

A.N. Turginbayeva^{1,2} , A.K. Kozhakhmetova^{3*} 

¹Al-Farabi Kazakh National University, Almaty, Kazakhstan

²University of Illinois Urbana-Champaign, Champaign, USA

³Institute of Applied Sciences and Information Technology, Almaty, Kazakhstan

*e-mail: a.kozhakhmetova@kbtu.kz

UNEVEN ACCESS TO R&D AS A DETERMINANT OF REGIONAL INNOVATION CAPACITY: EVIDENCE FROM KAZAKHSTAN

This study analyzed uneven access to R&D as a driver of the organizational capacity for innovation in the regions of the Republic of Kazakhstan. The aim of the study is to analyze regional inequality in access to R&D and its role as a factor in shaping regional innovation potential. Secondary statistical data from national and international sources (Bureau of National Statistics of Kazakhstan, OECD, and World Bank) are used to construct a regional panel dataset of 20 regions for 2016–2024, which is analyzed using panel regression with regional and time fixed effects to examine the relationship between access to R&D and innovation performance. Research findings from a regional perspective show that three patterns emerge: core regions efficiently convert R&D inputs into innovation outputs, resource-rich regions display an “efficiency gap” between investment and results, while peripheral and catch-up regions exhibit weak and unstable innovation dynamics driven mainly by temporary policy measures rather than sustained R&D development.

This study contributes to the existing research by applying a panel data approach with fixed effects, allowing for a more accurate identification of the relationship between R&D inputs and innovation outputs across regions. In addition, the study provides policy-relevant implications for improving the effectiveness of regional innovation systems and reducing spatial inequality in emerging economies.

Keywords: regional inequality, access to R&D, innovation capacity, R&D expenditure, Kazakhstan.

А.Н. Тургинбаева^{1,2}, Ә.К. Қожахметова^{3*}

¹Әл-Фараби атындағы Қазақ ұлттық университеті, Алматы, Қазақстан

²Урбана-Шампейн Иллинойс университеті, Шампейн, АҚШ

³Қолданбалы ғылымдар және ақпараттық технологиялар институты, Алматы, Қазақстан

*e-mail: a.kozhakhmetova@kbtu.kz

ҒЗТҚЖ-ға қолжетімділіктің әркелкілігі аймақтық инновациялық әлеуеттің факторы ретінде: Қазақстан мысалында

Бұл зерттеуде Қазақстан Республикасы аймақтарындағы инновацияның ұйымдастырушылық әлеуетін анықтайтын фактор ретінде ғылыми-зерттеу және тәжірибелік-конструкторлық жұмыстарға (ҒЗТҚЖ) тең емес қолжетімділік талданады. Зерттеудің мақсаты – ғылыми-зерттеу және тәжірибелік-конструкторлық жұмыстарға қолжетімділіктегі аймақтық теңсіздікті және оның аймақтық инновациялық әлеуетті қалыптастырудағы рөлін талдау. 2016–2024 жылдарға арналған 20 аймақ үшін аймақтық панельдік деректер жиынтығын құру үшін ұлттық және халықаралық көздерден (ҚР Ұлттық статистика бюросы, ЭЫДҰ және Дүниежүзілік банк) алынған қайталама статистикалық деректер пайдаланылды. Зерттеу және тәжірибелік-конструкторлық жұмыстарға қолжетімділік пен инновациялық көрсеткіштер арасындағы байланысты зерттеу үшін аймақтық және уақытша бекітілген әсерлері бар панельдік регрессияны қолдана отырып, деректерді талдау жүргізілді. Зерттеу нәтижелері, аймақтық тұрғыдан алғанда, үш заңдылықты көрсетеді: орталық аймақтар ғылыми-зерттеу және тәжірибелік-конструкторлық жұмыстарға жұмсалатын шығындарды инновациялық нәтижелерге тиімді түрде айналдырады; ресурстарды көп қажет ететін аймақтар инвестициялар мен нәтижелер арасында «тиімділік алшақтығын» көрсетеді; ал шеткі және қуып жететін аймақтар әлсіз және тұрақсыз инновациялық динамиканы көрсетеді, бұл негізінен ғылыми-зерттеу және тәжірибелік-конструкторлық жұмыстардың тұрақты дамуына емес, уақытша саяси шараларға байланысты.

