively supported, although further research is needed for its final validation.

H3: Higher greenhouse gas emissions lead to more ISO 14001 certifications.

The coefficient for GHG CO2 emissions is positive and statistically significant ($\beta = 0.054$, $p < 0.001$). This supports hypothesis H3, showing that countries with higher GHG emissions are more likely to implement ISO 14001 standards, which may be related to the need to mitigate environmental impacts and comply with environmental standards.

The analysis confirms all three hypotheses. GDP per capita and greenhouse gas emissions significantly increase the number of ISO 14001 certifications, while the impact of the share of renewable energy requires further study for more precise confirmation.

Regarding the quality of the model, the results of Fisher's test indicate its high statistical significance ($p < 0.001$), which confirms the reliability of the model as a whole.

Based on the above analysis, the panel regression results indicated that both economic factors and environmental performance are statistically significant determinants of the number of ISO 14001 certifications. A rise in GDP per capita and the consumption of renewable energy positively affect the adoption of the standards of environmental responsibility, while high levels of CO2 emissions encourage companies and governments to pursue certification measures.

Results from the panel regression analysis provide really valuable information on the factors affecting the adoption of ISO 14001 certification in various countries. Both economic and environmental factors seem important in encouraging responsible manufacturing practices. The positive and statistically significant coefficient of the GDP per capita in the fixed effects model reinforces the hypothesis (H1) that economic growth exerts a significant effect on the number of ISO 14001 certifications. This result also points to the same direction as earlier findings indicating that countries with higher economic means are in a better position to invest in sustainable technologies and put into practice environmental standards (Casadesús et al., 2008). The results suggest that at higher GDP per capita, governments are more like to be concerned with environmental responsibility and seek the certification of such as proof of an enabling environment of sustainable best practices.

The analysis also emphasizes the contribution of renewable energy to the determination of ISO 14001 certification, while the share of renewable energy enters positively and significantly at 5% in the fixed effects model (H2). Although the significance of this relationship requires further testing, the results show that countries with a higher share of renewable energy are more likely to adopt environmental standards, strengthening the link between renewable energy use and sustainable production practices (Daddi et al., 2015). This is also in line with the findings of Darnall and Edwards, who argue that the use of renewable energy is associated with a higher likelihood of adopting environmental management systems such as ISO 14001, especially in the context of improving resource efficiency and sustainability (Darnall N. & Edwards D., 2006).

The impact of the greenhouse gas emission factor (CO2) was positive and highly significant in the fixed and random effects models, too (H3). This result confirms that the higher the emission level, the more pressure on companies and governments to adopt standards like ISO 14001 to mitigate environmental damage and contribute to sustainable development (Testa et al., 2014). Neumayer & Perkins and Ziegler & Rennings also report a similar observation and highlight that environmental pressure-high pollution levels exercise the pulling effect for adopting environmental management standards. This variable's importance indicates that regulatory and environmental pressure is decisive in stimulating the adoption of responsible production standards, particularly for countries with high pollution levels (Neumayer & Perkins, 2004; Ziegler & Rennings, 2004).

The above results prove the hypothesis that economic development, renewable energy use, and environmental stress significantly affect ISO 14001 certification. In more detail, although the effects of GDP per capita and greenhouse gas emissions have been proven to

be strong and persistent, the economically positive impact of renewable energy needs further confirmation regarding its statistically significant effect in various contexts.

5. CONCLUSIONS

The primary purpose of this study was to analyze the influence of economic and environmental factors on the diffusion of ISO 14001 certifications in the period 2012-2022 for the five countries of China, Germany, Japan, Sweden, and the United States. The analysis provided key insights into the dynamics of responsible production standards in these diverse economies.

First, the findings confirm that GDP per capita is a significant driver of ISO 14001 adoptions. Economically resourced countries like Germany and the USA are better positioned to invest in green technologies and international environmental standards. This result supports previous studies that have indeed found a strong correlation between economic affluence and environmental responsibility since richer countries can afford to implement comprehensive environmental management systems.

Second, the share of renewable energy also becomes important, especially in countries like Sweden and Germany, where renewable energy sources are well integrated. While the relationship between renewable energy and ISO 14001 certifications was conditionally significant, this suggests that moving toward cleaner energy sources supports adopting sustainable production practices. This confirms that there is a need for further analysis of how renewable energy will eventually influence environmental certification.

Third, the findings indicate that greenhouse gas emissions are an important driver for ISO 14001 diffusion. Countries like China have higher levels of CO2 emissions and are under increasing pressure to reduce their environmental impacts. Thus, they are most likely to adopt ISO standards. This evidence underlines the role of regulatory and environmental pressures in the diffusion of responsible production measures by companies and governments, especially in countries with high pollution levels.

In sum, the study contributes to understanding how economic and environmental factors shape the diffusion of ISO 14001 certifications worldwide. The findings raise awareness of the need for integrated policies that advance economic growth and environmental sustainability. Governments and businesses can move forward with responsible production standards by incentivizing investment in green technologies and encouraging regulatory frameworks that work toward curbing pollution. Future studies in this field might touch upon a more specific look into an influence assessment of different factors on diverse economic sectors, and cross-country comparative studies of the dynamics of standards diffusion across countries at different economic and environmental development levels.

AUTHOR CONTRIBUTION

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Resources: Aknur Zhidebekkyzy.
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Visualization: Birganym Amangeldiyeva.
Writing review and editing research: Aknur Zhidebekkyzy, Birganym Amangeldiyeva.

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Banking Profitability, Inflation and GDP Relationship: A Monte Carlo Scenario Analysis for Turkey

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ABSTRACT

Economic and political catastrophes have a negative impact on the state budget and the banking industry. The purpose of the study is to assess the impact of macroeconomic factors on the profitability of the Turkish banking sector between 2016 and 2023, using the Monte Carlo method. The study uses the Monte Carlo method with 10, 50 and 100 iterations. The simulation is based on empirical data from the Association of Turkish Banks and the Turkish Statistical Institute, including gross domestic product, inflation, return on equity and return on assets. The results of the study showed that, when using the Monte Carlo model with 100 iterations, the values of ROE and ROA show moderate growth (to an average of 27.68% and 46.94%, respectively) under scenarios of strong economic development, despite the continued instability of inflation, which confirms the presence of stable but sensitive dependencies between variables. According to the findings, there will be no essential changes in the values of the Gross Domestic Product, Inflation values of the state, Return on Equity and Return on Assets values of the banking industry unless correlative relations and volatility (standard deviation) scores can not diminish or balance in 10, 50 and 100 iterations. The importance of macroeconomic variables and globalization is presented as a key factor contributing to this situation. On the other side, the period was very hard for Turkey and the banking industry. In the final section, a brief suggestion will be provided in light of the Monte Carlo Simulation Model algorithms.

KEYWORDS: Bank, Banking Profitability, Business Cycles, Monte Carlo Simulation, Economic Growth, Financial Stability, Turkey

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1. INTRODUCTION

The economic balance of Turkey underwent significant changes between 2016 and 2023, influenced by a military coup attempt, the COVID-19 pandemic, and an earthquake. At the same time, the country experienced conflicts and tensions between various forces, including the government and the central bank. These events are critical for the banking industry, which has been forced to balance the tensions between market forces and the needs and expectations of its stakeholders. As Demirel and Ulusoy (2021) explain, the impacts of the COVID-19 period on banking profitability are clearly evident in terms of the CAR (Capital Adequacy Ratio), ROE (Return on Equity), and ROA (Return on Assets), which are key variables or ratios in determining bank profitability. However, according to them, ROE and ROA have relatively less impact, while CAR maintains its position in the banking industry's profitability in Turkey. It should be noted that Capital adequacy helps the financial system absorb negative shocks by reducing the number of bank failures and losses (Rahman et al., 2020). Uslu (2020) statistically explained the importance of human-resource-depended variables and intellectual capital in the ROE and ROA structures in the Turkish Banking industry. Meanwhile, credit risk, loss of income and liquidity are the most critical factors of the COVID-19 period (Shishavan et al., 2021). According to the analysis by Ova (2020), Derbali (2021), and Raza et al. (2022), ROA and ROE are the most effective profitability ratios in the banking industries of Turkey and Morocco. Moreover, Altay (2021) emphasized the importance of CAMELS components, which include Capital adequacy, Asset quality, Management, Earnings, Liquidity, and Sensitivity, in the banking industry, as well as the relationships between these components and macroeconomic variables in Turkey's sample. Also, Daver (2020) utilises ROA as a profitability indicator in an analysis. Conversely, GDP (Gross Domestic Product) exhibits a positive and explanatory relationship with banking performance (Sayem et al., 2024; Alshadadi et al., 2024; Ghosh & Mondal, 2024; Rehman et al., 2024). Given the importance of GDP, another key variable is inflation. According to Akoi and Andrea (2020) and Almansour and Almansour (2021), banking performance is influenced by the country's inflation rate. Additionally, Alfadli and Rjoub (2020) found a negative relationship between the inflation rate and banking performance (portfolio confirmation and asset diversification) in Gulf Cooperation Council Countries. According to Calışkan and Lecuna's (2020) analysis, inflation, interest rates, and exchange rates play a significant role in shaping the performance of the banking system, with a positive impact on both return on equity (ROE) and return on assets (ROA). Besides these, İlarslan (2020) confirms the important and negative impacts of terrorist acts on the financial markets. Nonetheless, Wu and Cole (2024) stated that inflation and GDP growth played crucial roles and had detrimental impacts on the US Banking crisis between 1977 and 2019. Moreover, Inflation is so critical that states and governments always aim to suppress it through before-forecasting methods to achieve stability (Posta & Tamborini, 2023). Nonetheless, well-anchored inflation expectations also contribute to general financial markets by boosting economies and investments through which banking industries can create new credit and consumer opportunities (Choi et al., 2021). For this reason, the central bank's positioning in the economies of states should be managed efficiently and effectively, and its policies toward financial markets should be transparent and independent (Fratzcher et al., 2020). In particular, independent central bank policies can be vulnerable during inflationary and stagflationary periods and crises (Gnan et al., 2022). In the works of Gupta and Mahakud (2020) and Korneyev et al. (2022), the inflation rate and GDP Growth, which are determined by the central bank's monetary instruments and arrangements, are important components that shape banking performance under the influence of ROE and ROA. Near the GDP growth and inflation, oil and gas prices (Alyousfi et al.,

2021) and financial inclusion (Shihadeh, 2020) have a decisive impact on banks' performance. For example, not only in the Arabic Peninsula but also in other parts of the world, such as Turkey (Katırcıoğlu et al., 2020), banks' performances move in parallel with oil and gas prices, depending on their oil-related businesses. There is a positive correlation between financial inclusion and banks' performance in the MENAP (Middle Eastern and North African Countries).

In light of these arguments, it can be said that the banking system may suffer from the negative effects of the macroeconomic variables of the states. This research aims to empirically evaluate these negatives in Turkey's sample for 100, 50, and 10 years, as well as 53 banks. It attempts to answer the question of what will happen to the Turkish banking system's profitability over 100, 50, and 10 years, in correlation with GDP Growth and Inflation, if the situation of economic components remains unchanged. To reach this purpose, the research can be examined under three titles. In the first title, a literature review is presented. The methodology and data section will be placed in the second chapter. After the methodology and data section, there will be a discussion, conclusion and suggestion section. At the end of the paper, it can be stated that this research is one of the first examples to utilize the Monte Carlo Method for accurate data in the long term, examining the relationships between leading economic indicators and banking profitability indicators.

2. LITERATURE REVIEW

The Monte Carlo simulation method has also received considerable attention in financial literature, with its extensive utilization in various scientific fields. With the explanative power of Monte Carlo Simulations, this research concentrates on the development of a nexus between macroeconomic indicators and banking indicators.

Sanchez et al. (2016) developed a Bayesian approach for the Monte Carlo Method to evaluate operational risk in commercial banking, focusing on mistakes and errors across different branches between 2007 and 2011. Larcher and Leobacher (2005) argued that there are estimation differences between various applications of Monte Carlo Simulation Models in forecasting risk and asset pricing. According to them, scenario selection and the behaviours of randomness are important variables. One of the primary objectives of homo-economicus is to eliminate stochastic movements (randomness) in financial market behaviours. Monte Carlo applications serve as a suitable tool for this purpose. In the works of Dang et al. (2015) and Liberati and Platen (2004), this intention is observed utilization of complex mathematical calculations and transformations in the pricing of the Options. Platon and Constationescu (2014) emphasized the importance of ensuring randomness in Monte Carlo simulations through the use of random numbers, which provide a quasi-understanding or pseudo-understanding of the Monte Carlo simulation models. The primary measure to address randomness is to benefit from statistical distributions, such as the normal distribution (for relatively large samples, characterized by standard deviations and means), the Poisson distribution (for specific measurement units), etc. The boundaries of randomness, a critical element in the Monte Carlo Simulation, are determined by the power of randomness that develops depending on these statistical distributions. At the same time, the Monte Carlo simulation models can be utilized for future-oriented financial plans and calculations. For example, Arnold and Yıldız (2015), Zaman et al. (2017), Colantoni et al. (2021), Igbal and Purwanto (2022), and Saputra et al. (2023) calculated the future value of a complex financial investment considering different risk scenarios framed with various probability measures (randomness). Morales et al. (2013) utilized a Monte Carlo Simulation Model to determine credit banking risk in home equity loans, considering different scenarios for classifying loans as good or bad. Delis et al. (2020) evaluated one of banking CAMEL performances, management, benefiting from a

repeated random sampling (Monte Carlo Simulation Model) with a Bayesian Approach in which there are different output variables such as loan values of banks for different purposes of consumers and input variables such as physical variables, employees, deposits and financial capital under four important managerial scenarios. Barros and Wanke's (2014) cost efficiencies of banks can be proved with a Monte Carlo Simulation Model, which resulted in the statistical insignificance of cost efficiency in public banks and foreign banks. On the other side, the statistical significance of cost efficiency in mergers and acquisitions, big banks, deregulated and stressed banks. In general, the banking industry presents a suitable opportunity for Monte Carlo Simulation Models, particularly given the variety of variables, including macroeconomic and international economic factors.

