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Evaluating the Feasibility of Sustainable Consumer Behavior Among Generation Z Youth in Almaty

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ABSTRACT

One of the pressing global challenges today is managing humanity's unlimited needs with limited resources, emphasizing fostering sustainable consumption. This study aims to identify the key factors influencing adopting sustainable consumption behaviors among Generation Z, an active consumer segment, and evaluate the potential for their transition to sustainable consumption. A survey results, highlighted the primary influences and barriers to sustainable consumer behavior. A survey was conducted among 221 participants from Generation Z, aged 18-23, to examine the key motivators and obstacles to adopting sustainable consumer habits. The findings indicate that Generation Z is positive towards essential prerequisites for sustainable consumption. Furthermore, the study reveals that 85% of the surveyed representatives of Generation Z are familiar with sustainable consumption, and 59% believe that consumers play a crucial role in its promotion. At the same time, 67% of respondents sort waste at least sometimes, and 75% save water and energy. It concludes that, with proper support and encouragement, Generation Z could play a pivotal role in promoting and adopting sustainable consumption practices, contributing to broader sustainability goals. These insights guide efforts to promote sustainable consumption for policymakers and educators and inform the development of targeted strategies that resonate with this demographic's unique perspectives. The present study was conducted among participants from the city of Almaty, and further research could focus on other large cities and rural areas of Kazakhstan.

KEYWORDS: Generation Z, Green Economy, Environmental Economics, Sustainable Development, conscious consumer, Resource Management, Waste Sorting

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1. INTRODUCTION

In recent decades, environmental problems have intensified, posing significant threats to humanity and ecosystems. Critical issues such as air pollution, water contamination, global warming, ozone depletion, acid precipitation, and soil degradation have emerged as central global concerns. A primary driver of these problems is the overconsumption of natural resources (Tan & Lau, 2016). For example, humanity currently consumes approximately 30% more resources than the Earth can regenerate annually, with this figure steadily increasing over time (Kostadinova, 2016).

A critical solution lies in reshaping consumer behavior to align with sustainable principles. Encouraging sustainable consumption is essential for mitigating environmental damage. Moreover, this alternative approach may help adjust consumer behavior to the current environmental conditions, ensuring that consumption patterns are more sustainable and in harmony with the ecological limitations of the planet. This topic gained global attention at the 1992 UN Conference on Environment and Development in Rio de Janeiro. 2015, as part of the 2030 Agenda, 17 Sustainable Development Goals (SDGs) were introduced, with Goal 12 focusing on "Responsible Consumption and Production". The UN warns that if the global population reaches 9.8 billion by 2050, sustaining current consumption patterns would require the resources of three Earths.

Consequently, modifying consumer behavior presents a critical opportunity to mitigate the environmental consequences of sluggish economic and social development. A successful shift toward responsible consumption offers several benefits, including enhanced resource efficiency, a comprehensive evaluation of the entire life cycle of economic activities, and the execution of numerous initiatives and agreements aimed at environmental preservation. The consumption of goods and services has contributed to significant changes in lifestyle patterns (Abrar et al., 2021). Berglund and Matti (2006) underscore the role of consumers in environmental degradation, positioning them as central to the transition toward responsible consumption. Therefore, a key challenge in this shift is to foster the consumption of products with minimal negative environmental impact, reduce overall consumption, and adjust lifestyles accordingly. The age of consumers is another significant factor in this transition. Younger generations tend to consume a broader range of goods and services. Hill and Lee (2012) observed that Generations Y and Z members are among the most active consumers in the apparel sector. For instance, individuals within these cohorts allocate approximately 70% of their income to clothing and decorative items (Bakewell & Mitchell, 2003). This population size and income increase have led marketers to develop tailored strategies to understand and influence young people's behaviors and consumer characteristics (Dabija & Băbut, 2019).

This paper aims to achieve several key objectives. Firstly, while much of the existing literature examines sustainable consumer behavior across generations, the focus has primarily been on Western contexts. In contrast, the study of sustainable consumption among generations in Central Asia remains underexplored. Like many parts of the world, Central Asia faces pressing environmental challenges, including severe drinking water shortages in some areas, complex household waste management issues, and high levels of air pollution in urban centers. These problems will likely impact centennials most significantly, as they are the generation poised to confront and address these long-term environmental consequences.

Furthermore, research on Generation Z's values and behaviors in Central Asian countries is notably limited. As this generation enters adulthood, they are expected to play a growing role in shaping sustainable practices and influencing societal norms in the region. Ministry of Labour and Social Protection suggests that by 2030, centennials will represent 37% of the country's labor force. Therefore, understanding their attitudes toward

responsible consumption and sustainable consumer behavior is crucial for shaping future strategies and development pathways. Considering their distinctive perspectives and emerging influence, studying their unique attributes and attitudes toward sustainability provides valuable insights into how sustainable consumer behaviors may evolve in Kazakhstan. This foundation is essential for developing targeted policies and educational initiatives tailored to this context.

2. LITERATURE REVIEW

Most conceptual frameworks on sustainable consumption and consumer behavior address the topic through three key dimensions: social, economic, and environmental. Responsible consumption is defined as consumption that maintains a balance across these dimensions while considering the needs of future generations (Luchs et al., 2010). This concept is rooted in the 1987 United Nations Brundtland Commission report Our Common Future, which first defined "sustainable development" as "meeting the needs of the present without compromising the ability of future generations to meet their own needs". Additionally, the Oslo Symposium on Sustainable Consumption offered its definition, emphasizing the use of services and products that meet basic human needs and enhance the quality of life while minimizing the consumption of natural resources, toxic materials, and emissions, thereby ensuring that the product or service life cycle does not compromise the needs of future generations.

While these concepts have been extensively explored in Western countries, recent years have witnessed growing interest in sustainable consumption in countries such as Malaysia (Rehman et al., 2023), Indonesia, India, and China. These nations have begun to study the behaviors of different age groups about conscious consumption. In much of the literature, the terms "sustainable consumption" and "green consumer behavior" are often used interchangeably to describe environmentally positive consumer actions.

However, as Kostadinova (2016) highlighted, there is a significant distinction between the two. Green consumption refers specifically to products and activities that reduce humanity's negative environmental impact. In contrast, sustainable consumption implies a more comprehensive transformation in consumer paradigms, advocating for a balanced relationship with the environment and equitable resource distribution. The United Nations Environment Programme (UNEP) further categorizes sustainable consumption as encompassing essential human activities necessary for existence. Adopting sustainable consumer behavior in areas outlined in Table 1 facilitates the achievement of the United Nations Sustainable Development Goals (SDGs).

TABLE 1. Categories of sustainable consumer behavior

Nutrition	**Mobility**	**Housing**	**Clothing**	**Education**	**Health**	**Leisure**
Examples						
Food waste reduction, sustainable diets	Use of environment-tally friendly transport, fuels, car sharing	Sustainable building, energy, and water reservation	Preference for ethical clothing, organic fabrics	Teaching sustainable living, promoting sustainability	Healthy and environmen-tally friendly lifestyles	Sustainable tourism, leisure practices with low resource intensity
Descriptions						
Focus on reducing carbon footprint by	Low-impact transportatio n that reduces emissions	Building and retrofitting structures for energy	Prioritizing long-lasting and ethically-made	Educational programs that integrate sustainability	Reducing the impact of personal care products on	Promoting travel options that minimize environmental harm and

sourcing food locally and seasonally	and fossil fuel dependency	efficiency and low impact on resources.	clothing to reduce waste.	into various disciplines.	the environment.	support conservation efforts.

Note: compiled by authors

These categories represent the fundamental aspects of an individual's modern lifestyle. However, in practice, many of these sustainable consumption behaviors are particularly characteristic of younger generations. For instance, young people frequently make choices about transportation to school, purchase clothing more often, and actively organize their leisure activities. Therefore, examining sustainable consumption through a generational lens is of significant scientific interest.

According to various sources, the birth years attributed to Generation Z vary. In this article, we adopt Tari's (2011) definition, defining Generation Z as individuals born between 1995 and 2010. Generation Z currently includes over 4 million individuals in Kazakhstan, comprising approximately 23% of the country's population.

Generation Z has been immersed in the Internet, social media, and digital technologies from a young age (Francis & Hoefel, 2018). This generation is characterized by high levels of education and reliance on technology, with a strong inclination toward self-expression and fostering social connections (Gabrielova & Buchko, 2021). As consumers, Generation Z is discerning and places great importance on aligning purchasing decisions with personal values (Goldring & Azab, 2021). They expect brands to not only meet practical needs but also to contribute meaningfully to social causes. Their preferences emphasize efficiency and informed decision-making, focusing on products that support functional and social/environmental objectives.

Understanding Generation Z's sustainable consumer behavior and their intentions to purchase environmentally friendly products is crucial for developing effective sustainability strategies. As a generation receptive to new ideas, with widespread Internet access and a heightened awareness of environmental issues, Generation Z is poised to play a pivotal role in driving sustainable development in the future, supported by their growing purchasing power (Hume, 2010). Researchers identify this generation as agents of positive change, capable of engaging in responsible consumption, influencing their peers and families, and shaping broader consumer behaviors (Prakash et al., 2018). The influence of Generation Z on consumer behavior and their evolving expectations positions them as critical indicators for future consumer trends and the development of sustainable marketing strategies.

Sustainable consumer behavior

Sustainable lifestyle actions and consumer behavior are necessary for the future of both individuals and society. There are different ways to make consumer behavior sustainable. Sustainable consumer behavior includes sustainable energy use by individuals and households, low energy consumption, and choosing environmentally friendly products over products that can harm the environment. Minimizing household consumption does not necessarily mean reducing quality of life or poverty. If we look at the consumption habits of people and society, we can say that the current era is an era of consumption. Therefore, people's well-being and happiness are measured by the quantity of products they consume. What matters to people is not the qualitative value of the thing consumed but the quantity used. This situation creates many problems, such as increased energy use, increased waste, pollution, unconscious use of resources, and unnecessary consumption. Without awareness of these problems, it is impossible to prevent them and leave future generations with a livable and sustainable future. Sustainable consumption is usually associated with the environmental dimension of sustainable development. Sustainable

consumption requires the use of natural resources with certain limits, taking into account the needs of future generations. This type of consumption is based on the goal of reducing harm to the environment. The integration of this mode of consumption into our daily lives can be achieved through two main paths: environmentally conscious consumption and reduced consumption. Similarly, Ozgul's (2010) study showed that sustainable consumption behavior is characterized by two main aspects: “saving” and “environmental sensitivity”. Various factors, such as rapid population growth, increased awareness of environmental issues, loss of biodiversity, climate change, and depletion of natural resources, contribute to the importance of sustainable consumption on a sustainable basis.

Governments play a crucial role in promoting sustainable consumption by introducing and enforcing policies and regulations for waste reduction, such as setting targets, advancing circular economy practices, and supporting sustainable procurement policies. Individuals, in turn, can adopt sustainable lifestyles by consuming less, choosing products with minimal environmental impact, and reducing carbon emissions in their daily activities.

3. METHODOLOGY

Consumers and their behavior issues play a significant role in studying sustainable development. On this occasion, an online survey of the economically active generation in the consumer market was conducted on sustainable consumer behavior. Based on the review of existing literature, the research objectives were established as follows: (1) to examine whether Generation Z is familiar with the concept of sustainable consumption, (2) to evaluate whether there is a tendency to adopt sustainable consumer behavior among members of Generation Z, (3) to identify what challenges do centennials encounter concerning sustainable consumer behavior.

The survey was designed and distributed online using the Google Forms platform. A total of 221 members of Generation Z, aged between 18 and 23, participated in the survey \. The study's primary purpose, voluntary participation, and anonymity were explained to the respondents before the survey was conducted. Out of the completed questionnaires, 205 valid responses were identified, and the data were processed using Microsoft Excel.

This research paper employs quantitative, systematic, and comparative research methods. Quantitative methods are widely used in academic marketing research, while systematic methods are prevalent in interdisciplinary research. The systematic method helps identify cause-and-effect relationships and determine their origins.

The demographic composition of the survey is shown in Table 2.

TABLE 2. Demographic characteristics of respondents

Characteristic	Category	Frequency	Percentage, %
Age	18	76	37
	19	83	40
	20	36	18
	21	3	1
	22	4	2
	23	3	1
Gender	Male	74	36
	Female	131	64
Education	Secondary level	11	5
	Graduation level	186	91
	Post-graduation level or higher	8	4

Note: compiled by authors

The study adhered to ethical research principles to ensure participant rights and data integrity. Participation was voluntary, and informed consent was obtained from all respondents at the start of the survey. Respondents were informed of the study's objectives, their right to withdraw at any time and their responses' anonymity. Data privacy was maintained, with all responses stored securely and only used for research. The collected data were analyzed using descriptive and inferential statistical methods. Descriptive statistics, such as frequency distributions and percentage calculations, were employed to summarize the responses' demographic characteristics and overall patterns.

4. FINDINGS AND DISCUSSION

The bar chart shows the respondents' level of familiarity with the concept of sustainable/conscious consumption. Based on the results, 85% of respondents indicated they are familiar with sustainable or conscious consumption. This high percentage suggests a strong awareness of sustainability issues among the surveyed group. 15% of respondents indicated they needed to become more familiar with the concept. At the same time, a smaller proportion shows that some people may not be aware of or engaged with sustainable consumption.

The data obtained reflect prevailing sustainable trends and can form the basis for strategies aimed at further education and involvement in sustainable consumption. Increased awareness and engagement can contribute to the formation of more responsible behavior in society, which, in turn, will support the transition to environmentally balanced consumption and production patterns.

The bar chart illustrates the respondents' familiarity with sustainable or conscious consumption (Figure 1).

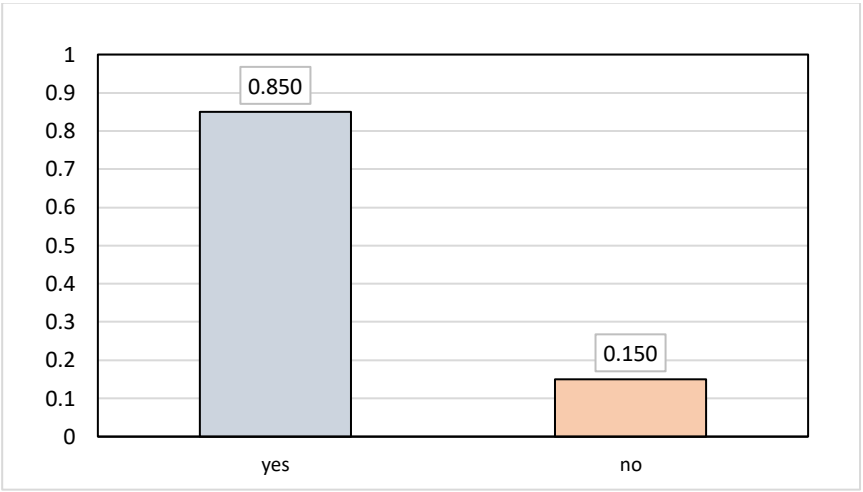


FIGURE 1. Respondents' familiarity with the concept of sustainable/conscious consumption

Note: compiled by authors

The assertion that most (59%) believe conscious consumers play the most significant role in sustainable consumption underscores individuals' perceived power and responsibility in making sustainable choices. The results align with the "consumer sovereignty" theory, which positions consumers as critical change agents in sustainability efforts. Thøgersen and Schrader (2012) discuss how consumer awareness and behavior are essential in creating demand for sustainable products, highlighting the impact individual choices can have on market trends. Companies perceived as having a considerable role (23%) are expected

to uphold corporate responsibility. This perspective aligns with the corporate social responsibility (CSR) principles, as Carroll (1991) outlined, encompassing economic, legal, ethical, and philanthropic responsibilities. By adopting sustainable business practices, companies can significantly reduce their environmental footprint and influence consumer behavior through their products and services.

The main roles in the transition to sustainable consumption are shown in Figure 2.

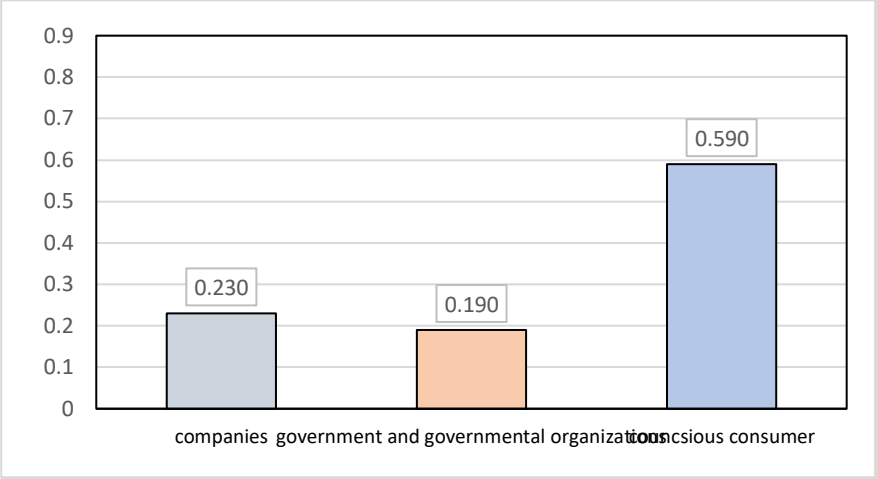


FIGURE 2. Roles in the transition to sustainable consumption

Note: compiled by authors

The relatively lower emphasis on government (19%) might indicate a perceived need for more adequate policies or enforcement in promoting sustainable practices. This observation echoes critiques suggesting that government actions often do not match the urgency needed to address environmental issues (Seyfang, 2005). However, Spaargaren (2000) points out that effective governmental regulations and incentives are crucial for fostering an environment where sustainable practices can thrive. This distribution of perceived roles highlights the interconnectedness of consumer behavior, corporate responsibility, and governmental policies in advancing sustainable consumption.

While 67% engage in garbage sorting at least occasionally, only a tiny fraction (7%) consistently sort their waste. This discrepancy indicates an "intention-behavior gap" frequently explored in sustainable behavior literature. Despite favorable attitudes toward recycling, behaviors often need to align due to numerous barriers (Kollmuss & Agyeman, 2002).

The data reveals a varied pattern in waste sorting behavior among respondents (Figure 3).

A notable 34% of respondents do not sort their garbage at all, underscoring a critical need for enhanced awareness and improved facilitation of recycling practices. This behavior gap indicates the challenges in promoting consistent waste management practices. Derksen and Gartrell (1993) emphasize that the availability of convenient recycling facilities and adequate information significantly impacts recycling behavior.

The lack of infrastructure and perceived inconvenience are often cited as significant impediments to regular recycling. These findings highlight the necessity for strategic interventions to increase the consistency of waste sorting practices among individuals.

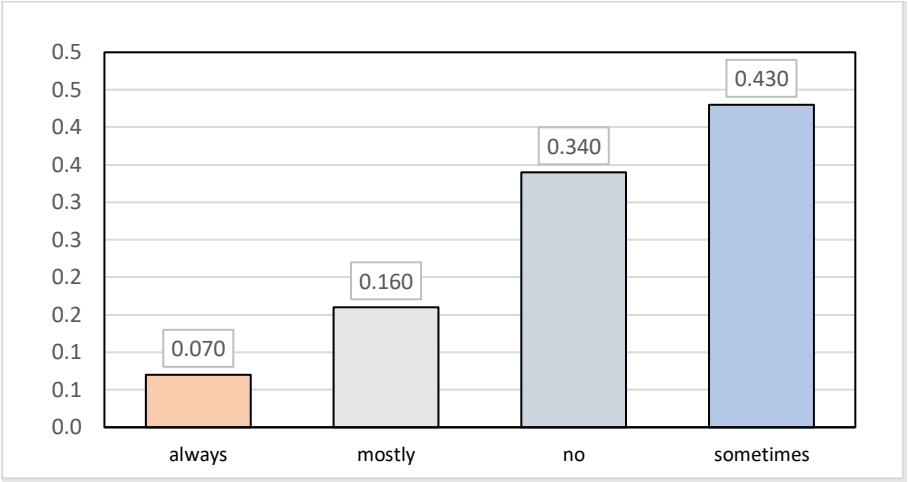


FIGURE 3. Respondents' waste sorting behavior

Note: compiled by authors

Improving infrastructure, enhancing accessibility, and providing clear information can bridge the gap between environmental intentions and actual behaviors.

A significant majority of respondents (75%) report saving water and energy either frequently or consistently, which is a positive indicator of sustainable behavior in resource conservation. This high level of engagement in water and energy conservation practices suggests an increasing awareness and adoption of sustainable habits. Various factors often influence such behaviors, including environmental attitudes, social norms, and perceived behavioral control (Stern, 2000). These factors collectively contribute to the likelihood of individuals adopting energy-saving measures and reducing water usage.

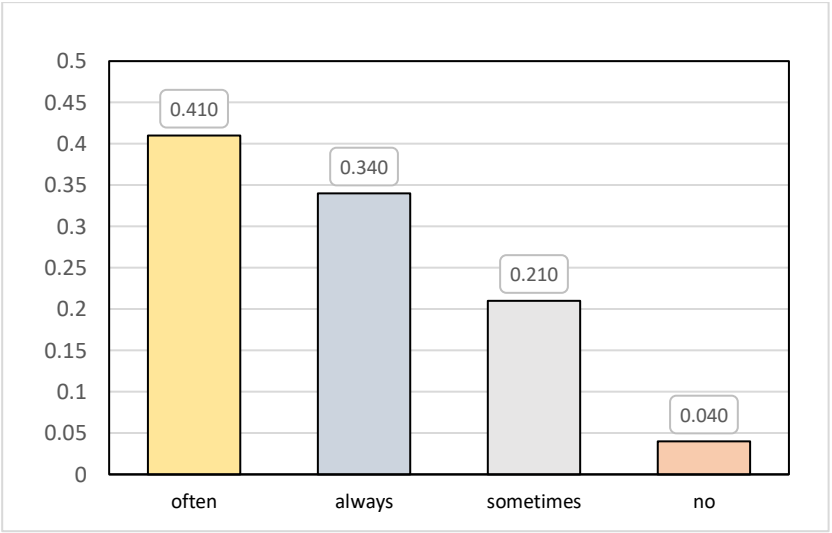


FIGURE 4. Water and energy conservation practices

Note: compiled by authors

Conversely, a minimal portion of the sample (4%) does not engage in water and energy conservation, highlighting a generally high level of awareness and practice among the population. This widespread engagement implies recognizing the importance of resource conservation for environmental sustainability. Evidence suggests that programs and interventions that provide feedback and incentives can effectively promote conservation behaviors (Abrahamse et al., 2005). These initiatives can enhance motivation and perceived control, thereby encouraging more consistent adoption of conservation practices.

This data indicates that while a majority are already practicing sustainable resource use, there is potential to optimize these behaviors through targeted interventions and educational programs. By understanding the underlying motivations and barriers to conservation behaviors, strategies can be developed to support even higher participation rates in sustainable practices.

The higher percentage of respondents highlighting the importance of enabling sustainable consumption reflects a broader understanding that practical, systemic changes are essential for sustainability (Figure 5).

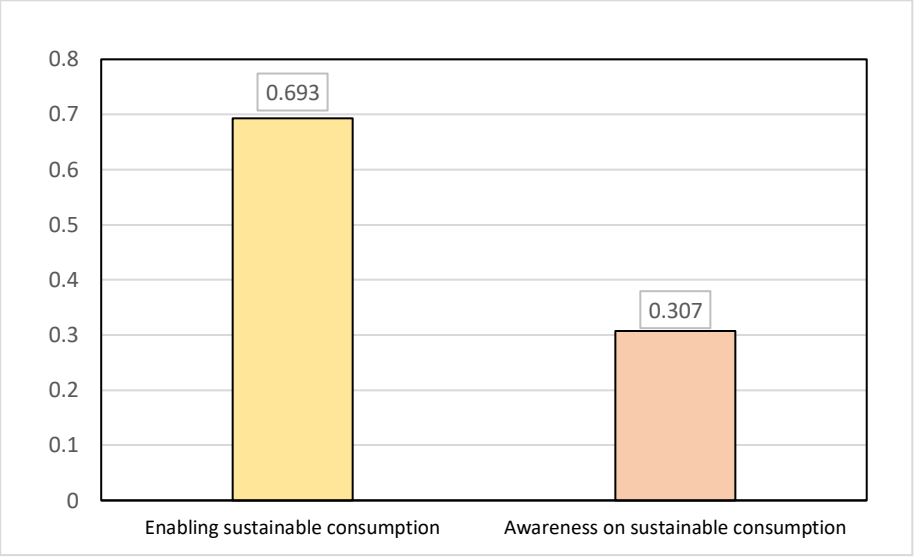


FIGURE 5. Important factors in sustainable consumption

Note: compiled by authors

According to Jackson (2005), simply raising awareness is not enough; enabling environments such as access to sustainable products, infrastructure for recycling, and energy-efficient technologies are crucial for making sustainable choices easier for consumers. Enabling sustainable consumption also involves changes at the policy and market levels. Theories of ecological modernization suggest that for sustainable consumption to be realized, there must be a combination of governmental regulation, corporate innovation, and consumer participation (Mol & Sonnenfeld, 2000). Policies such as subsidies for green products, stricter environmental regulations, and corporate sustainability initiatives are critical in creating an enabling environment.

While awareness is crucial, the lower percentage (31%) indicates that awareness alone may not lead to substantial behavioral change. This aligns with research by Kollmuss and Agyeman (2002), which argues that awareness is just one component of pro-environmental behavior. Other factors, such as social norms, values, and economic incentives,

often play a more significant role. Theories like the Theory of Planned Behavior (Ajzen, 1991) emphasize that awareness must be coupled with perceived behavioral control and social norms to change consumer behavior effectively. Thus, while awareness campaigns are necessary, they must be supported by enabling mechanisms that make sustainable choices more accessible and appealing.

The data analysis highlights the critical role of conscious consumers in driving sustainable consumption, although systemic changes by companies and governments are also essential. Waste sorting and resource conservation behaviors show varying levels of commitment, with social media emerging as a powerful tool for promoting sustainability. This suggests that effective sustainable consumption strategies must be multifaceted, combining individual action, corporate responsibility, government policy, and innovative use of social media.

5. CONCLUSIONS

The main purpose of this study was to study the factors influencing the formation of sustainable consumer behavior among the youth of generation Z, and to assess the prospects for their transition to responsible consumption. Special attention was paid to identifying this age group's motivations, barriers, and awareness of sustainable consumption. The uniqueness of this study lies in the study of the characteristics of sustainable consumption among generation Z in Central Asia, which remains a little-studied area in the context of global research. Unlike Western studies, the focus was on specific social and cultural aspects that influence the behavior of young people in Kazakhstan.

The literature review has identified three main areas in which sustainable consumption is key: social, economic, and environmental. Responsible consumption has been characterized as a process that maintains a balance between the present and future needs. The review examined the concepts of “green” and sustainable consumption while emphasizing that sustainable consumption requires more profound changes in consumer paradigms and society as a whole than a simple preference for environmentally friendly products. Moreover, the literature has focused on the importance of education and awareness for forming sustainable habits, especially among young consumers such as Generation Z, who are seen as agents of positive change in sustainable development.

The study highlights the critical role that sustainable consumer behavior plays in addressing the pressing environmental challenges of our time. With the global population projected to reach nearly 10 billion by 2050, shifting towards responsible consumption is more urgent than ever. Generation Z, characterized by their technological savviness and social awareness, emerges as a pivotal demographic in this transition. Their purchasing power and values-driven consumption patterns make them a key focus for strategies aimed at promoting sustainability.

The findings underscore the importance of fostering awareness and practical changes that enable sustainable choices. While there is a growing recognition of individual responsibility in sustainable consumption, inconsistencies in behaviors such as waste sorting reveal the need for improved infrastructure and clearer guidance.

Ultimately, the article advocates for a comprehensive approach that combines consumer education, corporate responsibility, and supportive government policies. By creating the necessary conditions for sustainable consumption, it is possible to mitigate the environmental impact of modern lifestyles and ensure that future generations can meet their needs without compromising the planet's resources. This approach requires concerted efforts across all sectors of society, with Generation Z positioned at the forefront of this transformative movement.

This study was conducted among the youth of Almaty, which limits its applicability for understanding the characteristics of sustainable consumption in other regions of Kazakhstan and Central Asia. Future research may focus on studying youth from other large cities and rural

areas to identify regional differences and characteristics related to sustainable behavior. One of the identified results of this study was the gap between the intention to follow sustainable practices and the actual behavior of young people. Future research may explore this phenomenon in more detail by analyzing the factors that prevent the introduction of sustainable habits, even among knowledgeable and motivated consumers.

Limitations and recommendations

Although this study encompasses a substantial array of findings derived from participants in the online survey, the authors acknowledge that the fact that research was conducted in Almaty city may result in certain conclusions not being applicable to the broader demographic of centennials within the nation. Consequently, subsequent research should be directed towards ascertaining whether the responses from a larger sample size of participants will yield analogous results, or if investigations conducted in other major urban centers or smaller municipalities may elicit different outcomes that could generate significant insights.

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The Impact of Economic Growth on Sustainable Development: an Analysis of ESG Indicators

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ABSTRACT

This study aims to evaluate economic growth's impact on key sustainability components, including carbon productivity, ecological conditions, healthcare, social well-being, and education. This paper employs Principal Component Analysis (PCA) to group complex ESG indicators into five distinct categories, followed by quadratic regression modeling to capture nonlinear relationships between GDP growth and each ESG component. The study uses statistical data collected from national and international sources for the period 2012-2022. The analysis showed that the impact of economic growth on ESG indicators in Kazakhstan is expressed heterogeneously. Economic growth showed the greatest correlation with education indicators ($R2 = 0.696$, $p < 0.01$), indicating a significant improvement in the educational sector as GDP per capita increases. At the same time, the impact on environmental indicators turned out to be weaker ($R2 = 0.352$, $p = 0.176$), which indicates minor improvements in the environment that require additional environmental initiatives. Economic growth had the least impact on carbon productivity, with $R2 = 0.13$ ($p = 0.58$), which underlines the need for targeted measures to improve carbon efficiency. The results highlight that although economic growth contributes to social and educational development, specific ESG-oriented strategies are required to achieve sustainable development in Kazakhstan, especially in the field of carbon efficiency. Therefore, future research may be aimed at localizing ESG metrics, evaluating the effectiveness of programs in the socio-environmental field, and creating multifactorial models for ESG analysis.

KEYWORDS: Sustainable Development, Economics, Green Economy, Carbon Productivity, Environmental Efficiency, Social Indicators, Economic Growth, Kazakhstan

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1. INTRODUCTION

In recent years, significant attention has been devoted to sustainable development and integrating Environmental, Social, and Governance (ESG) principles into national economic strategies. Countries with substantial carbon potential play a crucial role in these processes by developing concepts and strategies to reduce emissions and improve resource efficiency. However, the theoretical foundations, criteria, and methodological approaches to structural and technological modernization of the economy with ESG considerations require further development and adaptation, especially for countries in the midst of an energy transition, such as Kazakhstan. Thus, ESG indicators serve as a framework for assessing how countries and businesses manage environmental impact, social responsibilities, and governance standards, thereby enabling sustainable growth that aligns economic advancement with long-term well-being for society and the planet.

The ESG framework focuses on three key aspects: environmental, social, and governance components that form the basis of sustainable management for enterprises and industries. Environmental criteria, such as carbon footprint management and renewable resource use, are pivotal for creating long-term sustainability strategies in countries with high industrial production levels. Thus, structural changes in the mining and energy sectors can be successful only when technologies that contribute to reducing greenhouse gas emissions are integrated. Kazakhstan, as a major exporter of mineral resources, faces the challenge of adapting these theoretical provisions to its specific context.

Kazakhstan's technological potential indicates that many fundamental economic sectors, such as mining and agriculture, require significant reforms to achieve sustainable growth. Despite increasing production capacity, planning and corporate governance systems still need to be developed concerning ESG indicators. Current enterprise management models often need to fully consider the long-term environmental and social consequences of their actions, which could lead to inefficient resource use in the future. Integrating ESG indicators into corporate planning and management could improve resilience and promote more efficient resource utilization - a crucial factor for Kazakhstan, where natural resources play a key role in the economy.