Талдау нәтижелері ғылыми-зерттеу және тәжірибелік-конструкторлық жұмыстарға жұмсалатын шығындар мен инновациялық көрсеткіштер арасындағы байланысты дәлірек анықтауға мүмкіндік беретін бекітілген әсерлі панельдік деректер тәсілін қолдану арқылы

үлес қосады. Сонымен қатар, зерттеу аймақтық инновациялық жүйелердің тиімділігін арттыру және дамушы елдердегі кеңістіктік теңсіздікті азайту үшін саясатқа қатысты шаралар ұсынады.

Түйін сөздер: аймақтық теңсіздік, ҒЗТҚЖ-ға қолжетімділік, инновациялық әлеует, инновациялық көрсеткіштер, ҒЗТҚЖ шығындары, Қазақстан.

А.Н. Тургинбаева^{1, 2}, А.К. Кожакметова^{3*}

¹Казахский национальный университет имени аль-Фараби, Алматы, Казахстан

²Университет Иллинойса Урбана-Шампейн, Шампейн, США

³Институт прикладных наук и информационных технологий, Алматы, Казахстан

*e-mail: a.kozhakhmetova@kbtu.kz

Неравномерный доступ к НИОКР как фактор регионального инновационного потенциала: пример Казахстана

В данном исследовании анализируется неравномерный доступ к НИОКР как фактор, определяющий организационный потенциал инноваций в регионах Республики Казахстан. Цель исследования – проанализировать региональное неравенство в доступе к НИОКР и его роль как фактора формирования регионального инновационного потенциала. Для построения региональной панельной выборки данных по 20 регионам за 2016–2024 годы использованы вторичные статистические данные из национальных и международных источников (Бюро национальной статистики Казахстана, ОЭСР и Всемирный банк). Анализ данных проводится с помощью панельной регрессии с региональными и временными фиксированными эффектами для изучения взаимосвязи между доступом к НИОКР и инновационной эффективностью. Результаты исследования с региональной точки зрения показывают наличие трех закономерностей: центральные регионы эффективно преобразуют затраты на НИОКР в инновационные результаты, в ресурсоемких регионах наблюдается «разрыв в эффективности» между инвестициями и результатами, в то время как периферийные и догоняющие регионы демонстрируют слабую и нестабильную инновационную динамику, обусловленную в основном временными политическими мерами, а не устойчивым развитием НИОКР.

Данное исследование вносит вклад в существующие исследования, применяя подход панельных данных с фиксированными эффектами, что позволяет более точно определить взаимосвязь между затратами на НИОКР и результатами инноваций в разных регионах. Кроме того, исследование содержит важные для политики выводы по повышению эффективности региональных инновационных систем и сокращению пространственного неравенства в развивающихся странах.

Ключевые слова: региональное неравенство, доступ к НИОКР, инновационный потенциал, расходы на НИОКР, Казахстан.

Introduction

In the context of the knowledge economy, research and innovation activities have become key factors in the long-term economic development of territories. At the same time, numerous studies show that research resources and innovation potential are distributed extremely unevenly across regions (Cooke, 1997; Asheim & Gertler, 2005). Scientific organizations, research infrastructure, and highly qualified human capital are typically concentrated in large university and science and technology centers, while many peripheral regions have limited opportunities to participate in innovation activities. This spatial asymmetry creates significant differences in regional access to research resources and can exacerbate interregional disparities in innovative development (Rodríguez-Pose, A., & Crescenzi, 2008). Under these conditions, the problem of regional inequality in access to R&D becomes a key issue in the functioning of regional innovation systems.

The relevance of this research is particularly high for developing economies, where limited research resources require more effective management and a more balanced distribution of innovative potential. In such conditions, access to R&D can be viewed not only as an element of scientific infrastructure but also as an important factor in regional development, influencing the ability of regions to develop innovative competencies, attract investment, and integrate into global knowledge networks (Porter, 1998; Granstrand & Holgersson, 2020).

Kazakhstan provides a prime example of this situation. The development of a national innovation system has been accompanied by a significant spatial concentration of research resources. The bulk of research personnel, research organizations, and publication activity are concentrated in a few large universities and research centers, while most regions are characterized by a relatively low intensity of research activity and limited integration into national and international innovation networks. Meanwhile,

total R&D expenditure remains significantly below the OECD average, amounting to less than 0.3% of gross domestic product (World Bank, 2010), which reinforces the importance of efficient use of existing scientific and technological potential.

Despite significant advances in research on regional innovation systems, innovation ecosystems, and innovation policy, a certain analytical gap remains in the contemporary literature. Most studies examine regional differences in innovation activity primarily through the lens of institutional factors, scientific infrastructure, or mechanisms of state support for innovation (Cooke, 2002). At the same time, significantly less attention has been paid to analyzing access to R&D as a factor in regional differences in innovative potential. Even though R&D support leads to an increase in patenting activity of firms, confirming that access to R&D resources has a positive effect on formalized innovative results (Bronzini & Piselli, 2016).