Monte Carlo Models are one of the most powerful statistical tools in various fields of science. For example, Raeside (1976) argued their utilization in medical science. It should be noted that algorithms based on this method provide statistical estimates for any linear function of the solution by performing random sampling of a specific random variable whose mathematical expectation is the expected function (Atanassov & Dimov, 2008). According to Kroese and Rubinstein (2011), a Monte Carlo Analysis can be utilized for i) to generate random objects and processes to observe their behaviour, ii) to estimate numerical quantities by repeated sampling, and iii) to solve complicated optimization problems through randomized algorithms. In designing a Monte Carlo analysis, the events take their describing forces from a scenario or an event. For example, Glasserman et al. (2001) underlined the importance of case, event and scenario creation in a Monte Carlo VAR analysis. The last design of a Monte Carlo method takes a previous form with different forms, Bonate (2001) stated that the sampling distribution of the model inputs should be defined as an a priori, for example, a normal distribution with mean μ and variance σ^2. Monte Carlo simulations can explain the model repeatedly due to its structure, each time drawing a different random set of inputs from the sampling distribution of the model parameters, resulting in a set of possible outputs and highlighting the critical importance of Random Number generation in computer and mathematical sciences. At the same time, the Random Number Generation Process is also known as pseudo-random number generation, and there are different methodologies for producing numbers, such as Quasi-random number generation. Essentially, the Monte Carlo method is an integration of convergence theory, sampling methods and variance reduction techniques (Caflish, 1998). On the other hand, Ferson (1996) underlined the problems of the Monte Carlo methods, clarifying four important points: i) Like most methods based on probability theory, Monte Carlo methods are very data-intensive. Depending on this feature, they usually cannot reproduce results unless a considerable body of empirical information has been collected or the analyst is willing to make several assumptions in the place of such empirical details. ii). Although suitable for handling variability and stochasticity, Monte Carlo methods cannot be used to propagate partial ignorance under any frequentist interpretation of probability. iii). Monte Carlo methods cannot be used to conclude that exceedance risks are no more significant than a particular level. iv). Finally, Monte Carlo methods cannot be used to effect deconvolutions to solve back calculation problems that often arise in remediation planning. There are various utilisations of Monte Carlo Models, such as the Method of Maximum Likelihood, the Method of Moments and Nonlinear Optimisation (Raychaudhuri, 2008). However, the nature of the science branch and the intensity of risk gain importance in this context. In other words, there can be differences between the social sciences, natural sciences, and engineering sciences regarding iteration numbers and random number generation.

If a square matrix A happens to be symmetric and positive definite, then it has a special, more efficient, triangular

decomposition. As it is thought, a matrix has two important dimensions regarding triangularity. In a Cholesky decomposition, the standard matrix structure is divided into subparts using a decomposition process that consists of a lower triangular matrix and its conjugate transpose (A = L, where L is a lower triangular matrix and L* is its conjugate transpose).

3. METHODOLOGY

The methodological framework aims to assess the relationship between macroeconomic indicators and banking profitability in Turkey. A simulation-based approach utilizing the Monte Carlo method is employed to assess various economic development scenarios within controlled stochastic environments. The dataset comprises annual observations from 2016 to 2023, sourced from the Turkish Statistical Institute and The Banks Association of Turkey. Descriptive statistics, correlation analysis, Cholesky decomposition, and simulation models with varying iterations (10, 50, 100) constitute the backbone of the empirical design. The methodology is structured to provide robust insights into the variability and interdependence of GDP growth, inflation, ROE, and ROA.

GDP Growth, Inflation, Average Banking Profitability (ROE), and Average Banking Profitability (ROA) data are provided by the Banks Association of Turkey (ROE and ROA) and the Turkish Statistical Institute for the periods between 2016 and 2023. The variables are listed sequentially in Table 1.

TABLE 1. The variables of the analysis

Year, statıstıcal varıables	GDP growth	Inflation	Banking Profitability (ROE)	Banking Profitability (ROA)
2016	3.318	8.53	8.745	1.729
2017	7.458	11.92	10.258	2.029
2018	3.094	20.3	12.635	2.779
2019	0.862	11.84	8.126	2.829
2020	1.672	14.6	9.355	1.926
2021	11.796	36.08	14.806	3.072
2022	5.308	64.27	32.541	5.109
2023	4.474	64.77	32.926	5.148
AVERAGE	4.748	29.03875	16.174	3.078
STD.DEVIATION	3.520	23.48812188	10.449	1.352
VARIANCE	12.393	551.6918696	109.193	1.830
MIN	0.862	8.53	8.126	1.729
MAX	11.796	64.77	32.926	5.148

Note: compiled by author based on calculations

Using the Excel software package, a Monte Carlo simulation model based on random number generation was implemented. The simulation was carried out for different numbers of observations (iterations-years): 100, 50, and 10. The choice of exactly this number of iterations was made to demonstrate how an increase in sample size affects the stability and visibility of descriptive statistics.

As a result of the simulation, correlation matrices were obtained, reflecting the degree of interrelation among these economic indicators under different sample sizes.

The correlation results presented in Table 2 enable a visual assessment of the strength and direction of the relationships between variables.

TABLE 2. The correlation values of the analysis

Indicator	GDP growth	Inflation	Banking Profitability (ROE)	Banking Profitability (ROA)
GDP growth	1			
Inflation	-0.020457477	1		
Banking Profitability (ROE)	-0.043870175	0.029719616	1	
Banking Profitability (ROA)	0.017011838	-0.028741705	-0.127404127	1

Note: compiled by author based on calculations

The results indicate very weak correlations between macroeconomic variables and banking profitability ratios during the analyzed period (2016-2023), suggesting the absence of strong linear relationships. The strongest — albeit still weak and negative - correlation is observed between Return on Assets (ROA) and Return on Equity (ROE). Notably, inflation and GDP growth exhibit virtually no correlation, further emphasizing the structural independence of these indicators in the current dataset.

Cholesky decomposition is utilised for the correlation matrix, to decompose the correlation matrix (Table 3).

TABLE 3. Cholesky decomposition values of the analysis

Indicator	GDP growth	Inflation	Banking Profitability (ROE)	Banking Profitability (ROA)
GDP growth	1	0	0	0
Inflation	-0.020457477	0.999790724	0	0
Banking Profitability (ROE)	-0.043870175	0.028828176	0.998621221	0
Banking Profitability (ROA)	-0.020457477	-0.029166318	-0.127636771	0.991180948

Note: compiled by author based on calculations

This lower-triangular matrix is used to generate correlated random variables in the Monte Carlo simulations, ensuring consistency with the empirical relationships identified in Table 2. The decomposition reveals that the relationships between macroeconomic indicators and banking profitability metrics remain weak, confirming the results observed in the correlation matrix. While inflation exhibits a minimal negative association with GDP growth, ROE shows slight sensitivity to GDP growth and inflation. ROA demonstrates the most notable – albeit still weak – negative correlation with ROE, as well as minor dependencies on inflation and GDP growth. These patterns justify the use of Cholesky decomposition in the simulation framework, as it preserves the observed structural characteristics while generating correlated random variables.

Thus, based on descriptive statistics, correlation analysis and Cholesky decomposition, the proposed methodology allows the formation of a statistically sound data structure for modelling. Using the Monte Carlo method in various configurations (standard, correlated, and simulated models) provides the ability to assess volatility, stability of relationships, and the behaviour of key

macroeconomic and banking indicators, depending on the number of iterations.

4. FINDINGS AND DISCUSSION

The following analysis presents the simulation results obtained using the Monte Carlo methodology. Three models are constructed: the Normal, Correlated (adjusted via Cholesky decomposition), and Simulated (randomly generated values that respect the mean and variance). Each model is executed with 10, 50, and 100 iterations to assess how variability and model stability evolve with increasing sample sizes. The results reflect the behaviour of GDP growth, inflation, and banking profitability metrics (ROE and ROA) across different simulation environments.

In light of the argument above, three statistical models are presented: normal, correlated, and simulated models, along with their averages (arithmetic means), standard deviations (variances), and maximum and minimum values of the simulations for 10, 50, and 100 iterations (years), as shown in Table 4.

TABLE 4. Standard Monte Carlo simulation model

Simulation	Means	Std. Deviations	Maximum	Minimum
GDP growth (%)				
$Normal_{10}$	6.11	4.05	11.86	-0.46
$Normal_{50}$	5.76	3.00	11.86	-0.46
$Normal_{100}$	5.52	3.19	15.91	-0.46
Inflation				
$Normal_{10}$	44.10	28.07	82.58	-20.56
$Normal_{50}$	27.45	27.07	82.58	-53.15
$Normal_{100}$	27.67	25.94	104.15	-53.15
Banking Profitability (ROE)				
$Normal_{10}$	16.22	11.40	35.14	-5.35
$Normal_{50}$	16.11	9.23	35.14	-5.35
$Normal_{100}$	16.31	9.47	42.38	-10.21
Banking Profitability (ROA)				
$Normal_{10}$	2.11	1.83	4.56	-0.59
$Normal_{50}$	2.43	1.42	5.39	-0.59
$Normal_{100}$	2.82	1.31	5.40	-0.59

Note: compiled by author based on calculations

The convergence of the mean values with increasing iterations is revealed through the simulation based on the normal distribution with uncorrelated variables. A moderate reduction in standard deviations is observed, especially for GDP and ROA, indicating an increase in the stability of the distribution. At the same time, negative minimum values of ROE and ROA highlight the presence of hidden volatility in bank profitability indicators even under standard conditions.

To obtain the Correlated Monte Carlo results, Cholesky decomposition values are utilised on the standard model in Table 5.

TABLE 5. Correlated Monte Carlo Simulation Model

Simulation	Mean	Std. Deviations	Maximum	Minimum
GDP growth (%)				
$Normal_{10}$	6.11	4.05	11.86	-0.46
$Normal_{50}$	5.76	3.00	11.86	-0.46
$Normal_{100}$	5.52	3.59	15.92	-0.46
Inflation				
$Normal_{10}$	43.97	28.07	82.39	-20.72

$Normal_{50}$	27.32	27.07	82.39	-53.19
$Normal_{100}$	27.55	25.94	103.96	-53.19
Banking Profitability (ROE)				
$Normal_{10}$	17.20	11.52	35.92	-4.35
$Normal_{50}$	16.62	9.24	35.92	-4.35
$Normal_{100}$	16.84	9.51	43.64	-10.23
Banking Profitability(ROA)				
$Normal_{10}$	-1.38	1.96	4.90	-4.465
$Normal_{50}$	-0.56	1.35	4.90	-4.465
$Normal_{100}$	-0.20	2.05	5.55	-6.00

Note: compiled by author based on calculations

Taking into account the correlation structure through the Cholesky decomposition introduces refinements in the distributions of variables. While maintaining the general dynamics, there is a slight increase in the average ROE values and an increase in the volatility of ROA. In short horizons (10 and 50 iterations), the average ROA value becomes negative, reflecting the vulnerability of bank profitability, even with weak relationships between macroeconomic variables.

Table 6 below presents the results of a simulated Monte Carlo model based on random values, which preserves the empirical means and variances but does not impose a correlation structure between the variables.

TABLE 6. Simulated Monte Carlo Simulation Model

Simulation	Mean	Std. Deviations	Maximum	Minimum
GDP growth (%)				
$Normal_{10}$	25.06	12.96	43.43	4.04
$Normal_{50}$	23.93	9.59	43.43	4.04
$Normal_{100}$	20.72	12.93	56.37	4.04
Inflation				
$Normal_{10}$	1168.71	728.40	2165.68	-510.10
$Normal_{50}$	736.80	702.41	2165.68	-1352.57
$Normal_{100}$	609.75	450.24	2725.21	-1352.57
Banking Profitability (ROE)				
$Normal_{10}$	179.28	109.17	356.57	-24.90
$Normal_{50}$	173.79	87.55	356.57	-27.72
$Normal_{100}$	175.85	90.12	429.64	-80.58
Banking Profitability(ROA)				
$Normal_{10}$	1.00	2.66	6.70	-3.05
$Normal_{50}$	2.08	2.58	9.27	-3.05
$Normal_{100}$	2.56	2.70	10.13	-5.07

Note: compiled by author based on calculations

To obtain the Simulated Monte Carlo model results, the values are arranged to reflect average and variance values, ensuring that the originality of the standard model is not disrupted. The results are derived from the vast numbers of Monte Carlo Simulation models, which sample randomly according to the law of random numbers. The model without equilibrium disturbances has higher volatility than the usual and correlated simulations. Thus, the standard deviation of inflation reaches 728.40 after 10 iterations and remains at 450.24 even after 100 iterations, while the same indicator did not exceed 28.07. For ROE, the standard deviation is 109.17 after 10 iterations, while in regular models it is 11.40. The values of profitability (ROE and ROA) vary widely, with minimum values of -80.58 (ROE) and -5.07 (ROA), indicating the presence of extreme fluctuations. Unlike the models that observe

correlation (Table 5), the simulated model of economic theory is poorly interpretable, indicating the need to create an empirical structural dependence when analyzing the probabilistic trajectories of macroeconomic indicators.

Research Scenarios

At this stage, there are three development scenarios: weak, mild, and strong, which are randomly named. In the weak development scenario, there is a 0.1% increase in GDP growth, a 3% decrease in inflation, and a 1% increase in both the ROE and ROA banking profitability ratios, as shown in Table 7.

TABLE 7. Correlation and Cholesky decomposition (in parenthesis) result in weak economic development

Indicator	GDP growth	Inflation	Banking Profitability(ROE)	Banking Profitability(ROA)
GDP growth	1			
Inflation	-0.020(-0.020)	1 (0.999)		
Banking Profitability (ROE)	-0.045(-0.045)	0.029(0.028)	1 (0.998)	
Banking Profitability (ROA)	0.018 (0.018)	-0.029(-0.029)	-0.127 (-0.126)	1(0.991)

Note: compiled by author based on calculations

The correlation matrix, with elements of the Cholesky decomposition under the weak scenario, reflects minor deviations from the basic structure (see Table 3). The most noticeable change concerns the coefficient between ROA and ROE, which remains negative (-0.127) and demonstrates the stability of the relationship between the indicators of bank profitability, even with minimal macroeconomic shifts (0.1% GDP growth and a 3% decrease in inflation). In the mild development scenario, there is a 0.5% increase in GDP growth, a 4% decrease in inflation, and a 2% increase in both ROE and ROA. The overall structure of dependencies retains weak intensity and low correlation connectivity.