The study aims to evaluate the impact of economic growth on key components of sustainability, including carbon productivity, ecological conditions, healthcare, social well-being, and education. This analysis is vital for policymakers in Kazakhstan and other resource-dependent economies aiming to foster long-term growth while addressing environmental and social challenges. Hypotheses include:

H1: Economic growth has no significant impact on Carbon Productivity, indicating that increasing GDP per capita does not inherently lead to greater carbon efficiency.

H2: Economic growth exhibits a moderate impact on Ecology, initially leading to environmental degradation but potentially showing improvement at higher income levels, consistent with an inverted-U relationship.

H3: Economic growth positively influences Healthcare indicators, enhancing healthcare quality and accessibility as GDP per capita rises.

H4: Economic growth has a moderate effect on Social indicators, supporting social welfare improvements but insufficiently reducing inequality and social disparities without additional interventions.

H5: Economic growth has a strong positive relationship with Education, significantly improving educational quality and accessibility with rising GDP per capita.

2. LITERATURE REVIEW

Successful modernization of industries and agriculture, especially in countries with high carbon potential, is linked to developing and implementing new technologies that minimize emissions and reduce dependency on fossil

fuels. In countries focusing on the mining industry, the widespread adoption of ESG indicators has been a critical factor in reforming corporate strategies. Adopting environmental standards, such as carbon taxes and emission quotas, has reduced carbon footprints and increased investments in renewable energy.

Improving energy efficiency, particularly in rapidly urbanizing regions, was shown to reduce emissions while simultaneously supporting social and economic benefits significantly. Li and Colombier (2009) highlighted that building energy efficiency was crucial for climate change mitigation and also supported social development by reducing energy costs and improving living conditions, especially in developing countries. Huisingh et al. (2015) noted that a transition to low-carbon systems required substantial shifts in product design, production, and consumption patterns - adjustments that impacted not only environmental goals but also contributed to social well-being and the sustainability of urban growth.

The concepts of a circular economy and industrial ecology have been widely explored across various systems to enhance resource efficiency and reduce environmental impact. Prieto-Sandoval et al. (2019) examined the role of a circular economy, particularly within construction and production sectors, integrating resource-sharing models to achieve environmental benefits Sinha and Chaturvedi (2019) investigated energy-efficient processes as essential for reducing carbon emissions in industrial production, while Daniek (2020) developed a composite model to assess national progress toward environmentally sustainable economies, focusing on critical indicators like energy consumption, carbon emissions, and resource use intensity. Differences in methodologies for environmental, social, and governance ratings further hinder the adoption of effective global sustainability strategies (Rossi et al., 2024).

Approaches to sustainability are closely interconnected with economic growth, as ESG factors are shaped by economic conditions and influence long-term economic outcomes. Thus, economic growth can drive improvements in sustainability, while sustainable practices can support continued economic development. Ness and Xing (2017) explored how circular economy principles could enhance resource efficiency, while Ingarao (2017) considered energy-efficient processes essential for reducing carbon footprints in industrial production. Mohsin et al. (2019) introduced a composite model for evaluating national sustainability progress, outlining energy consumption and carbon emissions indicators. While ESG performance is often linked to financial outcomes, Daugaard and Ding (2022) observed that this relationship is complex and not always straightforward; higher ESG scores may support corporate growth by reducing risks. This complexity highlights the need for new models, such as those proposed by Tan et al. (2024), that incorporate multi-criteria decision-making to address gaps in current frameworks by better-capturing factors like political stability and governance.

Recently, multifactor models and composite indicators have been extensively applied to analyze the relationship between economic growth and ESG components. El Gibari et al. (2019) focused on the significance of multicriteria decision-making in constructing composite indicators, including economic, social, and environmental factors, into a sustainability index. Deng et al. (2019) found that sustainability declines in the early stages of growth, but after reaching a certain level of economic development, the trend reverses, and sustainability begins to increase. Rusu (2023) applied Principal Component Analysis (PCA) to analyze the interrelations among economic, social, and environmental indicators. Vargas-Santander et al. (2023) used PCA to create a country-level sustainability indicator, uncovering connections between sustainability and economic factors. Finally, Hussain et al. (2023) applied the Kuznets curve to analyze the relationship between financial inclusion and carbon emissions. This reveals a nonlinear dynamic where inclusion initially increases emissions at specific growth stages

but subsequently contributes to their reduction. Different countries accumulated varied experiences implementing ESG principles shaped by economic and technological disparities. Khoruzhy et al. (2022) indicated that developing countries faced limitations related to technology access, which influenced their ESG approaches. Meanwhile, Wang et al. (2023) demonstrated how levels of industrialization and technology access created distinct sustainable development trajectories, necessitating tailored strategies for each country.

Given the crucial role of economic growth in shaping the impact of a sustainable economy, a comprehensive analysis of the relationship of economic development with ESG components is essential. A review of existing studies showed that practices of successful modernization in high-carbon-potential industries, such as mining and agriculture, define the importance of associating economic growth with sustainable practices. Nevertheless, studies showed that the relationship between economic growth and ESG performance is complex, often requiring more specific frameworks to capture factors like social development and environmental impact. Conducting a detailed analysis will contribute to revealing the pathways through which economic expansion can drive sustainable growth.

3. RESEARCH METHODS

By grouping indicators into key sustainability categories such as carbon productivity, ecology, healthcare, social, and education - and applying PCA, the methodology effectively reduces data dimensionality while enhancing interpretability. Using PCA to form aggregated indicators allows for a structured and comprehensive analysis of how economic growth interacts with diverse socio-economic and environmental aspects.

Furthermore, using a quadratic regression model, incorporating a quadratic GDP term enables a more precise exploration of potential nonlinear, inverted U-shaped relationships within each sustainability component. This adaptation captures the concept of the Kuznets curve. At the same time, the inclusion of PCA and multi-component analysis expands the methodology's capacity to address complex interactions between economic growth and sustainability, providing deeper insights into the pathways through which economic development influences sustainable outcomes.

Based on a comprehensive literature review, we formulated a methodology to examine the relationship between economic growth and sustainability indicators. The Kuznets methodology was selected as the framework for analyzing these relationships due to its effectiveness in exploring the impact of economic growth on various socio-economic and environmental factors.

Given the many indicators, they were grouped into categories to improve interpretability and reduce dimensionality. Using Principal Component Analysis (PCA), aggregated indicators for critical components of sustainability were created: carbon productivity, ecology, healthcare, social, and education. In PCA, each component CiC_iCi is defined as a linear combination of the original indicators (1):

$$C_i = a_1X_1 + a_2X_2 + \cdots a_nX_n \qquad (1)$$

where:

a_n - the component loadings;

X_n - the standardized original indicators for each category.

Next, there was applied a quadratic regression model to these aggregated indicators to assess the relationship between economic growth (GDP per capita) and each sustainability component (2):

$$Y = \beta_0 + \beta_1 GDP_{PC} + \beta_2 GDP_{PC}{}^2 + \in \quad (2)$$

where:

Y - aggregated component (e.g., carbon productivity, ecology);

β_0- intercept;

β_1 and β_2 - coefficients representing the linear and quadratic effects of GDP per capita;
$\in$ - error term.

The quadratic term $GDP_{PC}{}^2$ captures any nonlinear, inverted-U-shaped relationships, according to the Kuznets theory.

The methodology was based on the versatility and established effectiveness of the Kuznets theorem in analyzing the relationship between economic growth and socio-economic and environmental indicators. The Kuznets theorem is traditionally used to explain inverted U-shaped relationships between income levels and factors such as inequality or ecological costs, proposing that as the economy and per capita income increase, these factors may worsen and improve.

This study modified and adapted the traditional Kuznets approach by incorporating Principal Component Analysis (PCA) to create aggregated indicators. Integrating the Kuznets curve with Principal Component Analysis (PCA) will create aggregated indicators for analyzing the relationship between economic growth and sustainability indicators. While the Kuznets theorem is traditionally used to identify U-shaped relationships between economic growth and individual factors, such as inequality or pollution, this approach extends its application to multidimensional analysis of ESG components.

4. FINDINGS AND DISCUSSION

The analysis consists of several stages. The first stage involved factor loadings to identify the main components influencing each sustainability category. Next, a component characteristics analysis was performed to determine the variance explained by each component, followed by a parallel study to validate the identified factors. A quadratic regression analysis was then applied to assess the relationship between economic growth and each aggregated ESG component. Finally, residuals were examined for each component to evaluate model fit and identify areas for potential improvement.

The results of the factor loadings analysis are presented in Table 1, indicating the primary components that influence each category.

TABLE 1. Factor loadings

Indicator	RC1	Uniqueness
Healthcare component		
Doctors	0.945	0.107
Healthcare staff	0.931	0.134
Hospitals	-0.886	0.214
Hospital beds	0.401	0.840
Ecology component		
GDP Energy Productivity	0.984	0.031
Per Capita Energy Use	-0.954	0.089
Water Stress Level	0.900	0.190
Hazardous Waste per Capita	-0.821	0.326
CO_2 Emissions per Capita (Energy)	-0.669	0.552
Stationary Source Emissions	0.580	0.663
RenewableEnergy Share	0.536	0.713
Social component		
Poverty_Depth	0.988	0.023
Poverty_Rate	0.965	0.069

Income-Subsistence_Ratio	-0.950	0.098
Employed	0.903	0.184
Gini_Index	0.874	0.235
Unemployement %	-0.645	0.584
Real_Income_Index	0.430	0.815
Education component		
Unemployment	-0.843	0.290
University graduates	0.843	0.290

Note: compiled based on calculations

In the healthcare component, the most significant indicators are 'Doctors' (0.945) and 'Healthcare staff' (0,931), emphasizing their essential roles within this category. In contrast, the 'Hospital beds' indicator shows minimal influence with a high uniqueness value (0,843), indicating its limited impact on the overall structure.

In the Ecological component, 'GDP Energy Productivity' (0,984) and 'Per Capita Energy Use' (-0,954) exhibit the highest loadings, underscoring their leading role in shaping the ecological component; additionally, 'Water Stress Level' (0,900) contributes strongly as a significant factor.

Within the Social component, the indicators 'Poverty Depth' (0,988) and 'Poverty Rate' (0.965) demonstrate the highest loadings, highlighting their influence on the social dimension. 'Income-Subsistence Ratio' (-0,950) and 'Employed' (0,903) indicators also play substantial roles, reflecting socioeconomic factors. In the Education component, 'Unemployment' (-0,843) and 'University Graduates' (0,843) show equal loadings, indicating opposing trends related to education and employment dynamics within this factor.

The Social component stands out with the highest eigenvalue, 4.991, explaining 71.3% of the variance independently and cumulatively. The Education component, with an eigenvalue of 1.421, captures 71.0% of the variance.

Table 2 presents the component characteristics, showing unrotated and rotated solutions for each extracted component.

TABLE 2. Component characteristics

Component	Unrotated solution			Rotated solution		
	Eigenvalue	Proportion var.	Cumulative	SumSq. Loadings	Proportion var.	Cumulative
Healthcare	2.705	0.676	0.676	2.705	0.676	0.676
Ecology	4.436	0.634	0.634	4.436	0.634	0.634
Social	4.991	0.713	0.713	4.991	0.713	0.713
Education	1.421	0.710	0.710	1.421	0.710	0.710

Note: complied based on calculations

For complete analysis the results were also interpreted through residual plots. Each plot shows eigenvalues from the data (black circles) and simulated eigenvalues from parallel analysis (black triangles) for the component groups: Healthcare (PC_Healthcare), Ecology (PC_Ecological), Social (PC_Social), and Education (PC_Education).

Figure 1 presents the results of a parallel analysis to confirm the components identified in the factor loadings and Component Characteristics.

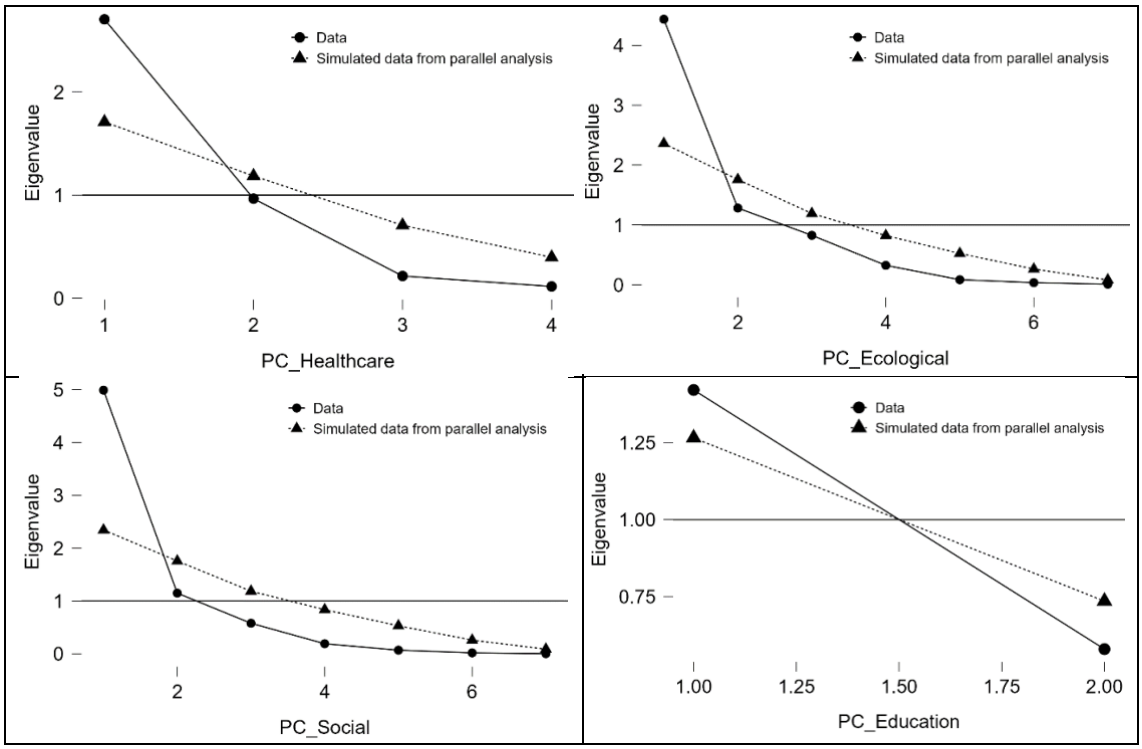


FIGURE 1. Residual plots

Note: compiled based on calculations

For Healthcare (PC_Healthcare), only the first component, with an eigenvalue of 2.705, exceeds the simulated threshold, confirming a single significant factor in this category. In Ecology (PC_Ecological), the first two components have eigenvalues of 4.436 and 2.634, respectively, supporting the need for two factors to capture the complexity in this group. The Social (PC_Social) group also shows two significant components with eigenvalues of 4.991 and 2.713, indicating two primary factors for this domain. In Education (PC_Education), only the first component, with an eigenvalue of 1.421, is above the threshold, confirming it as the sole necessary factor for this category.

Table 3 presents the results of the model summary for quadratic regression analysis.

TABLE 3. Model summary

No.	Model	R	R^2	Adjusted R^2	RMSE
1	M_0 Carbon Productivity	0.000	0.000	0.000	0.178
	M_1 Carbon Productivity	0.358	0.128	-0.090	0.186
2	M_0 PC_Ecological	0.000	0.000	0.000	1.000
	M_1 PC_Ecological	0.593	0.352	0.190	0.900
3	M_0 PC_Healthcare	0.000	0.000	0.000	1.000
	M_1 PC_Healthcare	0.648	0.419	0.274	0.852
4	M_0 PC_Social	0.000	0.000	0.000	1.000
	M_1 PC_Social	0.589	0.348	0.184	0.903
5	M_0 PC_Education	0.000	0.000		1.000
	M_1 PC_Education	0.834	0.696		0.616

Note: compiled based on calculations

Carbon Productivity has a low R^2 of 12.8% in the enhanced model (M_1), indicating a weak relationship with economic growth. This low explanatory power shows that GDP growth alone does not inherently lead to improvements in carbon productivity. Economic growth may contribute only marginally without specific measures directed toward emissions reduction and resource efficiency.

The Ecological component has a moderate association with economic growth, with M_1 explaining 35.2% of the variance. Some relationship exists between economic growth and ecological outcomes, yet it remains limited. Factors such as resource use inefficiencies or environmental degradation accompanying industrial expansion may influence this result. Economic growth may moderately impact ecological sustainability but does not guarantee substantial ecological benefits.

Healthcare shows a more substantial relationship with economic growth, with the model explaining 41.9% of the variance. Economic growth impacts healthcare accessibility and quality, often leading to increased investment in healthcare infrastructure, workforce, and technology. This model outcome emphasizes the positive impact of economic expansion on healthcare systems, which contributes to labor productivity and population well-being. However, more than GDP growth is needed to fully address healthcare needs in areas with underfunded healthcare systems.

The Social component has moderate explanatory power, with M_1 accounting for 34.8% of the variance. Economic growth can positively influence social well-being by reducing poverty or improving income distribution; however, GDP growth alone may not sufficiently address social inequalities or poverty depth. Therefore, economic growth alone does not guarantee comprehensive social progress.

The Education component exhibits the most vital relationship with economic growth, with M_1 explaining 69.6% of the variance. Economic growth impacts educational quality and accessibility, as higher GDP per capita generally correlates with greater investments in education. Improved educational outcomes contribute to a skilled labor force, fostering innovation and productivity, thus reinforcing a cycle of economic growth. Education funding directly correlates with long-term economic benefits by equipping the workforce with skills necessary for adapting to technological advancements and shifts in labor market demands.

Individual indicators within these aggregated components carry greater weight in shaping each ESG component. In the Healthcare component, indicators like “Doctors” and “Healthcare staff” show higher factor loadings, meaning that increases in these indicators drive much of the component's response to economic growth. In the Ecological component, “GDP Energy Productivity” and “Per Capita Energy Use” play the most influential roles, meaning that efforts to boost energy productivity or manage energy use per capita can be critical for advancing ecological sustainability.

Table 4 presents the results of the ANOVA analysis for each component model.

TABLE 4. ANOVA

Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**p**
M_1 Carbon Productivity	Regression	0.041	2	0.020	0.588	0.578
	Residual	0.276	8	0.035		
	Total	0.317	10			
M_1 PC_Ecological	Regression	3.520	2	1.760	2.173	0.176
	Residual	6.480	8	0.810		
	Total	10.000	10			
M_1 PC_Healthcare	Regression	4.194	2	2.097	2.890	0.114
	Residual	5.806	8	0.726		

	Total	10.000	10			
M_1 PC_Social	Regression	3.475	2	1.738	2.130	0.181
	Residual	6.525	8	0.816		
	Total	10.000	10			
M_1 PC_Education	Regression	6.961	2	3.480	9.160	0.009
	Residual	3.039	8	0.380		
	Total	10.000	10			

Note: complied based on calculations

For Carbon Productivity (M_1), the regression sum of squares is 0.041 with an F-value of 0.588 and a non-significant p-value of 0.578, indicating a weak model fit. In the Ecological component (M_1), the regression sum of squares is 3.520 with an F-value of 2.173 and a p-value of 0.176, suggesting a moderate fit but not statistically significant. The Healthcare component (M_1) shows a regression sum of squares of 4.194 with an F-value of 2.890 and a p-value of 0.114, indicating some predictive power but not reaching significance.

For the Social component (M_1), the regression sum of squares is 3.475 with an F-value of 2.130 and a p-value of 0.181, also showing a moderate fit without statistical significance. The Education component (M_1) has the strongest model fit, with a regression sum of squares of 6.961, an F-value of 9.160, and a significant p-value of 0.009, indicating a strong and statistically significant association with economic growth.

Table 5 shows the coefficients for each model, providing details on the intercepts, coefficients for GDP and its square (GDP_PCS2), and their significance levels.

TABLE 5. Coefficients

Model		Unstandardized	Standard Error	Standardized	t	p
M_0 Carbon Productivity	(Intercept)	1.620	0.054		30.177	< .001
M_1 (Carbon Productivity)	(Intercept)	-0.360	2.024		-0.178	0.863
	GDP_PCS2	-1.796×10^{-8}	1.721×10^{-8}	-4.029	-1.044	0.327
	GDP_PC	3.823×10^{-4}	3.768×10^{-4}	3.917	1.015	0.340
M_0 PC_Ecological	(Intercept)	-1.272×10^{-15}	0.302		-4.219×10^{-15}	1.000
M_1 PC_Ecological	(Intercept)	-13.676	9.800		-1.396	0.200
	GDP_PCS2	-1.365×10^{-7}	8.333×10^{-8}	-5.452	-1.638	0.140
	GDP_PC	0.003	0.002	5.065	1.522	0.166
M_0 PC_Healthcare	(Intercept)	-2.678×10^{-16}	0.302		-8.882×10^{-16}	1.000
M_1 *PC_Healthcare*	(Intercept)	-10.525	9.276		-1.135	0.289
	GDP_PCS2	-1.166×10^{-7}	7.887×10^{-8}	-4.656	-1.478	0.178
	GDP_PC	0.002	0.002	4.128	1.311	0.226
M_0 *PC_Social*	(Intercept)	5.189×10^{-16}	0.302		1.721×10^{-15}	1.000
M_1 *PC_Social*	(Intercept)	-17.073	9.834		-1.736	0.121
	GDP_PCS2	-1.589×10^{-7}	8.362×10^{-8}	-6.347	-1.901	0.094
	GDP_PC	0.003	0.002	6.094	1.825	0.105
M_0 *PC_Education*	(Intercept)	0.000	0.302		0.000	1.000
M_1 *PC_Education*	(Intercept)	2.969	6.712		0.442	0.670
	GDP_PCS2	6.610×10^{-8}	5.707×10^{-8}	2.640	1.158	0.280
	GDP_PC	-0.001	0.001	-1.827	-0.802	0.446

Note: compiled based on calculations

Carbon Productivity, the intercept in the baseline model (M_0) is highly significant (t=30.177t = 30.177t=30.177, p<.001p < .001p<.001), while the enhanced model (M_1) shows non-significant coefficients for both GDP_PCS2 (p=0.327p = 0.327p=0.327) and GDP_PC (p=0.340p = 0.340p=0.340), indicating limited impact from economic growth variables.

Ecological component (PC_Ecological), the intercept for M_0 is not significant, and in M_1, while GDP_PCS2 and GDP_PC have t-values of -1.638 and 1.522 respectively, they do not reach statistical significance (p=0.140p = 0.140p=0.140 and p=0.166p = 0.166p=0.166), indicating a moderate but non-significant effect.

Healthcare component (PC_Healthcare), neither GDP_PCS2 (p=0.178p = 0.178p=0.178) nor GDP_PC (p=0.226p = 0.226p=0.226) are statistically significant in the enhanced model (M_1), suggesting limited explanatory power of GDP growth for this component.

Social component (PC_Social), both GDP_PCS2 and GDP_PC coefficients approach significance, with t-values of -1.901 and 1.825 and p-values of 0.094 and 0.105, respectively. This indicates a potential relationship, although it remains marginally non-significant.

Education component (PC_Education), neither GDP_PCS2 (p=0.280p = 0.280p=0.280) nor GDP_PC (p=0.446p = 0.446p=0.446) in M_1 is significant, suggesting that GDP growth does not strongly influence this component based on the tested model. Overall, the results reveal limited significance across most components, with slight tendencies towards relevance in the social component.

The residual plots for each component, Residuals vs. Dependent Variable, illustrate the model's fit and highlight areas needing refinement in the Education, Healthcare, Ecology, Carbon Productivity, and social components (Figure 2).

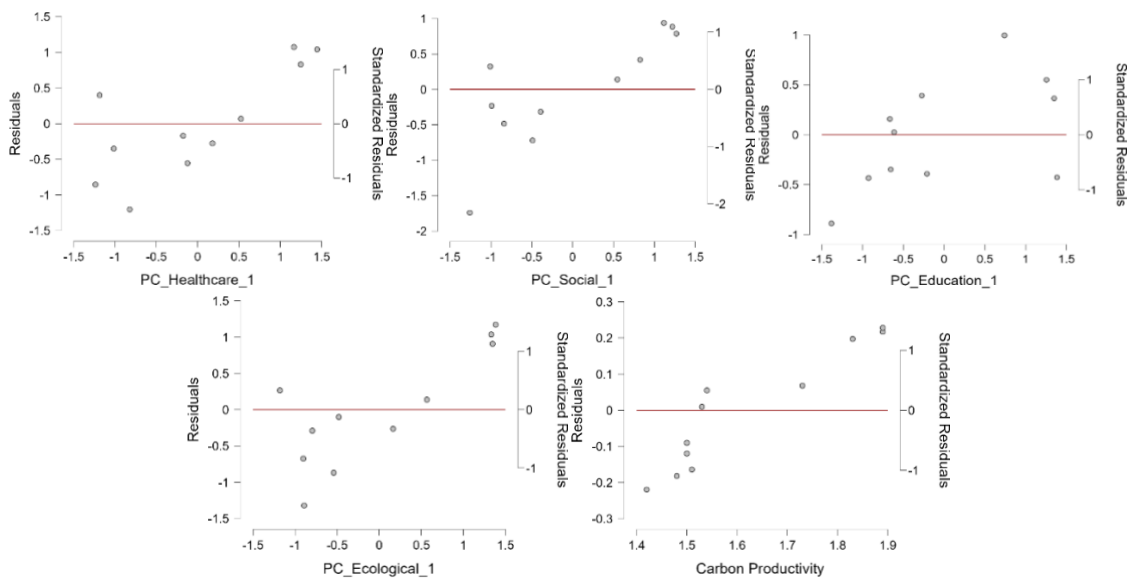


FIGURE 2. Residual plots

Note: complied based on calculations

In the Education component, residuals are evenly distributed around zero, with values ranging from approximately -1.0 to 1.0, demonstrating an excellent fit and minimal bias in the model's predictions. For the Healthcare component, residuals cluster at higher values, particularly between 0.5 and 1.5, which shows reduced model accuracy for dependent variable values in this range, possibly due to slight heteroscedasticity.

The Ecology component displays a few positive outliers, with residuals reaching up to 1.5, indicating underpredictions at higher dependent variable values, where the model does not capture these extremes accurately. In Carbon Productivity, residuals are small, generally between -0.3 and 0.3, and centered around zero. However, there is a minor upward trend as values increase, pointing to slight underfitting at higher productivity levels.

In the Social component, residuals range from -2.0 to 1.0, with positive residuals clustering at the higher end, which reveals limited model accuracy for certain outcomes in this category. Overall, while the model fits well for Education and Carbon Productivity, adjustments in the Healthcare and Ecology components could improve predictive accuracy across the full range of dependent variable values.

The absence of a significant relationship with GDP growth for carbon productivity shows that increases in GDP do not inherently lead to higher carbon efficiency. Direct environmental and technological interventions are necessary to enhance carbon productivity alongside economic growth, particularly in light of the growing emphasis on ESG (environmental, social, and governance) standards. Low carbon productivity with economic expansion increases the risk of ecological costs and challenges to long-term sustainability.

The Ecological Component, the moderate association with GDP growth, reveals that environmental conditions may improve with economic growth but only to a limited degree. The underprediction of higher ecological values indicates that GDP growth alone is insufficient to drive substantial ecological benefits, emphasizing the need for more stringent environmental policies and incentives that ensure economic growth aligns with ecological sustainability.

The Healthcare Component shows that GDP growth positively influences healthcare systems, though it does not fully determine healthcare quality and accessibility. Since population health directly affects labor productivity, a healthy workforce is crucial for sustained economic growth. Investments in healthcare, in addition to GDP growth, are essential to improving life quality and maximizing economic returns from a healthier, more productive population.

The Social Component's moderate link with GDP growth confirms that economic growth supports poverty reduction and social well-being. Still, it alone cannot ensure improved living conditions for all. Additional social programs are required to address inequality effectively, as GDP growth does not always benefit the most vulnerable groups. Supporting social programs would enable a more equitable distribution of economic gains, thus enhancing overall economic development.

The Education Component demonstrates the strongest relationship with GDP growth, indicating that economic expansion directly improves educational quality and accessibility. This connection is critical, as investment in education develops human capital, which sustains long-term economic growth and fosters innovation. Higher educational attainment strengthens the economy by equipping a skilled workforce and boosting productivity and technological advancement.

The analysis confirms the Kuznets hypothesis with specific distinctions. According to Kuznets' theory, economic growth initially worsens specific sustainability indicators, improving as development progresses. Quadratic regression, applied to each sustainability component (e.g., Carbon Productivity, Ecology), captures the inverted U-shaped relationships characteristic of the Kuznets model.

The results indicated that the relationship between economic growth and each component (e.g., Carbon Productivity and Ecology) could be more consistently strong and significant. GDP growth alone does not guarantee improvements in sustainability, particularly without targeted measures and environmental policies. Stronger correlations appear in components like Healthcare and Education, where GDP growth positively impacts these areas, underscoring the importance of social investments for sustainable development.

Therefore, the Kuznets method is partially validated: the link between growth and improvements in sustainability indicators varies across different areas, highlighting the necessity of a comprehensive approach that addresses the unique factors influencing each category.

5. CONCLUSIONS

The primary objective of this study is to evaluate the impact of economic growth on key components of sustainability, including carbon productivity, ecological conditions, healthcare, social well-being, and education. Results showed no significant relationship between GDP growth and Carbon Productivity, indicating that economic growth does not inherently improve carbon efficiency. For the Ecology and Healthcare components, moderate relationships were observed, suggesting that while economic growth contributes to some improvements, it does not fully meet ecological or healthcare needs. In the Social component, economic growth supported social outcomes moderately but without significantly reducing inequality or social disparities. Education showed the strongest relationship, with GDP growth substantially enhancing access and quality, underscoring the importance of prioritizing education funding and aligning it with labor market needs to leverage economic growth's impact on human capital fully. Building on these conclusions, the implications for Kazakhstan indicate that sustainable development cannot rely solely on economic growth. The study's findings support the Kuznets hypothesis in certain domains: while economic growth initially increases pressure on environmental resources, positive effects on social indicators, such as healthcare and education, become more apparent as income levels rise. The lack of a strong relationship between GDP growth and Carbon Productivity underscores that environmental sustainability demands direct policy interventions beyond economic expansion. For Kazakhstan, this analysis highlights that Sustainable Development Goals (SDGs) focused on environmental sustainability and carbon efficiency are not substantially advanced through economic growth alone. While the Kazakhstani economy continues to expand, this growth does not inherently address environmental challenges such as pollution or resource use efficiency. GDP growth in Kazakhstan has not translated into significant improvements in carbon efficiency or reduced ecological impact, underscoring the necessity of stricter environmental policies and the adoption of technologies designed to enhance resource management and lower emissions. Conversely, SDG areas related to social development show more positive outcomes associated with economic expansion. For instance, Kazakhstan has been able to improve access to healthcare and education, as well as elevate general living standards. As the economy grows, increased resources are available for investments in public health, education, and social welfare programs, helping to address issues of poverty and inequality. Social domains thus become more resilient and contribute to an enhanced quality of life for the Kazakhstani population.

To achieve Sustainable Development Goals in the areas of ecology and carbon efficiency, Kazakhstan must go beyond economic policies alone. Additional targeted efforts are essential, including stricter environmental regulations and advanced technologies aimed at improving carbon efficiency. While economic growth in Kazakhstan supports the social sphere, ensuring sustainable development in environmental areas requires a comprehensive approach. There must be considered economic

growth strategies with specific environmental policies focused on resource management, emissions reduction, and energy efficiency. Through prioritizing investments in education, social well-being, and environmental programs, Kazakhstan can foster sustainable economic growth, reduce its environmental impact, and create a foundation for long-term prosperity.