In regional innovation systems, R&D expenditure increases the resource base for research (Audretsch *et al.*, 2024), R&D staff provide the human capital necessary to generate and apply new knowledge (Cohen & Levinthal, 1990), and R&D-performing organizations create the institutional channels through which knowledge is transformed into patents, new products, and other innovation outputs (Filippopoulos & Fotopoulos, 2022). Therefore, unequal access to these inputs leads to disparities in innovation performance across regions, while the relationship between the spatial distribution of research resources and the formation of regional innovative potential remains insufficiently explored.

Therefore, the aim of this study is to analyze regional inequality in access to R&D and its role as a factor in shaping regional innovation potential. To achieve this goal, the following research questions were formulated:

RQ1. What is the level and spatial pattern of regional inequality in access to R&D across regions of Kazakhstan?

RQ2. To what extent does regional inequality in access to R&D resources shape disparities in innovation output across regions of Kazakhstan?

This article contributes to research on regional innovation systems by examining access to R&D as a factor in shaping regional innovation potential. The study clarifies the role of research resources in developing regional innovation potential and draws conclusions relevant to regional innovation development policy.

Literature review

Research on regional innovation is largely linked to the concept of regional innovation systems (RIS), which is grounded in the ideas of national innovation systems and the economic geography of innovation. In the classical interpretation, RIS is viewed as a set of organizations and institutions—firms, universities, research centers, government agencies, and intermediary structures—linked by stable interactions that ensure the creation, dissemination, and commercialization of knowledge at the regional level (Cooke, 1997). Within this framework, the innovative development of regions is determined not only by the presence of research organizations, but also by the quality of the institutional environment, the intensity of interactions between participants in the innovation process, and the ability of regions to utilize accumulated scientific and technological potential (Asheim & Gertler, 2005).

Further development of the RIS concept is linked to research on network interactions and multilevel innovation management. These studies emphasize that regional innovation activity depends not only on local resources but also on the ability to integrate into national and international knowledge production networks (Cooke, 2002). In this context, access to research infrastructure, research partnerships, and technology transfer channels becomes an important condition for developing regional innovation potential.

In recent years, the scientific literature has seen a shift in analytical focus from territorially oriented models of innovation to more network-based forms of organizing innovation activity. One such approach is the concept of innovation ecosystems, which views innovation as the result of interactions among various participants in value creation processes. Recent studies emphasize the role of innovation ecosystems in coordinating interactions among diverse actors involved in knowledge creation and technological development (Autio & Thomas, 2022). Within this approach, mechanisms of coordination, role distribution, and alignment of interests between universities, companies, and public institutions play a key role (Granstrand & Holgersson, 2020).

The structural approach to innovation ecosystems views them as a configuration of interconnected actors and activities, where the success of innovation projects depends on the alignment of partners and the architecture of interactions (Adner, 2017). In

this context, access to R&D can be interpreted as the ability of regions and organizations to integrate into the structure of an innovation ecosystem and assume a sustainable role in the processes of knowledge creation and dissemination. From this perspective, access to R&D is determined not only by the availability of research infrastructure but also by the ability of regions to integrate into knowledge networks and innovation ecosystems. In this context, the issue of access to research resources takes on particular significance. Access to R&D includes not only the availability of research infrastructure but also the regions' opportunities for participation in scientific networks, interactions between universities and industry, and technology transfer mechanisms. The presence or absence of such opportunities can significantly impact regions' ability to develop and nurture their own innovative potential.

Despite a significant amount of research devoted to regional innovation systems and innovation policy, the problem of uneven access to R&D remains understudied. The scientific literature focuses primarily on the institutional conditions for innovation and mechanisms of state support for innovation, while spatial differences in access to research resources and their impact on regional innovation potential are analyzed much less frequently.

The theoretical approaches discussed above allow for a better understanding of the relationship between access to R&D and the development of regional innovation potential. For a more comprehensive analysis of this problem, it is important to examine its manifestations in a specific national context. In this regard, Kazakhstan provides an illustrative example of an economy whose innovation system is characterized by a significant spatial concentration of research and development resources.

Hypotheses development. Studies of the spatial economics of innovation show that innovative activity has a pronounced tendency toward geographical concentration. High-tech industries, research organizations, and skilled human capital are typically concentrated in large urban agglomerations and science and technology centers. At the same time, peripheral regions have significantly limited opportunities to engage in innovative activity (Rodríguez-Pose & Lee, 2013). This spatial asymmetry leads to the formation of territorial differences in innovative potential.