The correlation and Cholesky decomposition results are given in Table 8.

TABLE 8. Correlation and Cholesky Decomposition (in parenthesis) result in mild economic development

Indicator	GDP growth	Inflation	Banking Profitability (ROE)	Banking Profitability (ROA)
GDP growth	1			
Inflation	-0.019(-0.019)	1(0.999)		
Banking Profitability (ROE)	-0.045(-0. 045)	0.028(0.028)	1(0.998)	
Banking Profitability (ROA)	0.018(0.018)	-0.0309(-0.0306)	-0.128 (-0.126)	1(0.991)

Note: compiled by author based on calculations

In an intense development scenario, GDP growth increases by 1%, inflation declines by 5%, and the return on equity (ROE) and return on assets (ROA) rise by 3%. The moderate scenario, with a 0.5% increase in GDP, a 4% decrease in inflation, and a 2% increase in bank profitability, results in negligible changes to the correlation structure. The correlation coefficients between the main variables remain close to those observed in the weak scenario: the correlation between ROA and ROE is –0.128, and between inflation and ROA is –0.0309. These values indicate a low sensitivity of correlation relationships to moderate economic shifts and emphasize the structural stability of the system.

The Correlation and Cholesky Decomposition results are given in Table 9.

TABLE 9. Correlation and Cholesky decomposition (in parenthesis) result in strong economic development

Indicator	GDP growth	Inflation	Banking Profitability (ROE)	Banking Profitability (ROA)
GDP growth	1			
Inflation	-0.021 (-0.021)	1(0.999)		
Banking Profitability (ROE)	-0.049 (-0.049)	0.028(0.027)	1(0.998)	
Banking Profitability (ROA)	0.072 (0.072)	-0.019(-0.017)	-0.048(-0.043)	1(0.996)

Note: compiled by author based on calculations

The scenario with 1% GDP growth, 5% inflation reduction and 3% increase in bank profitability leads to an insignificant strengthening of the relationships. The correlation between ROA and ROE decreases in absolute value to -0.048, and the relationship between inflation and ROA weakens to -0.019. At the same time, the positive correlation between GDP and ROA increases to 0.072, indicating the initial manifestation of a more transparent relationship between the real sector and bank profitability under significant economic growth.

Simulated Monte Carlo Simulation model results for 10, 50 and 100 days (iterations) are given in Table 10.

TABLE 10. Simulated Monte Carlo Simulation Model Results

Simulation	Mean	Std. Deviations	Maximum	Minimum
GDP growth (%)				
$Weak_{10;\ 50;\ 100}$	24.96; 23.88; 23.14	12.78; 9.53; 10.16	42.22; 42.22; 56.27	4.04; 4.04; 4.04
$Mild_{10;\ 50;\ 100}$	24.97; 23.88; 23.14	12.78; 9.53; 10.16	41.84; 42.04; 56.26	4.04; 4.04; 4.04
$Strong_{10;\ 50;\ 100}$	145.86; 92.66; 93.35	89.84; 86.38; 82.74	959.373; 959.373; 1157.77	-92.14; -94.72; -238.64
Inflation				
$Weak_{10;\ 50;\ 100}$	1169.23; 737.01; 742.77	729.40; 702.76; 673.39	2166.09; 2166.09; 2725.72	-515.50;-1352.80; -1352.80
$Mild_{10;\ 50;\ 100}$	1174.56; 738.15; 743.30	723.20; 702.04; 672.90	2165.60; 2165.60; 2725.03	-488.40; -1352.23; -1352.23
$Strong_{10;\ 50;\ 100}$	471.28; 457.29; 463.04	301.87; 240.54; 247.25	959.37; 959.37; 1157.77	-92.149; -94.72; -238.64
Banking Profitability (ROE)				
$Weak_{10;\ 50;\ 100}$	179.27; 173.73; 175.79	109.14; 87.53; 90.11	356.55; 356.55; 429.55	-26.03; -27.75; -80.61
$Mild_{10;\ 50;\ 100}$	*179.11; 173.62; 175.68*	*109.70; 87.71; 90.22*	356.589; 356.589; 429.413	-26.29;-28.04; 80.73
$Strong_{10;\ 50;\ 100}$	32.83; 26.70; 27.68	18.80; 18.52; 19.85	61.00; 61.00; 74.27	9.48; -25.56; -25.56
Banking Profitability (ROA)				
$Weak_{10;\ 50;\ 100}$	1.35; 2.41; 2.88	2.75; 2.57; 2.70	7.15; 9.49; 10.29	-3.00; -3.00; -4.70
$Mild_{10;\ 50;\ 100}$	10.85; 10.40; 10.09	5.27; 3.93; 4.19	17.66; 17.90; 23.77	2.216; 2.216; 2.216
$Strong_{10;\ 50;\ 100}$	50.47; 48.37; 46.94	24.85; 18.516; 19.736	83.98; 83.98; 111.25	9.87; 9.87; 9.87

Note: compiled by author based on calculations

In the weak and mild scenarios, the values of the indicators are almost identical, confirming the limited impact of minor macroeconomic adjustments on the simulation results. The average ROE fluctuates in a narrow range - from 173.62 to 179.27, and ROA - from 1.35 to 10.85. In the strong scenario, there is a sharp increase in the average ROA to 50.47 (after 10 iterations) and ROE to 32.83, accompanied by high volatility (σ_ROE = 18.80; σ_ROA = 24.85). Inflation under strong growth demonstrates a sharp decline: average values fall from 1174.56 (mild10) to 471.28 (strong10), reflecting the targeted reduction in inflationary pressure in the model. Such changes indicate the sensitivity of the results to scenario parameters and confirm the validity of the scenario approach in stress testing of bank profits.

If the same period continues with different economic policies, the following arguments can be concluded by Table 8: Weak, Mild and Strong economic development strategies have negative impacts on GDP Growth. On the other hand, all of the policies have a positive impact on inflation. ROE and ROA values are also positively affected by the randomly generated policies.

The correlative structure and high standard deviations in the research models indicate that volatility structures will exist in the model for the research period, consistent with the findings of Cariolle (2012). Numerous shocks can influence a country's market structure, and according to a substantial body of literature, the volatility-producing financial and economic structures are often a source of ambiguity in microeconomics, macroeconomics, and international economics. Tzeng (2023) uses this inference in its work on the Asian Markets affecting processes by the United States macro variables. On the other hand, Islam (2023) corrects the relationship between banking profitability and the Gross Domestic Product (GDP) relationship. Rakshit (2021) and Shresta (2023) also affirm the relationship between macroeconomic variables and banking industry profitability. The impacts of the countries's globalization are examined by Yakubu and Bunyaminu (2021) found that there is a relationship between the globalization level of countries and banking profitability.

In light of the findings section, it can be concluded that the period between 2016 and 2023 is very hard for Turkey and the Turkish Banking sector. Especially, the magnitude of the various crises will shape the future of the Turkish Financial System. Aksoy et al. (2024) state the destructive impacts of big earthquakes on the fiscal balance of states, and Daniell and Shinozuka et al. (1998) support the idea that earthquakes have re-definitive impacts on the banking and insurance industry. On the other hand, political changes, such as military coups, force states to implement infrastructural measures that are financially and economically feasible due to changing regimes. A military coup can be a cause of the elimination of the trust factor between economic and financial market participants. So, it is a chaotic situation for financial market makers (Lumiajiak et al., 2014; Suwanprasert, 2024). On the other hand, the negatives of COVID-19 are a familiar reality for the finance world.

5. CONCLUSIONS

In light of the above arguments, it can be concluded that policymakers and banking professionals should focus on anticipating and mitigating macroeconomic shocks that contribute to high volatility in key financial indicators. The period from 2016 to 2023 was particularly challenging for Turkey, marked by multiple crises that significantly affected the stability of the banking sector.

The study showed that the profitability of the Turkish banking sector is stable but sensitive to macroeconomic factors, primarily inflation and GDP growth rates. The use of the Monte Carlo method made it possible to identify the impact of different numbers of iterations on the degree of volatility of indicators and scenario changes under weak, moderate, and strong economic development.

The obtained results indicate that if the current economic policy and macroeconomic conditions are maintained, significant improvements in bank profitability indicators

are unlikely without reducing volatility and increasing the stability of correlations between variables.

The practical significance of this study lies in the proposed modelling approach, which, based on accurate data, enables consideration of potential risks and instability in strategic planning at the state macroeconomic level and the level of banks' activities. Politicians and financial analysts are advised to pay particular attention to the factors that contribute to macroeconomic shocks, thereby minimizing their impact on the country's banking system.

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Funding acquisition and research administration: Olcay Ölçen.
Development of research methodology: Olcay Ölçen.
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Data collection, analysis and interpretation: Olcay Ölçen.
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Analysis of Structural Changes and Employment Dynamics in the Labor Market of Kazakhstan

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ABSTRACT

Understanding structural dynamics and workforce segmentation has become essential for sustainable economic policy and employment regulation in the context of global economic transformation, technological change, and labour market volatility. The goal of the current study is to identify key worker groups with varying levels of employment stability, staff turnover, and personnel cost distribution. The fuzzy clustering algorithm (Fuzzy C-Means) is used as the primary method, which makes it possible to assign objects to several clusters with varying degrees of affiliation. The analysis was based on official statistics of the labor market in the Republic of Kazakhstan for the period 2013-2023. The analysis revealed three stable clusters: stable workforce flow cluster with low staff turnover (0.172) and balanced replacement (0.152); adaptive cluster with moderate instability, turnover of 0.355 and demand for labor up to 30 020 people; unbalanced cluster with high-cost variability (up to 19 billion tenge), compensation (coefficient of variation of 0.386) and maximum admission of graduates (up to 86,227 people). Kazakhstan's labor market is characterized by stability in traditional sectors, moderate adaptation in cyclical industries, and high volatility in technologically advanced and competitive segments. These results suggest the need for a differentiated employment policy that considers industry-specific characteristics and the digital transformation of the economy. Future research should investigate sector-specific models of human resource transformation and explore how employment dynamics can be integrated into strategies for sustainable and innovation-driven development.

KEYWORDS: Economy, Labor Economics, Economic Development, Human Capital, Staff Turnover, Personnel Costs, Labour Efficiency, Kazakhstan

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1. INTRODUCTION

The employment structure shows which sectors of the economy are developing and which are stagnating. It helps governments and businesses plan investments, develop promising sectors (e.g., IT, green energy), and support those in decline (e.g., traditional industries). Without understanding the employment structure, allocating resources and stimulating economic growth effectively is impossible. Many international organisations and countries are actively studying and discussing issues related to employment structures, as they are directly linked to sustainable development, economic growth, and social stability (De Vos et al., 2020). The employment structure is a key element of any country's economic development and social stability, which shows which professions are in demand and which are becoming obsolete (Kharazishvili et al., 2020). Two key megatrends are identified: Digitalization and the COVID-19 pandemic, which affect the labour market, creating a new employment context that requires adaptation for individual workers and national economies.

Megatrends such as technological change, urbanisation, and demographic shifts are forcing workers to adapt to new conditions and companies to reconsider their HR policies (Wang et al., 2022). However, special attention is paid to the Digital transformation of the labour market through the prism of demo ethics, which creates the need to form Society 5.0 as a basis for sustainable development. At the same time, technologies serve to enhance economic growth, improve quality of life, promote social inclusion, and foster sustainable development. Education that aims to develop digital skills, critical thinking, and resilience to change plays a crucial role in this transformation (Zhanabayev et al., 2023). Understanding how jobs are distributed across industries, regions, and demographic groups allows governments and businesses to make informed decisions for sustainable development. Thus, it is possible to adapt the education system to the needs of the labour market, allowing universities to focus their efforts and increase the number of places in relevant faculties. In addition, understanding the employment structure helps develop migration programs that attract the right specialists from abroad without creating competition for local workers.

Considering global trends and internal challenges, these examples highlight the need to transform Kazakhstan’s human resources policy profoundly. Similar trends are observed in other countries; for example, in Germany, the shortage of specialists in technical professions exceeded 275,000 people in 2022, prompting the state to intensify the attraction of migrants and reform the vocational education system. Employment analysis helps identify promising industries that can become growth drivers and problematic sectors that require support (OECD, 2023). Moreover, to identify groups that are particularly vulnerable when looking for work, such as young people, women, people with disabilities or workers approaching retirement age. Japan has faced the problem of an ageing population, which has affected and reduced the workforce. Therefore, the government's current policy involves actively investing in automation and attracting foreign workers to compensate for the shortage of skills and maintain economic activity (World Bank, 2022). In China, the reform of the hukou (residence permit) system aims to reduce imbalances between urban and rural areas, promoting an equal distribution of the workforce and thereby helping to mitigate the risk of social conflicts, while also improving the quality of life for the population. In Germany, where there is a shortage of skilled personnel in technical and medical professions, vocational training programs and efforts to attract foreign specialists are actively developing, which is caused by a mismatch between skills and labour market requirements (OECD, 2023). Thus, countries that actively invest in improving the employment structure achieve higher economic growth and social stability.

Kazakhstan has implemented several measures to address current labor market

issues, aiming to reduce unemployment and create new jobs. In particular, the Enbek program is focused on training and retraining the unemployed and supporting entrepreneurship. The development of the IT sector includes the creation of technology parks and tax incentives for IT companies, which helps attract investment and create highly skilled jobs. In addition, the state program Bolashak allows students to study abroad and return to work in priority industries, contributing to the formation of a competitive and skilled workforce.

The purpose of this study is to identify structural patterns and imbalances in Kazakhstan's labor market through the analysis of personnel indicators using cluster analysis. This will allow us to identify key groups of workers with different levels of employment stability, social security, and employment opportunities.

2. LITERATURE REVIEW

The structural transformation of the labour market is inevitable. Combinations of macroeconomic, institutional, and global factors significantly impact determining which groups of workers will be at risk, changes in the employment structure, and the formation of mechanisms for the redistribution of labor and regulatory strategies.