AUTHOR CONTRIBUTION

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RESEARCH ARTICLE
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Sustainable Agricultural Transformation: Insights from the Emilia-Romagna Region

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ABSTRACT

Today, Kazakhstan's agricultural industry remains one of the most risk-prone, heavily influenced by adverse weather conditions, volatile market prices, and insufficient infrastructure. The study aims to assess opportunities for enhancing Kazakhstan's agricultural sector's competitiveness through the adoption of smart technologies, drawing lessons from the Emilia-Romagna region in Italy. The research employs a combination of comparative analysis and case study methodologies to evaluate the applicability of international best practices in the context of Kazakhstan's agricultural development. The study relies on a variety of data sources, including government reports, international case studies, and performance metrics from both Kazakhstan and the Emilia Romagna Region. The findings demonstrate that integrating technologies such as IoT, robotics, and blockchain can improve productivity, sustainability, and market attractiveness in the agricultural sector. The study also highlights the need to enhance farmer and manager competencies and promote family businesses and cooperatives. By adopting these strategies, Kazakhstan could address the existing challenges in its agricultural sector, reduce vulnerabilities, and create a more robust agro-industrial ecosystem. Future research should focus on developing specific pilot programs that apply these integrated approaches at a regional level, as well as assessing the long-term impacts of digital and sustainable practices in enhancing the competitiveness of Kazakhstan's agricultural sector.

KEYWORDS: Smart Agriculture, Family Businesses, Agribusiness, Sustainable Development, Digitalization, Region, Regional Development, Emilia-Romagna

SCSTI: 06.73.91

JEL Code: Q01, Q13, R58

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1. INTRODUCTION

Kazakhstan's vast open spaces provide significant potential for agricultural development, presenting an ideal environment for integrating emerging technologies such as artificial intelligence, IoT, robotics, and edge computing. The agricultural sector in Kazakhstan holds considerable promise for the rapid adoption of these technologies, which could transform the industry on a large scale. However, agriculture in the country remains one of the most risk-prone sectors, influenced heavily by adverse weather conditions, diseases, and price volatility (OECD/FAO, 2021). Reactive, ex-post responses to crises essentially characterize current risk management practices in Kazakhstan, and there is an urgent need for a more comprehensive and integrated approach that addresses vulnerabilities proactively (Ibyzhanova et al., 2022).

The ongoing industrialization and digitization of agriculture, characterized by the adoption of intelligent technologies (Pavione et al., 2020), can potentially stimulate growth across related sectors and foster the overall development of the regional economy. The emphasis is on harnessing the benefits of digital transformation through an integrated ecosystem of technologies and data systems across the entire agricultural supply chain, encompassing operations from the field to farms, agribusiness, and government organizations (Smagulova, 2020). This transformation contributes to Kazakhstan's broader economic transition from reliance on oil and natural gas. Although agricultural production currently accounts for just over 4.5% of the national GDP, the sector has begun to attract a generation of young entrepreneurs who are eager to create start-ups focusing on productive genetics, biological advancements, and process digitization (U.S. Department of Agriculture, Foreign Agricultural Service, 2022).

The government of Kazakhstan has recognized the importance of modernizing agriculture. It has introduced a vital development strategy to drive the ecological transition, advance digitization, modernize agricultural practices, enhance the transit potential between China and Europe, diversify productive capacities beyond hydrocarbons, and implement privatizations. However, the adoption of innovative agricultural techniques, such as organic crop production, remains limited; only about 1.5% of Kazakhstan's 22 million hectares of total crop area is cultivated using organic methods (U.S. Department of Agriculture, Foreign Agricultural Service, 2022).

This paper explores how Kazakhstan can enhance its agricultural sector by drawing lessons from successful territorial development models, specifically the Emilia Romagna Region agro-industrial ecosystem in Italy. It also examines the feasibility of implementing integrated performance evaluation tools, proposes an educational methodology for entrepreneurship in agriculture, and highlights the potential for mentorship and cooperation between the Emilia Romagna Region and critical regions in Kazakhstan, including Almaty, Turkistan, and Mangystau. The overarching goal is to foster the capacity for entrepreneurship and self-achievement among farmers and agricultural managers through a "learning by doing" approach, thereby driving the adoption of new technologies and improving the agricultural sector's competitiveness. It was highlighted particularly the role of field experiences with the individuation of excellence cases available for the education of farmers and agricultural managers to entrepreneurship and self-achievement in order to apply new technologies and marketing applied knowledge.

The study assesses opportunities for enhancing Kazakhstan's agricultural sector's competitiveness. This will be achieved by evaluating the potential for adopting smart technologies, drawing on successful experiences from the Emilia-Romagna region in Italy, and tailoring these approaches to Kazakhstan's specific conditions and needs. The focus is on identifying practical strategies that can be implemented to drive innovation,

improve productivity, and foster sustainable growth in the agricultural sector.

2. LITERATURE REVIEW

Digitalization and the use of technologies for the future development of agriculture

In the research's target regions, Almaty, Mangystau, and Turkistan, one direction for regional development could be the agricultural recovery of lands affected, as stated by the Government Report, by a decline in fertility in the last twenty years. The recovery or fertility, connected to the fertilizing of soils, the application of modern technologies for cultivation, the rational watering, and the use of high-performance seeds, plants, and animal varieties, would have a drag effect on the entire regional economy and society with the involvement of people and activities spread in the territory and different economic sectors in the activities connected to the furniture of products and of production tools and in the chain products (Bianchi, 1999; Dinis Sousa et al., 2021). One risk to be avoided is the abandonment of territories and practices to enhance environmental ability (Mella & Gazzola, 2015). All this also guarantees jobs that also play a role in enhancing and protecting the territory.

To this end, the government has the job of valorizing the excellence of the agroindustry and, in general, agribusiness through pilot experiences. So, the intervention strategy passes through the analysis of the territory, the selection of the area of intervention, and within it, cases in which the combination of ownership structure, economic dimension, and land vocation would characterize opportunities for pilot experiences. Irrigation development is a critical economic development enabler and accelerator in an economy that is considered agro-based agriculture. Smart irrigation is the new frontier of irrigation.

Thanks to Smart irrigation technology, it's possible to use weather data or soil moisture data to determine the landscape's irrigation needs. In this way, irrigation efficiency is maximized by reducing water waste while maintaining plant health and quality. For big companies, this is not a problem, but for SMEs, it's not easy. SME irrigation development is viable and able. In many parts of the developing world, small-scale irrigation systems are an effective and necessary strategy for boosting agricultural output, bolstering household food security, and reducing rural poverty. Irrigation is critical to poverty alleviation, economic growth, food security, and environmental protection in developing countries. It is essential to the technologies, institutions, and policies underpinning increased agricultural output. Thus, as an agricultural production input, irrigation water is an essential socio-economic good with a positive role in poverty alleviation.

Socio-cultural and economic potentials, roadmap, models, and scenarios planning

The research focuses on comparing the regions of Almaty, Turkistan, and Mangystau in Kazakhstan with analogous areas in Italy, analyzing their development across three primary dimensions: efficacy, efficiency, and adequacy. These dimensions are interrelated within a fundamental system of regional performance. Efficiency pertains to enhancing agricultural productivity through the fertilization of soils and the widespread adoption of modern agro-industrial practices. Efficacy examines the promotion of entrepreneurship, emphasizing the growth of family businesses and cooperatives as key drivers of regional development. Adequacy evaluates the role of government policies in fostering entrepreneurship and providing incentives for regional growth. Together, these interconnected dimensions highlight the interplay between agricultural innovation, entrepreneurial activity, and policy support, offering a comprehensive framework for assessing and improving regional potential.

The interplay between efficacy, and adequacy provides a framework in the context of smart agriculture and sustainable development (Figure 1).

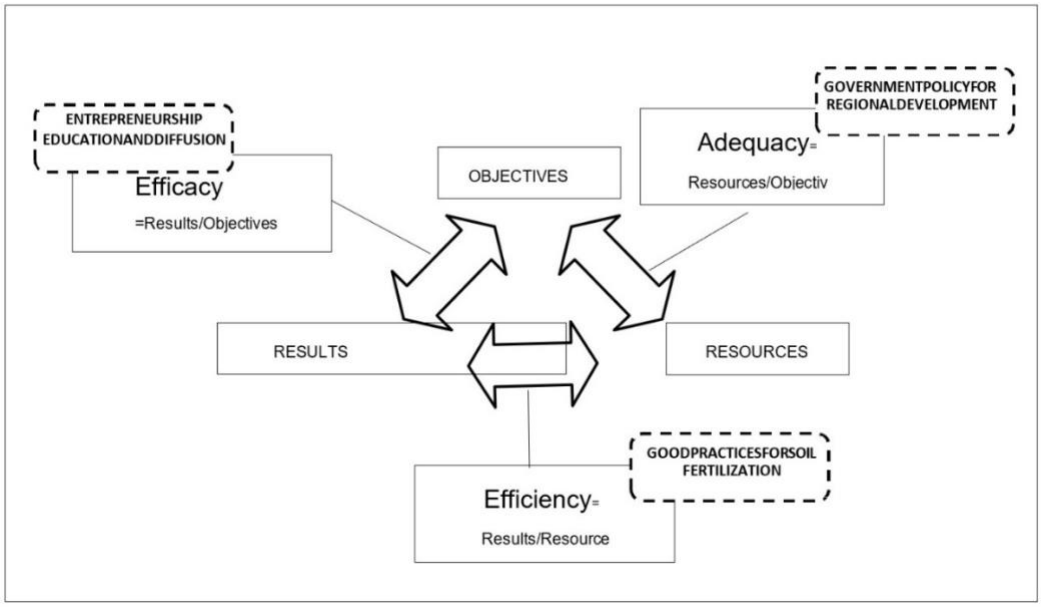


FIGURE 1. Main indexes related to the report subjects

Note: compiled by authors

Figure 1 illustrates the relationship between three critical dimensions: efficacy, efficiency, and adequacy. Efficacy refers to achieving desired results relative to set objectives, focusing on the diffusion of entrepreneurship and education in agriculture. Efficiency measures the effective utilization of resources, emphasizing best practices for soil fertilization and modern agricultural techniques. Adequacy evaluates the alignment of resources with objectives, highlighting the importance of government policies in fostering regional development.

These interconnected dimensions underline the need for a cohesive strategy integrating educational initiatives, resource optimization, and supportive policies to drive sustainable agricultural transformation. This system testifies that each item is connected with others and that the development is to be perceived in different directions with a coordination of interventions, a coordination almost now not completely achieved.

The Efficiency: The fertilization of soils and the diffusion of good modern agricultural practices

Kazakhstan has good-quality agricultural land, but its continental climate and soil-depleting agricultural practices have limited its exploitation. Moreover, only about 1.5% of the total crop area of 22 million hectares is cultivated using organic crop production technologies (U.S. Department of Agriculture, Foreign Agricultural Service, 2022). Agriculture is relatively poor due to the political inheritance of the past, which has not allowed the development of new cultivation technologies. Moreover, due to the presence of brackish land, it isn't easy to prepare correctly.

The crop industry faces several critical challenges that hinder its development and competitiveness. A key issue is the low level of diversification, which limits the resilience and sustainability of agricultural production. The underdevelopment of selection undertakings and the seed production system, coupled with a shortage of seeds from domestic breeding programs, further constrains the sector's growth. Additionally, soil fertility continues to deteriorate, exacerbating productivity challenges. Inefficient irrigation practices, characterized by insufficient adoption of water-

saving technologies, also impede optimal resource utilization.

The industry suffers from a low level of technical and technological modernization, which restricts the adoption of innovative farming practices. Moreover, the high corruption component in implementing control, supervisory functions, and public services undermines trust and efficiency within the sector. Insufficient digitalization further limits the ability to leverage modern data-driven solutions for improved management and productivity.

Organic farming remains underdeveloped, with inadequate technologies for producing and processing organic raw materials. Existing regulatory legal acts and national standards in organic production fail to align with international practices and do not adequately address the needs of domestic producers. Collectively, these issues underscore the need for comprehensive reform and strategic investment to modernize and enhance the crop industry's performance and global competitiveness.

A central subject to this purpose is the problem of black soils for a surface in Kazakhstan of 108 million hectares, as mentioned in the FAO Report. Black soils are more at risk than ever from the climate crisis, biodiversity loss, and land use change. Black Soils have the characteristic of being dense and dark lands, rich in organic matter. They are intrinsically fertile but are also very sensitive to human intervention and subject to degradation. They contain much organic carbon and represent enormous greenhouse gas potential. However, they guarantee a food basket for many countries. Therefore, promoting their conservation and sustainable use is essential to support and ensure food security where it is lacking while still protecting the environment.

In target Regions of the project, Almaty, Mangystau, Turkistan, one direction for the regional development could be the agricultural recovering of lands affected, as stated by Government Report, by a decline of fertility in last twenty years. This is partially connected, as FAO observed this caused phenomenon by the inappropriate use of black soils, meaningfully diffused in Kazakhstan, and from the loss of biodiversity and, generally, by climate change.

The recovery of fertility, connected to the fertilizing of soils, the application of modern technologies for cultivation, the rational watering, and the use of high-performance seeds, plants, and animal varieties, would have a drag effect on the entire regional economy and society with the involvement o people and activities spread in the territory and different economic sectors in the activities connected to the furniture of products and of production tools and in the chain products.

For this purpose, the government has the job of valorizing excellence through pilot experiences of agroindustry and, in general, agribusiness. So, the strategy of interventions passes through the analysis of the territory, the selection of the area of intervention, and within it of cases in which the combination of ownership structure, economic dimension, and land vocation would characterize opportunities of pilot experiences. Irrigation development is a key economic development enabler and accelerator in an economy that is considered agro-based agriculture. Smart irrigation is a new frontier of irrigation. Thanks to Smart irrigation technology, it is possible to use weather data or soil moisture data to determine the landscape's irrigation needs. In this way the, irrigation efficiency is maximized by reducing water waste, while maintaining plant health and quality. It is not a problem for the big companies, but it is not easy for the SMEs. SME irrigation development is viable and sustainable. In many parts of the developing world, small-scale irrigation systems are an effective and important strategy for boosting agricultural output, bolstering household food security, and clipping rural poverty. Irrigation is a critical input in developing countries for poverty alleviation, economic growth, food security, and environmental protection. Irrigation is essential to the package of technologies, institutions, and policies that underpin increased agricultural output. Thus, as an agricultural production input, irrigation water is an essential socio-economic good with

a positive role in poverty alleviation (UNDP, 2024).

The Efficacy: The diffusion of entrepreneurship and the opportunities for family business and Co-operatives

Family Businesses (FB) and Co-operatives play a central role not only in Italy, where it has a relevant position in the district model and in its contribution to employment and socio-economic stability. Also, in Balkan Countries and South America, the central position of FB and Co-operatives is recognized not only in quantitative but also from a qualitative point of view (European Commission, 2007; OECD, 2005; United Nations, 2003).

In particular, FB and Co-operatives are considered interesting models for the development processes of Transition Countries in which it is linked to enterprise culture. In this scenario, the large diffusion of FB and Coop are a characteristic of European and Italian economies and contributed to enriching the economic transactional models (Bartlett & Ghoshal, 2000). For this purpose, the Italian Region, Emilia Romagna, was chosen as a territorial laboratory of advanced agriculture and the application of smart agriculture. This laboratory was available for cultural and historical attitudes, initiatives of education entrepreneurship, self-achievement, and partnerships for projects and concrete initiatives leading to Kazakhstan agriculture's sustainable and technological development.

3. RESULTS

Considering the existing local systems, the differences did not constitute a relevant obstacle to comparing entrepreneurial aspects (Table 1).

TABLE 1. Main differences between Kazakhstan Areas considered in the Report and the Emilia Romagna Region of Italy

Kazakhstan	**Emilia-Romagna**
Scarce diffusion of individual and small business	There is a high diffusion of small businesses, many of them individual
Weak link of entrepreneurship with cultural events	Strong link of economic activities with local culture, supported by numerous cultural enterprises (fairs, festivals, cultural heritage, and events)
Minimal involvement of local government in the development of the territory and entrepreneurship	Active support from local municipalities in the development of territory and entrepreneurship
Most universities are directly dependent on the government	Universities spread throughout the territory
Intermediate level of interconnectivity in the global digital landscape	High interconnectivity with information and technological networks
Scarce diffusion of industry, concentrated in areas with high levels of pollution.	Industrial settlements and areas distributed across the territory with particular attention to ecological considerations

Note: compiled by authors

Today, family businesses (FB) and cooperatives are increasingly recognized within the e-economy as significant drivers of entrepreneurship, transitioning from post-Fordism to advanced applications of ICT and postmodern culture. These initiatives in land recovery for crops aim to leverage the expertise and successful practices from leading agricultural areas in Italy, particularly through partnerships with key companies in the Emilia-Romagna region. Notable contributors include SAIS, an Italian Agricultural Seed Group specializing in high-quality seeds; SubaSeeds Company SPA, a prominent seed production

company; and Amadori, a leading Italian agri-food group specializing in poultry and expanding into the broader protein sector with diverse offerings such as chicken meat, plant-based products, and frozen foods. Additionally, IRRINET, a regional irrigation system for agricultural water management developed by the Canale Emiliano Romagnolo consortium, provides advanced tools for optimizing water use through telematic technologies. Orogel, a cooperative of farmers and agronomic technicians, leads the production of fresh frozen vegetables with full supply chain control. Together, these partnerships serve as a model for integrating innovation, sustainability, and entrepreneurial strategies into agricultural development, offering valuable lessons for regions like Kazakhstan.

At the same time, these items can shortly be compared and targeted to the Emilia Romagna Region, evidencing the change of perspective needed to implement sustainable agricultural and technological development in Kazakhstan. Although it is a huge synthesis, this comparison clearly shows the relevance of the local system as a category that allows, for dimensions and structural characteristics, a confrontation among countries of different dimensional scales and structures.

The theoretical background of small and medium-sized business development is strongly linked to research on enterprise startups. Authors report various evolving approaches, culminating in recent ideas connected to neo-constructivism, neo-institutionalism, and systemic determinism (Table 2).

TABLE 2. The main evolutionary steps of theoretical approaches to business creation

Theoretical approaches	Approach to business creation
Rational Determinism (Spinoza)	It is possible to project the optimal path to enterprise creation.
Empirical theory (Locke)	Enterprises are born from single actions and experimental activities.
Constructivism (Berger, Luckman, Weick)	Enterprises are the result of put and take the approach
Institutionalism (Veblen)	Institutional and formal frameworks of the state and government condition the success of enterprise creation and development.
Neoempirical (Popper, Hempel)	It is impossible to define general principles deriving them from a limited number of cases. Each enterprise represents a fortuitous event unrepeatable.
Neo-constructivism	As for scientists and professionals, good enterprise practices derive from entrepreneurial practice communities.
Neo institutionalism (Albert, Hikermeier)	The private and public sectors can share in enterprise creation through a diverse framework.
Systemic Determinism (Scott, Nelson-Winter)	Relationships network limits and qualify the best practices available in a specific environment.

Note: compiled by authors

The lack of methodological rigor in previous research has resulted in a scarcity of comprehensive studies on family businesses (FB) despite the abundance of analyses on MSMEs and, more recently, on micro-enterprises. This gap has led scholars to adopt a utilitarian approach, often relying on findings from MSME research to examine the structures and processes of family businesses and cooperatives. While some aspects of MSMEs have been conveniently applied to these contexts, other authors, such as Livingston (2007), advocate for exploring new paradigms specific to family businesses and cooperatives. These paradigms could also be relevant for

studying the startup phase and the role of managerial control during this period.

There exist many kinds of business simulations that are used in vocational education and training. In order to ensure a clear definition of the different simulation methods, the Practice Enterprise will be compared to other methods like Business Games, Learning Office, and Junior Companies.

Table 3 provides an overview of the business simulations and of the main differences in terms of fictitious or actual performances.

TABLE 3. Comparison of four simulation methods

Simulation Method	Flow of Goods and Services	External Contacts
Business Games	Fictitious	Fictitious
Learning Office	Fictitious	Fictitious
Practice Enterprise	Fictitious	Real
Junior Company	Real	Real

Note: complied based on Gramlinger (2000)

Practice Enterprise and Business Games

Unlike Practice Enterprises, Business and Simulation Games have a pre-designed game structure. Under the constraint of specific resources and information (e.g., market data), learners strive to achieve maximum success for a fictitious business. The game is framed into time units or periods in which learners try to solve the underlying problem. Furthermore, Business Game did not consider social aspects or external contacts, and no commercial tasks were undertaken. Briefly, the didactics is focused on making decisions under different situations.

Practice Enterprise and Learning Offices

Literature defines the Learning Office as a model of a real business. The learners are divided into smaller learning groups than in Business Games. The company's daily business (e.g. business correspondence, bookkeeping) is performed by the different departments and upcoming business activities are planned. There are no real external contacts, and the flow of goods and money are fictitious, as can be seen in Table 1. In contrast to the Business Game, the focus lies on daily office activities (e.g., correspondence) instead of sole decision-making. The difference between the PE and the Learning Office is that the Learning Office is a closed system. There is neither a market where other Learning Offices co-exist nor real outside contacts since the trainer simulates all communication. Therefore, the students cannot observe and react to any market changes.

The Junior Company is a usual set for the duration of one school year, where students establish a company and offer self-developed products and services on the actual market. Initially, the students develop their business idea independently and go through all phases of an actual business project. These phases include idea generation, team building, planning, and production of the products or services. The students are also responsible for the marketing and selling of their products or services and, at the end of the school year, for the closing of their business.

As Table 1 indicates, unlike the Learning Office and the PE, a Junior Company trades with natural products and money and has (just like PEs) real external contacts. The Junior Company participates in the real market. Real capital is used (although only limited amounts) and establishes business relationships with customers and suppliers. The Junior Company and the PE have a different degree of reality. A PE has no real economic risk. Learning and working takes place in a protected area. Junior Companies bear entrepreneurial risk and, therefore, often operate under a mother company's legal and financial protection. Business simulation is a teaching methodology that refers to constructivism and connectivism theories through a learning-by-doing approach

that embodies all the instances of blended learning.

The key features of this teaching approach are its authenticity, contextualization, and situational design, aimed at replicating real-world scenarios representative of an organizational entity, typically a company, in all its functional and organizational dimensions, making it highly relevant and meaningful. It is active, requiring participants to process information dynamically and organize it efficiently to comprehensively understand the situation. It is also constructive, integrating new knowledge with existing understanding through reflection, enriching and giving purpose to the learning process. Additionally, it is intentional, focused on achieving a specific objective, such as managing business processes, and cooperative, as knowledge emerges from group discussions and shared re-elaborations. Here, the learning cooperation dimension represents a valid tool for integrating cognitive, professional, and social skills. In this didactic process, knowledge results from a re-elaboration of the group that discusses and shares (Gualdi, 2016).

Since 2001, Italian universities have started educational collaborations, particularly in the field of agricultural business: in 2001, the Faculty of Economics of the University of Bologna introduced a Business Management Course, the Practice Enterprise, as followed a few years later by the University of Parma (Bianchi, 2008), in 2023 an agreement was drawn up with the Oriental University of Naples and the universities of Almaty within the Erasmus+ program that will allow, in addition to the exchange of students, the exchange of teachers and researchers (Università Orientale di Napoli, 2023), in 2024 a Memorandum of Understanding was signed in Astana between the University of the Marche and Zhetysu University, in the field of agricultural sciences which provides for the activation of a double degree in Agricultural Sciences, Applied Technologies and Management of Bioresources, based on an educational path that will be held at the two universities, in English and Italian (Ansa, 2024).

Business Simulation is a participatory learning environment in which the dimension of cooperative learning represents a valid tool for integrating cognitive, professional, and social skills, as the members of the group, in order to achieve common goals, are called to work constructively and responsibly in the decision-making process with a positive interdependence, dialogic exchange, and collective reflection. All these activities aimed to improve participants' problem-solving and teamwork skills, qualities that the modern working context strongly requires, and they seem to have fruitful results in project management and performance (Table 4).

TABLE 4. Defining the skills citizens will need in the future world of work

<table>
<tr><th colspan="2">Cognitive</th><th colspan="2">Interpersonal</th></tr>
<tr><td>Critical Thinking
- Structured problem-solving
- Logical reasoning
- Understanding biases
- Seeking relevant information</td><td>Planning and Ways of Working:
- Work-plan development
- Time management and prioritization
- Agile thinking
-Ability to learn</td><td>Mobilizing Systems:
- Role modeling
- Win-win negotiations
- Crafting an inspiring vision
- Organizational awareness</td><td>Developing Relationships:
- Empathy
- Inspiring trust
- Humility
- Sociability</td></tr>
<tr><td>Communication:
- Storytelling and public speaking
- Asking the right questions</td><td>Mental Flexibility:
- Creativity and imagination
- Translating knowledge to different contexts</td><td colspan="2">Teamwork Effectiveness:
- Fostering inclusiveness
- Motivating different personalities
- Resolving conflicts
- Collaboration
- Coaching</td></tr>
</table>

<table>
<tr><td>- Synthesizing messages
- Active listening</td><td>- Adopting a different perspective
- Adaptability</td><td colspan="2">- Empowering</td></tr>
<tr><td colspan="2">Self-Leadership</td><td colspan="2">Digital skills</td></tr>
<tr><td>Self-Awareness and Self-Management:
- Understanding one's own emotions and triggers
- Self-control and regulation
- Understanding one's own strengths
- Self-motivation and wellness</td><td>Entrepreneurship:
- Courage and risk-taking
- Driving change and innovation
- Energy, passion, and optimism
- Breaking orthodoxies</td><td>Digital Fluency and Citizenship:
- Digital literacy
- Digital Learning
- Digital collaboration
- Digital ethics</td><td>Software Use and Development:
- Programming literacy
- Data analysis and statistics
- Computational and algorithmic thinking</td></tr>
<tr><td colspan="2">Goals Achievement:
- Ownership and decisiveness
- Achievement orientation
- Grit and persistence
- Coping with uncertainty</td><td colspan="2">Understanding Digital Systems:
- Data literacy
- Smart systems
- Cybersecurity literacy
- Tech translation and enablement</td></tr>
</table>

Note: compiled based on Dondi et al. (2021)

This teaching is based on Learning by doing. It aims to apply the theoretical knowledge acquired during studies in the business context to achieve fundamental skills such as problem-solving, decision-making, working teams, autonomy, responsibility, and communication. It also allows students to compete internationally with students from all over the world, participating in the international fair of simulated companies. It should be noted that the teaching staff comprises three profiles: the Teacher, the Tutor, and the Mentor.

The pervasive perspective of this didactical approach, developed by UIB in many International Projects like PICASP, is still in progress. Practice Enterprise could be diffused in many directions as synthesized, as shown in Table 5.

TABLE 5. Beneficiaries and targets group of practice enterprise

Category	Needs	Constraints
Final Beneficiaries	- Development and awareness of cultural diversity. - Building a shared vision of river governance. - Restoring knowledge and skills of high cultural quality. - More flexible delivery and fruition of services concerning cultural heritage, mobility, and local development linked to river basin governance.	- Scarce attitudes may be diffused in such organizations toward issues related to the social and economic framework for community revitalization.
Target Groups	- Achievement of international visibility. - Gathering additional resources (information, knowledge, funds). - Valorize human resources by improving the knowledge and skills of staff. - Enhancing the creation and development of networks with stakeholders at local, regional, national, and international levels. - Promotion of local heritage and connected mobility (especially in tourism).	- Different international standards must be followed when implementing policy. - Scarce internalization level of partner organizations. - Scarce collaboration and conflicts among project units. - Political and economic barriers for Universities, High Schools, and Research Centers.

	- Improve awareness regarding the relevance of local heritage to country development.	- Emerging conflicts among internal and external employees.

Note: compiled by authors

The Adequacy of Government Policy for Incentives to Entrepreneurship and Regional Development

The growth of competitiveness in transition countries is closely linked to the ability of local systems to organize a viable territorial offer in terms of infrastructure. Efforts by central and local governments and international cooperation have often focused on financial support and facilitation measures, including logistics, equipped areas, and grants to motivate investors and entrepreneurs. According to Bianchi (2011), these incentives include: no corporate taxes for 20 years, followed by a 10% rate; 5% personal income tax for five years, increasing to 10%; exemption from VAT and customs duties for export production; free connections to piped natural gas, electricity, water, and sewage systems; immediate access to major international airports, railroads, and key corridors; financial incentives for SMEs, including training cost subsidies; benefit package for eligible investors approved within ten business days.

Many of these incentives would focus on cooperation among small firms. Cooperation can be developed by building particular institutions, which would help mitigate the problem of small-scale production, for example, by forming an effective procurement system for agricultural products, a network of machine and tractor stations, service and procurement centers, etc.

Recently, some attentive scholars (Scherrer, 2004) attached importance to the nonmaterial conditions, such as the local attitude to entrepreneurship, the skills of local labor forces, and the orientation of local government. Other researchers consider the capability of local entities, public and private, to act as a system or the approach to consider the territory as a park in its different issues: cultural, technological, scientific, and entrepreneurial ones. Finally, some authors focus on their critical analysis of business creation, which is not a bureaucratic process, as imagined in International Cooperation Projects. All these new approaches can be discussed as the previous one because the situation constantly changes, orienting managerial theories to a dynamic perspective like Actor-Network Theory or ad hoc solutions. By the way, it can be an exciting challenge for researchers and applied scientists in business subjects to reconsider the components of the local entrepreneurial system, the cause of competitiveness as enterprises, and the relations among them.

The study on this area initially attempted to detect the relevance of relational management and relational borders individuated using concepts from the social research weak and strong ties (Bianchi & Barzanti, 2003; Bianchi, 2017). The continuity of business relationships with customers and suppliers limits the control area and, at the same time, the boundaries of organizational behaviors. The initial research target was afterward changed into an extension of the hypothesis aiming to explain the complexity of the business system and profitable hyperlinks. This last organizational category defines the established and deep roots coming from the enterprise's internal framework that projects its initiatives in a wide range of activities. Hyperlinks keep enterprises in touch with other organizations very differentiated, allowing them to create profitable situations and a stable network of exchanges (Bianchi, 2008). The experience of international collaboration projects for the development of entrepreneurship (and particularly of SMEs) further enforced these researches to consider the process of enterprise start-up and growth in different contexts (Bianchi, 1999). This process is considered in connection to the capability to create a profitable and stable network of contacts less than the availability of financial and economic resources (Table 6).

TABLE 6. Key areas policy in territorial knowledge management

Policy Areas in the TKM Approach	Metropolitan Areas (High-tech Sectors, Large Enterprises)	Industrial Clusters (Medium-tech Sectors, Innovative SMEs)	Peripheral Regions (Low-tech Sectors, Traditional SMEs)
1. Innovation Stimulus	Product innovation in specialized markets	Customer needs and supply chain integration	Cost competition in the global market
2. Accessibility	High international accessibility - low local accessibility	Low international accessibility - high local accessibility	Low international accessibility - low local accessibility
3. Receptivity	High internal diversity	High internal specialization	Low quality of human capital
4. Identity	High organizational and cognitive proximity	High local embeddedness and local identity	Fragmentation and external dependence
5. Creativity	High investments in R&D	Networking and interactive learning	Technology adoption
6. Governance	National industrial policies and strategy	Multi-level governance	Public finance and public regulations

Note: compiled by authors

Finally, a thought on the progress of Kazakhstan's agribusiness. Key indicators provided by the Bureau of National Statistics Agency for Strategic Planning and Reforms of the Republic of Kazakhstan show that in 2023, the gross production of products (services) of agriculture, forestry, and fishery in the Republic amounted to 7 625.2 billion tenge, which is 8.3% less than the previous year (Bureau of National Statistics Agency, 2023). The dynamics of gross output (services) of agriculture, forestry and fisheries in Kazakhstan for the period 2010-2023 is shown in Figure 2.