Many other studies in the regional innovation literature also emphasize the uneven spatial distribution of R&D activities and the results thereof. Previous studies show that innovation tends to concentrate geographically because of agglomera-

tion effects, localized knowledge spillovers, and research institutions and firms with geographical co-location. Innovative activity tends to be localized in a few areas (Crescenzi & Rodríguez-Pose, 2017) and knowledge creation tends towards geographic agglomeration due to localized spillovers (Audretsch & Feldman, 2004). Likewise, the OECD (2011) emphasizes how regional characteristics determine the quality of innovation performance, supporting the view that territory inequality has a structural role in innovation systems. Collectively, these findings indicate that areas with stronger institutional, infrastructural and human capital underpinnings accumulate their R&D resources and that peripheral regions experience disadvantage. This leads to persistent spatial inequality in access to R&D, which forms the basis for testing Hypothesis 1.

H1. Regional inequality in access to R&D in Kazakhstan is high and exhibits strong spatial concentration in major urban and economically developed regions, while peripheral regions demonstrate significantly lower levels of access.

Also, the literature points out that the access to R&D resources play an important role in determining the outcomes of innovation. According to Crescenzi and Rodríguez-Pose (2013), R&D investments are a major predictor of regional innovative performance, and Fritsch and Slavtchev (2011) show that the efficiency of regional innovation systems is primarily determined by the availability of R&D resources. Moreover, OECD (2011) documents more innovative output in high R&D input regions.

These results establish a direct and positive correlation between R&D capacity and innovation performance. Consequently, disparities in access to R&D are expected to mean unequal innovation outcome across regions. This forms the basis for the Hypothesis 2.

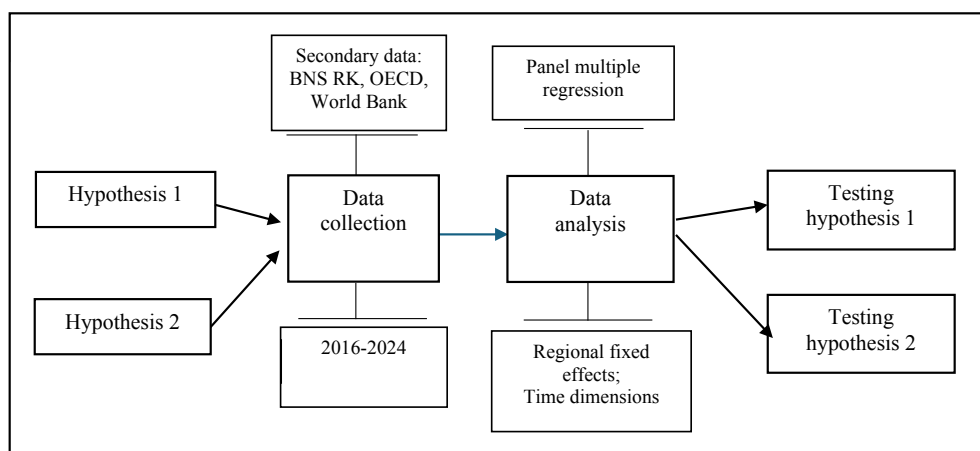
H2. Higher levels of R&D resource access (expenditure, personnel and infrastructure) are positively related to innovation outputs, leading to large regional variation in innovation performance across Kazakhstan.

Methodology

The methodological framework of the study is based on comparative analysis of secondary statistical data, which assesses the problem of uneven access to R&D and its relationship with the formation of regional innovation potential.

The study was conducted in several successive stages, shown in Figure 1.

Figure 1
Methodological framework of the research



Note: Compiled by the authors based on research

The study is organized in a sequential phase, starting with a problem statement, developing research questions and testable hypotheses. Secondary statistical data is then collected from international and national sources such as the Bureau of National Statistics of the Republic of Kazakhstan, the OECD, and the World Bank for the period 2016–2025, ensuring comparability and representativeness of the analysis. From these sources, a regional panel dataset of 20 regions of Kazakhstan for 2016–2024 is created to investigate the association between access to R&D and innovation performance. While the core empirical analysis is based on the 2016–2024 period, some descriptive figures and tables include broader or slightly different time intervals, such as 2015–2024, 2016–2025, or 2017–2024, depending on the availability of specific indicators in official statistical sources. In addition, the newly established regions of Kazakhstan, including **Abai**, **Zhetisu**, and **Ulytau**, were treated as separate regional units only for the years for which official regional statistics became available.