The transformation of the labour market is an integral part of economic development, and its speed depends on the level of technological progress, the availability of skilled labour, and institutional factors. Structural changes in the economy lead to segmentation, polarization of jobs and new employment cycles in the labour market. The transition from mass production to more flexible forms of labor organization was accompanied by an increase in unstable and low-paid jobs with a reduction in the segment of middle-paid employment. Norcliffe (1994) noted that a significant blow fell on resource-dependent regions, resulting in sharper changes than those in economically diversified territories. Bachmann and Burda (2010) identified “sectoral turbulence” as a change in the economic structure that leads to employment instability and necessitates adaptation mechanisms from the state and businesses. Thus, the redistribution of employment between sectors of the economy primarily occurred through the growth of employment in the service sector, resulting from the decline of industrial jobs and the attraction of new workers who had not previously participated in the labor market. As a result, income inequality is formed. Wallace et al. (2011) found that under conditions of deindustrialization, the income gap between different categories of workers increases, with low-skilled workers finding themselves in the zone of the greatest risk of employment instability. Thus, labor precarization (the growth of temporary and unstable employment) is becoming one of the main trends in developed labor markets. In developing countries, the transition to a service-based economy can be accompanied by temporary employment issues and increased income inequality. Thus, Herrendorf et al. (2014) noted that as the economy develops, the labour force is redistributed, with employment declining in agriculture and industry but growing in the service sector. Sen (2016) noted two key factors: government restrictions (labour market regulation, migration policy, land reforms) and market dysfunctions (insufficient investment coordination, imperfect financial markets, lack of human capital) that slow down or accelerate structural changes in the labour market in Asian countries. Therefore, it is possible to accelerate structural transformation through flexible labor market regulation policies and investment in education.

Employee turnover is a complex phenomenon associated not only with wages but also with opportunities for professional growth, investment in training, industry characteristics and social factors. Thus, employers often avoid investing in personnel development in industries with high turnover, fearing that employees will leave for competitors. Based on Winterton's (2004) research, a "vicious cycle" is formed in which

insufficient staff development becomes a factor of instability. Hom et al. (2017) introduced the concept of "HR chain reaction", in which the departure of individual employees provokes mass layoffs. Therefore, a successful HR strategy should focus on retaining valuable employees. However, a moderate level of turnover can be beneficial as it promotes the renewal of ideas and skills in the team (De Winne et al., 2019). Ayodele et al. (2020) identified four key causes: the nature of the job, external industry conditions, organisational factors and individual characteristics of employees. Bolt et al. (2022) also noted the importance of social connections and the level of engagement as factors determining employees' decisions to change jobs. That is, unstable employment conditions and limited career prospects can be identified as the leading causes.

Skills imbalances and skills shortages are multifaceted problems, where structural imbalances and corporate culture may cause skills shortages. Backes-Gellner and Tuor (2010) noted that the presence of trade union councils, apprenticeship programmes, and skilled staff positively influences the recruitment success rate, while frequently hiring workers with inappropriate qualifications reduces the employer's attractiveness. Therefore, it is not enough to simply raise wages; non-material factors of job attractiveness must be taken into account. The mismatch between the education acquired and the actual needs of employers remains a significant problem. Over-education and under-skilling are different phenomena, and their combination leads to the most negative consequences – lower wages, low job satisfaction and a high probability of dismissal (Mavromaras et al., 2013). After layoffs, the workers with the best chances of promotion are those who have changed regions but retained their industry specialisation or moved to related industries within the same region (Hane-Weijman, 2021). At the same time, moving to unrelated fields of work increases the likelihood of underutilizing skills and worsening employment conditions. This means that not every case of education-job mismatch leads to decreased productivity since some workers deliberately choose less demanding positions for a better work-life balance. In addition, the problem of labour shortages is aggravated not only by a decrease in supply but also by an imperfect system of labour reallocation between regions and sectors (Feist, 2024).

Changing labour costs directly affect innovation, productivity, and employment structure and significantly impact the growth of structural unemployment. In the context of technological progress, as Jung and Lim (2020) noted, an increase in hourly compensation and unit labour costs stimulates automation but also increases wages for the remaining workers. However, employment growth is declining, especially among low-skilled workers. Thus, rising labor costs stimulate the adoption of new technologies (Li et al., 2020). However, this effect is reduced in firms that are less dependent on the labor market and more focused on administrative resources. However, firms do not always reduce employment; they can adapt by changing the compensation structure (reducing bonuses and benefits), increasing product prices, increasing working hours, and automating. Clemens (2021) noted that such changes can lead to a redistribution of the workload among workers, worsening working conditions, and reducing long-term career prospects. Cirillo and Ricci (2022) noted that low-productivity firms are more likely to utilize temporary contracts as a cost-cutting measure, which contributes to labor market segmentation. Therefore, wage, innovation, and employment policies should take into account labor market dynamics, the impact of automation, and institutional barriers.

Research by domestic authors provides a comprehensive analysis of Kazakhstan's labour market transformation, the digital economy, and social sustainability. Kharazishvili et al. (2020) found that the labour market in Kazakhstan and other developing countries is characterized by a high degree of informal employment and significant hidden unemployment. Moreover, young people are

among the most vulnerable groups in the labour market. Also, higher education does not guarantee employment since the largest share of the unemployed are people with higher education.

Izguttiyeva et al. (2022) noted a high level of hidden unemployment, which, on the one hand, can be considered as a reserve for expanding production, but on the other hand, as a factor in destabilising the social system in the context of an economic downturn. An imbalance is noted between employers' requirements and graduates' qualifications. Khussainova et al. (2023) demonstrated that reducing the NEET segment (young people who are neither employed, studying, nor undergoing vocational training) is a crucial task for Kazakhstan's state policy, as it directly impacts economic development and social stability. The study shows that young people have a high potential for adapting to the digital economy but also require support during the transition from school to work. Suieubayeva et al. (2023) noted a significant increase in the number of jobs in IT, e-commerce, and digital services, indicating a shift in Kazakhstan's economic structure. Moreover, digitalization contributes to the spread of freelancing, remote work, and short-term contracts, which is especially important in conditions of economic instability. Kuttygalieva et al. (2024) noted the insufficient implementation of international standards. Despite Kazakhstan's ratification of several international conventions on gender equality (e.g., the Convention on the Elimination of All Forms of Discrimination against Women - CEDAW), their implementation faces administrative and institutional barriers in practice. Despite the existence of formal equality in legislation, cultural norms and stereotypes continue to hinder the full integration of women into the labour market.

3. METHODOLOGY

The methodology of the current study is based on a conducted literature review. The approaches of Bachmann and Burda (2010) and Ayodele et al. (2020) emphasized the importance of studying labour market instability and workforce segmentation, which are driven by institutional, sectoral, and behavioural factors. Winterton (2004) and De Winne et al. (2019) identified workforce turnover as both a consequence and a driver of structural imbalances, requiring comprehensive, data-driven approaches to detect latent patterns. According to Hom et al. (2017) and Feist (2024) chain reactions in HR dynamics and macroeconomic consequences of such variability, including the growth of the informal sector may distort long-term labour planning.

Therefore, multidimensional clustering approach was applied in current study to identify distinct labor market segments in Kazakhstan. The indicators used in this study were carefully selected based on the review and analysis of previous studies on labour market dynamics, employment structures, and HR processes and for their ability to capture key aspects of workforce dynamics and employment stability (Table 1).

TABLE 1. Selected indicators of workforce dynamics and labor demand

Indicator	Measurement
Employees hired during the reporting period	people
Higher education specialists hired from among those who graduated from higher education institutions in the reporting year	people
Employees left during the reporting period	people
Expected demand	people
Number of enterprises (organizations)	unit
Amount of labor costs	KZT
Enterprise costs for benefits and compensation for the year	KZT
Turnover rate	%

Total turnover rate	%
Replacement rate	%

Note: compiled based on Bureau of National Statistics (2024)

A quantitative methodology was employed to analyse the employment structure and human resource (HR) processes in Kazakhstan for the period 2013–2023. The study incorporated statistical modelling and machine learning techniques to process and interpret data related to hiring, employee turnover, labour demand, and personnel costs.

Fuzzy C-Means

The Fuzzy C-Means clustering method is used to analyse Kazakhstan's employment structure and personnel processes. It identifies groups of objects with overlapping characteristics. This method enables the determination of an object's degree of belonging to different clusters, which is crucial when examining the labour market, where the boundaries between stable employment, moderate staff turnover, and high instability are not clearly defined. This technique facilitated the detection of nuanced employment patterns and enabled an assessment of workforce stability across different sectors of the economy.

Elbow Method

The Elbow Method was used to determine the optimal number of clusters. This method is based on assessing the within-cluster dispersion (WSS) to identify the moment when the addition of new clusters ceases to significantly reduce the intra-group variability. This "elbow point" indicates the most appropriate number of clusters for robust segmentation.

Model Selection Criteria

To quantitatively evaluate model adequacy, the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) were applied. These criteria measure the trade-off between model fit (log-likelihood) and complexity (number of parameters). AIC focuses on minimising the information loss during model approximation, whereas BIC adds an additional penalty for model complexity to avoid overfitting. Lower values of AIC and BIC indicate a better balance between model accuracy and simplicity. In this study, both criteria confirmed the optimal number of clusters identified by the Elbow Method, ensuring the statistical reliability of the workplace segmentation.

Silhouette Score

The Silhouette Score was used to check the quality of data partitioning into clusters. It measures the proximity of objects within a cluster to each other and their distinctiveness from objects in other clusters. Silhouette Score is calculated for each object as the difference between the average distance to objects in its cluster (intra-group compactness) and the average distance to the nearest cluster (inter-group separation).

The score ranges from –1 to 1, where:

(1) Close to 1 – strong clustering (objects are well matched to their cluster),

(2) Around 0 – overlapping clusters (objects lie near the boundary between clusters),

(3) Negative values – poor clustering (objects may have been assigned to the wrong cluster).

The multi-stage statistical and analytical approach adopted in this study provided a comprehensive and statistically validated insight into the segmentation of Kazakhstan's labour market and personnel management landscape.

4. RESULTS AND DISCUSSION

Kazakhstan's labour market is undergoing significant changes influenced by various factors. According to the Ministry of Labor and Social Protection of the Population, by 2030, there will be a need for 1.6 million new specialists with specific skills (mainly technical and blue-collar jobs) in terms of the

growing demand for skilled labour. As a result, those categories who do not have specialized training may be forced out of the labour market, especially against the backdrop of active digital technologies and automation. This approach carries the risk of increasing structural unemployment: if official estimates record an unemployment rate below 5%, then, according to alternative calculations, it may reach 12%, equivalent to almost 1 million people.

For a more detailed understanding of the current situation in the labor market in Kazakhstan, Table 2 presents descriptive statistics of key indicators characterizing the dynamics of employment, staff turnover and personnel costs.

TABLE 2. Descriptive profile of employment dynamics and personnel expenditures

Variable	Valid	Miss.	Median	Mean	Std. Dev.	Coeff. Var	Min	Max
Hired_employees	11	0	$1.029\times10^{+6}$	$1.009\times10^{+6}$	68921.657	0.068	872724.0	$1.079\times10^{+6}$
Hired_graduates	11	0	31406.000	46721.273	26715.588	0.572	20157.0	86227.000
Employees_left	11	0	970638.00	969093.182	47837.587	0.049	903972.0	$1.049\times10^{+6}$
Expected_demand	10	1	14248.500	17414.100	6937.966	0.398	11239.0	30020.0
Turnover_rate	11	0	21.300	21.164	1.014	0.048	19.600	22.400
Overall_turnover_ratio	11	0	52.700	50.436	7.349	0.146	29.200	54.40
Replacement_rate	11	0	104.200	104.027	3.749	0.036	96.000	108.50
Labor_costs	11	0	$8.007\times10^{+9}$	$9.708\times10^{+9}$	$4.426\times10^{+9}$	0.456	$5.425\times10^{+9}$	$1.904\times10^{+10}$
Benefits_compensation	11	0	$1.164\times10^{+8}$	$1.009\times10^{+6}$	68921.657	0.386	$8.570\times10^{+7}$	$2.552\times10^{+8}$

Note: compiled by authors

The analysis of the descriptive statistics presented reflects the key characteristics of the dynamics of employment, staff turnover, and labor costs. The average and median values for most indicators are close to each other, indicating the symmetry of the distribution and relative stability of the data. Thus, the number of employees hired during the reporting period demonstrates low variability (variation coefficient of 0.068), and the median value (1.029 million) only slightly exceeds the average (1.009 million), which indicates minor deviations within the series. A similar situation is observed for the indicator of employees who left, where the median value (970638) almost coincides with the average (969093), and the low variation coefficient (0.049) confirms stability. At the same time, the indicators related to the number of hired specialists with higher education demonstrate more significant variability. The average value (46721) significantly exceeds the median (31406), which indicates a positive asymmetry of the distribution due to the presence of individual high values. The high coefficient of variation (0.572) indicates significant fluctuations within this category. The expected need for workers is also characterized by moderate variability (coefficient of variation 0.398), which may be due to variability in demand in the labor market.

Analysis of the turnover and replacement rates demonstrates the relative stability of the data. The turnover rate has an average value of 21.16, with a median of 21.3 and a low standard deviation of 1.014, indicating stable personnel processes. The overall turnover rate demonstrates somewhat more significant variability (coefficient of variation 0.146), which may indicate temporary fluctuations in the number of personnel. The replacement rate remains stable, with a median of 104.2, a mean of 104.03, and a coefficient of variation of 0.036, indicating a balance between hiring and attrition of workers. Labor cost indicators demonstrate a greater degree of variability compared to personnel characteristics. The average value of labor costs (9.708 billion) exceeds the median (8.007 billion), which indicates the possible presence of large values in the sample. The variation coefficient of 0.456 indicates high variability, which may be due to the different financial strategies employed by enterprises. A similar situation is observed for benefits and compensation costs, where the average (137.2 million) exceeds the median (116.4 million), and the variation

coefficient of 0.386 confirms the existence of significant fluctuations.