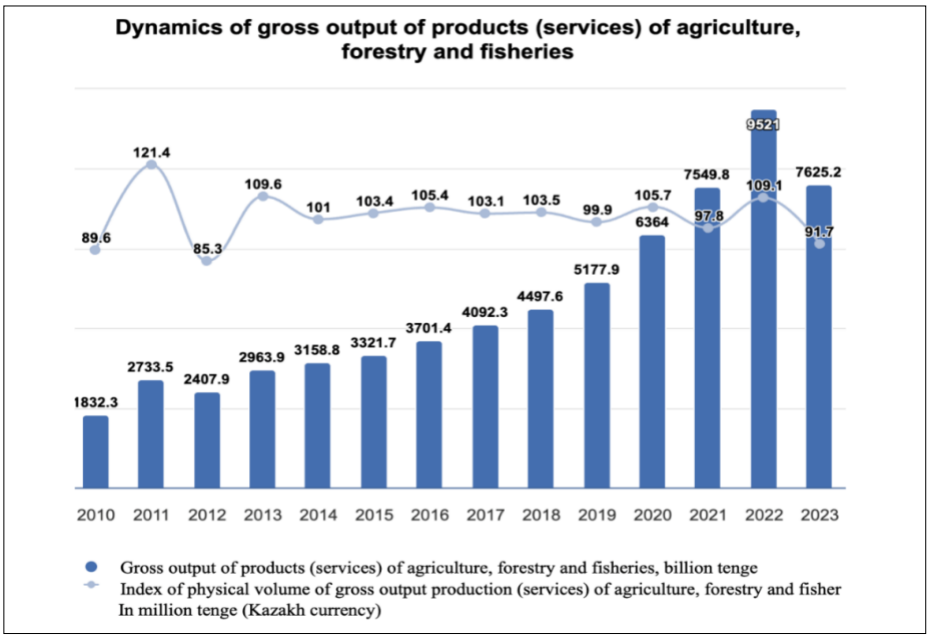


FIGURE 1. Trends in Environmental taxes for 2016-2022

Note: compiled by authors

The data presents the dynamics of the gross output of the agriculture, forestry, and fisheries sectors in Kazakhstan from 2010 to 2023. The graph shows the gross output values in billion tenge, represented by the vertical bars, alongside the index of the physical volume of gross output, expressed as a percentage change from the previous year, indicated by the line graph. The gross output of the sectors has shown a consistent upward trend over the period from 2010 to 2023, indicating a significant increase in value from 1,832.3 billion tenge in 2010 to 7,625.2 billion tenge in 2023, with a peak of 9,521 billion tenge in 2022. During this time, the index of physical volume has fluctuated, with notable spikes in 2011 (121.4%) and decreases in years like 2013 (85.3%). More recent years have seen stable performance, with the index peaking at 109.1% in 2022 and then decreasing slightly to 91.7% in 2023. These growth trends reflect periods of both expansion and stagnation in agricultural output, which are influenced by various economic and sector-specific factors.

4. CONCLUSIONS

Within the framework of this study, we are exploring the possibilities of enhancing the competitiveness of Kazakhstan's agricultural sector through the use of innovative technologies and by studying the experience of Emilia-Romagna in Italy. Our findings indicate that the integration of cutting-edge technologies such as the Internet of Things (IoT), robotics, and blockchain has the potential to significantly boost agricultural productivity, sustainability, and market appeal. Kazakhstan is working to fully integrate its agricultural and industrial chain, develop a sustainable development strategy to enter new markets, and use predictive information systems. The country is in the process of transitioning to the implementation of smart technologies such as real-time environmental monitoring, spatial analysis tools, and farm land mapping, aimed at modernizing agriculture and increasing its global competitiveness.

Rural development through agriculture can be achieved in two main ways:

1. Enhancing government intervention to foster the formation of cooperatives, which will make efficient use of resources, improve infrastructure, and innovate collectively.

2. Supporting privatization and establishing partnerships with domestic and international stakeholders to expedite the introduction of advanced technologies.

The future of agriculture in Kazakhstan is closely linked to the potential for establishing collaborative systems with international partners, such as Italy. Through joint ventures and knowledge exchange, we can contribute to the development of automated processes, utilizing robotics, AI-driven decision-making systems, IoT technologies, and blockchain for supply chain transparency - essential elements for promoting organic farming and sustainability.

Sensors that communicate the best weather conditions, agricultural machines capable of talking to other production nodes and at the same time capable of transmitting sound information to the players in the commercial chain and a university system that inspires innovative startups are some of the areas in which European FinTech more reactive will have to invest in Kazakhstan to create an economy of awareness that innovates agriculture, the oldest and most solid of a country (Nurbatsin & Gazzola, 2022).

In addition to technological innovations, it is important to increase the level of education and cooperation between the regions of Kazakhstan and international partners. The creation of training programs and mentoring mechanisms, as well as the use of “learning by doing” methods, contributes to increase the competitiveness of agriculture.

In the future, it will be necessary to pay more attention to creating pilot projects that use an integrated approach on the regional level. It will also be important to assess long-term outcomes of the implementation of digital and

eco-friendly methods in agricultural development in Kazakhstan.

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Analysis of Sustainable Agricultural Development in Kazakhstan: Key Economic and Climatic Indicators

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ABSTRACT

Agriculture is a key sector in Kazakhstan's economy, contributing significantly to employment and GDP. However, geographic, climatic, economic, and policy-related factors contribute to substantial regional differences in agricultural performance. This paper aims to assess the level of agricultural development across Kazakhstan's regions using an integral index based on key variables that influence productivity, such as soil surface temperature, producer price indices, total sown area, employment figures, and domestic R&D expenditure. The paper used the following methods: correlation analysis to determine the relationship, regression analysis after filtering variables, integral index for a generalized assessment of agricultural productivity by region, and cartographic analysis. The findings highlight significant geographical variations, with regions like Almaty and Turkestan showing high productivity, benefiting from favorable climatic conditions and infrastructure. In contrast, regions such as North Kazakhstan and Pavlodar need to catch up, primarily due to harsher environmental conditions and lower investment levels. These differences point to the need for a targeted approach aimed at supporting less developed regions, as well as the dissemination of best practices from successful areas. The cartographic analysis visualizes these imbalances. The southern regions are highlighted as zones of high productivity, while the northern and eastern regions are shown as risk zones that require priority attention and resources. This research underscores the need for adaptive strategies to address regional inequalities, aiming to boost agricultural productivity and foster sustainable growth across Kazakhstan.

KEYWORDS: Agriculture, Agricultural Productivity, Economy, Diversification, Sustainability, Climate Change, Agricultural Policy

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JEL Code: Q10, Q18, R11

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1. INTRODUCTION

Agriculture is the leading sector in Kazakhstan's economy, as it forms the most important source of employment and contribution to GDP. However, despite being very promising, with its great extents of arable land and a wide variety of climatic zones, agriculture has serious challenges, especially those related to regional disparities in agricultural productivity and development. These inequalities pose challenges in attaining food security and sustainable development; hence, a close analysis is necessary concerning those conditions that affect agricultural performance in different regions.

The geographical diversity of Kazakhstan largely affects the mode of its agricultural practices. With its vast steppes, mountain areas, and very productive river valleys, the country supports an extensive range of crops and livestock. The southern parts, like Almaty and Turkestan, have good climatic conditions with fertile soils, thus enabling them to produce higher agricultural output. On the other hand, northern parts, such as North Kazakhstan and Pavlodar, are generally crippled by harsher climates that give way to meager crop yield and agricultural productivity. Understanding these geographic and climatic influences is critical for making appropriate agricultural policies targeted to the needs of each and every region.

Not considering geographical factors, the economic conditions of the land also play an important role in determining productivity in agriculture. Also, access to markets, investment in technology, and infrastructure development form the basic ingredients that determine performance in the agricultural sector. As can be seen, regions that invest highly in R&D often realize increased productivity through the adoption of new methods and technologies in farming. Besides, favorable market conditions sign of stability in the producer price index of agricultural products and farmers' confidence to enhance their operations, thus contributing to increased agricultural growth.

Government policies are significant and have a direct effect on agricultural development. Good support programs involving subsidies, credit facilities, and infrastructure investment in agriculture raise productivity very substantially in lagging regions. Policymakers must consider regional needs when developing strategies and ensure that support mechanisms address specific challenges and opportunities.

Climate change has become the most pressing topic affecting Kazakhstan's agricultural development. Indeed, shifting rainfall patterns and increasing temperatures may pose an unusually high risk to crop yields and livestock production, especially in areas already vulnerable to climatic variability. According to the literature, climate change exacerbates existing problems, and therefore, adaptive measures need to be implemented to mitigate its negative impacts on agricultural productivity. In fact, there is an urgent need to understand how climate change interacts with local agricultural practices to develop appropriate responses that ensure increased resilience and sustainability.

The paper aims to comprehensively assess agricultural development across different regions of Kazakhstan by using an integral index that represents key variables influencing productivity. These include soil surface temperature, the producer price index of agricultural products, total sown area, number of employed, domestic R&D expenditure, and others that may serve for a multidimensional analysis of agricultural performance. It is possible to find out the relations between these variables and agricultural productivity using appropriate weights to create a robust integral index through correlation and regression analyses.

This study's findings surpass the academic debate, providing beneficial information to policymakers, investors, and other agricultural stakeholders. This research will identify areas of strength and weaknesses in agricultural performance to inform appropriate targeted interventions to enhance equitable growth and sustainability within the sector. The findings

will also highlight best practices from high-performing regions that could serve as models for less productive areas, fostering knowledge transfer and innovation.

This, therefore, has implications for a study in Kazakhstan, which also has set for itself economic diversification and rural development. Improved agricultural productivity and reduced regional disparities will mean the sector can better contribute to national development goals of poverty reduction and food security. The developed integral index in this paper will be a crucial tool in understanding the complex dynamics of agricultural development across the different regions of Kazakhstan, as it gives substance to informed decision-making and strategic planning.

The challenges and opportunities facing Kazakhstan's agriculture are at the core of the complex interaction between geographical, climatic, economic, and policy factors. Addressing prevailing regional disparities in pursuit of inclusive growth and ensuring the sector's sustainability against changing environmental conditions is essential. This study's integral index and comprehensive analysis will provide valuable insights for stakeholders in the process of developing agricultural productivity and sustainable practices throughout Kazakhstan.

2. LITERATURE REVIEW

Sustainable agricultural development is shaped by economic, climatic, and technological factors, which significantly influence regional productivity and resource management. A review of existing literature highlights the critical role of adaptive strategies, investment in innovation, and regional policy measures in addressing disparities and ensuring long-term growth in the agricultural sector.

Environmental challenges and social sustainability in agriculture play a crucial role in the sector's development. Agriculture is both a victim and a contributor to environmental degradation. Gomiero, Pimentel, and Paoletti (2011) explore the environmental impacts of different agricultural management practices, focusing on the comparison between conventional and organic farming methods. As Johnson and Villumsen (2020) note, the sector suffers from climate change impacts, such as altered precipitation patterns, extreme weather events, and soil degradation. The adoption of sustainable agricultural practices has gained prominence as a solution to mitigate environmental degradation. Practices such as crop rotation, agroforestry, and conservation agriculture enhance soil health, reduce dependency on chemical inputs, and align agriculture with global climate goals (Suchkov et al., 2021). These methods promote ecosystem resilience by maintaining soil fertility, controlling pests, and reducing erosion. The concept of "climate-smart agriculture" (CSA), introduced by the FAO, represents a holistic approach to managing agricultural systems under climate change. CSA integrates three pillars: increasing productivity, enhancing resilience, and reducing emissions. According to Maniatakou et al. (2024), CSA strategies include precision farming, efficient irrigation systems, and integrated crop-livestock systems. These approaches not only reduce environmental footprints but also improve farmers' incomes and contribute to biodiversity conservation.

The social dimension of agriculture emphasizes equitable labor practices, resource distribution, and rural livelihoods. Allen et al. (1991) stress the importance of addressing issues such as land ownership rights, gender inequality, and farm workers' access to education and healthcare. As suggested by Jackson-Smith (2004), empowering women in agriculture leads to substantial productivity and household income gains. Janker and Mann (2020) further emphasize that ensuring food safety and combating malnutrition are integral to the social sustainability of the agricultural sector. Pandey and Pandey (2023) examine the critical role of agriculture and geospatial technology in advancing food security and achieving Sustainable Development Goals (SDGs) in their study published in Sustainable

Development. The paper highlights how geospatial tools, such as remote sensing and GIS, can optimize agricultural practices, monitor resources, and enhance decision-making processes.

The role of agriculture in economic growth is discussed in this section. Agriculture has long been recognized as a cornerstone of economic development, especially in emerging economies. Advanced agricultural techniques, such as those explored by Omorogiuwa et al. (2014), significantly enhance productivity, driving economic output. However, the benefits are region-specific, relying on resource availability, governance structures, and infrastructure investments. Awokuse and Xie (2015) explore the critical role of agriculture in driving economic growth in developing countries, challenging traditional perspectives that often downplay its significance. The article examined whether agriculture serves as a primary catalyst for economic development or if its impact is limited to specific conditions. Using empirical data and econometric analysis, the authors demonstrate that agriculture significantly contributes to economic growth, especially in economies with high reliance on the agricultural sector. The findings highlight that investment in agricultural productivity and infrastructure can yield substantial economic benefits, including poverty reduction and employment generation. This work emphasizes the importance of integrating agriculture into broader economic policies to ensure inclusive and sustainable development in developing regions.

Effective governance and well-structured policy frameworks are critical for guiding agricultural development, ensuring resource efficiency, and addressing regional disparities. Governance plays a crucial role in shaping agricultural development. Lio and Liu (2008) underscore the importance of strong institutions and transparent policies in ensuring efficient resource allocation, adherence to environmental regulations, and equitable benefit distribution. Bayyurt and Arikan (2015) highlight the role of public-private partnerships and international collaborations in promoting sustainability by facilitating access to funding, technology, and expertise. For instance, the EU's Common Agricultural Policy (CAP) is a model for balancing subsidies with environmental and social compliance. The article analyzed governance indicators such as transparency, accountability, and institutional effectiveness to assess their impact on agricultural outcomes. Using a combination of theoretical frameworks and empirical data, the authors argue that good governance enhances resource allocation, reduces inefficiencies, and fosters sustainable agricultural development. Their findings suggest that improving governance practices, such as reducing corruption and increasing institutional support, can significantly boost agricultural efficiency, particularly in developing economies. This research underscores the importance of integrating governance reforms into agricultural policies to achieve long-term growth and sustainability.

Technological advancements, such as precision agriculture and improved seed varieties, are crucial for enhancing productivity. Connor et al. (2011) also note that technology-driven approaches, such as drip irrigation and precision agriculture, minimize waste while maximizing yields. Zhang et al. (2022) emphasize that investment in R&D fosters innovation, enabling farmers to adopt new practices that improve efficiency and yield. However, a significant challenge lies in ensuring these innovations reach less productive regions, often constrained by limited resources and infrastructure. Also, Getahun and et. al. (2024) examined the application of precision agriculture technologies in promoting sustainable crop production and environmental sustainability in their systematic review. The study explores various precision agriculture tools, including remote sensing, GPS-based systems, and drone technology, and their role in optimizing resource use and minimizing environmental impacts. The Getahun and et. al. highlighted that these technologies enable precise monitoring of soil health, water usage, and crop

growth, leading to increased productivity and reduced waste. Furthermore, the review emphasizes the potential of precision agriculture to mitigate the adverse effects of climate change by promoting adaptive farming practices. The study concludes that integrating precision agriculture technologies is crucial for achieving sustainable development goals related to food security and environmental conservation.

Green finance has emerged as a mechanism for promoting resource efficiency, reducing environmental degradation, and fostering sustainable economic growth in the face of global environmental challenges. Xu, She, Gao, and Sun (2023) investigated the role of green finance in promoting resource efficiency and fostering green economic growth. The study highlights how green finance mechanisms, such as green bonds, sustainability-linked loans, and eco-friendly investments, can enhance resource allocation, reduce environmental degradation, and stimulate economic activities that align with sustainability goals. Using empirical analysis, the authors demonstrate that green finance not only drives innovation in sustainable technologies but also incentivizes businesses to adopt environmentally responsible practices.

Agriculture in Kazakhstan is integral to national economic stability, rural development, and food security. However, significant regional disparities in productivity and resource allocation persist. The country's geographical diversity, including vast steppes, mountains, and varied climatic conditions, creates unique challenges for farmers. Southern regions benefit from warmer temperatures and longer growing seasons, whereas northern regions face shorter seasons and cooler climates, necessitating region-specific agricultural policies. Tolkynova and Shalabayev (2021) highlight significant disparities between the northern and southern regions, with the north favoring cereal crops due to its cooler climate and fertile soils, while the south supports fruit and vegetable cultivation due to its warmer weather and longer growing seasons. The study emphasizes the need for region-specific agricultural policies and practices to optimize productivity and sustainability.

Technology and innovation remain underutilized in many regions, with less productive areas particularly lagging due to limited resources and infrastructure. The paper, which is written by Gollin (2010) discussed the long-term impacts of technological innovation, policy reforms, and market integration on enhancing productivity. By analyzing historical and contemporary data, Gollin underscores agriculture's foundational role in initiating and sustaining economic growth, while also addressing the challenges of resource allocation and environmental sustainability in the agricultural sector. Climate change poses a pressing challenge for Kazakhstan's agriculture, with extreme weather events, shifting precipitation patterns, and rising temperatures impacting crop yields and livestock health (Tleuberdin & Abdimanapov, 2020).

Socio-economic factors, including rural employment and market dynamics, further influence the sector's performance. Stable producer prices and targeted government interventions, such as subsidies and credit facilities, are essential for addressing disparities and ensuring sustainable growth (Nurbekov et al., 2021; Toimbek, 2022). Moreover, Tsoy and Nurbatsin (2024) and Abraliyev et al. (20214) highlighted the regional disparities in agricultural development within Kazakhstan in their study. The paper explores the variations in agricultural productivity, infrastructure, and resource allocation across different regions of the country. Through the combination of quantitative and qualitative analyses, the authors identify the important factors contributing to these disparities, such climatic conditions, economic policies, and technological changes.

The reviewed literature highlights the multifaceted nature of agricultural development, influenced by climatic, technological, socio-economic, market-related, and policy-driven factors. Addressing regional disparities through tailored approaches that

account for unique geographical and climatic conditions is crucial for Kazakhstan. Technology, infrastructure, and R&D investments, combined with adaptive strategies to combat climate change, can boost agricultural productivity and sustainability. Integrating ESG principles into agricultural policies will further enhance the sector's resilience and contribute to achieving broader economic, social, and environmental goals. By fostering collaboration between the government, research institutions, and farming communities, Kazakhstan can establish a more equitable and sustainable agricultural sector that ensures long-term food security and rural development.

3. RESEARCH METHODS

A multidimensional approach was used to assess the level of development of the agricultural sector in the regions of Kazakhstan. This approach includes an assessment of agricultural production volume and indicators of its profitability and sustainability. The primary research tool is an integral index that considers key indicators affecting productivity. The paper used the following methods: correlation analysis to determine the relationship, regression analysis after filtering variables, integral index for a generalized assessment of agricultural productivity by region, and cartographic analysis.

Thus, the analysis in this work was carried out in four stages:

Step 1. Correlation Analysis. The first step was a correlation analysis to determine the direction and strength of the relationship between independent variables (such as soil temperature, producer price index, acreage, etc.) and the dependent variable - the volume of agricultural products. This analysis allowed us to identify significant factors affecting productivity and eliminate insignificant ones.

Step 2. Regression Analysis. In the next stage, regression analysis was used to assess the magnitude and significance of the influence of independent variables on the dependent variable. This method allowed us to determine the weight of each factor in the formation of the overall result and assess its statistical significance. Based on the regression analysis results, weights were calculated for each factor, which were then used in constructing the integral index.

Step 3. Building an integral index. The integral index is a composite indicator combining many agricultural development factors into one measure. The weights applied to each factor were derived from regression analysis and reflect the relative importance of each indicator in determining the level of agricultural production. Thus, this index allows to identify regional differences and areas for increasing agrarian productivity and sustainability in various regions of Kazakhstan.

Step 4. Cartographic method and recommendations. The proposed approach allows not only to identify the weaknesses and strengths of agricultural development in each region, but also to formulate recommendations for improving the situation in those regions that need support. The cartographic method was also used to visualize the data obtained and their spatial analysis, which made it possible to identify regional differences and identify areas with the greatest potential for development.

The methodology integrates statistical and spatial tools to provide a comprehensive framework for analyzing regional agricultural productivity and sustainability. Several steps were undertaken to evaluate the regions of Kazakhstan, as illustrated in Figure 1.

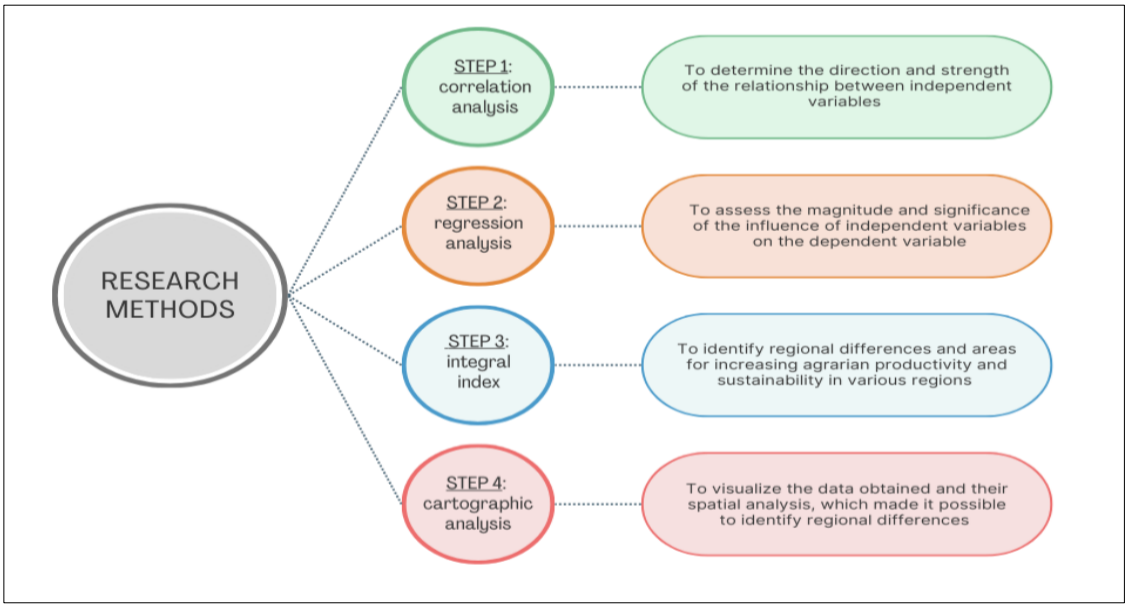


FIGURE 1. The steps of analysis

Note: compiled by authors

Figure 1 shows that the first step was to conduct a correlation analysis. This determines the direction and strength of the relationship that exists between independent variables - for example, soil temperature, producer price indices, sown area, etc., and the dependent variable. On the other hand, variables which are poorly correlated or show a negative relationship might have less impact or be harmful to growth. Correlation sifts those variables that have the most significant impact on agricultural output, otherwise the importance of less relevant variables or underestimate important factors.

Then, after filtering the variables, regression analysis was used to estimate the magnitude and significance of the relationships between independent variables and the dependent variable. In this case, the dependent variable is regional agricultural productivity, while the integral index is an aggregated measure of multiple factors influencing agricultural development. The weights assigned to each factor were obtained through regression analysis and reflect the relative importance of each variable in determining agricultural output. To further deepen the analysis, a cartographic approach is employed. This method adds a spatial dimension to the research, allowing the visualization of data collected and calculated in previous stages. By mapping out regional differences, it becomes easier to highlight spatial discrepancies in agricultural productivity and pinpoint underperforming areas. Identifying regions with the greatest potential for growth helps to better understand the spatial variation and effectively communicate findings with policymakers and stakeholders.

The approach outlined integrates statistical and spatial analyses to provide a comprehensive understanding of regional agricultural dynamics. The presented methodology effectively addresses complex regional agricultural issues.

4. FINDINGS AND DISCUSSIONS

The analysis of agricultural productivity in Kazakhstan requires a comprehensive understanding of the factors that influence regional performance. Key indicators such as soil surface temperature, economic variables like producer price indices and R&D expenditure, and agricultural activity metrics like sown area and harvested area provide a

holistic framework for evaluation. By employing correlation and regression analyses, this study identifies the main drivers and barriers to agricultural output, highlighting the interconnectedness of environmental, economic, and production-related variables. These findings offer insights into regional disparities and potential strategies for enhancing agricultural sustainability and efficiency across Kazakhstan.

The selection of the variables listed for the study of agricultural development in Kazakhstan, particularly for the assessment of regional development in crop production, is based on their direct and indirect influence on agricultural productivity and economic sustainability in Table 1.

TABLE 1. Indicators for analysis

No.	Type	Indicator / unit of measurement
1	Weather and climate conditions	Soil surface temperature, degrees.
2	Agricultural price indices	Producer price index for agricultural products.
		Producer price index for crop products.
		Producer price index for livestock products.
3	Tarif index	Index of tariffs for freight transportation by all types of transport.
4	Economic indicators	Domestic R&D expenditure (research and development), million tenge.
		Employment in the economy (total and in agriculture), thousand people
5	Agricultural activity indicators	Total adjusted sown area, hectares.
		Harvested area of main agricultural crops, hectares.
		Indices of physical volume of gross agricultural output (services).

Note: compiled by authors

These variables offer a comprehensive framework to analyze the agricultural performance and regional development in Kazakhstan. They balance both natural factors (such as soil temperature) and economic indicators (price indices, R&D expenditure, employment), along with production metrics (sown area, harvested area, output index).

In figure 2, we observe the relationships between nine variables related to agricultural and economic factors in Kazakhstan.

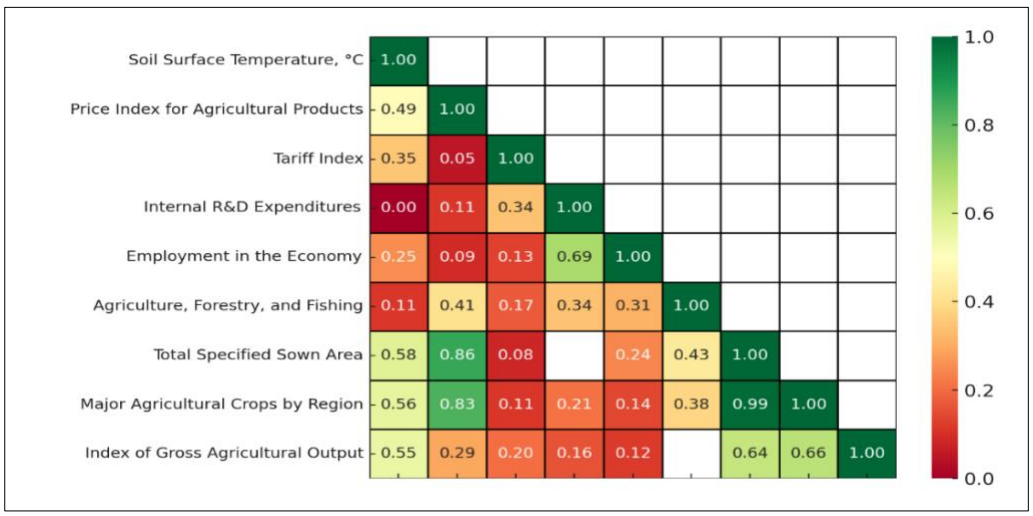


FIGURE 2. Results of correlation analysis

Note: compiled by authors

In the presented diagram, a correlation matrix between various variables is visualized as a heat map in the format of heat maps. The color scheme shows the degree of relationship between variables, with green indicating a high positive correlation and red indicating a low correlation. For variable soil surface temperature, both positive and negative correlations were identified. The correlation with the producer price index for agricultural products was 0.49, indicating a moderate positive relationship. This suggests that higher soil temperatures are associated with higher prices for agricultural products. However, for variables such as total specified sown area and harvested area of major agricultural crops, the correlation was negative. A high negative correlation could indicate that, with increasing soil temperature, areas sown and areas harvested are lower. This is probably due to poor growing conditions in hotter climates for crops.

Overall, the soil surface temperature seems to play a significant role in agricultural productivity, as evidenced by a strong positive correlation with the physical volume index of agricultural output. On the other hand, there is a strong negative correlation between producer prices and areas sown and harvested, indicating that higher prices may be driven by low supplies, resulting in smaller areas of cultivation. While internal R&D expenditure is positively correlated with employment, underscoring the vital role of innovation in creating jobs, agricultural output has almost no relationship with it. Agricultural areas both sown and harvested are inversely related to output, indicating inefficiencies in production, where mere increase in area under cultivation does not lead to increased productivity.

Those variables which may be considered for regression analysis based on their significant relationship in this correlation analysis. These two variables will help model the main drivers and barriers to agricultural productivity in Kazakhstan. Soil surface temperature was chosen since this factor impacts directly agricultural productivity by setting the growth conditions for crops. Including this helps capture the environmental influence on agricultural performance. The producer price index for agriculture products reflects the changes in prices for agricultural products. This becomes important when considering how market conditions affect profitability and sustainability; hence, it is one of the key variables for determining regional economic health. The total area sown broken down indicates the size of the area under agricultural use. It depicts the agricultural potentiality of a region, which is great and needed when assessing the production potentialities and resource allocation. Employment in the economy provides an accounting for the availability of the labor force and its potential impact on regional agricultural productivity and economic conditions.

The Table 2 shows the regression output provides insight into how several factors affect the dependent variable, which is presumably the Index of physical volume of gross agricultural output.

TABLE 2. The result of regression analysis

Indicator	Coeff.	Stnd.Err	*t*	P-value	Lower 95%	Upper 95%
Intercept	301,99	52,43	5,76	0,00	190,24	413,75
Soil surface temperature	0,84	0,42	1,99	0,07	- 0,06	1,73
Producer price index for agricultural products	-1,95	0,48	- 4,06	0,00	- 2,98	- 0,93
Total specified sown area	-0,01	0,00	- 5,05	0,00	- 0,01	- 0,00
Employment in the economy, total	-0,01	0,01	- 1,47	0,16	- 0,03	0,00

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.

Based on this analysis, weights for the Integral Index Weights is made. The absolute value of coefficients of regression is taken and applied to the data below (Table 3).

TABLE 3. 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

Positive Areas in Figure 4 appear as green, reflecting stronger agricultural development and productivity. Neutral Areas would be in lighter shades to show moderate agricultural performance. Negative Areas would appear in red to reflect serious problems in agricultural development.

Figure 4 shows a geographic map of the integral index weights of agricultural development within different regions of Kazakhstan, which allows for a visual understanding of the disparities in agricultural performance.

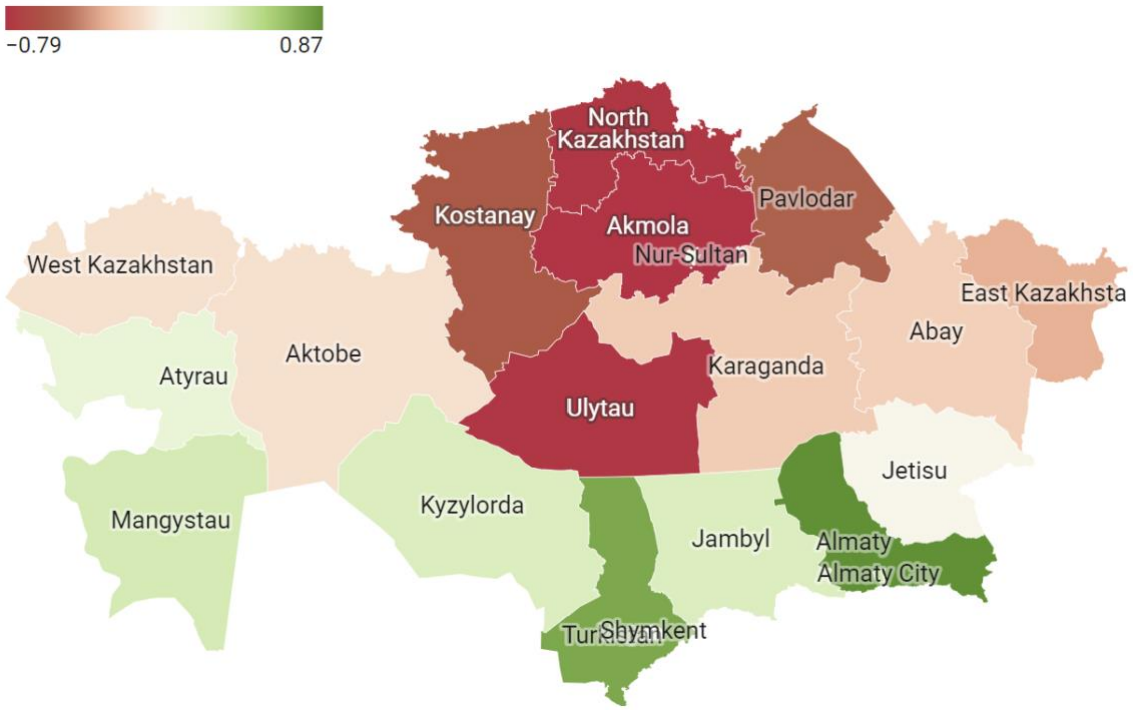


FIGURE 4. Regional Agricultural Development Index Map of Kazakhstan

Note: compiled by authors

Results above of the Integral Index Weights from the geographic table allow for presenting agricultural development for regions of Kazakhstan explicitly: The highest positive weights fall to the Almaty region with 0.87 and the Turkestan region with 0.77, which already shows very strong development of agriculture in these regions.