The data analysis involves a panel regression analysis with regional and time fixed effects. The data analysis involves panel regression with regional and time fixed effects. Due to the creation of new regions and the availability of official statistics only from certain years onward, the resulting dataset constitutes an unbalanced regional panel.

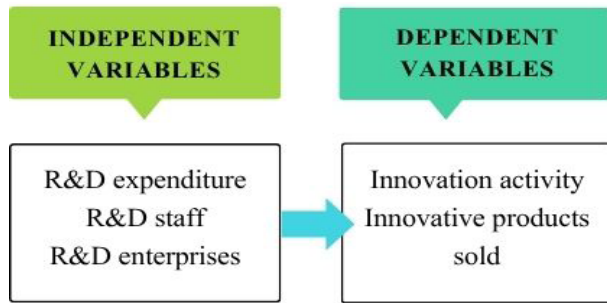
The output variables used in the data analysis are the level of enterprise innovation activity (%)

and the volume of innovative products sold. Input variables include access to R&D was expressed as input variables for three key indicators: R&D expenditures, the number of personnel engaged in R&D, and the number of organizations performing R&D. These variables were selected in line with the logic of the innovation production process and established innovation measurement frameworks. R&D personnel and expenditures represent key input resources, reflecting the human and financial capacity for knowledge creation (Edeh & Prevot, 2024). Enterprise innovation activity captures the transformation of these resources into innovation processes, while the share of sold innovative products reflects the output stage, measuring the market realization of innovation. This structure follows the input–process–output logic widely used in the literature, including the Oslo Manual (2018).

The choice of two indicators for innovation output is based on two factors, namely data availability and the multidimensionality of innovation outcomes. Such indicators were chosen because they are consistently available and comparable within the national statistical system of Kazakhstan, which ensures the reliability of the empirical study and provides a consistent way of comparing at various regional levels over time.

Variables used to characterize the spatial distribution of research resources and identify differences in regional innovation potential are depicted in Figure 2.

Figure 2
Variables of the model



Note: Compiled by the authors based on research

The model applies a log (1+x) transformation of such variables to ensure robustness, preventing extreme values from influencing the estimates log. is the key value for R&D expenditures, research personnel, number of organizations, and volume

of innovative output. Such a structure reduces the distribution asymmetry and smooths out the large effect differences between the observations, which leads to more accurate specification of the regression model and comparability of the coefficients. In addition, the log(1+x) transformation enables zero values to be included as a part of the sample without losing observations, which is particularly important when reviewing regional data with a heterogeneous structure.

Results and discussion

Regional inequality in access to R&D

Descriptive statistics for the selected indicators provide a comprehensive overview of regional patterns and disparities. These calculations show which territories truly form the core of the regional innovation system, which remain on the periphery (Table 1).

Table 1

Descriptive statistics of regional disparities in R&D and innovation indicators across regions (2017–2024)

Region	R&D Exp. Mean	R&D Exp. SD	Staff Mean	Staff SD	Enterprises Mean	Enterprises SD	Innov. Activity Mean (%)	Innov. Activity SD	Innov. Products Mean	Innov. Products SD
Abai	3,760.72	1,826.11	1,181.88	178.31	11.00	1.07	9.43	1.59	47,130.17	34,975.40
Akmola	2,117.58	1,141.38	754.00	37.95	11.75	1.49	6.65	1.02	107,543.15	99,759.78
Aktobe	1,580.58	849.52	419.00	55.41	14.38	1.51	12.18	1.83	48,993.70	15,246.14
Almaty	1,681.15	889.20	496.25	109.97	8.38	0.52	8.08	1.34	54,192.40	35,879.71
Atyrau	3,416.07	2,461.08	343.13	166.91	9.63	1.06	7.61	2.33	80,965.88	134,498.85
West Kazakhstan	1,098.25	438.43	434.50	68.41	9.13	1.55	5.19	0.95	20,989.43	5,204.68
Zhambyl	3,030.47	2,138.61	354.63	48.36	9.00	1.20	9.84	3.07	49,297.41	18,929.55
Zhetisu	189.39	268.67	338.71	43.13	0.75	1.04	10.78	2.18	18,783.00	13,532.00
Karaganda	5,444.76	2,351.95	1,320.00	144.20	32.25	4.62	13.90	1.65	153,356.91	103,186.30
Kostanay	1,184.65	595.29	552.63	58.24	13.50	1.20	11.46	1.71	378,829.03	264,180.86
Kyzylorda	610.60	429.74	282.75	89.20	7.88	1.36	12.58	1.05	32,204.49	26,185.54
Mangystau	11,672.00	2,910.89	681.50	16.93	6.00	0.53	5.10	1.58	4,561.93	3,443.35
Pavlodar	864.50	515.57	552.63	74.45	9.25	3.06	11.00	4.28	130,852.75	67,816.54
North Kazakhstan	1,772.00	2,988.90	126.75	32.76	6.13	1.25	12.04	2.07	51,952.83	51,682.46
Turkestan	784.13	835.59	266.00	103.67	7.63	1.19	9.14	2.20	11,773.25	2,810.71
Ulytau	46.36	81.04	9.00	9.06	1.67	0.58	9.30	3.86	38,146.50	52,577.63
East Kazakhstan	5,209.74	2,964.78	974.63	71.63	23.25	2.60	12.01	3.02	79,418.15	60,568.98
Astana	24,013.61	10,885.16	3,946.25	889.23	76.75	15.27	14.43	0.93	75,503.71	44,966.26
Almaty city	46,774.42	25,734.93	9,366.13	652.73	135.75	3.69	12.09	2.47	60,698.78	35,628.74
Shymkent	1,718.81	909.73	820.63	269.36	12.25	1.28	6.50	0.96	86,265.36	48,606.98