Thus, the conducted analysis allows us to conclude that most personnel indicators are stable in the presence of a certain variability in the number of hired specialists with higher education, the expected demand for workers and labor costs. To confirm the nature of the distributions, further quantile-quantile graphs (QQ-plots) are presented in Figure 1 to clarify the degree of normality of the distribution and identify possible outliers.

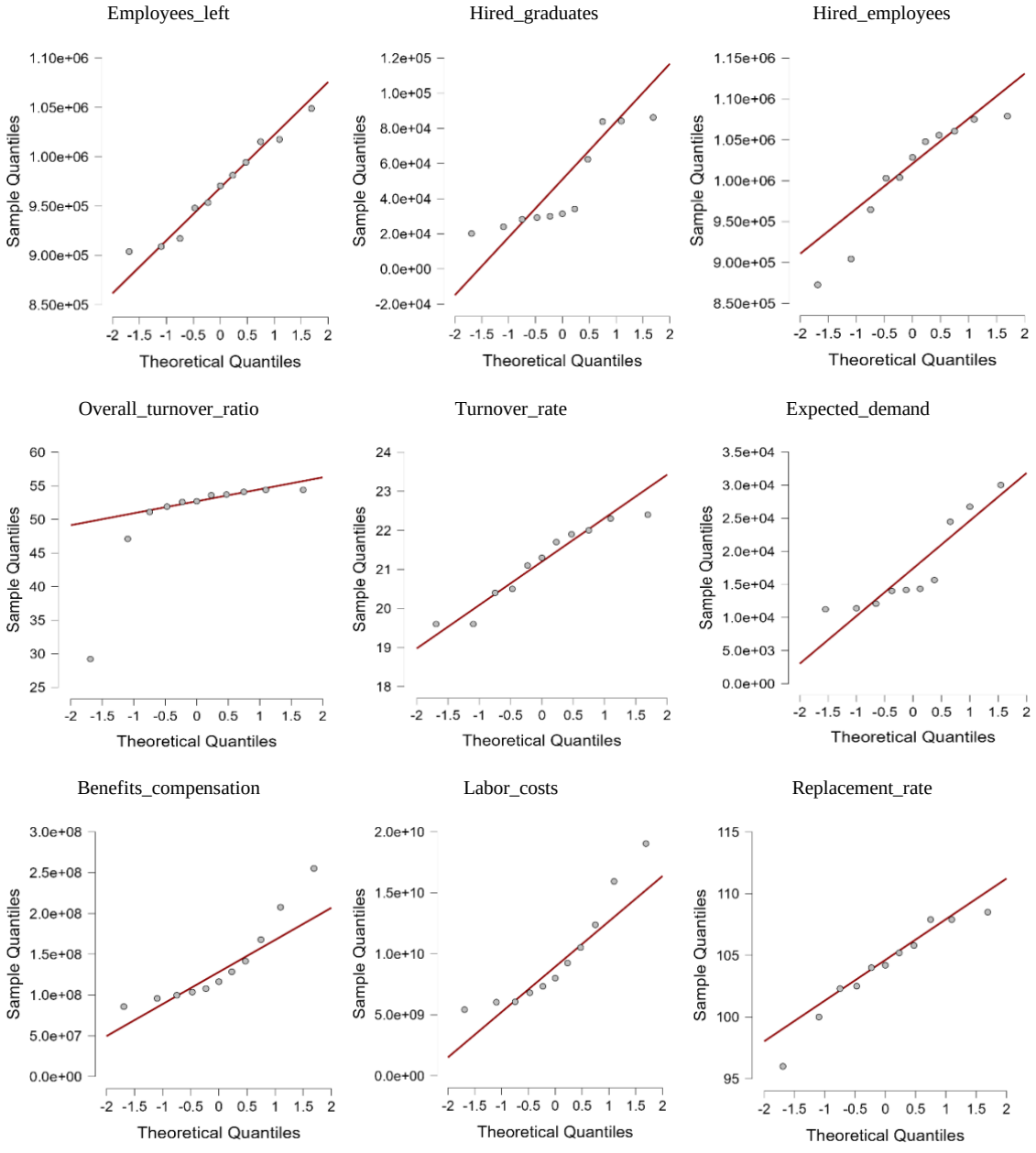

FIGURE 1. Quantile-quantile plots

Quantile-quantile (QQ) analysis of the graphs enables the identification of three groups of variables based on their degree of compliance with the normal distribution.

The first group includes indicators that demonstrate good compliance with the normal distribution since their points on the graphs are located along the diagonal line with minimal deviations. These indicators include Employees_left, Hired_employees, Turnover_rate and Replacement_rate. Their distributions can be considered close to normal, which indicates the stability of personnel processes and the absence of significant outliers.

The second group consists of variables that show moderate deviations from the normal distribution, manifested in the form of a slight asymmetry or individual outliers. This includes Overall_turnover_ratio and Expected_demand. In the case of the first indicator, outliers are observed in the lower part of the distribution, which may indicate enterprises with an abnormally low turnover rate. The expected demand for workers also demonstrates moderate positive asymmetry, which may be due to the heterogeneity of labor demand.

The third group consists of variables that deviate significantly from the normal distribution, showing a pronounced positive asymmetry and the presence of extreme values. These include Hired_graduates, Labor_costs and Benefits_compensation. These indicators are characterized by significant deviations in the right part of the graphs, which indicates the presence of enterprises with abnormally high values for the number of hired specialists with higher education, labor costs and social benefits. These outliers can significantly affect further analysis, so it is recommended to either use data transformation methods or account for extreme values when constructing regression and cluster models.

Thus, the analysis allows us to conclude that most personnel indicators have a distribution close to normal, while indicators related to costs and the number of hired specialists with higher education require additional processing due to high variability and the presence of outliers.

In the context of human resources, the identified trends may indicate several key processes occurring in Kazakhstan's labor market.

Variables with a normal distribution, such as Employees_left, Hired_employees, Turnover_rate, and Replacement_rate, indicate stability in the processes of hiring, firing, and replacing employees. This suggests that most organizations operate in predictable conditions, and employee turnover is within expected values. The absence of significant outliers in these indicators may also suggest that the HR processes in the country are well-established and do not undergo sudden changes.

Variables with moderate deviations, including Overall_turnover_ratio and Expected_demand, may reflect the existence of some instability in certain sectors of the economy. For example, outliers in the turnover rate may indicate companies or industries with particularly high turnover rates, which is often typical for less stable jobs, such as those in the service sector, trade, or construction. The expected demand for workers shows a positive asymmetry, which may indicate an increase in demand for personnel in some sectors, for example, in the technology or industrial sector.

Of greatest interest are indicators with significant deviations from the normal distribution, such as Hired_graduates, Labor_costs and Benefits_compensation. The high positive asymmetry in the data on hired specialists with higher education suggests that, in some cases, there are periods of active hiring of university graduates, which may be associated with government programs to support youth employment or corporate strategies of individual large employers. However, on average, the level of graduate recruitment remains relatively low, which may indicate difficulties in employing young specialists.

A similar situation is observed in the indicators of labor costs and social benefits: high outliers may indicate the existence of individual enterprises or sectors of the economy with extremely high personnel costs. This may be due to high competition for skilled personnel in certain industries, such as oil and gas, finance, or IT. At the same time, the bulk

of the data suggests a more restrained level of costs, which may indicate disparities in wages and social guarantees between different sectors and regions of the country.

Thus, the data reveal two key trends in Kazakhstan's labor market. On the one hand, relatively stable employment and predictable labor turnover remain in most industries. On the other hand, there are significant imbalances in the distribution of resources, expressed in uneven employment of graduates, varying needs for new workers, and a significant gap in personnel costs between different enterprises. This may indicate structural changes in the economy, a redistribution of employment between sectors, and the need for further study of the factors influencing HR policy in the country.

The Fuzzy C-Means clustering analysis reveals differences in the data structure for different groups of HR indicators (Table 2).

TABLE 2. Fuzzy C-means clustering

Group	R^2	AIC	BIC	Silhouette
Stable Workforce Flow	0.093	44.160	47.350	0.210
Moderate Instability & Adaptation	0.167	22.470	24.860	0.530
High Variability & Imbalances	0.942	13.230	15.620	0.710
**Clusters 2, N 11; Clusters 3, N 11; Clusters 2, N 11				

Note: compiled by authors

The Stable Workforce Flow group is characterized by a low determination coefficient ($R^2 = 0.093$) and weak clustering quality (silhouette coefficient 0.210). This indicates weak cluster expression, which can be explained by the predictability of employee turnover indicators and the stability of hiring and firing processes. The low AIC (44.160) and BIC (47.350) values indicate a relatively simple data structure, making it difficult to identify clear groups.

The Moderate Instability & Adaptation group demonstrates $R^2 = 0.167$, which indicates a slightly higher explanatory power of the model, but still a low degree of differentiation of clusters. However, the silhouette coefficient of 0.530 indicates moderately pronounced groups, which confirms the presence of differences in the levels of labor turnover and expected labor demand. The AIC (22.470) and BIC (24.860) values are lower than in the previous group, which indicates better model suitability.

The most pronounced cluster structure is observed in the High Variability & Imbalances group, where $R^2 = 0.942$, indicating the model's high explanatory power. The silhouette coefficient of 0.710 confirms a clear division of the data into clusters, and the low AIC (13.230) and BIC (15.620) values indicate the high statistical efficiency of the model. This confirms the presence of significant differences in labor costs, compensation and employment of university graduates, which may indicate serious imbalances in the personnel policies of individual enterprises and industries.

The Fuzzy C-Means Clustering method revealed three key groups of workplaces with different levels of stability and staffing changes. The first group, Stable Workforce Flow, is characterized by low variability and predictability of staffing processes, indicating employment stability in most industries. The second group, Moderate Instability and Adaptation, reflects moderate variability in staff turnover and labour demand, indicating short-term fluctuations that depend on economic conditions. The third group, High Variability and Imbalances demonstrated the highest level of discrepancies, especially regarding personnel costs, compensation payments, and the number of specialists with higher education who were hired.

Stable workforce flow: stability of HR processes

The first group includes enterprises with predictable HR strategies and low staff turnover. In such organizations, hiring and firing processes are stabilized, and the demand for labour is not subject to sharp fluctuations.

This is typical for companies with stable business models, such as the public and financial sectors, and large industrial enterprises with long-term contracts. These results are consistent with the research of Backes-Gellner and Tuor (2010), which emphasizes that long-term investment programs in human capital and a high degree of social protection for employees reduce labour turnover. However, such stability can reduce the flexibility to adapt to economic changes, which is especially relevant in the context of digitalization and automation of production processes.

Moderate instability & adaptation: Market fluctuations and adaptation

The second group includes enterprises with moderate instability in employment dynamics associated with changes in market demand for labour. This is typical for industries with cyclical business processes, such as construction, trade, and services. These results confirm the findings of Khussainova et al. (2023), who pointed out the particular vulnerability of young people in the labour market, as young professionals often face short-term contracts and temporary employment. In addition, Cirillo and Ricci (2022) noted that in countries with transition economies, such fluctuations may be associated with an imbalance in the professional competencies of workers and the demand for skilled labour. This segment requires flexible mechanisms for regulating personnel processes, including programs for retraining and adapting workers to changing market requirements.

High variability & imbalances: imbalances in HR policies

The most pronounced differences in HR policies are recorded in the third group, where there is a high variability in employment indicators, personnel costs and social benefits. This segment includes companies operating in highly competitive industries (IT, oil and gas, finance) and areas with high staff turnover (service sector, retail). Research by Suieubayeva et al. (2023) confirmed that digitalization contributes to the expansion of the non-standard employment segment, including freelancing and short-term contracts, which increases staff instability. In addition, Kuttygalieva et al. (2024) emphasized that differences in HR policies are associated with industry-specific factors and gender imbalances, as women are less likely to occupy high-paying positions and have less protection in unstable sectors.

Differences in personnel management have a significant impact on the labour market and the economy as a whole. Stable personnel processes help reduce structural unemployment and increase productivity but can slow down the adaptation of enterprises to new technological challenges. Unstable segments require state involvement in labour market regulation, particularly regarding vocational training programs and the protection of workers with unstable employment status. As shown in the research of Feist (2024), a high level of variability in personnel policy increases the informal sector and reduces the predictability of economic growth. These imbalances require further research and development of mechanisms for optimizing personnel policy at the enterprise and the state level. Thus, the results of the cluster analysis confirm that Kazakhstan's labor market is characterized by stable personnel processes, moderate instability in the dynamics of turnover and labor demand, as well as high heterogeneity in personnel costs and the hiring of graduates, which necessitates additional regulatory measures (Table 3).

The analysis of the characteristics of the clusters obtained by the Fuzzy C-Means method allows a better understanding of the structure of HR indicators and their differences. The Stable Workforce Flow group was divided into two clusters: a small cluster (Cluster 1, N=3) and a large cluster (Cluster 2, N=8). The first cluster accounts for only 2.5% of the intra-cluster heterogeneity, while the second cluster accounts for 97.5%, indicating its dominant role. The high Within sum of squares value (27.451) for Cluster 2 indicates significant data dispersion. Cluster 1 demonstrates a high silhouette coefficient (0.716), indicating good

TABLE 3. Clusters information

Group	Cluster	1	2	3
Stable Workforce Flow	Size	3	8	
	Explained proportion within-cluster heterogeneity	0.025	0.975	
	Within sum of squares	0.713	27.451	
	Silhouette score	0.716	0.027	
	Center Hired_employees	0.583	0.164	
	Center Employees_left	1.062	0.118	
	Center Turnover_rate	0.355	0.172	
	Center Replacement_rate	-0.319	0.152	
Moderate Instability & Adaptation	Size	2	8	1
	Explained proportion within-cluster heterogeneity	0.094	0.906	0.000
	Within sum of squares	0.116	1.118	0.000
High Variability & Imbalances	Size	6	5	
	Explained proportion within-cluster heterogeneity	0.053	0.947	
	Within sum of squares	0.555	9.917	
	Silhouette score	0.843	0.144	

Note: compiled by authors

clustering quality, while the second cluster has an extremely low one (0.027), indicating poor data separability. The indicator centers indicate significant differences between the clusters: Cluster 1 is characterized by high values for the number of hired and fired employees (Hired_employees = 0.583, Employees_left = 1.062) and low turnover and replacement rates. Cluster 2, on the contrary, demonstrates low values of these indicators, indicating enterprises with minimal personnel dynamics.