This may indicate not only a proper exploitation of resources but also good agricultural practice and, probably, favorable climatic conditions that could raise the agricultural output. This is followed by Almaty City with 0.58: the urban area has considerable agricultural activity. This perhaps indicates the concentration of agricultural services or innovation, or regional support systems that might enhance agricultural output. Further, Mangystau shows 0.41, Jambyl 0.38, and Kyzylorda 0.38-each of these also has positive integral index values, meaning fairly good agricultural development levels in these regions. Neutral to Low Positive Weights Regions like Shymkent at 0.29, Atyrau at 0.29, and Nur-Sultan at 0.27 have lower positive weights, suggesting fair to moderate agricultural development. This might mean that there is still scope for growth but also points

toward the issues that need development concerning agricultural infrastructure and investment. The negative weights of regions, such as Aktobe with a weight of -0.07, West Kazakhstan -0.07, Abay -0.15, and Karaganda -0.16, determine their potentially problematic agricultural productivity due to unfavorable environmental conditions, low investment in agricultural practices, or an undeveloped agricultural infrastructure. The most unfavorable regions are East Kazakhstan (-0.27), Pavlodar (-0.50), Kostanay (-0.54), North Kazakhstan (-0.77), Ulytau (-0.77), and Akmola (-0.79); they all show noticeably negative values, which may indicate serious problems in agricultural development. These regions probably need urgent attention to improve agricultural practices, increase funding, or implement policies that help enhance agricultural productivity.

There is much variation in the level of agricultural development across and within regions. However, the central part and southern part seem better off than those in northern and eastern parts. Therefore, the policymakers are suggested giving attention to those regions of negative or low positive weights by investing in their infrastructure, training, and technology so that agricultural productivity may be enhanced. Regions with high positive weights can thus be examples for the leading regions in agricultural practices, sharing resources and best practices to uplift lagging regions. This integrated index provides a useful framework for understanding the disparate magnitudes of agricultural development across various regions in Kazakhstan. By exploiting the strengths of more productive regions and tackling the challenges in less-developed areas, a balanced approach can be used to enhance the overall agricultural output and sustainability in Kazakhstan.

5. CONCLUSIONS

Agricultural development assessment in regions of Kazakhstan represents a very complicated picture with serious differences in the productivity level and resource use. An integral index included in the present study is a tool that helps to explain these variations and enables politicians to define the regions that need immediate attention and support.

The analysis identified both leading regions and problem areas.Thus, the study made a significant contribution to understanding the factors influencing agricultural productivity and provided practical recommendations for economically sound decision-making at both the national policy and regional management levels.

The study highlights pronounced regional disparities in the agricultural development of Kazakhstan, shaped by both natural-climatic and economic factors. Regions such as Almaty and Turkestan exhibit the highest integral index values, a reflection of their favorable climatic conditions, effective resource management, substantial infrastructure investment, and active adoption of innovative practices. These regions represent exemplary management models that could be adapted to improve agricultural performance across other territories.

Conversely, North Kazakhstan, Pavlodar, Kostanay, and Ulytau regions demonstrated negative integral index values, indicative of their lower agricultural productivity. The challenges in these regions stem from limited investment access, low levels of innovation, and adverse climatic conditions, which collectively hinder their economic potential.

Regions like Zhambyl and Kyzylorda, which reported moderate index values, underscore a complex mix of positive trends and persistent structural constraints, such as insufficient technological modernization and low employment levels. These regions present significant growth potential, contingent upon targeted funding and the integration of advanced agricultural technologies.

The economic analysis further emphasizes the critical role of increasing agricultural employment, enhancing infrastructure, and stabilizing market prices for agricultural products. Achieving this will require strategic interventions, including heightened investment in research and development and expanded

state support programs tailored to the needs of underperforming regions.

Addressing regional disparities in agricultural productivity is pivotal for advancing overall economic stability and food security in Kazakhstan. By adopting a region-specific approach that accounts for unique local characteristics and systematically monitoring the impact of implemented measures, policymakers can foster a balanced and sustainable agricultural sector that contributes to the nation's broader development goals. Regions such as North Kazakhstan, Pavlodar, Kostanay, and Ulytau demonstrate the weakest agricultural performance, as evidenced by their negative integral index values. These results highlight profound structural and environmental challenges that inhibit productivity. Among the key factors are limited access to investment capital, insufficient integration of innovative practices, and adverse climatic conditions that further exacerbate the constraints on agricultural development.

The persistence of these issues underscores the need for urgent and targeted intervention. Addressing these disparities will require a multifaceted approach, combining enhanced investment mechanisms, support for research and development to drive innovation, and adaptive measures to counteract unfavorable environmental conditions. These regions, characterized by their lagging agricultural output, reflect the broader necessity of crafting strategies that not only address immediate productivity concerns but also pave the way for sustainable, long-term growth. Without such efforts, the economic and social potential of these territories risks remaining unfulfilled, perpetuating regional inequalities in Kazakhstan's agricultural sector.

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The Impact of Economic and Environmental Factors on the Consumption of Renewable Energy: The Case of Kazakhstan

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ABSTRACT

The article examines the impact of economic and environmental factors on the consumption of renewable energy sources (RES) in Kazakhstan. The study is based on a quantitative analysis of data, including adjusted net savings (ANS), the share of renewable electricity output (REO), and carbon dioxide (CO_2) emissions per capita. The dependent variable in this analysis is the share of renewable energy in the total final energy consumption. The results of the regression analysis revealed the following relationships: an increase in the share of electricity production from renewable energy sources (REO) by 1% leads to an increase in their consumption by 0.119% ($p < 0.01$), which is associated with reduced production costs and improved accessibility. Adjusted net savings (ANS) also have a positive effect: their growth by 1% increases renewable energy consumption by 0.055% ($p < 0.05$), confirming the role of economic stability and investment in the development of green energy. At the same time, an increase in CO_2 emissions negatively affects renewable energy consumption, decreasing it by 0.154% for each additional ton of CO_2 per capita ($p < 0.01$), which is explained by the predominance of traditional hydrocarbon energy sources. The study highlights that the sustainable development of renewable energy sources requires a comprehensive approach, including the stimulation of its production, reduction of carbon emissions, and maintenance of economic stability. The results have practical value for the formation of Kazakhstan's state policy aimed at transition to sustainable energy and reducing environmental pressure.

KEYWORDS: Renewable Energy, Energy Consumption, Carbon Emissions, Electricity Output, Sustainable Development, Economic Stability

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1. INTRODUCTION

Since fluctuations in global oil and gas prices significantly impact Kazakhstan's economy, diversifying energy sources through renewable energy use has become a strategic priority. Kazakhstan is a major producer and exporter of fossil fuels, such as oil, natural gas, and coal. The country ranks 9th globally in coal production, 17th in crude oil production, and 24th in natural gas production (IEA, 2020). The country's total oil reserves are estimated at 30 billion barrels, with proven natural gas reserves of 2.3 trillion cubic meters (BP, 2021). As a result, as an oil and gas exporting country, Kazakhstan is vulnerable to global market fluctuations, which could adversely affect national income and economic stability.

The installed capacity of renewable energy sources (RES) has been steadily increasing each year. As of January 1, 2020, the installed capacity of RES facilities was 1050 MW, and by January 1, 2023, it had reached 2388 MW, marking an increase of approximately 2.3 times over three years. By the end of 2023, Kazakhstan's total installed capacity of renewable energy sources amounted to 2.9 thousand MW, which is 20.1% higher compared to the end of 2022. Compared to 2018, the capacity of renewable energy facilities increased significantly by 5.4 times (Energyprom.kz, 2024).

The volume of energy produced by renewable energy sources (RES) has also been increasing annually. In 2020, 2400 million kWh of electricity was produced, and by 2023, this had grown to 5110 million kWh. In the period from January to December 2023, the electricity generation from renewable energy sources amounted to 6675 million kWh, showing a 30.6% increase compared to the same period in 2022. The share of electricity produced by renewable energy facilities in the total volume of electricity production increased from 4.5% to 5.9% (Energyprom.kz, 2024).

The number of people employed in the renewable energy sector is also growing. In 2020, it amounted to 955 people, and in 2023 this figure reached 1660 people. Between 2020 and 2023, Kazakhstan's renewable energy sector has developed rapidly and undergone significant changes. The increase in the number of RES facilities, the substantial growth in their installed capacity, and the rising share of electricity generation from renewable sources highlight the sector's potential. For instance, the theoretical capacity of solar energy in Kazakhstan is about 2,500-3,000 hours of sunlight per year (USAID, 2020), which is one of the highest in the world. The capacity of wind energy is also huge – about 1,820 billion kWh per year (USAID, 2020). Therefore, it is important to study the impact of the integration of renewable energy sources on sustainable economic development. At the same time, there is a need to study in more depth the various aspects that contribute to these trends in order to ensure the efficiency and sustainability of the level of RES consumption.

By increasing the consumption of renewable energy, Kazakhstan not only seeks to diversify its economy but also to reduce dependence on energy imports and stabilize the domestic market. Therefore, studying the factors influencing the level of renewable energy consumption in Kazakhstan has become one of the key issues today.

In general, a broad examination of the indicators affecting renewable energy consumption has become a major topic of interest for researchers and experts at both global and national levels. Numerous studies have explored the relationship between energy consumption and its influencing factors (Şener et al., 2018; Bourcet, 2020). However, it is challenging to claim that all factors influencing renewable energy consumption have been fully studied. Specific models and data for Kazakhstan are particularly scarce. Additionally, it is essential to consider that each aspect (factor) of renewable energy use can have either a positive or negative impact. The interaction of these factors could significantly influence the formation of policies for renewable energy use.

This study will provide a scientific basis for developing the renewable energy sector and achieving environmental sustainability in Kazakhstan, as well as help identify the link

between increasing renewable energy production and improving environmental indicators.

The structure of this work is as follows: The second section reviews the literature; the third section explains data sources, model specifications, and methodology; the fourth section presents empirical results along with brief discussions. The final section provides conclusions and recommendations.

2. LITERATURE REVIEW

There are many studies in the literature to determine the factors affecting the demand for renewable energy consumption. Several academic studies have examined the economic, technical, environmental, and political factors that determine renewable energy consumption (Aguirre & Ibikunle, 2014; Papież et al., 2018; Lin et al., 2016; Omri & Nguyen, 2014). Some empirical research has identified a direct link between energy consumption and carbon dioxide (CO2) emissions (Mukhtarov et al., 2020). Furthermore, researchers indicate that the development of the industrial, agricultural, and service sectors is essential for a country's growth and significantly impacts national income. All three sectors are highly dependent on energy availability, indirectly increasing CO2 emissions (Nugraha & Osman, 2019). Nevertheless, despite the significant amount of research dedicated to the development of renewable energy sources (RES) and their impact on the economy, both globally and in Kazakhstan, certain gaps need to be explored.

In this section, the studies devoted to the impact of various indicators on the level of renewable energy consumption and the impact of renewable energy integration on economic growth in the case of different countries are reviewed.

Panel data analysis across many countries shows that renewable energy consumption is linked to per capita GDP growth (Al-Darraji & Bakir, 2020; Singh et al., 2019). This effect is observed in both developed and developing countries, with slightly stronger impacts in developed nations (Singh et al., 2019). The relationship between renewable energy and economic growth is either bidirectional or unidirectional, depending on the country (Soava et al., 2018). Beyond economic benefits, adopting renewable energy catalyzes green economic transformations, job creation, and enhanced energy security (Chou et al., 2023). It also positively correlates with industrial productivity and technological innovations, particularly in regions with abundant renewable resources (Chou et al., 2023). These findings support policy decisions to increase renewable energy consumption and highlight its potential as a driver of sustainable economic development (Soava et al., 2018; Chou et al., 2023).

Globally, much attention is focused on the impact of RES on macroeconomic indicators, including gross domestic product (GDP), employment, and sustainable economic growth. Studies in the European Union (Fischer & Newell, 2008) confirm that active adoption of RES leads to long-term economic growth, reduced dependence on hydrocarbon imports, and the creation of new jobs in the «green» energy sector.

For developing countries, studies show mixed results. Some authors, such as Apergis & Danuletiu (2014), note that the transition to RES may be accompanied by temporary economic losses due to the need for significant investments and reduced revenues from traditional energy resources. At the same time, research in China shows that RES can become a powerful catalyst for stimulating long-term economic growth when supported by government policies and incentives for private investment (He & Huang, 2021).

Sadorsky (2009) analyzed the effects of real GDP per capita, CO2 emissions, and oil prices on renewable energy consumption using various panel cointegration methods with annual data from 1980 to 2005 for the G7 countries. He found that real GDP per capita and CO2 emissions positively and significantly influence renewable energy consumption, whereas oil prices have a negative impact. Salim & Rafiq (2012) examined how renewable energy consumption relates to real

GDP and oil prices across six emerging economies, applying methods like panel fully modified ordinary least squares (FMOLS), panel dynamic ordinary least squares (DOLS), and the autoregressive distributed lag (ARDL) approach. Their ARDL findings revealed that oil prices negatively and significantly affect renewable energy consumption in China and Indonesia, while having no significant effect in Brazil, India, the Philippines, and Turkey. Additionally, both panel DOLS and FMOLS analyses indicated that the impact of oil prices was statistically insignificant.

Hassoun and Hicham (2020) investigated the relationship between the renewable energy and the sustainable development. The authors employed the endogenous variable the adjusted net savings as the sustainable development factor, the renewable energy consumption as the exogenous variable. Their research is based on a balanced panel model, panel random effect model and a panel ARDL cointegration model. The outcomes showed that the renewable energy consumption has a negative and significant impact on the adjusted net saving in the short-run, but in the long-term the renewable energy consumption has a positive influence on the sustainable development factor.

Behboudi et al. (2017) employed a Bayesian vector autoregressive to study the link among the adjusted net saving, carbon dioxide emissions (CO2), renewable and non-renewable energy for the case of Iran during the period of 1980-2013. They concluded with impulse response that there is a positive influence of renewable and nonrenewable consumption on (ANS), while the adjusted net saving has a positive impact on renewable energy consumption, but a negative effect on non-renewable energy consumption.

You (2011) analyzed the relationship between energy and (ANS) in China during the period of 1980-2004. The authors concluded that the consumption from renewables and non-renewables contribute positively to increase the rate of the adjusted net saving.

A study covering 193 countries from 2011 to 2020 found that renewable electricity generation is positively associated with adjusted net savings and renewable energy consumption, while negatively affecting CO2 emissions. This suggests that increasing renewable energy generation can contribute to the development of an environmentally sustainable economy and improve environmental quality (Laureti et al., 2022). Additionally, the study also used a variety of econometric techniques, including panel data regression and machine learning algorithms, to predict future trends in renewable electricity generation.

Behboudi & Moosavi (2014) analyzed the relationship between sustainable development (measured by adjusted net savings), the human development index, natural resource exports, and the quality of governmental institutions (such as rule of law, political stability, etc.) across 11 MENA countries from 1996 to 2010. Using panel cointegration methods, they found that natural resources have a significant and negative impact on sustainable development.

Mirziyoyeva & Salahodjaev (2022) examined the link between renewable energy and CO2 emissions intensity in the countries with the highest carbon emissions from 2000 to 2015. For these purposes the authors employed panel data methods such as fixed effects regression and the two-step GMM estimator. According to their study, the findings indicate that renewable energy significantly reduces CO2 emissions. Specifically, a 1% increase in renewable energy consumption is associated with a 0.98% reduction in CO2 emissions.

The relationship between renewable energy (RE) consumption and CO2 emissions in a sample of major renewable energy-consuming countries over the period 2000–2015 was studied by Huang et al. (2021). The primary contribution of their study was to address whether a substantial shift toward renewable energy consumption would result in lower CO2 emissions. Using the two-step generalized method of moments (GMM) estimator; authors' empirical findings indicated that RE has a significant negative impact on CO2 emissions: a one percentage point increase in

RE consumption leads to a 0.5% decrease in CO2 emissions.

In Kazakhstan, research in this area is more limited. Existing works, such as the study by Sansyzbayeva et al. (2020), justify the need for accelerated and active use of renewable energy sources in Kazakhstan based on the analysis of both domestic and international experience. The study identifies the positive and negative aspects of renewable energy development and the factors hindering its progress.

Other studies indicate a positive correlation between renewable energy consumption and economic growth in a country (Sarkhanov & Huseynli, 2022; Abdibekov et al., 2023). While renewable energy shocks have a limited impact on economic growth, their effect on growth variance decomposition is higher for Kazakhstan compared to Turkey (Abdibekov et al., 2023). It is expected that the support of renewable energy by the government of Kazakhstan through national targets, policies, and auction systems will contribute to sustainable economic growth and the development of a green economy (Bespalyy, 2021).

Issayeva et al. (2023) examined the industrial production index, economic growth, and the percentage of energy produced from renewable energy sources in Kazakhstan's energy consumption and CO2 emissions. The study data were analyzed using the Johansen cointegration test, vector autoregressive (VAR) analysis, Granger causality analysis, and the VECM model. In the study, they examined three key factors that affect CO2 emissions in Kazakhstan. The results of their study showed that these factors account for 16.1% of the variability in CO2 emissions, indicating the statistical accuracy of the selected variables.

Raihan & Tuspekova (2022) in their research examine the potential of economic growth, renewable energy use, and technological innovations to achieve environmental sustainability by reducing CO2 emissions in Kazakhstan. Time series data from 1996 to 2018 were analyzed using the Dynamic Ordinary Least Squares (DOLS) method. The DOLS estimation results indicate that the coefficient for economic growth is positive and significant with respect to CO2 emissions, suggesting that a 1% increase in economic growth is associated with a 0.34% rise in CO2 emissions.

These studies collectively emphasize the crucial role of renewable energy in promoting sustainable development across various economic contexts. However, the main drawback of existing studies is that much focus either on the environmental aspects of renewable energy development or energy security issues. Their impact on long-term economic indicators, such as investment, trade balance, and adjusted net savings, has not been sufficiently studied. Kazakhstan, as a resource-dependent economy, requires a specific approach that takes into account not only the transition to renewable energy but also the potential risks associated with reduced hydrocarbon revenues and the costs of implementing new technologies.

One of the important scenarios of factor interaction includes examining the impact of adjusted net savings (as a percentage of GDP), carbon dioxide emissions (per capita, in tons), and the volume of renewable electricity production (as a percentage of total energy produced) on renewable energy consumption (as a share of total energy consumption). However, the interrelationships between renewable energy, CO_2 emissions, adjusted net savings, and renewable energy production have not been comprehensively studied. While previous research has analyzed the general benefits and economic viability of renewable energy use, the direct impact of these factors on consumption levels has not been investigated in Kazakhstan's context. This situation enhances the theoretical and practical significance of the study. Specifically, evaluating and analyzing the interrelationships of the proposed indicators and their capacity to influence the growth in renewable energy consumption could help reduce the environmental burden in the country. Additionally, developing domestic electricity production based on renewable energy sources would allow Kazakhstan to reduce dependency on energy imports and

stabilize the domestic energy market, which could, in turn, play a key role in the nation's transition to a «green economy». Therefore, the study aims to identify opportunities for achieving sustainable development in Kazakhstan by analyzing the relationships between renewable energy consumption, CO_2 emissions, and adjusted net savings.

3. METHODOLOGY

The study employed a quantitative research method to examine the impact of sustainable development indicators on the share of renewable energy consumption. This method involves collecting quantitative data and using statistical techniques to test hypotheses about the relationships between variables.

The research design focuses on correlational analysis, as it aims to determine the strength and direction of relationships between dependent and independent variables. Thus, this study investigates the impact of factors such as the volume of renewable electricity production (as a percentage of total electricity), adjusted net savings (ANS), and CO2 emissions (in metric tons per capita) on renewable energy consumption in Kazakhstan. Table 1 provides explanations of the variables used in the study and their data sources.

TABLE 1 - Explanation of variables and their data source

Variable	Explanation	Data source
RES	Renewable energy consumption, share of total final energy consumption, in %	World Bank Data
REO	Output of renewable electricity production, share of total energy production, in %	World Bank Data
ANS	Adjusted net savings, share of gross national income, in %	World Bank Data
CO_2	CO_2 emissions, tons per capita	World Bank Data

Note: compiled by authors

In this study, renewable energy consumption is considered as the share of renewable energy in the country's total final energy consumption, and this indicator is used as the dependent variable. The independent variables include the volume of renewable electricity output (REO), expressed as a percentage of total electricity production, and CO2 emissions measured in tons per capita. The independent variable ANS (Adjusted Net Savings) represents adjusted net national savings, expressed as a percentage of gross national income (% GNI).

It considers profits and costs (depreciation of fixed capital, depletion of natural resources and forests, and pollution-related damages). The study used secondary data from Kazakhstan, spanning from 2001 to 2020. Thus, look at the formula (1):

$$ES = \beta_0 + \beta_1 \cdot REO + \beta_2 \cdot ANS + \beta_3 \cdot CO_2 + \varepsilon \quad (1)$$

where:

RES – consumption of renewable energy sources, % of total energy consumption;

REO – volume of renewable electricity production, % of total electricity production;

ANS – adjusted net savings, % of gross national income;

CO_2 – CO_2 emissions, metric tons per capita;

β_i – the coefficients of the equation.

The coefficients of the obtained equations were analyzed to increase their significance level. In this case, the student's t-test was used to test the statistical predictions. The assessment was based on comparing the statistical and critical values of the F-test (Fisher's test). Time series analysis was performed using the STATA 17 software.

Within the scope of the study, the residuals of the model variables, specifically the differences between empirical and theoretical variables, were also examined. This included testing for the normal distribution of the model

residuals and considering the null hypothesis (H0) that there is no first-order autocorrelation in the vector of regression model residuals. For this purpose, the Durbin-Watson tests were used, as this test indicates whether autocorrelation in the residuals suggests the model is correctly specified or if time series patterns are accounted for in the model (Rybak et al., 2024).

Furthermore, look at the formula (2):

$$DW = \frac{\sum_{i=2}^{n}(\varepsilon_i - \varepsilon_{i-1})^2}{\sum_{i=2}^{n}\varepsilon_i^2} \qquad (2)$$

Where: ε_i – residuals of the regression model, n is the number of observations.

According to the hypothesis acceptance theory based on the Durbin-Watson criterion, the critical values form five regions for different statistical decisions (Kobzar, 2006).

In addition, in this study, Spearman's rank correlation test was used as a nonparametric test to assess the presence of heteroscedasticity in the random errors of the regression (econometric) model. Spearman's test allows for the evaluation of the strength and direction of the association between the ranked values of variables, making it a valuable tool for checking the robustness of model results against heteroscedasticity and other violations in the error distribution.

The procedure involves estimating the initial linear regression model and determining the regression residuals (εt). The residuals and the variable xt, on which the variance of the random errors is presumed to depend, are then ranked, and the Spearman's rank correlation coefficient is calculated (3):

$$\rho = 1 - \frac{6 \cdot \sum d_t^2}{n(n^2-1)} \qquad (3)$$

where: d_t^2 is the squared difference of the ranks of the variables ε_t and x_t. Under the null hypothesis, which assumes no heteroscedasticity, the test statistic $\rho \cdot \sqrt{n-1}$ asymptotically follows a standard normal distribution.

In this case, if the coefficient significantly deviates from zero, it may indicate the presence of heteroscedasticity (Corder & Foreman, 1972).

4. FINDINGS AND DISCUSSIONS

Empirical results of the analysis are presented, focusing on the relationships between renewable energy consumption, adjusted net savings, renewable electricity output, and carbon dioxide emissions. Descriptive statistics of the key variables are followed by the outcomes of the regression analysis, highlighting the implications of the findings for Kazakhstan's renewable energy development.

Table 2 presents the descriptive statistics of the variables used in the model.

TABLE 2. Descriptive statistics

Variables	Obs	Mean	Std.dev.	Min	Max
RES	20	1.79	0.45	1.1	2.8
REO	20	11.05	2.13	8.1	15.24
ANS	20	17.52	2.90	9.98	23.47
CO_2	20	12.05	2.06	7.90	15.34

Note: Compiled by the authors using STATA 17

The table shows the number of observations for each variable based on 20 years of data (2001-2020). The average values were 1.79% for RES, 11.05% for REO, 17.52% for ANS, and 12.05 metric tons for CO2. These figures indicate that the share of renewable energy consumption is relatively low, while the share of renewable energy generation in total electricity is significantly high. The ANS value indicates the country's savings rate stability,

while the CO2 value indicates the dependence on conventional energy sources.

The standard deviation indicators reflect the degree of deviation of variables from the mean value. For instance, the standard deviation for RES is 0.45, indicating a significant stability of the indicator. In contrast, the relatively higher deviations of the REO and CO2 variables suggest more significant variability, which certain external or internal factors may influence. The minimum and maximum values indicate the dynamics of the variables over time. For example, RES changed from 1.1% to 2.8%, which may indicate an increasing trend in renewable energy consumption. The minimum value of the REO variable is 8.1%, and the maximum value is 15.24%, indicating a steady increase in production. The ANS indicator fluctuates from 9.98% to 23.47%, indicating the significant role of economic savings in the country. CO2 emissions range from 7.9 to 15.34 metric tons, characterizing considerable variability in the environmental situation.

Overall, the table provides a crucial statistical basis for assessing the relationship between renewable energy consumption and production, environmental conditions, and economic sustainability in Kazakhstan.

Table 3 presents the regression analysis results for three different specifications of the model used to study the factors influencing renewable energy consumption in Kazakhstan.

TABLE 3. Results of time series analysis (dependent variable – RES)

Variable	Specification		
	I	II	III
REO	0.119*** (0.037)	0.175*** (0.012)	0.09** (0.037)
ANS	0.055** (0.026)	0,073*** (0.024)	
CO_2	-0.154*** (0.04)	-0.118*** (0.034)	-0.116*** (0.039)
Constant	1.378 (0.857)		2.184** (0.842)
Number of observations	20	20	20
R^2	0.842	0.99	0.81
Significance test	F (3,16) = 34.73 [0.0000]	F (3,17) = 636.42 [0.0000]	F (2,17) = 41.38 [0.0000]

Note:
1) Compiled by the authors using STATA 17;
2) **, *** – statistical significance of coefficients at the 5% and 1% levels, respectively.

The specifications of the models in Table 3 differ in terms of included variables, explanatory power and interpretation of the influence of factors on the consumption of renewable energy. Specification I includes three independent variables: renewable energy production (REO), adjusted net savings (ANS), and CO2 emissions. The coefficients of all variables are statistically significant at the 1% and 5% levels, which is confirmed by low p-values. The value of the ANS coefficient is 0.055, which indicates a positive influence of savings on the consumption of renewable energy. This means that a 1% increase in adjusted net savings raises the share of renewable energy in total consumption by 0.055%. Growth in savings is generally associated with increased investments in sustainable energy, contributing to its development.

The REO coefficient is 0.119, which also indicates a positive effect: an increase in the share of renewable energy production by 1% increases its consumption by 0.119%. This effect is explained by the fact that the increase in production reduces the cost of renewable energy and makes it more affordable for use. However, CO2 emissions have a negative impact, with a coefficient of -0.154. This means that an increase in emissions of 1 ton per

capita reduces the consumption of renewable energy by 0.154%. This effect can be explained by the dominance of traditional energy sources. The increase in emissions in Kazakhstan is largely associated with the extensive use of conventional fuels such as coal and oil. This situation reduces the incentive to transition to renewable energy sources and supports the continued use of traditional energy sources. In addition, high emissions indicate a lack of effective environmental policies and the presence of barriers to the adoption of renewable energy.

Specification II demonstrates a higher explanatory power, with an R^2 value of 0.99, which indicates that the model explains 99% of the changes in the consumption of renewable energy. The coefficients of the variables in this specification are similar to those in Specification I; however, due to the removal of the constant from the model, their value is slightly higher. For instance, the coefficient for REO is 0.175, for ANS is 0.073, and for CO2 is 0.118. The high statistical significance of all variables (p-value less than 0.01) indicates that each of them has a significant influence on the dependent variable and is statistically significant at the 1% level. At the same time, the negative impact of CO2 highlights the need for stricter environmental regulations to encourage a shift toward cleaner energy sources.

Specification III excludes the variable ANS, retaining only REO and CO2. This reduces the value of R^2 to 0.81, which indicates that the model explains the variation of the dependent variable worse. Although the coefficient REO (0.09) and CO2 (-0.116) remain statistically significant, the absence of ANS makes the model less comprehensive, as it overlooks the impact of savings as a key factor.

The significance of the F-statistic, confirmed by the low level of Significance F across all three specifications, demonstrates that the proposed model adequately reflects the relationship between consumption and production of renewable energy, savings, and CO2 emissions.

A comparison of specifications shows that specification II is the best. The high value of R^2 (0.99) and the statistical significance of all variables confirm its reliability. Coefficients of variables demonstrate both positive (REO and ANS) and negative (CO2) impacts on consumption of renewable energy. The reasons for the positive effect include the improvement of the availability of renewable energy through the increase in its production and the growth of investments due to savings. The negative impact of CO2 emissions is associated with the competition of traditional energy sources and environmental pressures. These results highlight the need to stimulate renewable energy production and reduce emissions to increase its consumption. Thus, Specification II is the most suitable for analyzing the factors influencing renewable energy development in Kazakhstan.

Respectively, the general equation of the model is as follows:

$$RES = \underset{(0,012)}{0,175REO} + \underset{(0,024)}{0,073ANS} - \underset{(0,034)}{0,118CO_2} \quad (4)$$

This graph illustrates the relationship between the share of renewable energy production (variable REO) on the X axis and the consumption of renewable energy on the Y axis. The blue points reflect the observed values (Observed), that is, actual data, and the red line (Regression Line) represents a linear regression relationship between these two variables (see Figure 1).

The regression line has a positive slope, which indicates a direct relationship between renewable energy production and consumption. This means that when the share of renewable energy production increases, its consumption also rises. Most of the observed points are close to the regression line, which indicates a high degree of correspondence between the model and the actual data. However, some points significantly deviate from the line, which may be due to the presence of emissions or the influence of factors not taken into account in the model.

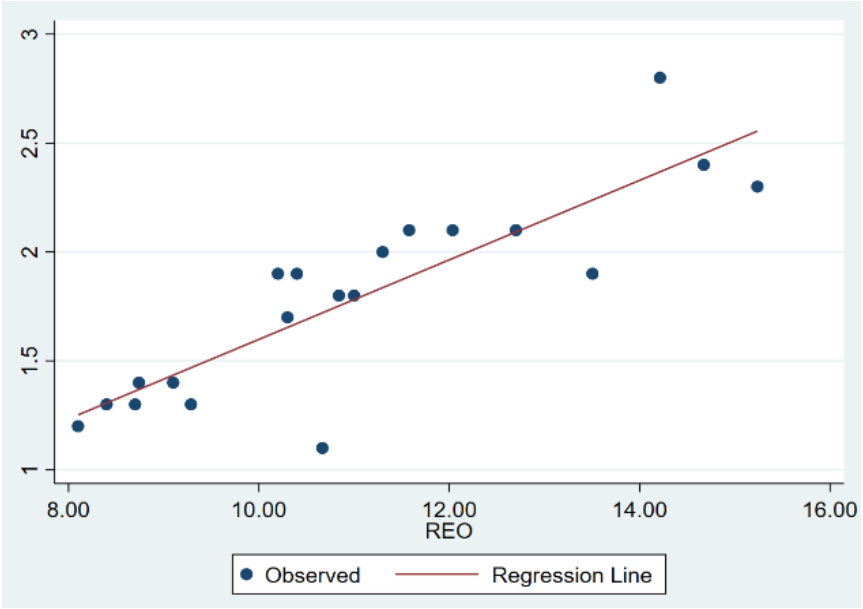


FIGURE 1. Graph of dependence between variables

Note: Compiled by the authors using STATA 17

The graph illustrates that the increase in the share of renewable energy (REO) production is positively correlated to its consumption, which confirms the results of the regression analysis.