Note: Compiled by the authors based on data from the BNS RK

The table confirms the significant spatial concentration of R&D efforts in Kazakhstan. The cities of Almaty and Astana clearly lead in R&D expenditures (46,774; 24, 013), the number of employees engaged in R&D (9,366.13; 3,946.25), and the number of organizations conducting R&D (135,75; 76,75). This supports the thesis that access to R&D is concentrated in large urban and institutional centers, where universities, research organizations, administrative levers, and the innovation base are more developed.

Karaganda occupies a significant intermediate position. It demonstrates some of the highest average indicators for the number of employees engaged in R&D (1,320.00), organizations conducting R&D (32.25), innovation activity (13.90), and sales volume of innovative products (153,356.91). This indicates that Karaganda is not an isolated region in the national innovation system; instead, it functions as an industrial and scientific center with a relatively balanced R&D potential.

At the same time, the table shows that generous R&D investments do not always lead to high innovation returns. Mangystau boasts relatively high average R&D expenditures, but very low innovation activity and very modest sales of innovative products. This points to an “efficiency gap”: funds are available, but institutional capacity and commercialization effectiveness remain weak.

A different picture is observed in Kostanay, where R&D expenditures and personnel levels are not the highest, but sales of innovative products reach very high values. This may reflect the role of individual industrial enterprises or industry-specific production effects, rather than broad-based regional R&D potential.

Peripheral and innovative regions such as Ulytau, Zhetisu, and parts of Turkestan demonstrate a more modest R&D infrastructure, particularly in terms of organizations and personnel engaged in R&D. Their innovation performance indicators are more variable, suggesting that innovation performance may depend on individual projects or temporary political support rather than on an established regional innovation environment.

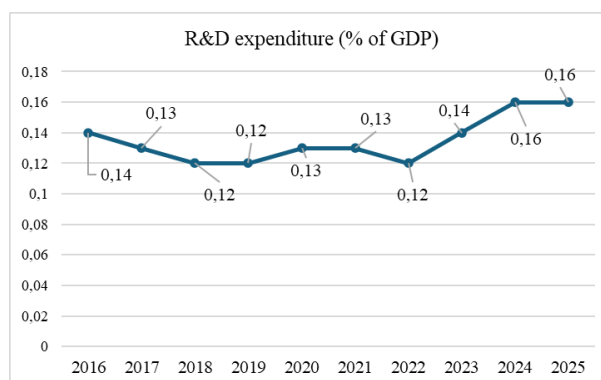
Overall, the findings support the conclusion that regional innovation inequality in Kazakhstan is not solely a matter of funding. The main difference lies in the availability of a sufficient number of organizations conducting R&D, qualified personnel, and institutional mechanisms for transforming resources

into tangible innovative results.

To further substantiate the identified regional patterns and the observed inequality in access to R&D, it is important to examine the temporal dimension of these processes. While the previous analysis highlighted structural differences between regions based on average values, the dynamics of R&D expenditures provide additional insight into how these disparities have evolved over time. The dynamics of R&D expenditures for 2015–2025 are presented below (Figure 3).