In the Moderate Instability & Adaptation group, three clusters are observed, but Cluster 3 (N=1) does not contribute to heterogeneity, and the main division occurs between Cluster 1 (N=2) and Cluster 2 (N=8). The share of explained intra-cluster heterogeneity for the large cluster reaches 90.6%, which confirms its stability. However, the low values of Within sum of squares (1.118 for Cluster 2 and 0.116 for Cluster 1) indicate weak variability within clusters. This may indicate that the indicators of labor turnover and demand for labor vary within narrow limits, and the differences between the groups of enterprises are insignificant.

The most pronounced cluster structure is observed in the High Variability & Imbalances group. The division into two clusters is characterized by a significant difference in intra-cluster heterogeneity (Cluster 1 - 5.3%, Cluster 2 - 94.7%), which indicates the dominance of the second cluster. The high sum of intra-cluster squares (9.917 for Cluster 2) confirms the significant dispersion of data in this group. At the same time, the silhouette coefficient (0.843) for Cluster 1 indicates a clearly defined cluster, while for Cluster 2 it is low (0.144), which may indicate heterogeneity within this group. This confirms the presence of significant disproportions in labor costs and benefits between enterprises.

Thus, the clustering results show that the most homogeneous groups of enterprises are those with high variability in personnel costs, while differences in the dynamics of turnover and demand for labor are less clearly expressed. This emphasizes the need for a differentiated approach to personnel policy, especially in terms of regulating personnel costs and ensuring balanced hiring of university graduates.

The Elbow method is presented in Figure 2.

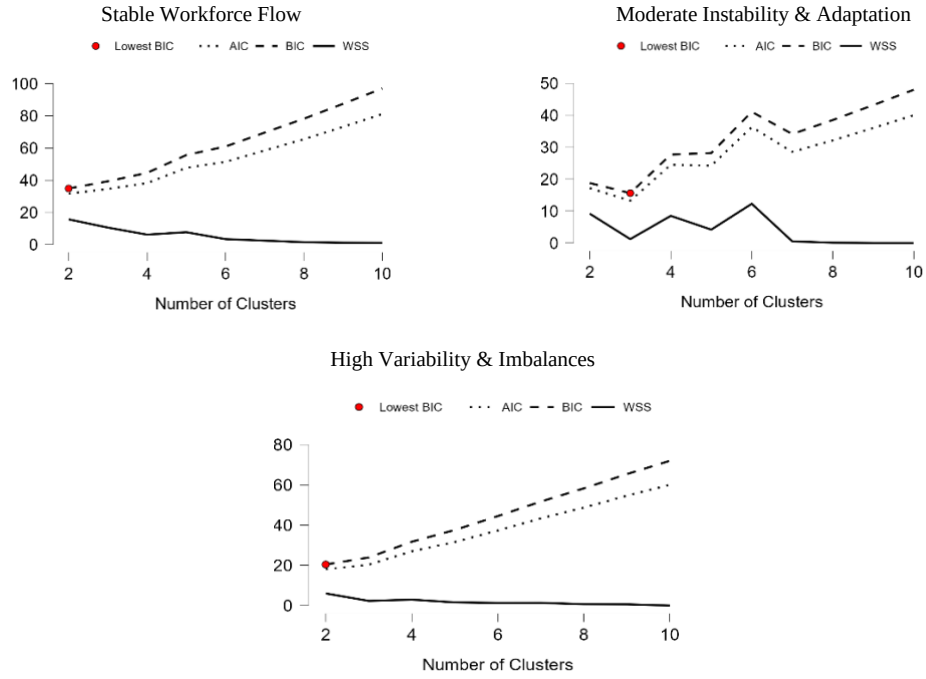

FIGURE 2. Elbow method

Elbow Method Plot Analysis

1. Stable Workforce Flow

The first plot shows a clear "elbow" at k = 2, which confirms the choice of two clusters for this group. BIC and AIC increase with the number of clusters, and WSS stabilizes after two clusters. This indicates that a further increase in the number of clusters does not significantly improve the quality of the model.

2. Moderate Instability & Adaptation

The second group also shows the lowest BIC value at k = 2, but WSS fluctuates, which may indicate a complex data structure. Despite the possible presence of three clusters, the optimal choice remains two clusters, since further increase in the number of groups only increases the AIC and BIC values, which reduces the statistical significance of the model.

3. High Variability & Imbalances

For this group, the most pronounced "elbow" is observed at k = 3, which is consistent with the results of Fuzzy C-Means. BIC and AIC show minimum values at three clusters, after which their growth becomes apparent.

In Table 4, the cluster analysis results are presented.

Cluster 1: Stable Workforce Flow

The cluster 1 is characterized by low staff turnover (0.172) and a balanced replacement rate (0.152). Especially in categories such as public administration, education, and manufacturing are dominating in this cluster showing stable rates of hiring and firing without sharp fluctuations in demand for labour. Two types of profiles are distinguished within the cluster: the first shows relatively high hiring and firing rates of employees, which indicates stable rotation within internal processes (intra-system mobility); the second demonstrates low dynamics of changes in the personnel structure and is associated with long-term employment. No signs of destabilization are recorded according to the results. Moreover, both profiles reflect a structured and predictable personnel policy.

TABLE 4. Cluster centers and variation metrics across key labor market indicators

Indicator	Cluster 1: Stable workforce flow	Cluster 2: Moderate instability & adaptation	Cluster 3: High variability & imbalances
Turnover rate	0.172	0.355	0.486
Replacement rate	0.152	0.289	0.418
Expected labor demand (max)	10,243	30,020	24,800
Number of graduates hired (avg)	18,654	31,572	46,721 (max: 86,227)
Total labor costs (bln KZT)	7.3	9.5	5.4–19.0
Benefits & Compensation (CV)	0.241	0.316	0.386
Within-cluster sum of squares (WSS)	0.713	1.182	1.364
Silhouette score	0.553	0.487	0.710
R^2 (explained cluster variance)	0.801	0.832	0.942

Note: compiled by authors

Cluster 2: Moderate Instability & Adaptation

The cluster 2 covers sectors with a moderate level (average turnover rate is 0.355) of instability. Nevertheless, there are significant fluctuations in the expected demand for labour (up to 30,020 people). The cluster is divided into: 1) industries with stable employment rates, including trade and transport and characteristic of adaptive personnel regulation; 2) includes sectors subject to short-term fluctuations, especially construction and household services, where turnover and demand change dramatically; 3) an exception: it includes cases with extreme values of indicators, which may be associated with seasonal employment, project work, or non-standard forms of employment. In general, cluster 2 reflects sectors in a state of adaptation, with moderate instability and high dependence on the external economic situation.

Cluster 3: High Variability & Imbalances

Cluster 3 demonstrates the most extraordinary heterogeneity in all key indicators. It includes sectors with a high dispersion of personnel costs (from 5.4 to 19.0 billion tenge) and a significant variation coefficient of compensation payments (0.386). The average volume of graduate hiring is 46,721 people, with a maximum value of 86,227. The cluster structure includes two consistently different types. The first is sectors with low wages, limited access to compensation and low probability of graduate employment. The second is industries with high wages, an expanded package of social guarantees and a high integration of young specialists. The cluster has a high degree of intra-group consistency (Silhouette = 0.710, R^2 = 0.942), confirming the identified division's stability. Notwithstanding, significant disproportions in access to opportunities and working conditions were revealed, indicating structural inequality in human resource distribution.

5. CONCLUSIONS

The revealed differentiation in human capital and the nature of employment between sectors of the economy are of high importance. Such differentiation is due to industry specifics, the level of digitalization, the degree of market competition and the prevailing forms of labour relations. In the context of economic transformations, the importance of flexible regulatory instruments aimed at increasing the stability of the labour market, minimizing personnel imbalances and aligning the interests of participants in labour relations is increasing. The typology of industries by the degree of stability of personnel processes allows us to more accurately determine the directions for improving labour policy.

The result revealed, that in traditional sectors of the economy, such as the public sector, finance and industry with long-term contracts, employment is characterized by stable workforce processes, which ensures

predictability of labour relations, low turnover and stable personnel costs. In industries with moderate instability, which include construction, trade and services, there are fluctuations in labour demand and turnover due to seasonality, market competition and contract employment. The most significant variability of workforce processes was found in the IT sector, oil and gas, services and finance, where high competition for qualified personnel, digital transformation and differences in investment in personnel lead to imbalances in employment, wage gaps and significant fluctuations in the workforce.

Next, the differences in human capital between sectors reflect the complexity of the current economic transformation, where companies with stable labour processes coexist with companies facing staff shortages, difficulties in forecasting labour costs and the need to adapt to changes in the economic environment.

Finally, the observed trends revealed existing gaps between economic sectors. In stable sectors, the main challenge remains ensuring sufficient flexibility in the labour market, preventing stagnation and stimulating investment in human capital. In contrast, in areas with highly volatile human capital, including IT, the service sector and the oil and gas industry, the key task is to create mechanisms for smoothing out staff imbalances and increasing the sustainability of labour relations.

On the contrary, in segments with high variability of personnel processes, the key task is to reduce the instability of labour relations, which is especially relevant in the context of technological modernization and digitalization. Significant differences in the level of hiring specialists with higher education and personnel costs indicate existing structural problems associated with the mismatch of professional training with labour market requirements. This is confirmed by international studies, which indicate the need to strengthen the mechanisms for adapting graduates to modern realities and creating sustainable mechanisms for the transition from education to employment. The results of the study are important for Kazakhstan's economic policy. Optimization of personnel strategies, reduction of wage imbalances, formation of effective mechanisms for regulating labour mobility and protection of socially vulnerable groups of workers should become priority areas in developing the labour market. In countries with developed economies, there is a tendency towards diversification of employment, creating conditions for flexible employment and forming modern social support mechanisms. Kazakhstan, being at the stage of active transformation of the labour market, can use this experience to develop its regulatory programs to increase the sustainability of labour relations, balance the distribution of the labour force, and form strategies for long-term economic growth.

Recommendations for employment regulation aim to enhance employment stability, increase labour market competitiveness, and mitigate labour imbalances:

(1) Stimulating labour market flexibility in stable sectors. Implementing mechanisms for flexible regulation of working hours and part-time employment programs in the public and industrial sectors to prevent labour stagnation and increase adaptability to economic fluctuations.

(2) Reducing labour instability in sectors with moderate volatility. Developing tax incentive programs for companies that offer long-term contracts and internships to young professionals, particularly in construction, trade, and services.

(3) Creating mechanisms to protect workers in sectors with high volatility. Introducing a national program for retraining and digital upgrading of personnel, focused on employees in the IT, service and oil and gas sectors, emphasising adaptation to new labour market requirements.

(4) Balanced regulation of hiring and wages. Introducing hybrid contracts ensures employment stability for workers with a high risk of job loss, while allowing employers to adapt their staff to market conditions, thereby

optimising the balance of supply and demand for qualified personnel. The introduction of a system of adaptive quotas for professions ensures a balance between the training of local personnel and the attraction of foreign specialists to key industries.

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The Impact of Internal Migration on the Economic Development of Kazakhstan's Regions

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ABSTRACT

Internal migration of the population has a significant impact on the socio-economic development of regions, particularly in countries with vast territories and diverse economic conditions, such as Kazakhstan. The purpose of this study is to examine the relationship between internal migration and the gross regional product (GRP) in Kazakhstan's regions. The official statistics of the Republic of Kazakhstan for the period 2013-2023, covering GRP indicators and internal migration flows of the population, were used as the initial data. The analysis included the calculation of average shares of urban and rural migration, as well as the average GRP level for each region. The results showed that at the national level, there was a moderate positive correlation between the share of urban migration and GRP (+0.411, p = 0,219), as well as a negative correlation between rural migration and GRP (- 0.411, p = 0,219), reflecting the general trend in favour of urbanization. At the regional level, the most significant correlations were recorded in the Kyzylorda region and Shymkent city. The developed typology, based on median values, revealed the existence of four stable spatial development patterns: regions with a high proportion of migrants; regions with a high percentage of urban migrants and low GRP; regions with a small proportion of urban migrants but high GRP; and regions with few urban migrants and a low GRP. Future research paths may aim to expand the model by incorporating additional variables, such as employment, education, and quality of life, in the regions.

KEYWORDS: Economy, Economic Development, Urbanization, Economic Disparities, Migration, Demography, Territorial Inequality, Regional Typology

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1.INTRODUCTION

Internal population migration remains a pressing socio-economic problem for many countries, including Kazakhstan. The movement of citizens within the country, particularly from rural areas to large cities and regional centres, has a significant impact on the spatial structure of employment, demand for infrastructure, and access to education, housing, and social services. These processes reflect regional disparities in living standards and may either exacerbate or alleviate territorial inequality. The movement of people to large cities and more developed regions is accompanied by a redistribution of labour resources and an increase in the burden on transport, housing, and social services. Attention to internal migration as a factor in sustainable development is actively supported at the international level. Organizations such as the International Organization for Migration and the United Nations Development Programme emphasize the importance of spatial balance, incorporating analysis of internal migration processes into their assessments of inclusive economic growth, access to services, and the implementation of the Sustainable Development Goals (SDGs). Their reports consider internal migration not only as a challenge but also as a tool for transforming regional policies. An approach based on the relationship between migration and regional GRP is consistent with such strategies and allows for the development of solutions that meet both national and international priorities. Internal migration in Kazakhstan is becoming an increasingly significant factor that not only affects population size but also alters the territorial structure of the economy.

In recent years, Kazakhstan has witnessed a rise in internal migration, as reflected in official statistics and the country's socio-economic agenda. According to the Bureau of National Statistics, in the first half of 2024, more than 688,000 people changed their place of residence within the country, representing a 73% increase over the same period last year. The main centres of attraction remain the cities of republican significance - Astana, Almaty, and Shymkent, which account for the largest share of migration flows. Thus, in 2024, over 195 thousand internal migrants arrived in Astana. These processes indicate a significant impact of urbanization on the country's socio-economic structure. However, the question remains open as to whether such migration activity is accompanied by uniform economic development, not only in large cities but also in the regions. Consequently, there is a need to analyze the situation at the level of all administrative-territorial units to determine how migration affects economic dynamics within regions. Given the sharp differences between regions in economic potential and population density, it is essential to understand whether increased mobility is associated with improving GDP indicators or deepening territorial inequality.