Calculations based on the variables of the examined model show that the Durbin-Watson test value equals 2.19. Using Tables (Kobzar, 2006; Ayvazyan, 2001), the critical values of the Durbin-Watson statistic, specifically the lower bound (dl) and the upper bound (du), were determined based on the number of parameters in the regression model (k) and the number of observations (n).

In this case, the Durbin-Watson test value is 1.676<2.19<2.324. Accordingly, since the DW value lies in the range $du \leq DW \leq 4 - du$, it can be concluded that the residuals are not autocorrelated. This means that the model residuals do not depend systematically on the previous values, and the regression model adequately describes the data regarding the independence of errors.

When evaluating the presence of heteroscedasticity in the random errors of the regression model using Spearman's rank correlation test, the Spearman rank correlation coefficient (ρ) was found to be 0.19. Therefore, under the null hypothesis, the test statistic $\rho\sqrt{n-1}$ is observed to be asymptotically normally distributed. In this case, considering that the coefficient does not deviate significantly from zero, and based on the obtained results indicating the test statistic value is insignificant, it can be concluded that there is no heteroscedasticity in the examined model, and the residual variance is constant. The absence of heteroscedasticity confirms the model's validity and the reliability of the statistical results.

The residuals graph in Figure 2 confirms the results of the tests for autocorrelation and heteroskedasticity. This graph is used for visual analysis of the regression model's residuals. The residuals are the difference between the actual and predicted values of the dependent variable on the Y axis, and the linear predicted values are shown on the X axis.

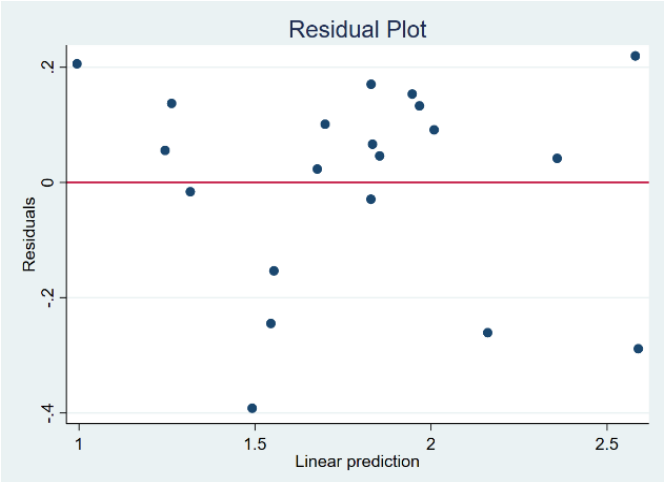


FIGURE 2. Graph of residuals

Note: Compiled by the authors using STATA 17

The main purpose of such a graph is to verify the validity of the assumptions of linear regression, such as the uniformity of the variance of the residuals (homoskedasticity) and the absence of systematic deviations (autocorrelation).

In this graph, the residuals are distributed around the line y = 0, which indicates that the model as a whole is correctly specified. This means that the forecast of the model is not systematically overstated or understated, and the residuals have a random character. If a clear dependency were observed in the plot, such as a curve or cone-shaped pattern, it would indicate an incorrect model specification or the presence of heteroscedasticity. If there is an increase or decrease in the residuals with the growth of the predicted values, it could indicate that the model is incorrectly constructed or that the data may have been improperly processed.

Figure 3 shows that in this model the residuals are generally randomly distributed around the line y = 0, indicating that the specification is correct and there are no obvious issues.

Thus, the regression results confirm that the model adequately describes the relationship between renewable energy consumption and the included factors. The key independent variables, such as the share of renewable energy production, adjusted net savings and carbon dioxide emissions, have a significant impact on renewable energy consumption.

The positive impact of renewable energy production on its consumption indicates that increased production volumes help reduce costs, enhance accessibility, and promote wider adoption of renewable sources. This underscores the need for further investment in infrastructure and technologies that enable the growth of clean energy production.

The role of savings in increasing renewable energy consumption is explained by their importance as a financial basis for investments in sustainable energy. A high level of savings reflects economic stability and create opportunities for long-term financing of green energy projects. This points to the need to develop mechanisms that support economic sustainability and encourage savings.

The negative impact of carbon dioxide emissions is due to the dominance of traditional energy sources. High emissions indicate a heavy dependence on coal, oil and gas, which slows the transition to renewable sources. This highlights the need for stricter environmental policies, the implementation of emission-reducing technologies and the creation of incentives for the use of renewable energy.

The model as a whole demonstrates high explanatory power and significance of the included variables. It confirms that the

development of renewable energy requires an integrated approach, including stimulating production, maintaining economic stability through savings, and reducing the environmental impact of traditional energy sources. These results emphasize the importance of coordinated public policy and private investment to ensure a sustainable energy transition.

5. CONCLUSIONS

The study confirmed that the development of renewable energy is a key element of sustainable economic growth and environmental stability in Kazakhstan. Increasing the volume of electricity production from renewable energy sources (REO) contributes to the growth of their consumption due to lower costs and increased availability. The high level of adjusted net savings (ANS) supports long-term investments in green energy, ensuring the necessary financial stability. However, the high carbon intensity of the Kazakhstan's economy and dependence on traditional energy sources (oil, gas and coal) significantly hinder the development of renewable energy sources. The negative impact of CO_2 emissions on the use of renewable energy confirms the country's relatively low inclination toward adopting alternative energy, as the increase in CO_2 emissions does not significantly push the country towards adopting environmentally friendly policies.

Based on the results obtained in this study, it can be concluded that policymakers in Kazakhstan should increase the share of renewable energy in the overall energy mix to diversify the economy and achieve sustainable economic development targets. It is also important to note that given the limited supply of oil and the need to reduce the environmental impact of fossil fuels, it is crucial to prioritize the production and use of renewable energy. This requires a stricter environmental policy, the introduction of emission reduction technologies and the creation of incentive mechanisms for the transition to renewable energy sources. To achieve a sustainable energy transition, Kazakhstan should focus on increasing investments in renewable energy infrastructure and technologies, which will reduce costs and improve accessibility. Additionally, strengthening environmental policies with stringent CO_2 reduction regulations, alongside economic incentives such as tax breaks and subsidies for renewable energy, will accelerate the transition to clean energy. Finally, maintaining economic stability through the development of mechanisms for saving and effectively utilizing savings is essential to provide a financial foundation for sustainable investments in the renewable energy sector.

Kazakhstan has significant potential in both renewable energy and fossil fuel sectors. A substantial portion of national income comes from fossil fuel-related exports. However, the depletion of fossil fuels and the decreasing global demand for them indicate that Kazakhstan may lose this advantage in the future. In this regard, Kazakhstan needs to implement projects to harness renewable energy at the earliest opportunity. For this reasons comprehensive and effective research in the area of renewable energy has become a pressing issue. With its great potential in renewable energy, Kazakhstan can become one of the leaders in renewable energy production, just as it is in fossil fuel production, setting an example for oil-exporting countries.

The research results deepen scientific knowledge in the field of renewable energy economics and contribute to the development of interdisciplinary research in the fields of economics, ecology, and technology. The model and forecasts developed within the framework of the research can be used to optimize state energy policy.

In the future, the study can be further expanded through regional analysis, which will reveal differences in the potential for renewable energy development across various regions of Kazakhstan. Attention should also be given to studying the impact of external factors, such as Kazakhstan's participation in international environmental initiatives and the dynamics of global energy markets.

Furthermore, a promising direction for research is to explore the impact of renewable energy integration on social indicators, such as employment, living standards, and air quality, which will help develop comprehensive strategies for sustainable development..

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Writing review and editing research: Zhansaya S. Temerbulatova.

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Analysis of Tourism's Impact on the Economy, Employment, and Export Potential of Kazakhstan

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ABSTRACT

In Kazakhstan, the tourism sector exhibits significant potential to contribute to the national economy through its influence on employment dynamics, gross value added, and trade balances. However, challenges such as gender disparities in employment and varying contributions to goods and services exports highlight the need for deeper analysis. This study aimed to examine the impact of tourism on Kazakhstan's economy, focusing on employment trends, gross value added, and trade performance. The data from 2012 to 2022 provided by the Bureau of National Statistics of the Republic of Kazakhstan were analyzed using the ARIMA model. The analysis showed that the average value added from tourism (GVAT) over the period amounted to 2,050.5 billion tenge, peaking at 3,270.1 billion tenges in 2022. The share of GVAT in GDP ranged from 2.9% to 4.1%, confirming its stable contribution to the economy. Foreign tourists' spending significantly contributed to GVAT growth, while domestic spending had a minimal impact. Key findings revealed stable growth in tourism's contribution to GDP and employment, with significant disparities in male and female employment trends, particularly in recent years. The findings of the study emphasize the need to attract high-spending tourists, promote gender equality in employment, and expand exports of services as key areas for sustainable tourism growth in Kazakhstan. In future studies, it is proposed that the impact of environmental factors on tourism development and gender barriers to employment be studied in depth.

KEYWORDS: Tourism, Inbound Tourism, Outbound Tourism, Tourism Consumption, Service Export, Gross Value Added, Gender Employment, Kazakhstan

SCSTI: 06.71.51

JEL Code: A11, Z30, Z32

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1. INTRODUCTION

Tourism is a cornerstone of the global economy, serving as a powerful engine for employment, entrepreneurship, and cultural exchange. In many countries, it is a vital source of revenue and a strategic tool for economic diversification. Moreover, tourism acts as a bridge between cultures, fostering international business collaborations and diplomatic connections. As one of the fastest-growing sectors worldwide, tourism contributes approximately 10% of global GDP and accounts for 1 in 10 jobs globally (UNWTO, 2023). The sector's influence extends beyond direct economic gains, fostering cultural exchange, regional development, and infrastructure improvements (Drápela, 2023). However, the development of tourism is not without its challenges. Seasonal fluctuations, limited diversification of tourist offerings, and environmental pressures hinder its sustainable growth. Additionally, the global tourism landscape is marked by uneven development across regions, with some countries struggling to integrate effectively into international tourism networks (Truyols, 2023).

In recent years, the COVID-19 pandemic further exposed the vulnerability of tourism-dependent economies, triggering a dramatic drop in international arrivals and revealing the sector's sensitivity to global shocks. According to the World Tourism Organization (UNWTO), international tourist arrivals fell by over 74% in 2020, leading to a loss of $1.3 trillion in global tourism revenue (Uçar & Alsu, 2024). As economies now strive for recovery, there is an increasing emphasis on building resilience in tourism through diversification, sustainable practices, and digital transformation.

For developing economies, tourism represents a critical opportunity for economic transformation. It attracts foreign investments, bolsters national branding, and improves regional socio-economic conditions. For example, in Southeast Asia, nations like Thailand and Vietnam have successfully utilized tourism to catalyze rapid economic growth, creating jobs and enhancing infrastructure to accommodate increasing tourist flows.

With its unique geographic location, abundant natural resources, and rich cultural heritage, Kazakhstan holds immense potential for tourism development. The country boasts a wide array of tourism opportunities, from ecotourism in the Altai Mountains and national parks to historical tourism along the ancient Silk Road, as well as business tourism in dynamic urban hubs such as Astana and Almaty (Glukhovtsev & Yermekbayeva, 2001).

Despite these advantages, the tourism sector’s contribution to Kazakhstan’s GDP remains modest when compared to global benchmarks. The industry faces notable challenges, including underdeveloped infrastructure, limited environmental sustainability initiatives, and insufficient international marketing strategies. However, recent initiatives—such as expanding international travel routes, supporting small and medium-sized enterprises in the tourism sector, and branding Kazakhstan as a key global tourism destination—highlight the potential for sustainable growth in this field (UNDP, 2021).

Tourism in Kazakhstan has the capacity to play a dual role: as a driver of economic growth and as a conduit for strengthening international relations. Realizing this potential requires a holistic approach that goes beyond the economic dimensions of tourism to address its environmental and social implications. In particular, understanding the intersection of tourism with issues such as ecological sustainability and gender equality in employment is critical. These factors are becoming increasingly crucial amid global environmental awareness and social inclusion trends.

This study aims to evaluate tourism’s contribution to Kazakhstan’s economy, explore its interactions with environmental and social factors, and develop recommendations to enhance the sector’s efficiency and sustainability.

2. LITERATURE REVIEW

Tourism has long been recognized as a key driver of economic development (Li et al., 2018), with the potential to stimulate employment, generate foreign exchange, and diversify national economies (UNWTO, 2020). In developing countries, where reliance on extractive industries and resource-based growth is common, tourism provides an alternative pathway for achieving economic stability (Sisneros-Kidd et al., 2019). Tourism is regarded as a catalyst for broader economic development, particularly in countries aiming to transition toward more diversified economies (Brida et al., 2010; Khan et al., 2020). Tourism accounts for 9% of GDP and 10% of employment in Kenya, highlighting its key role in inclusive economic growth and social development. Sustained growth in tourism drives demand in hospitality, transportation, and retail, creating a multiplier effect (Bitok, 2019; Manzoor et al., 2019) Thus, contributing not only to direct revenue growth but also to increased indirect employment, strengthening the country's economic resilience.

In the case of Kazakhstan, tourism is positioned as a strategic priority for economic diversification, especially given the country's reliance on extractive industries like oil and gas. Policy documents, including Kazakhstan's "Tourism Industry Development Plan," highlight efforts to leverage cultural, historical, and natural resources to attract international tourists (Ministry of Culture and Sports, 2019). Several studies have demonstrated that the tourism sector has the capacity to generate employment, particularly in rural areas, and enhance the socio-economic status of local communities (Abdygaliyev et al., 2022). However, Kazakhstan's tourism sector faces significant challenges, including limited infrastructure, insufficient international marketing, and the need for skilled human capital.

Other studies focused their attention on ecological issues and raised awareness of the emerging trends for eco-agro tourism. Tourism has a dual impact on the environment, acting as a constructive and destructive force. On the one hand, sustainable tourism supports environmental conservation, raises awareness, and promotes biodiversity protection. Özgürel et al. (2023) state the importance of eco-agro tourism as it fosters sustainable development in rural areas, especially (by enhancing the green economy and attracting local communities to tourism activities, affecting sociocultural, economic, and natural environments). Notwithstanding, tourism puts pressure on ecosystems due to over-tourism, leading to habitat degradation and the exploitation of natural resources. Newsome (2021) noted that poor management of protected areas and increased tourism ultimately result from environmental degradation. At the same time, the COVID-19 pandemic revealed that wildlife tourism is vulnerable and fragile. Moreover, broader tourism was also affected, disrupting financial support for conservation efforts and increasing the risk of habitat destruction and biodiversity loss. Orîndaru et al. (2021) pointed out that the pandemic-induced shift in consumer behavior changed preferences to less crowded destinations caused by concerns about safety, reshaping demand, and habits for tourism services. Traskevich and Fontanari (2023) pointed out that management strategies and strengthening of social institutes are of great importance for leveraging local resources, promoting mental well-being, and implementing sustainable practices into the tourism value chain.

Another area of interest was the relationship between tourism and export potential. Some studies mainly focused on the contribution of inbound tourism through service consumption and the indirect impact on local production chains. According to El-Sahli (2018), inbound tourism boosts exports of services and goods (such as processed foods and consumer products purchased by tourists). Similarly, Khan et al. (2017) stated that service exports are enhanced through inbound tourist flows, thus marking the role of transport infrastructure. Other works analyzed the impact of outbound tourism and its negative

implications for export potential and economic risks resulting in reduced domestic consumption and limited export-driven production. Dai et al. (2017), in their study of China's outbound tourism, showed that increased outbound tourist flows lead to capital outflows and result in the trade deficit widening. On the contrary, Menegaki et al. (2020) stated that outbound tourism is another "inferior good" in Europe, as during economic downturns, consumers reduce spending on outbound travel, opting to stay home and save money.

Gender factor significantly shapes employment patterns in the tourism industry, with women predominantly occupying low-skilled, low-wage roles such as housekeeping, catering, and customer service. At the same time, men are concentrated in higher-paying managerial and leadership positions (Baum, 2013). Abdou et al. (2019) noted that in the MENA region, cultural and societal barriers are the primary barriers to further women's access to better-paying jobs, showing a lack of policies considering maternity leave and childcare support. Morgan and Pritchard (2019) pointed out that regardless of growing awareness of gender issues in hospitality, women remain underrepresented in higher-level positions, with gender pay gaps and cases of workplace harassment persisting. Lasso-Dela-Vega et al. (2023) revealed similar patterns in the food industry. The authors also stated that educational mismatches contribute to wage disparities, as men with adequate education are better compensated than overqualified women in the same roles. Escalonilla and Boto-García (2024) prove that gender differences in employment persist among tourism graduates. Women are more likely than men to work part-time, hold temporary contracts, and face horizontal job mismatches. Revealed disparities are cases not only at entry-level positions but also present over time, with men promoting careers more quickly into stable, higher-paying jobs.

Therefore, the following research questions were developed.

RQ1: What is the current trajectory of tourism development in Kazakhstan, and how does it influence the national economy?

RQ1: How does inbound tourism influence Kazakhstan's export potential, and which export components are most affected?

RQ1: What are the gender dynamics in tourism employment, and how can they be incorporated into strategies for sustainable development?

3. RESEARCH METHODS

The research methodology was designed to assess the impact of economic and tourism indicators on Gross Value Added in Tourism (GVAT). The analysis used time series data from 2012 to 2022. The primary methodological approach adopted was the ARIMA (Auto Regressive Integrated Moving Average) model, which includes the decomposition of time series data to conduct trend dynamics and the influence of predictor variables. The modeling process consisted of data preparation, which included normalizing variables to account for scale differences and conducting tests. ARIMA modeling was performed, and for this purpose, the Augmented Dickey-Fuller test was applied to ensure that the time series met the prerequisites, for lag order selection, partial autocorrelation and autocorrelation functions were conducted, with the optimal model parameters (p, d, q) determined through an iterative process based on Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) minimization. The ARIMA model was then extended to include exogenous variables reflecting key economic and tourism indicators such as GVAT as a percentage of GDP, employment rates disaggregated by gender, domestic and inbound tourism consumption, and trade-related measures. Coefficients for these predictors were estimated using Maximum Likelihood Estimation, providing a deeper analysis of the significance and magnitude of impact on GVAT (Figure 1).



FIGURE 1. Research Methodology

Note: compiled by authors

A set of analyses was conducted to confirm the model's reliability in capturing the underlying dynamics. Residual diagnostics were conducted post-modeling to evaluate the adequacy of the fitted model, examining standardized residuals for independence, variance consistency, and normality. Next, a Q-Q plot was used to verify the normality assumption, while the Ljung-Box test assessed the independence of residuals.

Tourism in Kazakhstan is an emerging sector of economy. Kazakhstan aims to diversify economy and leverage rich cultural heritage, natural landscapes, and strategic location for attracting tourists. To better understand its development and challenges, it is important to analyze changes in key indicators. Current analysis provides discussion of key factors influencing the development of the tourism sector in Kazakhstan, showing cyclical patterns and fluctuations caused by external economic and social shocks like the COVID-19 pandemic. Next, an ARIMA model was conducted to predict future trends and provide assessment of the stability of tourism sector in Kazakhstan.

The final stage involved hypothesis testing, wherein the estimated coefficients were interpreted in the context of their respective p-values and confidence intervals.

Conducting an ARIMA model. Throughout the process, challenges primarily related to model specification and the validation of results existed.

4. FINDINGS AND DISCUSSIONS

The current state of the tourism sector and its contribution to Kazakhstan's economy were analyzed from 2012 to 2022. The first stage of the analysis included descriptive statistics analysis. The analysis of employment in tourism and the contribution of tourism to the economy showed a cyclical pattern. Every two years there was observed growth in employment, from 2012 to 2014 and from 2017 to 2019 and declined in subsequent years 2015 and 202 respectively.

Figure 1 illustrates the dynamics in tourism employment by gender from 2012 to 2022.

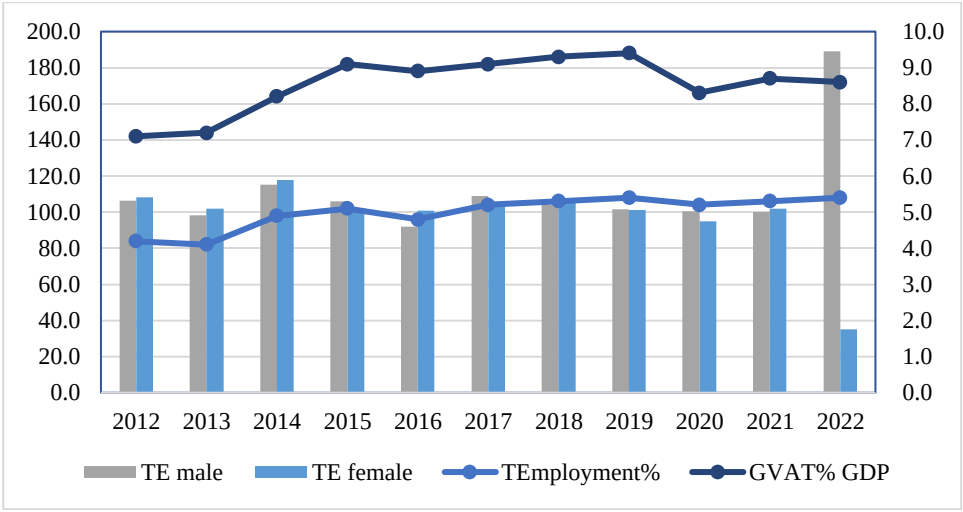
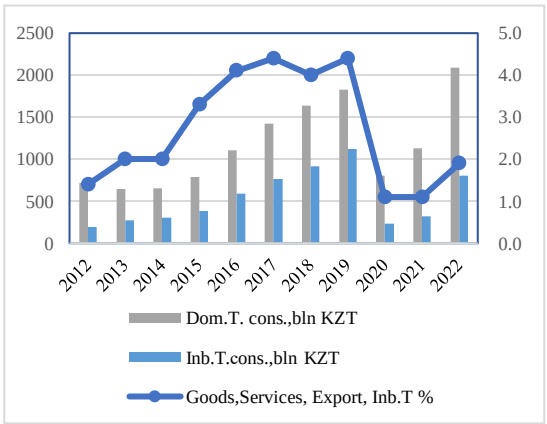


FIGURE 2. Tourism employment and gross value-added dynamics

Note: compiled by authors

The most significant downturn was observed in 2020 due to the consequences after COVID-19 pandemic. Recovery, driven by the increase in the involvement of women in the tourism sector, was in 2021, and in 2022 there was a sharp rise. The contribution of tourism to GDP (GVAT% GDP) followed a similar pattern — growth to 1.3% in 2017 and 1.0% in 2022, but there was a drop to 0.6% in 2020. Observed fluctuations showed that tourism sector though sensitive to crisis, has strong capacity for recovery.

In Figure 3, there is an analysis of the outcome of tourism consumption and export potential.



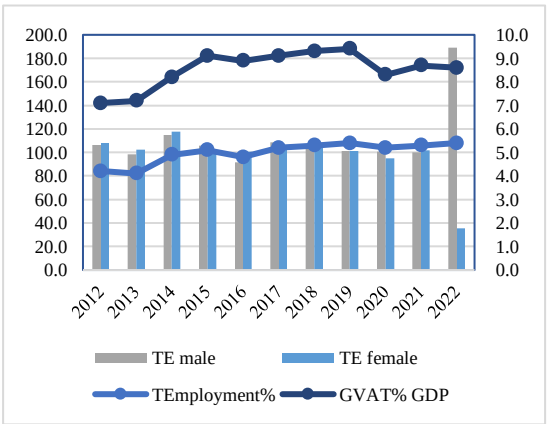


FIGURE 3. Tourism consumption and number of tourists

Note: compiled by authors

Domestic tourism consumption showed a steady increase overall until 2019. There was a similar trend for inbound tourism consumption but at a lower scale. After the COVID-19 pandemic burst out, there was a decline in 2020 in the number of inbound and outbound

tourists. Concerning services exports, there was a steady upward trend until 2019. In 2020, services exports declined considerably, with signs of recovery in subsequent years. Goods and services exports tied to inbound tourism remained consistently lower, showing the increasing role of services in export dynamics.

The following was observed about the contribution of inbound and outbound tourism numbers and their contributions to services and goods exports. Outbound tourism consistently exceeds inbound tourism, showing a high preference for international travel among residents. The analysis showed that the inbound tourist increases correlates with service export growth associated with higher tourism spending. In contrast, goods exports related to tourism remain stable, or the export of goods is not dependent on tourism.

An ARIMA analysis was conducted to explore further the factors driving these dynamics and their economic impact as a critical component of Kazakhstan's economy. At the initial stage, descriptive statistical analysis of employment and gross value-added (GVAT) metrics was conducted to understand better the sector's stability and the role of tourism in national economic performance, focusing on gender composition and economic impact (Table 1).

TABLE 1. Analysis results in descriptive statistics

Variable	TEmployment	TE male	TE female	GVAT, bln KZT	GVAT% GDP
Valid	11	11	11	11	11
Missing	0	0	0	0	0
Median	442.500	104.000	102.000	2089.900	3.400
Mean	431.745	110.982	97.755	2050.491	3.545
Std. Deviation	45.089	26.575	21.506	758.042	0.455
Minimum	353.400	91.800	35.200	914.700	2.900
Maximum	488.600	189.000	117.800	3270.100	4.100

Note: compiled by authors

The average employment in the tourism sector was found to be 431.745 thousand people, with a range spanning from 353.400 thousand to 488.600 thousand. The standard deviation results showed moderate variation in workforce levels over the observed period. Thus, in external shocks or economic challenges, tourism employment demonstrates resilience. Moreover, employment in tourism in Kazakhstan experiences little sharp or prolonged declines, and it adapts and continues to create jobs even under challenging conditions. In other words, employment in tourism sees only limited or temporary declines, demonstrating resilience.

The analysis for employment by gender showed the following results. The average number of men employed in tourism exceeds that of women. Men, on average, occupy more positions in the tourism sector. The range for male employment spans 91.800 - 189.000 thousand, whereas, for women, the range is narrower, 35.200 - 117.800 thousand. A broader range reflects the high presence of men in both high-competition roles (e.g., tourism management) and less stable segments (e.g., seasonal work). Meanwhile, results for female employment showed a limited range, which could be due to fewer high-paying opportunities or barriers to job promotion for women. These closely aligned medians for both genders confirmed a relatively balanced central tendency in workforce distribution between genders. On the other hand, a substantially higher maximum for men (189.000 thousand) highlighted potential gender inequality in access to higher-level positions. The results showed structural gender inequality and limited career advancement for women in tourism. High variability in absolute GVAT and stability in its GDP contribution showed that tourism faces external challenges but maintains a proportional economic role. The contribution of GVAT to GDP showed stability, averaging 3.545, with a narrow range of 2.900 - 4.100 and a low standard deviation

(0.455). Therefore, tourism is regarded as a stable contributor to Kazakhstan's economic framework. The ARIMA model was applied to assess the trends and dynamics of gross value added in tourism (GVAT) in Kazakhstan. The time series plot in Figure 4 demonstrated an upward trajectory of GVAT over the analyzed period.

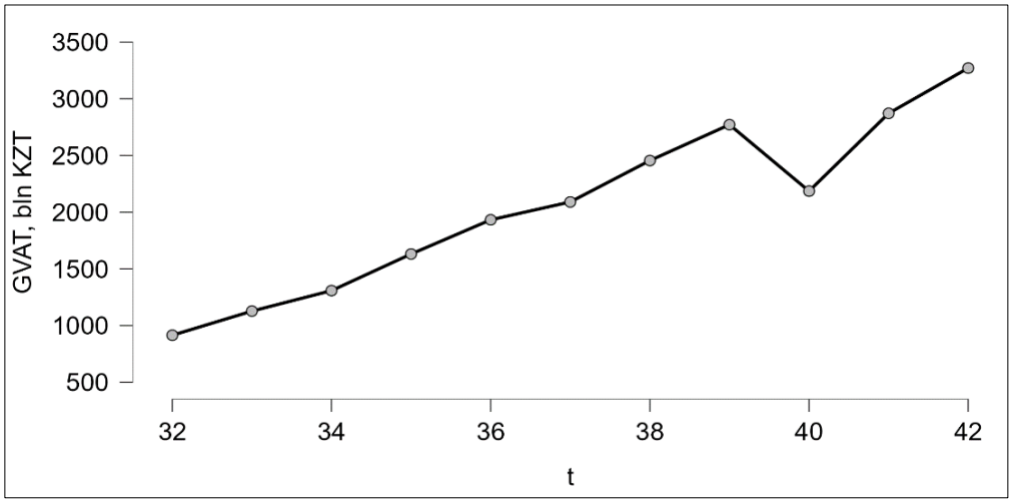


FIGURE 4. Time series plot

Note: compiled by authors

Temporary fluctuations were observed, which supported the descriptive analysis results, the sector's resilience to macroeconomic shifts, global tourism shocks, or internal structural adjustments within the industry, and its integral role in economic development. The consistent rise in GVAT aligns with the goals to improve Kazakhstan's tourism infrastructure and attract domestic and international visitors. The results of the ARIMA model coefficients, considering key covariates related to tourism and economic indicators, revealed significant relationships.

In Table 2, the coefficients provided insight into various variables' direct and indirect contributions to GVAT's performance.

TABLE 2. Coefficients of the model

Indicator	Estimate	STND. Err.	t	p	Lower (95%CI)	Upper (95%CI)
Intercept	-2724.001	190.103	-14.329	0.044	-5139.484	-308.517
GVAT% GDP	1449.830	50.249	28.853	0.022	811.352	2088.308
TE male	9.709	0.673	14.432	0.044	1.161	18.257
TE female	-1.238	0.468	-2.642	0.230	-7.190	4.714
Domestic T Cons.	-0.291	0.060	-4.880	0.129	-1.048	0.466
Inbound T Cons.	2.426	0.087	27.955	0.023	1.323	3.528
Goods, Services Export,Inbound T %	-512.601	18.108	-28.308	0.022	-742.683	-282.520
Services Export, Inbound T %	49.157	2.655	18.513	0.034	15.419	82.895
Inbound T, #	-0.177	0.011	-16.229	0.039	-0.315	-0.038
Outbound T, #	-0.134	0.009	-14.155	0.045	-0.255	-0.014

Note: compiled by authors

The residual variance showed an insignificant level of unexplained variability. Similarly, the log-likelihood and AIC values confirmed the fitness of the model (lower values signify a superior fit). The results suggest that the chosen set of variables adequately describes the underlying structure of the data. Interpreting the result's economic value showed that GVAT's growth trajectory is characterized by a consistent and stable pattern, confirming the sector's resilience and potential as a driver of economic development in Kazakhstan. The share of GVAT in GDP (GVAT% GDP) was identified as a strong positive contributor to GVAT, highlighting the sector's alignment with broader economic trends. Similarly, the impact of male employment in tourism was significant, suggesting a measurable influence of gender-specific workforce dynamics on economic outcomes. Conversely, the coefficient for female employment was not statistically significant, reflecting potential structural disparities in the sector or its economic integration.

Among consumption-based indicators, inbound tourism consumption reflected a significant positive effect, underscoring the importance of international tourism in driving sectoral growth. In contrast, domestic tourism consumption showed no significant relationship with GVAT in the current model, suggesting a more limited role in overall economic performance.

Trade-related variables displayed contrasting effects. Services export as a share of inbound tourism positively influenced GVAT, indicating the economic importance of tourism-driven service exports. However, the share of goods and services exports attributable to inbound tourism had a significant negative coefficient, potentially reflecting shifts in resource allocation or trade dynamics influenced by the tourism sector. Interestingly, both inbound and outbound tourist numbers had small but significant negative coefficients. These findings may indicate complex underlying relationships, such as the economic leakage associated with outbound tourism or inefficiencies in leveraging inbound tourist activity to enhance value creation.

In summary, the model highlights the significant roles of international tourism consumption, gendered employment patterns, and trade-related variables in shaping GVAT dynamics. While some factors exhibit clear and significant impacts, others may require further exploration to understand their nuanced effects within Kazakhstan's tourism sector.