Figure 3

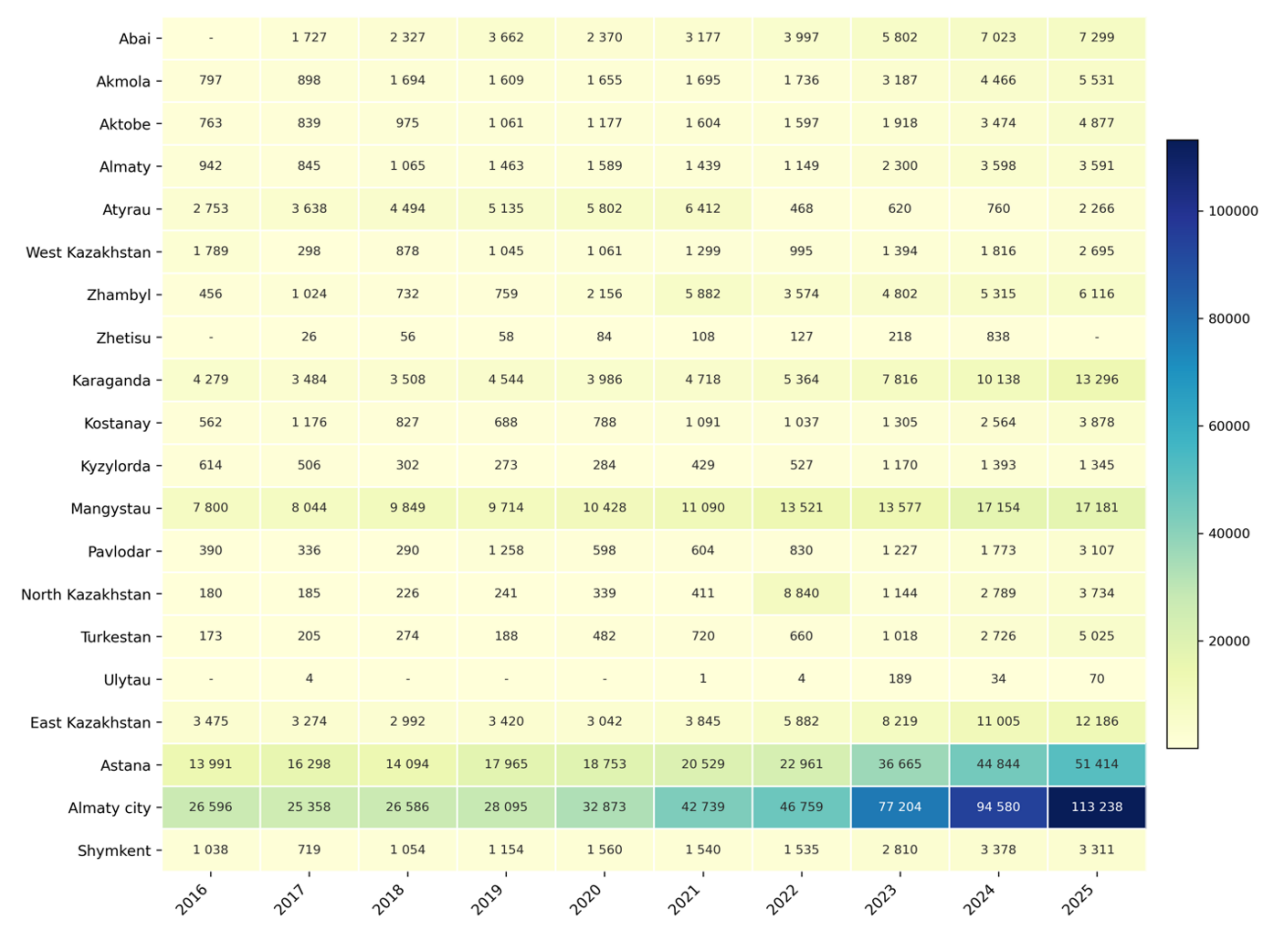
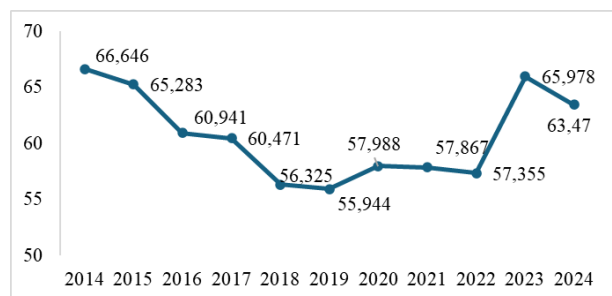
The share of R&D costs in GDP in Kazakhstan for 2016–2025, in %



Note: Compiled by the authors based on data from the BNS RK

At the national level, the share of R&D expenditure in Kazakhstan’s GDP fluctuated between 0.12% and 0.16% from 2016 to 2025, initially declining (until 2019), then moderately stabilizing, and then increasing after 2022. This dynamic may be due to changes in budget policy, the influence of macroeconomic factors (including COVID-19), and the gradual strengthening of state support for science. However, the achieved level remains low by international standards (for example, in OECD countries it is over 2% of GDP), indicating a persistent lag and the need to improve the efficiency of resource use.