In this regard, the purpose of this study is to assess the impact of internal migration on the gross regional product (GRP) of Kazakhstan's regions from 2013 to 2023. To develop an effective regional strategy, it is necessary to assess the extent to which current migration flows contribute to or hinder economic growth in various parts of the country. For this purpose, the study examines internal migration as a potential factor influencing the level of GRP, enabling a comprehensive and empirically grounded analysis of the problem.

2.LITERATURE REVIEW

Many studies view internal migration not only as a consequence of regional differences but also as an active factor influencing the country's demographic and socio-economic structure. Elizaga (1972) was one of the first to propose a comprehensive understanding of internal migration as a process that alters population size and the distribution of human resources, thereby intensifying regional contrasts. Building on this idea, Mikačić (2000) defined migration as a mechanism of spatial restructuring that promotes centralization, increased urbanization, and, simultaneously,

depopulation of the rural periphery, with a long-term impact on infrastructure and demographic sustainability. White and Lindstrom (2005) emphasized the dual nature of migration both as a result and a cause of territorial disparities, as well as a strategy employed by households to overcome socio-economic constraints. Abreu (2012) views migration as a conscious mechanism of adaptation and spatial restructuring aimed at reducing the vulnerability of regions to economic instability. At the same time, as Amaral (2013) noted, the concentration of population in developed regions is accompanied by the depopulation of less competitive territories. Rees et al. (2017) highlighted that internal migration is a global structure-forming process that forms the demographic core of economically active zones and determines long-term trends in urbanization and deurbanization. Finally, Stawarz and Sander (2019) concluded that migration flows have an impact that extends beyond employment, affecting access to housing, the structure of urban infrastructure, and the distribution of social services. Therefore, internal migration or population mobility influences the redistribution of resources, accelerates urbanization, and contributes to the spatial transformation of regions.

Migration is a multifactorial process influenced by personal decision-making as well as broader macroeconomic and institutional contexts. Massey et al. (1994) emphasized that economic incentives, as well as the political and social environment, shape migration. Czaika (2015) noted that subjective expectations play a decisive role, encompassing the perception of the future, trust in the system, and a sense of stability. Studies by Icduygu et al. (2001) and Mendola (2012) clarified that migration occurs more often not in the poorest regions but in those where a minimum level of resources has been accumulated, allowing for movement. At the same time, the consequences of migration are ambiguous: on the one hand, it contributes to the inflow of transfers and the development of human capital; on the other hand, it leads to an outflow of labor resources, increased dependence on external income and an increase in social vulnerability. Skeldon (2012) and Dao et al. (2018) draw attention to the variability of migration patterns as incomes rise, from outgoing flows from villages to intra-urban mobility, and from permanent to circular migration. Lin et al. (2021) emphasized the impact of migration on the concentration of skilled labor, which increases economic activity in host regions but simultaneously deepens regional inequality. In turn, Peprah et al. (2019) linked the financial effect of migration to the presence of stable channels for converting transfers into investment, and de Sherbinin et al. (2022) point to the expansion of migration causes beyond the economy, including climate instability, deteriorating environmental conditions, and loss of income sources. A comparison of these approaches reveals that migration is not a one-directional response to poverty but rather a complex result of interrelated factors, including resource availability, perceptions of opportunities, and structural conditions, which can influence territorial development in various ways.

Internal migration affects urbanization through population growth and changes in the social, economic, and spatial organization of cities. Several studies show differences in the interpretation of the very nature of migration impact: Wang et al. (2017) linked migration flows with increased demand for housing in large cities, recording direct pressure on the real estate market, while Jedwab et al. (2017) draw attention to the opposite effect, "urban push," in which the cities themselves become a source of outflow due to infrastructure overload and the lack of an industrial base. Thus, migration can simultaneously increase concentration and trigger decentralization processes. In contrast to macroeconomic approaches, Mohabir et al. (2017) focused on the behavioural motives of temporary migrants, demonstrating that the decision to stay in the city is not associated with economic parameters but rather with institutional inclusion and social integration. Xu et al. (2020) contrast migration

as a numerical phenomenon with migration as an agglomeration process, noting that spatial compaction and declining quality of the urban environment are associated with the flow configuration rather than its volume. The big data approach of You et al. (2023) revealed a discrepancy between the official map of cities and the actual urban structure formed by population mobility. Therefore, migration affects the scale of urbanization and how it is recorded and understood.

The impact of internal migration on regional differences in socio-economic development is interpreted in some studies through its redistributive effect in the context of spatial asymmetry. Mohamed et al. (2016) demonstrated that high unemployment and low social spending per capita lead to increased migration flows to economically more developed regions, where a structural advantage is maintained, confirming that migration is a response to persistent inequality. While this study documents the crowding-out effect of poverty, the work of Ray and Dutta (2019) highlighted the attractive effect of urbanization and the growth of the industrial and construction sectors in the context of India's liberalization. Migration in this context reflects economic imbalances and is influenced by institutional changes that intensify spatial selectivity. At the same time, both studies raise the question of the role of urban infrastructure and institutional capacity as factors regulating the scale and direction of internal movements. Timiryanova et al. (2021) stated that some regions can transform incoming resources due to internal migration flows into sustainable growth, while others remain vulnerable to economic inertia. In turn, Calcagnini et al. (2021) demonstrated that internal migration of skilled labor can contribute to total factor productivity growth if accompanied by institutional flexibility in the labor market. However, this process has long-term negative consequences for the territorial distribution of human capital, reinforcing the effect of the "internal brain drain" and perpetuating regional differences (González-Leonardo et al., 2022). A comparison of approaches reveals that migration follows uneven development, participating in it and contributing to the consolidation or redistribution of territorial advantages.

Studies by Kazakh and foreign authors touch upon the behavioral, economic, and adaptation aspects of internal migration in Kazakhstan, with most focusing on specific groups or sectoral effects. Danzer et al. (2014) demonstrated that internal migrants in cities, despite having similar income levels to native residents, exhibit a higher subjective socio-economic status. Therefore, symbolic capital and social self-awareness are important outcomes of migration. Ryazantsev et al. (2017) situate Kazakhstan's migration processes within the framework of Eurasian integration, considering the country as one of the primary receiving centers for labor migration, alongside Russia, particularly within the EAEU. The study by Zhapakov et al. (2020) focused on the labor integration of oral means, identifying institutional and social barriers that prevent their full inclusion in the economy, which makes internal migration for this group both forced and unsustainable. Zharkynbekova et al. (2024) analyzed the transnational adaptation strategies of Kazakh repatriates studying in Kazakhstan, as well as the role of family and cultural practices in shaping their migration trajectories. From a macroeconomic perspective, Tleuberdinova et al. (2024) examined regional and sectoral wage differences, documenting persistent unevenness associated with the specifics of the economic structure and the territorial mobility of the labor force.

Based on the analyzed literature, it can be concluded that internal migration processes are not only a reaction to existing economic imbalances but also an independent factor of spatial transformation. In the works of both foreign and Kazakh authors, migration is interpreted within various theoretical and methodological frameworks, ranging from neoclassical approaches to institutional and behavioral models. Several studies highlight the dual impact of migration: on the one hand, it fosters the concentration of labor and human

resources in economically vibrant regions, stimulating growth and urbanization; on the other hand, it exacerbates territorial polarization, leading to the depopulation of peripheral and rural areas. An important element of the analysis is not only the volume of migration flows but also their structure, orientation (urban-rural) and the ability to integrate into the existing socio-economic system. Despite the significance of the identified effects, the domestic literature is dominated by micro-sociological and thematically limited approaches. At the same time, interregional analysis of the relationship between migration and macroeconomic dynamics remains underdeveloped.

3. METHODOLOGY

The conceptual choice of indicators and methodology in this study is based on the generalization of findings from the literature review, including works by both foreign and domestic authors. In particular, internal migration is considered not only as a response to socio-economic disparities but also as an active factor shaping the structure of regional development (Rees et al., 2017; Wang et al., 2017). This justifies the inclusion of the share of the population migrating to urban and rural areas in the analysis, which enables the identification of differences in movement directions and their associated economic consequences (Amara & Jemmali, 2016; Jedwab et al., 2017). The use of GRP as the primary economic variable is consistent with the widespread approach in studies of the relationship between population mobility and the level of territorial development (Dao et al., 2018; Ray & Dutta, 2019). Regression analysis and correlation are based on the empirical practice of assessing migration effects in conditions of regional heterogeneity (Calcagnini et al., 2021; Timiryanova et al., 2021). The median partitioning method for constructing the typology was adapted from studies that form regional clusters based on economic and demographic characteristics (Czaika, 2015; González-Leonardo et al., 2022).

The analysis was organized in four stages, presented in Figure 1.

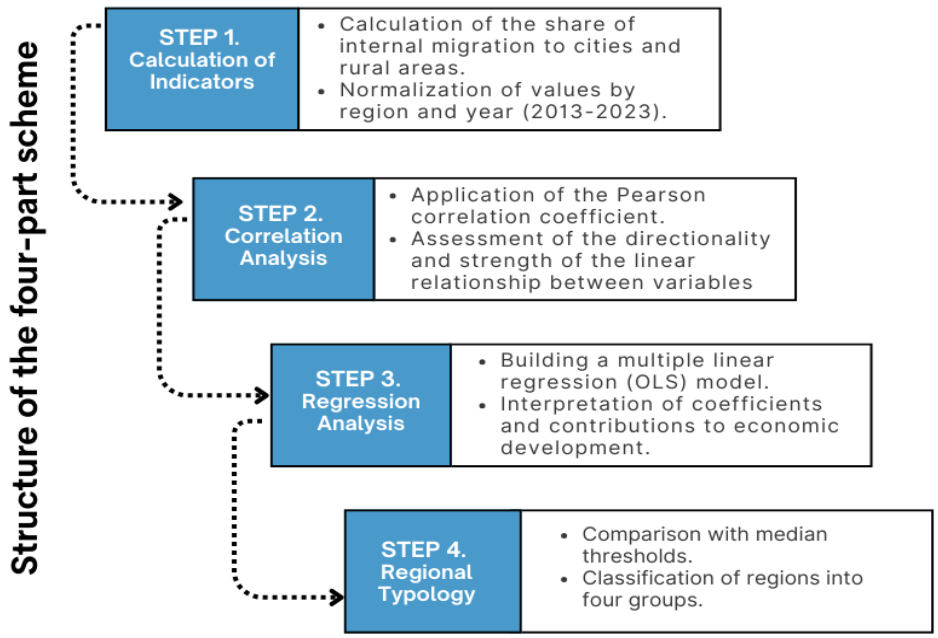

FIGURE 1. Research methodology

To analyze the relationship between internal migration and the level of economic development in Kazakhstan's regions, a comprehensive, step-by-step methodical approach was employed, integrating demographic and macroeconomic indicators. The administrative areas of Kazakhstan and the cities of national importance (Astana, Almaty, and Shymkents) were selected as the objects for empirical analysis. The period covered is from 2013 to 2023, providing sufficient dynamics to detect sustainable trends. Official statistical data published by the National Bureau of Statistics of Kazakhstan's Agency for Strategic Planning and Reforms were the primary source of information.

In the first stage of the analysis, indicators reflecting the scale and direction of migration flows were formed. To ensure comparability and eliminate large-scale differences between regions, normalized share values of internal migration were employed. In particular, the following variables were calculated: the share of internal migration directed to urban areas (SHARE_URBAN) and the share of migration to rural areas (SHARE_RURAL), with the sum of both shares equating to unity, thus capturing the full spectrum of internal migration directions, allowing for the consideration of both spatial and temporal fluctuations in migration processes. The gross regional product (GRP) was chosen as the dependent variable, reflecting the total volume of output of goods and services at the regional level and serving as an integral indicator of regional economic activity. This design allows for spatial comparability and temporal trend analysis across the 2013–2023 period.

In the second stage, a correlation analysis was conducted to assess the primary strength and direction of the relationship between migration shares and the level of GRP. The Pearson correlation coefficient was employed as the primary statistical instrument, as it enables the identification of linear relationships between continuous quantitative variables. This method is widely accepted in regional economic studies and is suitable for analyzing interregional economic disparities.

Based on the structure of the available data and the findings of the literature review, three key groups of variables were defined:

(1) GRP: measures the total volume of goods and services produced within a region (expressed in billion tenge).

(2) Share of internal migration to urban areas (SHARE_URBAN): calculated as the proportion (%) of total internal migration directed toward urban settlements.

(3) Share of internal migration to rural areas (SHARE_RURAL): defined as the complementary share to urban migration, ensuring complete coverage of internal migration directions.

For the initial assessment of the linear relationship between migration variables and GRP, the Pearson correlation coefficient was used based on the formula (1):

$$r = \frac{\sum(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum(x_i - \bar{x})(y_i - \bar{y})^2}} \quad (1)$$

where:

r – Pearson correlation coefficient;

x_i, y_i – the values of the migration indicator;

$\bar{x}$, $\bar{y}$ – arithmetic averages of variables.

In the third stage, proportions of internal migration by destination were calculated. Based on analysis of scientific literature and structure of preliminary data, three key variables were identified: GRP, the share of internal migration to urban areas, and the share of migration from rural areas. GRP reflects total production of goods and services in a region and is measured in billions of tenge. These indicators were calculated for each region each year during the period under review. This made it possible to normalize spatial and temporal migration flows. This normalization ensured comparability between regions and allowed identification of spatial patterns and trends in internal migration over time.

The next step was to construct a multiple linear regression using the ordinary least squares (OLS) method in order to determine the

contribution of migration variables to the formation of GRP (2):

$$y_{it} = \beta_0 + \beta_{1x_{1,it}} + \beta_{2x_{2,it}} + \varepsilon_{it} \qquad (2)$$

where:

y_{it} – the dependent variable (e.g. GRP);
$x_{1,it}, x_{2,it}$ – independent variables (e.g. migration);
$\beta_0, \beta_1, \beta_2$ – model parameters;
ε_{it} – error.