This analysis of a time series plot showed the importance of residual diagnostics in model evaluation and the Q-Q plot, which evaluates the normality of the residuals from the ARIMA model (Figure 5).

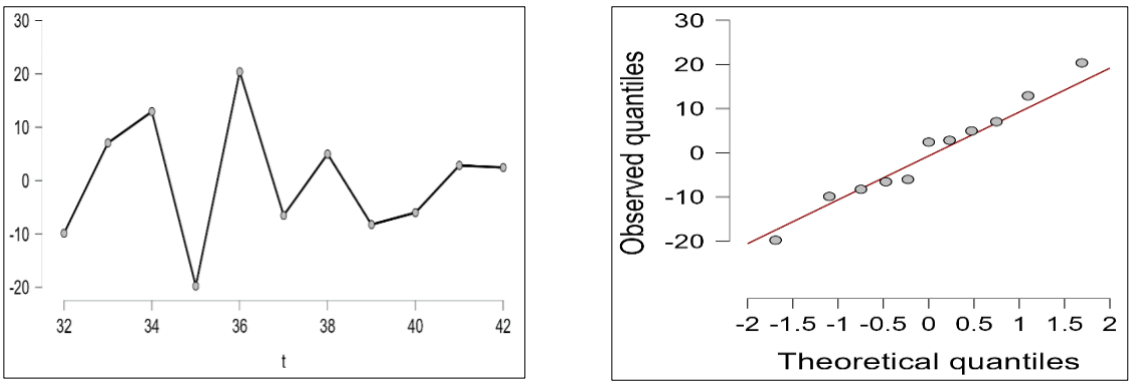


FIGURE 5. Time Series Plot and QQ plot

Note: compiled by authors

As shown in the figure, the time series plot of standardized residuals provides an overview of the deviations between observed and predicted values from the ARIMA model. Residuals oscillate around zero, with varying magnitudes across the observed periods. This pattern indicates the differences between the actual GVAT values and those estimated by the model.

Key observations from the plot include notable spikes in residuals during specific periods, such as around 36t, which could suggest potential external influences or events impacting the model's accuracy in those years. The overall trend does not exhibit systematic bias, as the residuals fluctuate positively and negatively, reflecting the model's ability to capture general trends without consistent over- or underestimation.

However, the magnitude of some residuals, particularly the extreme positive and negative spikes, suggests that the model may only partially account for inevitable fluctuations in the data. These deviations could be associated with external shocks, unmodeled seasonal patterns, or omitted variables influencing GVAT during those specific timeframes.

The QQ plot compares the observed quantiles of the residuals with the theoretical quantiles of a standard normal distribution, providing insights into whether the residuals conform to the normality assumption. Ideally, the points should align closely with the 45-degree reference line if the residuals are normally distributed. The plot indicates that most residuals are closely aligned with the reference line, particularly in the central portion of the distribution. This suggests that the residuals exhibit approximate normality, supporting the model's adequacy for capturing the data's central dynamics. However, some deviations are observed at the extremes of the plot, with a few residuals deviating from the line in the upper and lower tails. These deviations could indicate mild non-normality, potentially arising from unmodeled variability, outliers, or external shocks in specific periods.

Despite these minor deviations, the overall alignment of residuals with the reference line suggests that the normality assumption is mainly satisfied. This level of conformity is generally acceptable for ARIMA modeling, as minor deviations at the tails are unlikely to impact the model's performance or predictive accuracy substantially. Nonetheless, further refinement of the model, such as incorporating additional explanatory variables or testing alternative specifications, could help address these residual discrepancies and enhance the robustness of the analysis

5. CONCLUSIONS

The analysis of tourism in Kazakhstan and its impact on the economy, particularly Gross Value Added in Tourism (GVAT), was based on environmental and gender indicators.

Trajectory of tourism development in Kazakhstan and its influence on the national economy

The study results showed positive development of the tourism sector in Kazakhstan. There was revealed that GVAT as a percentage of GDP is one of the strongest drivers of tourism growth and had positive, significant relationship with GVAT, indicating that as tourism's share of GDP increases, the absolute value of GVAT increases as well. Furthermore, considerable participation and contribution of male employment in tourism were observed. Therefore, the gender-specific labor market affects sectoral growth. On the contrary, female employment in tourism did not exhibit a significant impact on GVAT. In terms of consumption, domestic tourism consumption contributed less to economic development than inbound tourism consumption. Therefore, foreign tourists have a better economic contribution to the development of tourism and, even more, the development of new directions in tourism. Thus, the tourism sector in Kazakhstan is on a steady upward trajectory, with its steadily increasing contribution to the economy. According to the results, the primary factors driving this growth are inbound tourism consumption and male employment in tourism.

Inbound tourism influences Kazakhstan's

export potential.

The results showed that inbound and outbound tourist numbers have statistically significant but adverse effects on GVAT. While this result initially appears counterintuitive, it may be linked to external factors affecting tourist flows or structural inefficiencies. Additionally, fluctuations in tourist numbers may correlate with other global factors. Tourism flows, especially inbound and outbound, have potential environmental impact. Domestic tourism consumption (including expenses of Kazakhstan's citizens within the country) does not significantly impact the GVAT, as it merely redistributes existing financial resources within the national economy. In contrast, inbound tourism consumption (expenditures of foreign tourists in Kazakhstan) is regarded as foreign or external income, boosting the country's revenue. In other words, more tourists only sometimes increase GVAT if those tourists spend minimally. Therefore, the main objective is to attract higher-spending tourists for sustainable tourism development. The development of inbound tourism facilitates the growth of service exports (accommodation, tours, dining, etc.), increasing the sector's added value and positively influencing the national economy. There was also a negative effect of inbound tourism's share in goods exports on GVAT, which could be due to the structure of the exports in Kazakhstan, primarily focused on raw materials (oil, metals, etc.). Hence, the structure of export goods is not related to tourism activity. It contributes insignificantly to the growth of the tourism sector. Therefore, it can be assumed that tourism products have an insignificant role in Kazakhstan's overall export structure.

Gender dynamics in tourism employment and their role in sustainable development.

The study explored the impact of women's and men's employment in tourism on GVAT and revealed significant differences disaggregated by gender. An increase in the number of men in tourism had a statistically significant positive effect on gross value added in the sector. On the contrary, women's employment in tourism showed an insignificant impact, reflecting a lack of gender inclusion and equity in tourism-related employment.

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Data collection, analysis and interpretation: Altynay A. Maukenova.
Visualization: Aida D. Aimagambetova, Aigul B. Alibekova.
Writing review and editing research: Kuralay M. Balginova, Gulnara M. Sagindykova.

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The Role of Deposits and Securities in Shaping Banking Operations and Mutual Funds in Kazakhstan

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ABSTRACT

This study examines the influence of client deposits, securities, and outstanding shares on key banking operations and their role in the development of mutual funds within Kazakhstan's financial system. The research focuses on identifying which financial instruments contribute significantly to resource allocation and the sustainability of mutual funds. Two primary hypotheses were tested: first, that securities and deposits of legal entities significantly impact banking performance and mutual fund growth, and second, that individual deposits and outstanding securities have a measurable influence on these outcomes. To address these questions, a multivariate analysis of covariance (MANCOVA) was conducted, supported by univariate tests and graphical methods such as Q-Q plots and raincloud plots. Data from Kazakhstan's financial institutions between 2012 and 2023 were analyzed to assess the statistical significance of these factors. Deposits from legal entities demonstrated their dominant role in the financial system, significantly impacting bank liquidity and resource allocation. In contrast, individual deposits and outstanding securities showed no statistical significance, reflecting the low engagement of private investors and their preference for traditional deposits over more complex investment instruments. Securities showed a significant impact on banking operations but were focused on the corporate sector and institutional investments. The results contrast with international markets in a strong dependence of the financial system on the corporate sector. Although securities are widely used to attract capital and manage investments, their market in Kazakhstan likely remains narrowly specialized and insufficiently liquid, a contrast rarely seen in studies of more developed markets.

KEYWORDS: Economy, Economic Development, Mutual Fund, Client Deposits Securities, Investment, Bank, Banking Sector, Capital Market, Public Investment Fund, Kazakhstan

SCSTI: 06.73.55

JEL Code: G20, G21, G23

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1. INTRODUCTION

Globally, there have appeared challenges for the banking sector due to economic uncertainty in the international arena, resulting mainly in rising interest rates and financial market volatility. The International Monetary Fund has emphasized the growing pressures on banking profitability and the capital-raising capacity of financial institutions. Banks find it difficult to attract capital through equity issuance, which in turn affects their investment capacity, particularly banks whose market value drops below their book value.

The banking sector in Kazakhstan has undergone tremendous changes over the last decade and has taken a fundamental role in economic development. It has become a primary conduit for resource allocation, financial intermediation, and productive investments. Since 2014, some crucial moments have been observed. In 2014, Kaspi bank launched an online marketplace platform and accumulative bonus system for the clients. In 2015, online bank loans became available for the population, especially car loans, and the next year, Kapsi extended its line of services and launched the KaspiRed shopping system. At the same time, in 2015, there was launched a state program in support of local businesses, particularly in rural areas or those who struggled to gain access to financial resources. That project involved the majority of the banks and put the banking sector as a core player in the development of the economy in Kazakhstan. The next prominent situation was the development of the dominant participant in the market, Halyk Bank, due to a merger with Kazkommertsbank, which holds a considerable share of assets, loans, and deposits. Banks are responsible for channeling deposits from households, businesses, and institutions into loans, securities, and other financial instruments.

A stable economy, especially for emerging ones such as Kazakhstan, depends on banking efficiency. Most of the bank liabilities are contributed by client deposits. In 2023, the deposit portfolio in the banking sector of Kazakhstan accounted for 7.6% of client deposits, totaling 13.3% of bank assets. There is also the contribution of securities and outstanding shares to the investment portfolio of banks, which ensures liquidity management, mitigation of risks, and profitability. Banks stand out as backup for the economy of Kazakhstan through the provision of loans to legal entities and individuals, supporting the state, etc. Nevertheless, to keep up with the strategy of "maintaining balance", they have to diversify their securities portfolio. Therefore, in Kazakhstan, banks have expanded their securities holdings, taking advantage of domestic and international investment opportunities.

Considering the current state of action in the banking sector of Kazakhstan, mutual funds have gained traction as one of the core mechanisms for resource distribution and diversification of investments. Regarding banks, the position of mutual funds is loop-sided: they complement and compete with banks, driving innovation and diversification in the financial sector. Therefore, it is important to understand the influence of deposits and securities on banking operations and their relation to the development of mutual funds. Mutual funds reallocate capital and provide banks with alternative investment opportunities. The aim of this study is to examine the influence of deposits, securities, and outstanding shares on key banking operations, highlighting their role in resource allocation and the development of mutual funds.

2. LITERATURE REVIEW

Liquidity and sustainable funding ensure investment operations and development of mutual funds, and deposits are viewed as a critical source. Mainly, studies are devoted to the system of deposit resources utilization by banks based on the objective in terms of collective financial instruments to maintain liquidity, manage risks, and expand opportunities for investments. Some scientists suggest that deposits stand out as mechanisms

for a stable inflow of funds directed toward financing mutual funds, making them a significant element of the financial system.

Some works were more specific in the analysis of deposits' role in mutual funds development. Usually, deposits are attributed to such functions as support of investment operations in collective financial instruments, maintaining liquidity, managing risks, and consequently, the development of mutual funds. They are vied as another source of liquidity and sustainable funding. Moreover, deposits ensure stable financial contributions or mutual funds inflow and, therefore, become a significant element of the financial system. Nanda et al. (2000) stated that liquid resources are a core element in providing market operations and managing share redemptions effectively. Thereby, banks reduce price risks and improve resistance to market volatility. Macey (2011) looked at mutual funds as an alternative to traditional bank deposits, as in the chase to achieve higher returns, clients usually reallocate funds from deposits to money market mutual funds. As a result, mutual fund assets grow due to retail and institutional investors. Chernykh and Cole (2011) showed that deposit insurance affects clients' perception as they develop confidence and stabilize deposit flows. Accordingly, part of the accumulated liquidity banks can invest in mutual funds. Pellinen et al. (2011) paid attention to clients' financial literacy level, as it affects their willingness to diversify their portfolios and increase the share of assets allocated to mutual funds. Ultimately, the inflow of new funds into mutual funds is developed, improving their liquidity and financial stability.

Another relevant topic is the capacity of banks to engage in investment activities. The significant volume of stable deposits develops the fundamental capacity of banks to finance or invest in projects and issue mutual fund products as they are provided with liquid funds (Estrin et al., 2000; Acaravcı & Çalım, 2013). At the same time, the issue of deposit withdrawal arises. Gros and Schoenmaker (2014) emphasized that deposit insurance systems are designed to prevent mass deposit withdrawals distinctly during financial instability and maintain stable deposit flow. Ogege and Boloupremo (2014) studied the fact that funds raised through deposits are directed into investment projects, thereby increasing the volume of mutual fund assets. Since banks use part of depositors' funds to finance financial instruments, this promotes the growth of mutual fund assets within the collective investment market. According to Allen et al. (2015), a stable deposit base ensures banks have access to liquid resources to finance long-term investment projects, including mutual funds. Tuyishime et al. (2015) and Edem (2017) stated that the growth of the deposit base increases bank liquidity and its capacity to engage in investment operations, as banks direct excess liquidity into investments, contributing to the increase in mutual fund assets. Some research examined the role of securities, whereas investment funds utilizing securities can drive governance reforms and enhance market efficiency. Burkhanov (2018) stated the stabilization effects of securities within mutual fund portfolios, particularly during periods of economic uncertainty.

A second perspective centers on how investor behaviors or financial literacy affect the reliance on securities in mutual fund strategies. Also, regulatory implications of securities in mutual fund operations form the core of studies. Smirnova and Sprenger (2011) showed that the level of development of financial technologies and instruments creates so-called localized knowledge of market conditions, which differs in a deeper understanding of local demands and needs. Such strategic advantage enables mutual funds in Russia to outperform their foreign counterparts. Marian (2016) revealed that private investment funds use securities as instruments for tax avoidance. This creates the dual role of securities for investment and financial engineering. Baker and Puttonen (2017) focused on the trust preferences of investors, where regulatory mechanisms are crucial as they provide a level of accuracy in risk presentation. Misrepresentation of risky securities as safe investments weakens the level

of trust of clients (investors) and destabilizes mutual funds. Therefore, increased transparency and adherence to regulatory standards enhance interest in mutual funds. Public investment funds (PIFs) use securities as part of diversification strategies in favor of long-term macroeconomic goals. According to McPherson-Smith (2021), implementing PIFs into investment strategy enables the diversification of securities' assets. It reduces economic vulnerabilities and contributes to the economic image in global financial markets. Apart from financial instruments, Montambault Trudelle (2023) highlighted its political power and economic influence driven by the transformation of the domestic economy.

The literature review showed that mutual funds play a crucial role in the economy's diversification process, based on several factors such as deposits, securities, loans, etc. Therefore, it is important to analyze the role of highlighted factors in the perspective of banking sector development in Kazakhstan. The following hypotheses were developed.

Hypothesis 1. Investments in securities and deposits placed with other banks influence bank loans and short-term liquidity operations, including retail loans, residential mortgage loans, and "reverse REPO" operations.

Hypothesis 2. Client deposits, including total deposits, deposits of legal entities, deposits of individuals, and outstanding shares, significantly impact retail loans and residential mortgage loans, reflecting their role as key resources for bank operations.

3. RESEARCH METHODS

In this study, we aim to analyze the relationships between various banking factors and their influence on key loan and liquidity operations, focusing on the role of client deposits, securities, and outstanding shares in the context of mutual funds. Based on the conducted literature review, a set of factors influencing the dependent variables was identified in Table 1.

Table 1. Independent and Dependent Variables with Code Assignments

Variable	Code	Description	Type
Client deposits, including	CD1	Total client deposits	Independent
Deposits of legal entities	CD2	Deposits placed by corporate entities	Independent
Deposits of individuals	CD3	Deposits placed by individual clients	Independent
Outstanding shares	CD4	Issued securities into circulation	Independent
Deposits placed with other banks	BF1	Interbank deposits	Independent
Securities	BF2	Investments in securities	Independent
Bank loans and "reverse REPO" operations	BF3	Total bank loans and "reverse REPO" operations	Independent
Retail loans	BF4	Loans issued for retail purposes	Dependent
Residential mortgage loans	BF5	Loans issued for residential mortgages	Dependent
Loans to small and medium-sized enterprises	BF6	Loans issued to SMEs (Residents of Kazakhstan)	Independent
"Reverse REPO" operation	BF7	Short-term liquidity operations	Independent

Note: compiled by authors

MANCOVA will be applied to test the hypotheses and assess the combined effect of the independent variables on the dependent variables. The analysis includes multivariate tests to determine the strength and statistical significance of the effects. Additionally, the specific contributions of each independent variable to the dependent variables will be provided through univariate tests. The Shapiro-Wilk test will be applied to validate normality assumptions further as well. For a visual assumption check of the results, Q-Q

Plots will be applied for multivariate normality (for both groups of variables to visually examine the relationships between the independent and dependent variables to identify potential patterns, outliers, and nonlinear trends that may influence the results of the MANCOVA.

4. FINDINGS AND DISCUSSIONS

The structure of the analysis included an analysis of the key factors in the Banking Factors and Client Deposits groups, highlighting their dynamics over time. As revealed in the literature review, deposits play a significant part in the growth of banks' investment ability, portfolio diversification, and state project implementation. Next, an analysis of both groups of indicators is provided.

Figure 1 presents changes in the relative scale and distribution of variable groups in 2012, 2016, and 2023 to clearly identify growth patterns and stability.

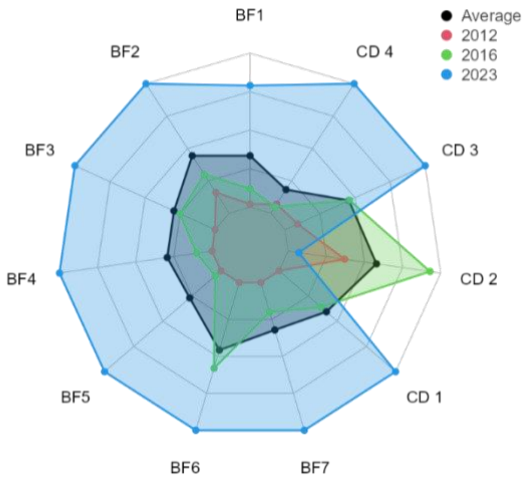


FIGURE 1. Comparative Overview of Banking Factors and Client Deposits

Note: compiled by authors

As presented in the chart, total client deposits and deposits of legal entities showed consistent growth, especially after 2019. It could be assumed that the role of institutional deposits in supporting banking operations increased. Deposits of individuals and outstanding shares, on the contrary, showed rather slow growth and fluctuating behavior as a limited contribution to the overall funding structure of banks. The most striking growth was from 2020 to 2023, where key variables (client and corporate deposits) showed a sharp increase. Shifts in financial market conditions and regulatory changes could cause this. In contrast, a delayed impact was observed among variables like outstanding shares exhibiting sporadic growth, with a significant rise only in 2022 and 2023. To sum up, the results showed the growing importance of institutional funding sources for banks. At the same time, it also showed instability and slower growth in the role of individual deposits and securities.

Table 2 presents the results of the BF group multivariate tests.

TABLE 2. Bank financial operations multivariate tests

Var	Tests	Value	F	df1	df2	p
BF1	Pillai's Trace	0.989	216.32	2	5	<.001
	Wilks' Lambda	0.0114	216.32	2	5	<.001
	Hotelling's Trace	86.528	216.32	2	5	<.001
	Roy's Largest Root	86.528	216.32	2	5	<.001

BF2	Pillai's Trace	0.882	18.73	2	5	0.005
	Wilks' Lambda	0.1177	18.73	2	5	0.005
	Hotelling's Trace	7.494	18.73	2	5	0.005
	Roy's Largest Root	7.494	18.73	2	5	0.005
BF3	Pillai's Trace	0.925	31.06	2	5	0.002
	Wilks' Lambda	0.0745	31.06	2	5	0.002
	Hotelling's Trace	12.422	31.06	2	5	0.002
	Roy's Largest Root	12.422	31.06	2	5	0.002
BF6	Pillai's Trace	0.422	1.82	2	5	0.254
	Wilks' Lambda	0.5784	1.82	2	5	0.254
	Hotelling's Trace	0.729	1.82	2	5	0.254
	Roy's Largest Root	0.729	1.82	2	5	0.254
BF7	Pillai's Trace	0.365	1.44	2	5	0.321
	Wilks' Lambda	0.6349	1.44	2	5	0.321
	Hotelling's Trace	0.575	1.44	2	5	0.321
	Roy's Largest Root	0.575	1.44	2	5	0.321

Note: compiled by authors

The multivariate tests showed that there are significant effects of BF1, BF2, and BF3 variables, based on their low Wilks' Lambda values and high F-statistics, all with p-values below 0.01. They had a strong influence on the dependent variables, due to their role in institutional liquidity management and resource allocation. BF6 and BF7 variables showed insignificant effect (p-values exceed the 0.05 threshold) and limited contribution to overall bank operations. The results identified BF1, BF2, and BF3 variables as critical drivers of banking activities. The failure to achieve significance for variables BF6 and BF7 is the ground for further exclusion of these variables from the model. In Table 3, results of the Univariate Tests demonstrated relationships between dependent variables and independent.

TABLE 3. Univariate analysis of bank financial operations

Code	Dependent Variable	Sum of Squares	df	Mean Square	F	p
BF1	BF5	2.05e+7	1	2.05e+7	517.906	<.001
	BF4	1.60e+8	1	1.60e+8	425.757	<.001
BF2	BF5	1.13e+6	1	1.13e+6	28.731	0.002
	BF4	1.65e+7	1	1.65e+7	43.860	<.001
BF3	BF5	2.82e+6	1	2.82e+6	71.362	<.001
	BF4	2.59e+7	1	2.59e+7	68.858	<.001
BF6	BF5	135698	1	135698	3.436	0.113
	BF4	526894	1	526894	1.403	0.281
BF7	BF5	81006	1	81006	2.051	0.202
	BF4	190145	1	190145	0.506	0.503
Residuals	BF5	236940	6	39490		
	BF4	2.25e+6	6	375576		

Note: compiled by authors

The univariate tests demonstrate statistically significant results for BF1, BF2, and BF3 across both dependent variables, BF5 (residential mortgage loans) and BF4 (retail loans). Specifically, BF1 exhibits the largest effect, with extremely high F-values (517.906 for BF5 and 425.757 for BF4, $p < 0.001$), confirming its critical role in influencing both outcomes. Similarly, BF2 and BF3 show significant effects, with F-values ranging from 28.731 to 71.362 and p-values well below the 0.05 threshold. These results highlight the strong contribution of interbank deposits, securities, and bank loans to banking

operations. In contrast, BF6 and BF7 failed to achieve statistical significance, as their p-values exceeded 0.05. The observed F-values (3.436 for BF6 and 2.051 for BF7 on BF5) suggest limited explanatory power, likely due to lower variability or smaller scale relative to other financial operations. The residuals indicate that a notable portion of the variance remains unexplained, particularly for BF4, reinforcing the dominance of BF1, BF2, and BF3 as key predictors. Overall, the results confirm the substantial impact of institutional tools like interbank deposits and securities on loan operations. At the same time, the insignificant outcomes for BF6 and BF7 may reflect their secondary role in resource allocation strategies or sample limitations.

Table 4 presents the results of the CD group multivariate tests.

TABLE 4. Client deposit factors multivariate tests

Var	Tests	Value	F	df1	df2	p
CD 1	Pillai's Trace	b	118.053	2	6	<.001
	Wilks' Lambda	0.0248	118.053	2	6	<.001
	Hotelling's Trace	39.351	118.053	2	6	<.001
	Roy's Largest Root	39.351	118.053	2	6	<.001
CD 2	Pillai's Trace	0.7645	9.739	2	6	0.013
	Wilks' Lambda	0.2355	9.739	2	6	0.013
	Hotelling's Trace	3.246	9.739	2	6	0.013
	Roy's Largest Root	3.246	9.739	2	6	0.013
CD 3	Pillai's Trace	0.0957	0.317	2	6	0.740
	Wilks' Lambda	0.9043	0.317	2	6	0.740
	Hotelling's Trace	0.106	0.317	2	6	0.740
	Roy's Largest Root	0.106	0.317	2	6	0.740
CD 4	Pillai's Trace	0.1140	0.386	2	6	0.695
	Wilks' Lambda	0.8860	0.386	2	6	0.695
	Hotelling's Trace	0.129	0.386	2	6	0.695
	Roy's Largest Root	0.129	0.386	2	6	0.695

Note: compiled by authors

The multivariate tests for the CD group reveal that the variables CD1 and CD2 have a statistically significant impact on banking operations. The significance of these variables is confirmed by multiple statistical tests, including Pillai's Trace, Wilks' Lambda, Hotelling's Trace, and Roy's Largest Root, all of which returned p-values below the commonly accepted threshold of $p < 0.05$. For CD1, the p-value was < 0.001, and for CD2, the p-value was 0.013, confirming their significant influence on key banking outcomes. On the other hand, the variables CD3 and CD4 did not demonstrate statistical significance, as their p-values exceeded the 0.05 threshold in all four multivariate tests. This indicates that these factors have limited explanatory power in the context of the analyzed banking activities. The higher Wilks' Lambda values for CD3 (0.9043) and CD4 (0.8860) suggest a weaker contribution to the variation in banking outcomes, as opposed to CD1 and CD2, which exhibited much lower Wilks' Lambda values of 0.0248 and 0.2355, respectively.

The results obtained showed the central role of client deposits (CD1) and corporate deposits (CD2) as key sources of funding for banks, directly supporting their capacity for lending and operational flexibility. The limited impact of individual deposits (CD3) and outstanding shares (CD4) may be due to the relatively smaller scale of household savings and the underdeveloped role of market-issued securities a major bank funding source.

Table 6 shows the results of the Shapiro-Wilk multivariate normality test for CD and BF groups.

TABLE 5. Univariate analysis of client deposit factors

Code	Dependent Variable	Sum of Squares	df	Mean Square	F	p
CD 1	BF5	1.88e+8	1	1.88e+8	225.8327	<.001
	BF4	2.24e+7	1	2.24e+7	273.6317	<.001
CD 2	BF5	1.08e+7	1	1.08e+7	12.9990	0.009
	BF4	1.79e+6	1	1.79e+6	21.8862	0.002
CD 3	BF5	514587	1	514587	0.6189	0.457
	BF4	60071	1	60071	0.7329	0.420
CD 4	BF5	302115	1	302115	0.3634	0.566
	BF4	2071	1	2071	0.0253	0.878
Residuals	BF5	5.82e+6	7	831432		
	BF4	573764	7	81966		

Note: compiled by authors

The univariate tests for the CD group revealed that CD1 and CD2 had statistically significant effects on the dependent variables BF4 and BF5, confirmed by the F-tests, where p-values for the variables are well below the commonly accepted threshold of $p < 0.05$. Specifically, for CD1, the F-statistics are 225.83 for BF4 and 273.63 for BF5, with p-values less than 0.001, a strong influence on both outcomes is supported. Similarly, CD2 demonstrated significant effects, with p-values of 0.009 for BF4 and 0.002 for BF5, confirming its relevance in explaining variations in these dependent variables. In contrast, CD3 and CD4 do not exhibited statistical significance, as all p-values exceeded 0.05. The F-values for CD3 are 0.6189 for BF4 and 0.7329 for BF5, while for CD4, the F-values are 0.3634 and 0.0253, respectively. Lack of significance reports that deposits from individuals and outstanding shares did not meaningfully contribute to variations in BF4 and BF5 within the analyzed period. These findings emphasize the dominant role of client deposits (CD1) and corporate deposits (CD2) in driving changes in retail loans and residential mortgage loans. The strong impact of these variables reflects their role as essential sources of bank liquidity and credit supply. In contrast, the insignificant effects of individual deposits (CD3) and outstanding shares (CD4) may be attributed to the smaller scale or limited utilization of these resources within the broader banking strategy.

In Table 6, there are results for Shapiro-Wilk multivariate normality test for CD and BF groups.

TABLE 6. Shapiro-Wilk Multivariate Normality Test

Hypotheses	W	p
BF	0.870	0.066
CD	0.870	0.066

Note: compiled by authors

According to the Shapiro-Wilk multivariate normality test results, the assumption of multivariate normality is not violated by both the BF and CD groups. The test produced a $W = 0.870$ and a $p = 0.066$ for both groups. Since the p-value is greater than 0.05, we fail to reject the null hypothesis of normality. Therefore, the data for the BF and CD variables are sufficiently normal. Figure 2 shows the results of normality validation for BF and CD groups.

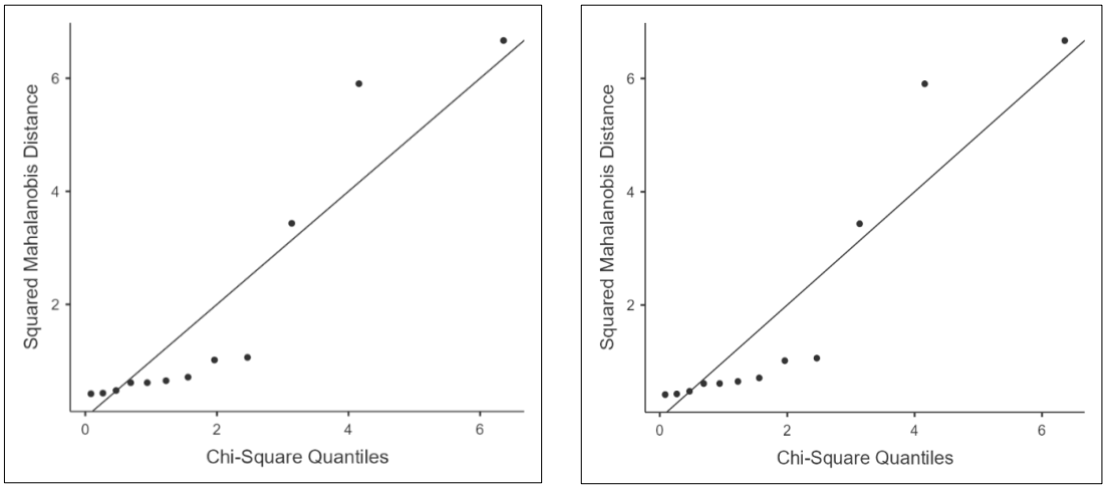


FIGURE 2. Q-Q Plots Normality validation for banking factors and client deposits

Note: compiled by authors

The Q-Q plots for both hypotheses provide a graphical assessment of the multivariate normality assumption, which is critical for validating the results of the MANCOVA analysis. In both cases, most data points align closely with the diagonal reference line, indicating that the squared Mahalanobis distances are approximately chi-square distributed. This alignment suggests that the assumption of multivariate normality is generally satisfied. However, slight deviations are observed in the upper quantiles, where a few points diverge from the reference line, indicating the presence of mild outliers. The deviations, though noticeable, are not substantial enough to undermine the overall validity of the normality assumption. Thus, the Q-Q plots confirm that the data sufficiently meets the requirement of multivariate normality for both hypotheses.

The raincloud plots in Figure 3 clearly confirm the findings from the Q-Q plots and multivariate tests, illustrating which factors play a significant role in bank performance.

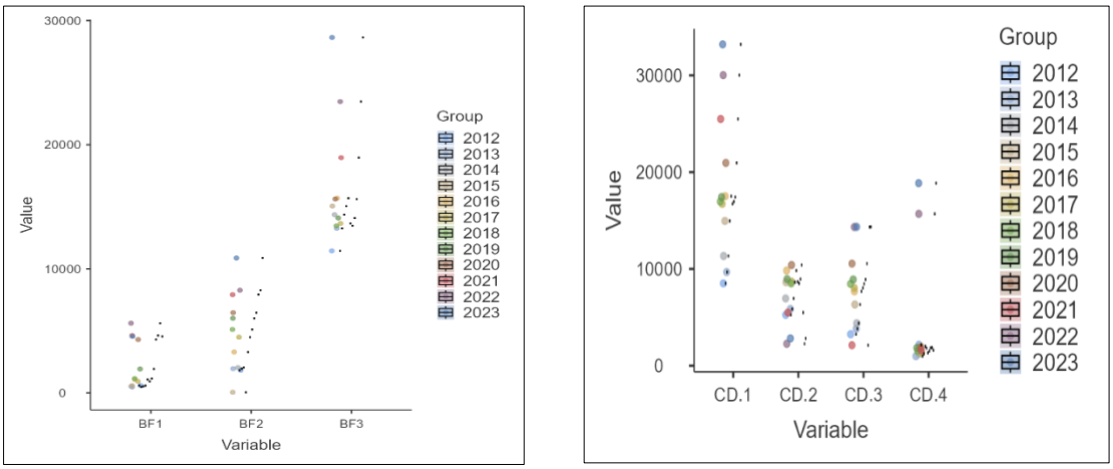


FIGURE 3. Contributions of banking factors and client deposits

Note: compiled by authors

In the banking factors group, variables such as BF2 and BF3 showed steady growth, particularly from 2018 onwards, showing their substantial contribution to banking activities. In contrast, BF1 remained stable but less influential. In the Client Deposits group, CD1 and CD2 had consistent and notable growth, especially in recent years, supporting their statistically significant role in the multivariate tests. Conversely, CD3 and CD4 exhibited lower and more inconsistent values, which explains their limited impact on banking performance.

Overall, the raincloud plots demonstrate that institutional deposits and investments, such as securities and mutual funds, have a far more significant influence on banking operations than individual deposits or smaller financial instruments.

Some of the obtained results align with existing studies. Total client deposits significantly impact key banking operations and the development of mutual funds. The results supported conclusions drawn in the existing literature that stable deposit flows facilitate liquidity management and enable banks to allocate resources to long-term projects, including mutual funds (Chernykh & Cole, 2011; Edem, 2017). Similarly, deposit-based diversification enhances bank liquidity and capacity to invest in financial instruments, thereby supporting the growth of mutual funds (Tuyishime et al., 2015). The findings also resonate with the fact that securities are significant in diversification and risk management by stabilizing mutual fund portfolios, particularly during periods of economic volatility (Burkhanov, 2018), and they are instrumental in achieving long-term asset diversification and economic resilience (McPherson-Smith, 2021; Montambault Trudelle, 2023).

However, some results diverge from studies concerning the role of individual deposits and outstanding securities. Notably, individual deposits in the analysis did not exhibit statistically significant effects on the analyzed banking operations, contradicting the study of Pellinen et al. (2011). Similarly, the findings did not comply with existing studies on the positive effect of individual deposit reallocation to money market mutual funds (Macey, 2011). Additionally, outstanding securities showed no significant influence, whereas the literature identified securities as the main factors and tools for corporate governance, investor attraction, and tax planning (Estrin, 2000; Marian, 2016).

5. CONCLUSIONS

Mutual funds in Kazakhstan may be a relatively new financial instrument with limited introduction into the financial system. Thus, the results reflect the unique regional characteristics of Kazakhstan. The primary objective of this study was to analyze the impact of key banking operations and client deposits on bank performance, focusing on identifying significant contributors, such as institutional deposits, securities, and mutual funds. This goal has been achieved through a comprehensive statistical analysis, including multivariate tests, Q-Q plots, and visualizations that demonstrated clear trends and relationships among the variables.

The first hypothesis, focused on the role of banking operations, confirmed that investments in securities and bank loans, including reverse REPO operations, significantly impact bank performance. These factors showed consistent growth and strong statistical significance, highlighting their critical role in shaping banking outcomes. Conversely, other operations, such as deposits placed with other banks, contributed less, indicating a stable but relatively smaller influence.

The second hypothesis examined client deposits and related instruments. The analysis revealed that total client deposits and deposits of legal entities exert a substantial and statistically significant influence on bank performance. In contrast, individual deposits and outstanding shares were found to have limited explanatory power, reflecting their smaller scale and variability over time.

The structure of the financial market in Kazakhstan differs from that of more mature markets and is still in its developmental stage. The share of individual investors and the accessibility of financial instruments, such as securities or mutual funds, as considered in the study, is significantly lower, limiting the influence of factors like individual deposits on the overall banking system. Financial literacy in Kazakhstan is considered to be lower compared to developed markets, affecting the behavior of individuals. As a result, people may prefer traditional forms of savings over more complex instruments like mutual funds. Therefore, the involvement of individuals in mutual fund development is challenging. Limited capital market development reduces the significance of outstanding securities in the banking system and mutual funds. This could be explained by the possibility that in Kazakhstan, individual deposits are not directly channeled into instruments like mutual funds. Moreover, individuals prefer using deposits for savings purposes rather than as a source for investments in complex financial instruments. Another moment is that Kazakhstan's regulatory environment and economic strategies do not consider mutual funds development or utilization of securities. Therefore, the results showed that bank deposits are regarded as the primary means of capital mobilization, which explains the high significance of corporate deposits in the analysis.

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The Role of Small and Medium Enterprises in Poverty Alleviation and Economic Well-Being

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ABSTRACT

In socio-economic development and poverty reduction, particularly in countries with agrarian economies and a high proportion of rural populations small and medium-sized enterprises (SMEs) are essential. Due to limited government resources for supporting social sectors, SMEs become means for job creation, household income growth, and economic stimulation. The purpose of this study is to examine the role of SMEs in well-being development and poverty reduction in Kazakhstan. For this purpose, there was conducted regression analysis and the study was focused on three main independent variables: SME share in GDP, employment in agriculture, and employment in individual entrepreneurship. The data covers the period from 2013 to 2023. The results showed that the SME contribution to GDP has a significant positive effect on household incomes and thus key role in enhancing economic well-being. Employment in individual entrepreneurship was directly associated with income growth and improved well-being, particularly in rural areas. Employment in agriculture demonstrated a dual effect: while it remained an essential source of income, its impact was constrained by low labor productivity and seasonality. However, crucial effect on poverty reduction and well-being improvement was achieved through the combined influence of SMEs, individual entrepreneurship, and agricultural employment. Thus, there is great need in diversifying income sources and adopting a comprehensive approach to economic development for effective poverty reduction.

KEYWORDS: Individual Entrepreneurship Employment, Small and Medium Enterprises, Regional Economy, Socio-Economic Development, Sustainable Development, Community Supported Agriculture, Kazakhstan

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1. INTRODUCTION

Small and Medium Enterprises (SMEs) role in fostering economic development and mitigating poverty-related issues is on academic and policy attention agenda. The contribution of SMEs is attributed to the well-being of the population; they are regarded as drivers of employment, income generation, and regional development; SMEs are often considered the backbone of economies in both developed and developing nations. Their contributions extend beyond economic metrics, influencing societal well-being and equitable resource distribution. However, the multifaceted nature of SME operations and their impacts necessitates a deeper understanding of the specific mechanisms through which they affect poverty alleviation and economic outcomes.

Over the past five years, Kazakhstan has demonstrated significant progress in key socio-economic indicators, particularly in developing the small and medium-sized enterprise (SME) sector, employment, and poverty reduction. The growth of SMEs, reflected in their increasing contribution to GDP from 28% in 2018 to 36.4% in 2023, highlights their growing role in economic diversification and employment generation. SMEs now account for the employment of approximately 43.6% of the economically active population, offering new opportunities for labor market participation, particularly in regions with limited access to formal employment. Simultaneously, unemployment has declined from 4.9% in 2022 to 4.7% in 2023, supported by the growing capacity of SMEs to absorb labor. These changes have contributed to a reduction in the national poverty rate, which fell to 5.3% in 2022, down from significantly higher levels in previous decades. The observed socio-economic shifts underscore the role of SMEs as a catalyst for sustainable development, poverty reduction, and economic inclusion in Kazakhstan.

Recent research underscores the importance of SMEs in generating employment opportunities, particularly in labor-intensive sectors and underserved regions, while also highlighting their potential to reduce poverty by integrating marginalized populations into formal economic systems. These enterprises are critical bridges between rural economies and broader markets, contributing to household income growth and community resilience. Despite their potential, SMEs face structural challenges, including limited access to credit, infrastructural deficits, and regulatory barriers, constraining their ability to achieve sustained growth and impact.

This article aims to explore the role of SMEs in poverty alleviation by examining their contributions to employment, income generation, and overall economic well-being. Focusing on key factors such as SME share in GDP, employment in agriculture and individual entrepreneurship, poverty rates, and per capita income, the study synthesizes insights from existing literature to comprehensively understand how SMEs shape socio-economic development. By identifying the key drivers and constraints of SME performance, this research seeks to inform policy strategies that enhance their effectiveness in addressing poverty and promoting sustainable development.

2. LITERATURE REVIEW

The role of Small and Medium Enterprises (SMEs) has been extensively analyzed across various domains, reflecting their influence on poverty alleviation, employment generation, and broader economic performance. As pivotal drivers of economic development, SMEs impact multiple facets, including employment, income distribution, and well-being. Studies collectively emphasize their potential to foster economic inclusivity but also highlight complexities and disparities in outcomes depending on contextual variables.

In countries where economy is resource and rural-dependent economy, agriculture usually serves as the primary source of income for a significant portion of the households. In this context, small and medium-sized enterprises (SMEs) become the driver for diversifying

income sources, and mostly through the development of the agro-industrial sector (Okpara, 2011). As rewarded by Van Vliet and Wang (2015), SMEs have a more immediate and direct impact on household incomes, unlike public spending on education and health, as it yields results over the long term. Manzoor et al. (2019) confirmed that SME completes a set of objectives, unlike direct government spending. First, it generates local employment opportunities and sustains income growth, particularly through labor-intensive activities such as agricultural processing and the production of value-added goods. It offers a decentralized, market-driven approach and contributes to short-term poverty alleviation. As a result, SMEs contribute to job creation and provide stable sources of income for rural households, making them a more effective tool for poverty reduction compared to the indirect effects of public investments (Nursini, 2020).

Some studies explored the relationship between SMEs and economic development. According to Beck et al. (2005), although there is a statistically significant positive association between the relative size of the SME sector and GDP per capita growth, this association does not imply a causal relationship. In other words, economic growth might create favorable conditions for the expansion of SMEs rather than SMEs being the primary cause of the growth. Vandenberg (2006) highlighted issues such as financial accessibility and the need for integrated policies that enhance SME sustainability. Similarly, Sokoto and Abdullahi (2013) argued that SMEs in developing regions like North-West Nigeria significantly contribute to poverty reduction by generating localized employment opportunities. Moreover, microfinance institutions, vocational training, and market accessibility are important as key interventions to enhance SME contributions to poverty alleviation. Further, Maksimov et al. (2017) advocated for a complex approach that combines structural reforms, capability enhancement, and strategic support to amplify the poverty-alleviating impact of SMEs. Rather than focusing solely on direct financial support or subsidies, they advocate for systemic interventions that address the root causes of SME underperformance in least-developed countries.

SMEs are often lauded for their role in employment generation. De Kok et al. (2011) stated that SMEs are responsible for net employment growth within the EU. In particular,micro-enterprises disproportionately contribute to net job creation compared to medium-sized enterprises within the SME category, and they tend to experience higher job losses than large enterprises during downturns but recover more dynamically in favorable economic conditions. Galabova and McKie (2013) stressed the relationship between human capital development and employee well-being in enhancing SME productivity and competitiveness. Happier and more engaged employees contribute positively to enterprise performance; hence, SMEs have unique approaches to managing human capital and well-being that are driven by resource constraints and closer relationships between employers and employees. That is why SME managers place significant value on "soft" skills, such as enthusiasm, willingness to learn, and adaptability, over formal qualifications.

Agriculture is regarded as a key mechanism in reducing poverty. Some studies focus on modernizing agriculture, while others regard it as a source for attracting foreign capital and investment and stress the impact of side factors. Separate studies relate to the relationship between agricultural and non-agricultural employment opportunities. Christiaensen et al. (2011) and Bello (2020) revealed the direct impact of agriculture on income growth and well-being. Specifically, agriculture helps to reduce extreme poverty and is widespread in rural or extremely poor regions. According to Page and Shimeles (2014), Dev (2017), and Sikandar et al. (2021), agriculture is the main source of income in developing countries, and it is dependent on external capital and aid in enhancing agricultural productivity and supporting agri-value chains. Moreover, foreign capital inflows contribute to the increase in exports, and as a result, rural

employment and household incomes are driven by agricultural development.

SMEs provide essential support in processing, packaging, and distribution, increasing agricultural output value. Abisuga-Oyekunle et al. (2019) underscored SMEs' transformative role in sub-Saharan Africa through employment and sustainable development. The labor-intensive nature of SMEs makes them particularly effective in addressing unemployment and underemployment and promoting inclusive growth by providing opportunities for marginalized groups, such as women and youth. In agricultural contexts, Banerjee and Rahman (2019) highlighted the relationship between SMEs and agricultural sectors, where SMEs facilitate value addition, thereby increasing income levels and reducing rural poverty. In other words, SMEs are a critical bridge between agricultural production and broader market integration. Examining per capita income as a proxy for well-being, Azmi (2020) explored the dual impact of SME growth on business success and owner well-being. Maharaj and Doorasamy (2024) stated that financial planning observed among SME business owners enhances SMEs' resilience and contributes to long-term income stability.

To sum up, SMEs and the agricultural economy play a significant part in maintaining an adequate income level for the population and reducing extreme poverty. Therefore, it is important to analyze the relationship between SMEs' development and population living standards, such as poverty reduction and income increase.

3. METHODOLOGY

The literature review conducted revealed the main sectors of the economy that are affected by the development of individual entrepreneurship or small and medium-sized businesses. Initially, the analysis was built on the assumption that identified variables through the literature review might have a direct or indirect impact on dependent variables. Table 1 presents the variables applied at the initial stage.

TABLE 1. List of variables

Set	Variable	Coding	Type
1	Poverty Rate	Poverty_rate	Dependent
	Food Basket Expenditures	Food_Basket_Poverty	Dependent
	Below 60% Median Income	Below_60%_Median_Income	Dependent
	Poverty Severity	Poverty_Severity	Dependent
	Poverty Depth	Poverty_Depth	Dependent
	Poverty Rate	Poverty_Rate	Dependent
2	Per Capita Income	Per_capita_income	Dependent
	Per Capita Expenditures	Per_Capita_Expenditures	Dependent
	Real Income Index	Real_Income_Index	Dependent
	Income-Subsistence Ratio	Income-Subsistence_Ratio	Dependent
	Household Income Consumption	Household_Income_Consumption	Dependent
3	SME Share in GDP	SME%GDP	Independent
	Employment in Agriculture	Employed_Agro	Independent
	Employment in Individual Entrepreneurship	Employed_IE	Independent
4	Inflation Rate	Infl_R	Independent
	Exchange Rate	Exch_R	Independent
	Foreign Direct Investment	FDI	Independent
	Public Spending on Education	PS_Educ	Independent
	Public Spending on Health	PS_H	Independent

Note: compiled by authors

There were used four sets of variables. The first two sets of variables were considered dependent variables as they reflected the state of well-being and poverty in Kazakhstan. However, to ensure the validity of the analysis and the correct selection of dependent variables, there a conducted centrality plot analysis. Centrality analysis was used as a part of network analysis to identify which variables have the most significant connections to other key variables in the dataset. The results for the independent variables through ANOVA analysis showed that the fourth set of variables failed to pass the statistical significance threshold (e.g., $p > 0.05$) and, therefore, were excluded because they did not explain enough variation in the dependent variables. Removing irrelevant or weakly connected variables allowed focus on the most significant factors that directly impacted employment, well-being, and poverty. Moreover, this allowed for the avoidance of redundancy and reduced multicollinearity by removing variables with overlapping effects and allowing for more stable and interpretable coefficient estimates. Table 2 presents the list of applied variables in the analysis.

TABLE 2. Cleaned list of variables

Set	Variables	Role	Coding
1	Per Capita Income	Wellbeing (M_1)	Per_capita_income
	Poverty Rate	Wellbeing(M_2)	Poverty_Rate
2	SME Share in GDP	Independent	SME%GDP
	Employment in Agriculture	Independent	Employed_Agro
	Employment in Individual Entrepreneurship	Independent	Employed_IE

Note: compiled by the authors

The cleaned list of variables allowed for proper and deep analysis. Complete analysis and results for variable selection are provided in the results part of the research. The following hypotheses were formed:

Hypothesis 1. The share of SMEs in GDP, employment in individual entrepreneurship, and agriculture together significantly impact wellbeing.

Hypothesis 2. The share of SMEs in GDP, employment in individual entrepreneurship, and agriculture combined have a significant impact on the poverty rate.

Hypothesis 3. The share of SMEs in GDP has a significant impact on poverty levels and well-being.

Hypothesis 4. Employment in agriculture significantly influences poverty reduction and economic well-being, reflected in income- per capita.

Hypothesis 5. Employment in individual entrepreneurship significantly influences poverty reduction and economic well-being, reflected in income- per capita.

Overall, the analysis included four stages.

Network analysis. A network analysis was conducted to determine the most central and potentially dependent indicators. This method allowed for identifying interdependencies among variables, with centrality measures highlighting key indicators that act as significant connectors within the network. This analysis identified poverty rate and per capita income as central indicators, suggesting their relevance as dependent variables for further analysis.

Regression analysis involved multiple regression analysis to assess the relationships between per capita income and the independent variables. The model's explanatory power was evaluated using R-squared and adjusted R-squared values, while the statistical significance of each predictor was examined through P-values and F-tests.

Collinearity diagnostics. To ensure the accuracy of the regression model, the Variance Inflation Factor was calculated to identify whether there is multicollinearity among predictors.

Marginal effects analysis plots were used to visualize each predictor-dependent variable's impact and understand the relationships between variables.

4. FINDINGS AND DISCUSSION

Individual entrepreneurship plays a significant part in ensuring income and financial stability for the population. However, its role and importance are usually understudied due to emerging economic issues such as inflation or global crises. Therefore, the initial stage of the analysis is devoted to selecting core variables for further analysis and focusing attention on real issues.

The first stage of the analysis of the network of identified variables is that the data was divided into two groups. The first group included five indicators, and nine non-zero connection networks were revealed, indicating a highly interconnected structure. The network sparsity was very low, 0.100, or only 10% of potential connections were missing, and there was a high degree of interdependence among the indicators. The indicators in the first group were closely related, with mostly significant associations (Figure 1).

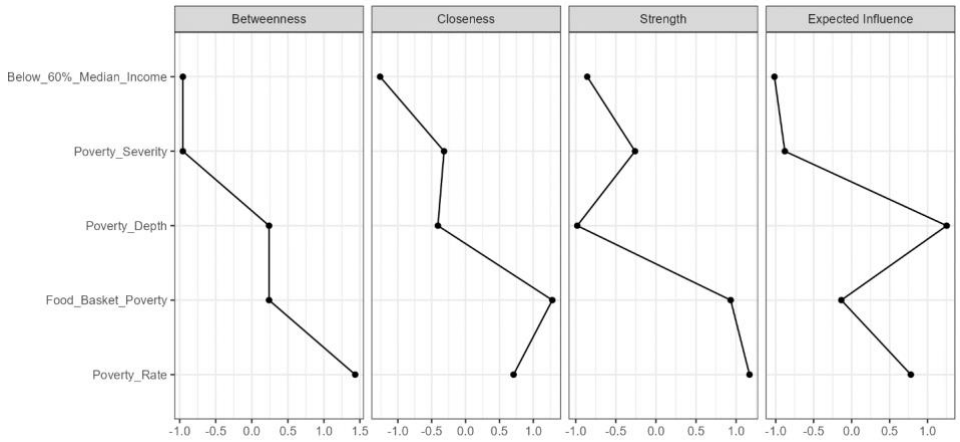


FIGURE 1. Centrality measures per variable, group 1

Note: compiled by authors

The centrality measures highlight Poverty_Rate as the most central indicator in this network, making it a strong candidate for a dependent variable to represent welfare levels in Kazakhstan. Poverty_Rate has a betweenness score of 1.434, the highest among the indicators, and connects other variables. Additionally, a closeness score of 0.708 and a strength score of 1.168 showed that Poverty_Rate is central in the provided network of variables and is a key factor in understanding the population's well-being. Therefore, changes in Poverty_Rate affect the whole network and have strong direct connections to other indicators and accessibility to the broader network. Other indicators, Poverty_Severity and Below_60%_Median_Income, have negative betweenness and closeness scores and a weak network impact. Poverty_Rate was identified as the central indicator, capturing core welfare dynamics and a comprehensive measure for assessing the well-being landscape in Kazakhstan.

The second group network included five nodes with a moderately interconnected structure (Figure 2).

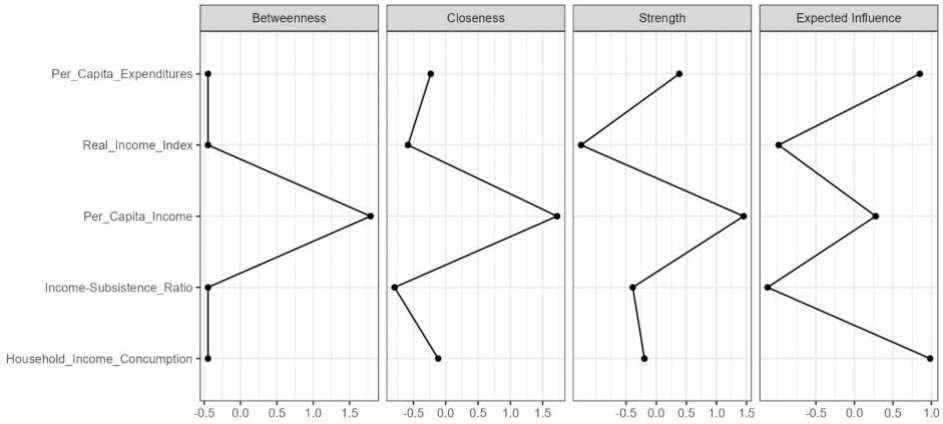


FIGURE 2. Centrality measures per variable, group 2

Note: compiled by authors

Per_Capita_Income was identified as the central indicator in the second group (betweenness (1.789), closeness (1.722), strength (1.451)): significant influence over other variables; links key indicators and complex interdependencies. Therefore, Per_Capita_Income define the economic landscape conditions in Kazakhstan. Others, showed moderate centrality.

Based on the analysis of the two groups, Per_Capita_Income and Poverty_Rate were selected as the dependent indicators.

Table 3 presents the models summary for regression analysis.

TABLE 3. Models Summary

Model	R	R^2	Adjusted R^2	RMSE
Wellbeing (M_1)	0.943	0.890	0.843	13829.040
Poverty rate (M_2)	0.952	0.907	0.867	0.409

Note: compiled by authors

The analysis for per capita income has an R-squared of 0.890, or 89% of the population's income level change is affected by the independent variables. The adjusted R-squared of 0.843 confirms the model's reliability. SMEs and individual entrepreneurship are closely linked to higher income levels. Thus, it confirms the crucial impact of SME development on the well-being of the population. The second model examines poverty rates and has an R-squared of 0.907. In other words, the same variables explain 90.7% of the increase and decrease in poverty rates. The adjusted R-squared of 0.867 and RMSE of 0.409 confirm the model's precision.

In table 4, the results of ANOVA analyses are presented.

TABLE 4. ANOVA results for both models

Model		Sum of Squares	df	Mean Square	F	p
Wellbeing (M_1)	Regression	$1.081\times10^{+10}$	3	$3.602\times10^{+9}$	18.834	< .001
	Residual	$1.339\times10^{+9}$	7	$1.912\times10^{+8}$		
	Total	$1.214\times10^{+10}$	10			
Poverty rate (M_2)	Regression	11.457	3	3.819	22.813	< .001
	Residual	1.172	7	0.167		
	Total	12.629	10			

Note: compiled by authors based on calculations

SSR results showed that the variance explained by the model significantly exceeded the unexplained variance. The F-value of 18.834 and a p-value below .001, the model surpassed acceptable significance threshold thus the model is statistically significant. Thus, Hypotheses 1 and 2 are accepted.

The strong connection between variables in the context of Kazakhstan is explained through the direct role independent variables in income generation and poverty reduction. Thus, SMEs drive job creation and income diversity. For example, SMEs in retail, services, or small manufacturing provide employment opportunities for a large share of the population, particularly in urban areas, increasing household income, which, in turn, boosts consumption and overall economic activity. Individual entrepreneurship has a similar impact by enabling people to start businesses, often in sectors like trade or local services, which generate income even in regions with fewer industrial jobs.

Table 5 presents the regression coefficients for Model M_1 and Model M_2.

TABLE 5. Coefficients

Model		Unstandardized	Standard Error	Standardized	t	p	Collinearity Statistics	
							Tolerance	VIF
M_1	(Intercept)	-18263.137	32338.437		-0.565	0.590		
	SME%GDP	1026.609	1932.268	0.180	0.531	0.612	0.137	7.315
	Employed_Agro	-0.030	0.013	-0.392	-2.352	0.051	0.567	1.765
	Employed__IE	0.082	0.047	0.525	1.760	0.122	0.177	5.663
M_2	(Intercept)	4.745	0.957		4.960	0.002		
	SME%GDP	0.044	0.057	0.240	0.771	0.466	0.137	7.315
	Employed_Agro	-2.047×10^{-6}	3.729×10^{-7}	-0.839	-5.488	< .001	0.567	1.765
	Employed__IE	-4.741×10^{-7}	1.384×10^{-6}	-0.094	-0.342	0.742	0.177	5.663

Note: compiled by authors based on calculations

The coefficients in Model M_1 indicated that SME%GDP has a positive coefficient with no statistical significance, suggesting a limited direct impact. Employed_Agro shows a negative coefficient that is marginally significant, indicating an inverse relationship with the dependent variable. Employed_IE has a positive coefficient but lacks statistical significance, indicating an inconclusive association with Per_Capita_Income. Collinearity diagnostics revealed manageable multicollinearity among predictors, though SME%GDP has a higher VIF, suggesting moderate redundancy with other variables. The coefficients highlighted Employed_Agro as the most influential predictor on Per_Capita_Income in this model. To sum up, the results revealed the following hypotheses testing.

SME%GDP does not significantly impact well-being ($p = 0.612$) or poverty rate ($p = 0.466$). Hypothesis 3 was rejected.

Employment in agriculture has a significant effect on poverty rate ($p < 0.001$) and a marginal effect on well-being ($p = 0.051$). Hypothesis 4 is partially accepted.

Employment in individual entrepreneurship does not significantly impact well-being ($p = 0.122$) or poverty rate ($p = 0.742$). Hypothesis 5 was rejected.

The descriptive statistics in Table 6 present the mean, standard deviation, and standard error for each variable in the model.

TABLE 6. Descriptives

Variable	Mean	SD	SE
Per_Capita_Income	91526.091	34848.986	10507.365
Poverty_Rate	3.791	1.124	0.339
SME%GDP	27.245	6.121	1.846
Employed_Agro	759303.455	460958.581	138984.242
Employed__IE	$1.267\times10^{+6}$	222432.964	67066.062

Note: compiled by authors based on calculations

Per_Capita_Income has a mean of 91,526.091 and a standard deviation of 34,848.986, indicating variability in income levels. SME%GDP shows an average of 27.245 with a standard deviation of 6.121, indicating moderate consistency in the share of SMEs within GDP across observations. Employed_Agro has a mean of 759,303.455 and a standard deviation of 460,958.581, reflecting variation in agricultural employment levels. Employed_IE has the highest mean at 1,267,000 and a standard deviation of 222,432.964, showing variability in individual entrepreneurship employment figures. The standard errors (SE) indicate the precision of each variable's mean estimate, with Per_Capita_Income having the most significant SE, aligning with its wide range in income distribution. The descriptive statistics summarize the data's spread and central values, which support interpretations in the regression model.

Figure 3 illustrates the relationship between agricultural / IE employment and two socioeconomic indicators—poverty rate and per capita income.

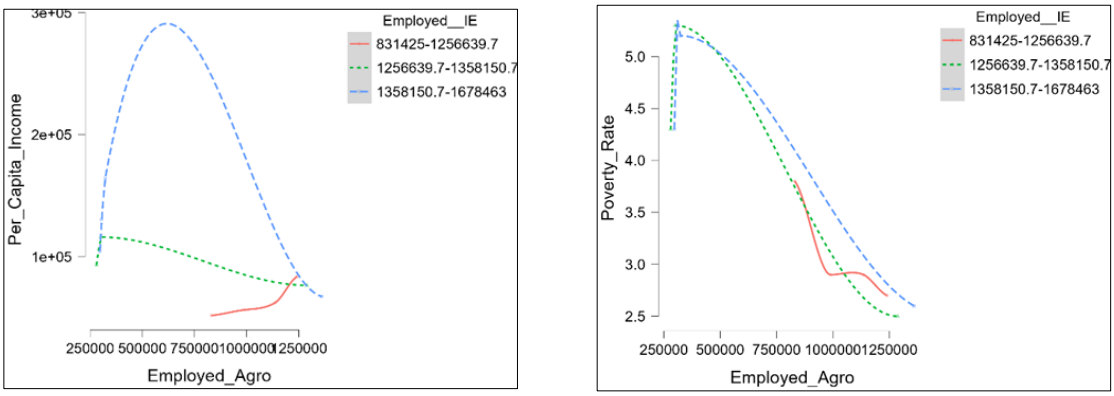


FIGURE 3. Dynamics of the relationships between SME contribution, employment and poverty reduction

Note: complied by authors based on calculations

In the first graph, poverty rates decrease as agricultural employment rises, but the extent of this reduction varies depending on industrial employment levels. At low industrial employment levels (red line), increasing agricultural employment substantially reduces poverty, indicated by a steep initial decline that then stabilizes. The poverty reduction is more moderate at medium levels of industrial employment (green line). In contrast, at high levels of industrial employment (blue line), the decline in poverty is gradual, suggesting that higher industrial employment mitigates the poverty-reducing effect of agricultural employment. This may imply that when industrial employment is high, income sources

become more diversified, reducing reliance on agriculture for poverty alleviation.

The second graph shows that per capita income initially rises with increasing agricultural employment but then declines, with the income peak varying across industrial employment categories. At low industrial employment (red line), per capita income exhibits limited growth with rising agricultural employment. At medium levels of industrial employment (green line), income rises modestly, reaching a small peak. At high levels of industrial employment (blue line), income sharply increases at lower levels of agricultural employment, peaks, and then declines as agricultural employment continues to grow. This pattern suggests that when industrial employment is high, additional agricultural employment initially drives income gains but yields diminishing returns as agricultural employment increases further, potentially due to a shift from higher-wage industrial jobs to lower-wage agricultural roles.

Simply supporting SMEs is not enough to guarantee accelerated economic growth. Without addressing broader institutional factors such as property rights, access to finance, and lowering barriers to business, SME support may not effectively contribute to growth or poverty alleviation.

5. CONCLUSIONS

In this study, the objective was to analyze the impact of the share of SMEs in GDP, agricultural employment, and employment in individual entrepreneurship, poverty rate and wellbeing in Kazakhstan. Based on this goal, several hypotheses were formulated to assess the relationships and significance of these factors in shaping welfare dynamics.

There was revealed to be no significant impact of the SME share in GDP on poverty and well-being. Hence, simply increasing the share of SMEs in the economy does not automatically lead to improvements in the well-being of the population or reduce the poverty rate. As the base recommendation, the creation of high-quality jobs within SMEs should be considered. Moreover, policies could be directed at developing sectors with higher added value.

The significant impact of employment in agriculture on poverty reduction bridged emerging needs. As a productive sector for the population, tactics must be considered to modernize the agricultural sector and reduce the proportion of the population engaged in low-productivity agricultural work. Again, here is the issue of quality job availability, as employment in agriculture is often associated with low wages and informal labor, which results in an increase in poverty.

The lack of a significant impact of individual entrepreneurship on poverty and well-being is a consequence of the large proportion of the population engaged in individual entrepreneurship (the majority as self-employed or solo entrepreneurs), which is engaged in low-income activities that do not guarantee higher incomes or improved living conditions.

Overall, the findings showed that the situation for population wellbeing in Kazakhstan needs a complex approach and provision of quality employment. There should be developed policies that consider specific support for private small businesses.

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