The regression model enabled us to quantitatively assess the contribution of each migration direction to the regional economic development. To assess the impact of migration on the regional economy, a regression model will be built. It will enable us to determine how the change in the share of migration is related to the level of GRP and to identify which form of migration — rural or urban — makes the more outstanding contribution to the economic outcome.

In the fourth stage, a basis was formed for the typological division of regions, using average indicators of the selected variables. This approach made it possible to identify structural differences between territories and prepare them for further classification by the nature of development. The typological approach ensured the transition from element-by-element analysis to a generalized picture of regional differences, revealing areas of balanced and unbalanced relationships between migration and economic growth.

Furthermore, a typology of regions was formed based on the average values of the share of urban migration and GRP for the entire analyzed period. For this, the following formula was used (3):

$$T_i = f(x_i, y_i) = Type_i, x_i \geq \lesseqgtr Me_x \text{^} y_i \geq / < Me_y \qquad (3)$$

where:

T_i – region type;
Me_x , Me_y – median values for x and y.
x_i – one of the classification bases (average share of migration in urban and rural area);
y_i – the second classification base (average GRP);
$f(x_i, y_i)$ – a classification function that assigns a regional type to each pair of values.

A regional typology was formed to summarize the results and visualize the differences based on migration activity and economic development. Based on average values of migration shares and GRP for the period 2013–2023, regions will be grouped by type to compare them by levels of economic development and the nature of migration, as well as to identify patterns and contrasts in the distribution of resources and population. This approach will make it possible to identify stable types of territories and determine where there is consistency between internal migration and GRP and where there is a pronounced imbalance. The analysis results will allow the recording of spatial heterogeneity in the country's development.

4. RESULTS

Understanding the relationship between internal migration and economic development, as well as revealing existing dependencies and structural differences, requires a quantitative analysis. At this stage, it is necessary to assess the direction and strength of the influence of migration flows on the GRP and classify regions by type based on a combination of migration activity and the level of economic development.The conducted correlation analysis, using the Pearson coefficient, allowed us to identify the degree of connection between the share of internal migration to cities and villages and the level of economic development of Kazakhstan's regions, measured by the GRP for the period 2013–2023. The analysis covers all administrative regions and cities of national significance: Astana, Almaty, and Shymkent. In Table 2, the results are presented for all administrative regions, excluding Astana, Almaty, and Shymkent cities.

TABLE 2. Correlation between internal migration and GRP by region for 2013–2023

Region	Variable	Pearson's r	p-value
Kazakhstan	SHARE_RURAL	–0.411	0.219
	SHARE_URBAN	+0.411	0.219
Akmola	SHARE_RURAL	+0.265	0.437
	SHARE_URBAN	–0.265	0.437
Aktobe	SHARE_RURAL	+0.100	0.774
	SHARE_URBAN	–0.100	0.774
Almaty	SHARE_RURAL	+0.235	0.495
	SHARE_URBAN	–0.235	0.495
Atyrau	SHARE_RURAL	+0.380	0.256
	SHARE_URBAN	–0.380	0.256
West Kazakhstan	SHARE_RURAL	–0.501	0.122*
	SHARE_URBAN	+0.501	0.122*
Zhambyl	SHARE_RURAL	–0.100	0.774
	SHARE_URBAN	+0.100	0.774
Karaganda	SHARE_RURAL	–0.353	0.285
	SHARE_URBAN	+0.353	0.285
Kostanay	SHARE_RURAL	–0.395	0.230
	SHARE_URBAN	+0.395	0.230
Kyzylorda	SHARE_RURAL	–0.695	0.018*
	SHARE_URBAN	+0.695	0.018*
Mangystau	SHARE_RURAL	+0.182	0.596
	SHARE_URBAN	–0.182	0.596
Pavlodar	SHARE_RURAL	–0.533	0.096*
	SHARE_URBAN	+0.533	0.096*
North Kazakhstan	SHARE_RURAL	–0.391	0.235
	SHARE_URBAN	+0.391	0.235
Turkestan	SHARE_RURAL	–0.062	0.864
	SHARE_URBAN	+0.062	0.864
East Kazakhstan	SHARE_RURAL	–0.342	0.302
	SHARE_URBAN	+0.342	0.302

Note: compiled by authors

The results show that in several regions, the migration structure is meaningfully linked to GRP dynamics. In particular, statistically significant negative correlations were found between the rural migration share and GRP in Kyzylorda ($r = –0.695$, $p = 0.018$), Pavlodar ($r = –0.533$, $p = 0.096$), and West Kazakhstan ($r = –0.501$, $p = 0.122$). Interestingly, there are positive and statistically significant or borderline correlations between the urban migration share and GRP for these regions, concluding that increasing urban migration is associated with stronger economic performance.

At the national level, we observe a moderate negative correlation between the share of rural migration and GRP ($r = –0.411$) and, conversely, a positive correlation with the share of urban migration ($r = +0.411$). Even though the results overpassed the threshold ($p = 0.219$), they align with urbanization trends observed globally, where rural out-migration towards urban centers supports productivity gains, infrastructure investment, and diversified labor markets.

In other regions, such as Aktobe, Almaty (region), or Zhambyl, the relationship between migration shares and GRP appears weak and statistically insignificant. Therefore, based on the results, we can assume there is a balanced migration structure with low volatility or the presence of other dominant economic drivers,

such as natural resource extraction, public investment, or industrial development, which are not directly tied to internal migration flows.

Overall, in regions with significant out-migration from rural areas and growth in urban settlement, economic outcomes (reflected in regional GRP) tend to improve, particularly in regions undergoing urban transformation or benefiting from concentrated development policies. Notably, the Kyzylorda, Pavlodar, and West Kazakhstan regions exhibit statistically significant or borderline significant negative correlations between the share of rural migration and GRP, alongside positive correlations with urban migration. The economic structure has been shifting in these areas due to urbanization processes, reindustrialization efforts, or investment concentration in regional centres. For example, Kyzylorda has experienced sustained rural out-migration amid economic stagnation, while Pavlodar and West Kazakhstan reflect more industrial and infrastructural urban growth. These regions illustrate how internal migration dynamics, particularly toward urban areas that can reflect and potentially reinforce broader patterns of economic development.

Table 3 presents the results of the correlation analysis between the share of urban migration and GRP for the three cities of republican significance in Kazakhstan - Astana, Almaty, and Shymkent cities between 2013 and 2023.

TABLE 3. Correlation between the share of migration and GRP in the largest cities for 2013–2023

City	Variable Type	Pearson's r	p-value	Interpretation
Astana	Constant	—	—	The correlation could not be computed because the share_urban variable had a constant value across all years. (SHARE_URBAN = 1 for all years)
Almaty	Constant	—	—	The correlation is undefined due to the constant variable (SHARE_URBAN = 1 for all years)
Shymkent	Variable	0.948	0.000	Strong and statistically significant positive correlation between urban migration share and GRP

Note: compiled by authors

The analysis showed that for Astana and Almaty cities, the urban migration share remained constant at 100% throughout the observed period (2013-2023); thus, the independent variable lacks variance. Therefore, it is impossible to compute a correlation coefficient between Astana and Almaty cities and GRP. In contrast, Shymkent city underwent a significant administrative and functional transformation in 2018 following its designation as a city of republican significance. The results showed a sharp increase in the share of urban migration and the level of GRP, as well as a strong and statistically significant positive correlation between the urban migration share and GRP in Shymkent ($r = 0.948$, $p < 0.001$). The analyzed results showed that the urbanization process and administrative elevation were closely associated with accelerated economic growth.

Next, we will conduct a regression analysis to determine the impact of migration shares (urban and rural) on GRP, assessing the extent to which changes in the migration structure contribute to regional economic development (Table 4).

Regression analysis shows that SHARE_URBAN and SHARE_RURAL have a positive and statistically significant impact on the GRP. All other things being equal, an increase in the share of migration to cities by one unit (in this model, by one percentage point) is associated with an increase in GRP by an average of 1,196.4 billion tenge ($p < 0.001$) and an increase in the share of rural migration by 1,173.2 billion tenge ($p < 0.001$).

TABLE 4. Regression results of the effect of urban and rural migration shares on GRP

Variable	Coefficient	p-value	Interpretation
Constant	2369.60	< 0.001	Baseline GRP when both migration shares (urban and rural) are equal to zero
SHARE_URBAN	+1196.44	< 0.001	For every 1-unit increase in the urban migration share, the GRP increases by ~1,196 billion KZT
SHARE_RURAL	+1173.17	< 0.001	For every 1-unit increase in the rural migration share, the GRP increases by ~1,173 billion KZT

Note: compiled by authors

The model constant (2,369.6 billion tenge) represents the baseline GRP level with zero values for both migration variables. Despite the positive values of the coefficients of both variables, it is necessary to consider that the shares of migration to cities and villages are logical.

The positive impact of rural migration on GRP may be due to specific characteristics of individual regions, such as high economic activity in rural areas (e.g., the extractive sector in the Atyrau region). Thus, the model confirms a close relationship between migration dynamics and the economic development level of regions while emphasizing the importance of contextual analysis of territorial specifics.

The results of the typological distribution of regions in Kazakhstan for 2013–2023 are presented, and four steadily reproducing profiles of territorial development are identified based on a combination of the share of migration to urban areas and the average GRP level (see Table 5).

TABLE 5. Regional typology based on urban migration share and GRP for 2013-2023

Region	Avg. SHARE_ URBAN	Avg. SHARE_ RURAL	Avg. GRP (bln. KZT)	Migration–GRP Type
Kazakhstan	–1.60	3.12	3,746.3	Low Urban Migration & High GRP
Akmola	0.86	0.96	2,629.4	High Urban Migration & Low GRP
Aktobe	–0.39	1.39	3,193.3	Low Urban Migration & High GRP
Almaty (region)	1.21	–0.21	1,690.4	High Urban Migration & Low GRP
Atyrau	6.17	–5.17	12,445.7	High Urban Migration & High GRP
West Kazakhstan	–0.74	2.09	4,471.7	Low Urban Migration & High GRP
Zhambyl	0.30	0.71	1,537.3	Low Urban Migration & Low GRP
Karaganda	0.25	0.69	4,204.1	Low Urban Migration & High GRP
Kostanay	–0.60	1.63	3,370.1	Low Urban Migration & High GRP
Kyzylorda	0.26	0.87	2,246.7	Low Urban Migration & Low GRP
Mangystau	0.37	1.10	4,803.1	High Urban Migration & High GRP
Pavlodar	0.16	1.18	3,766.3	Low Urban Migration & High GRP

North Kazakhstan	–0.11	1.09	2,496.3	Low Urban Migration & Low GRP
Turkestan	0.10	0.96	988.7	Low Urban Migration & Low GRP
East Kazakhstan	0.07	0.95	3,014.8	High Urban Migration & High GRP
Astana city	1.00	0.00	6,440.3	High Urban Migration & High GRP
Almaty city	1.00	0.00	6,979.9	High Urban Migration & High GRP
Shymkent city	0.55	0.45	1,700.7	High Urban Migration & Low GRP

Note: compiled by authors

The analysis of migration indicators and the GRP for 2013–2023 revealed various forms of relationship between internal migration to urban areas and the level of economic development in Kazakhstan's regions. In some cases, a high share of migration to cities is associated with an increase in GRP, but in others, there is no such dependence. In order to systematize the results obtained, the regions were divided into four typological groups formed based on median values of the share of migration to urban areas and the average level of GRP.

The first typological group – *High Urban Migration and High GRP – includes the Atyrau, Mangistau, and East Kazakhstan regions, as well as the republican significant* cities of Astana and Almaty. In these administrative-territorial units, a high average share of migration to the urban environment and a high GRP are recorded simultaneously.

The second group – *High Urban Migration and Low GRP – includes the Akmola and Almaty regions, as well as Shymkent, a city of regional* significance. These regions are characterized by significant migration to cities with an average GRP below the median value.

The third group – Low Urban Migration and High GRP is represented by the Aktobe, West Kazakhstan, Karaganda, Kostanay, and Pavlodar regions. In these cases, urban migration is relatively low, and average GRP values are high.

The fourth group – *Low Urban Migration and Low GRP – includes the Zhambyl, Kyzylorda, North Kazakhstan,* and Turkestan regions. They are characterized by both low values of the share of migration to cities and a relatively low level of GRP.

The presented typology reflects the spatial differences in the combination of migration dynamics and economic development among Kazakhstan's regions. It can serve as a basis for the formation of regionally differentiated policies to manage internal mobility and stimulate economic growth.

5. CONCLUSION

Internal migration consistently plays a significant role in transforming Kazakhstan's socio-economic space. A redistribution of labor and human resources occurs between regions as the urban population grows. However, such migration dynamics do not always have a clear impact on economic development.

The study revealed that in Kazakhstan, multiple migration scenarios exist, where high or low migration activity can be accompanied by growth in the GRP or lack of a stable connection. The work made it possible to identify types of regions based on the relationship between migration to cities and the level of GRP, thereby identifying characteristic models of spatial development.

High migration activity has been observed in cities of national significance, including Astana, Almaty, and Shymkent. At the same time, Astana and Almaty demonstrate a stable correspondence between a high level of urbanisation and economic growth, while Shymkent is characterized by an imbalance in

these processes: migration is high, but the level of GRP remains below the threshold value.

At the regional level, economically strong regions with low migration to cities were identified, such as Aktobe, Karaganda, Kostanay, Pavlodar, and West Kazakhstan. At the same time, regions with a high share of migration to the urban environment with a relatively low level of GRP were recorded, including the Akmola and Almaty regions and the city of Shymkent, which shows a lack of regional strategies for the actual combination of migration pressure and economic potential at the local level.

A limitation of this work is its focus on quantitative indicators, excluding qualitative characteristics of migration, such as the motivation for resettlement, the demographic structure of migrants, or the institutional conditions on the ground. Additionally, factors related to external migration and cross-border flows were not considered.

Nevertheless, there is a need to more accurately assess the consequences of migration and formulate targeted territorial policies that promote the balanced development of Kazakhstan's regions. For this purpose, it is recommended that the model be expanded further by including additional variables, such as employment, level of infrastructure, investment, and quality of life, and consider the dynamics not only by region but also by inner-city and rural areas.

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