To provide a comprehensive assessment of the development of the national innovation system, it is necessary to consider not only financial indicators, but also the institutional and human resource components of R&D. In this context, the following figures present key indicators characterizing the scale and structure of research activity in Kazakhstan (Figures 4–7).

Figure 4*Domestic R&D expenditure by region for 2016-2025, in mln tg**Note: Compiled by the authors based on data from the BNS RK***Figure 5***Share of top 2 regions (Almaty city and Astana) in R&D expenditures for 2014-2024, in %**Note: Compiled by the authors based on data from the BNS RK*

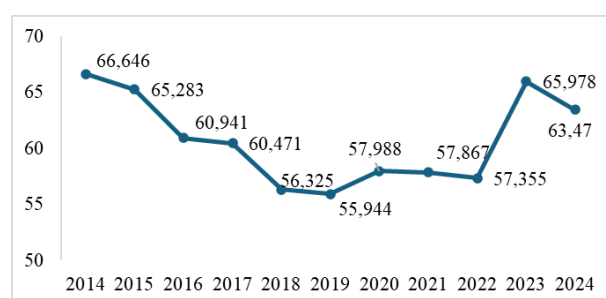
As the table shows, Kazakhstan exhibits a regional imbalance in the distribution of R&D expenditure, with the two largest cities, Almaty city and Astana, demonstrating a concentration of resources. Throughout the period, these two centers accumulate the largest share of national expenditure, and the gap between them and other regions does not narrow, but rather widens. The share of these two largest centers Almaty city and Astana in total R&D expenditure was: 66.6% in 2014, 56.3% in 2018, and 63.5% in 2024 (Figure 5).

Almaty city spends over 113 billion tenge, while Astana spends over 51 billion tenge by 2025, while the gap with most regions remains between 1 billion and 13 billion tenge (BNS, 2025). On the other

hand, resource-rich regions like Mangystau with relatively high indicators demonstrate significant dynamics, indicating that they are sectoral in nature rather than fully developed innovation systems. At the same time, there are groups of regions “catching up”, for example Zhambyl and Turkestan regions, where expenditures are growing, but this growth starts from a low level, which does not change the overall pattern of inequality. For several small or new regions such as Ulytau or Zhetysu, funding is sporadic and extremely insignificant. Overall, the R&D distribution structure in Kazakhstan exhibits a pronounced center-periphery structure, with resources consistently concentrated in a few large agglomerations, while most regional regions remain on the periphery of the innovation system. This inequality is not random, but institutionalized, due to the concentration of scientific infrastructure, labor force, and financial flows.

Figure 5

Share of top 2 regions (Almaty city and Astana) in R&D expenditures for 2014-2024, in %



Note: Compiled by the authors based on data from the BNS RK

As for the enterprises that carried out R&D, the statistics also indicate a significant inequality documented below in Figure 6.

Figure 6

Number of enterprises carrying out R&D in the regions of the Republic of Kazakhstan for 2016-2025

Abai	-	12	13	11	10	10	10	11	11	11
Akmola	9	11	11	13	12	10	10	13	14	12
Aktobe	14	16	16	15	15	15	13	13	12	13
Almaty	10	9	8	8	8	8	8	9	9	7
Atyrau	11	10	10	10	10	10	8	11	8	6
West Kazakhstan	8	8	10	12	10	9	9	7	8	8
Zhambyl	11	11	9	10	9	9	9	7	8	7
Zhetysu	-	2	1	1	1	2	2	2	2	1
Karaganda	33	28	28	30	29	36	38	39	30	35
Kostanay	13	14	12	12	13	15	14	15	13	14
Kyzylorda	10	8	7	6	7	10	7	9	9	9
Mangystau	7	6	6	6	6	7	5	6	6	5
Pavlodar	10	11	14	12	10	9	6	6	6	6
North Kazakhstan	5	5	5	5	5	8	7	7	7	9
Turkestan	5	6	6	7	8	9	8	9	8	10
Ulytau	-	1	-	-	-	2	1	2	2	2
East Kazakhstan	35	22	22	20	20	27	25	25	25	23
Astana	55	62	60	56	76	90	90	90	90	103
Almaty city	133	131	135	138	135	139	132	134	142	141
Shymkent	14	13	11	14	12	13	12	10	13	12
	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025

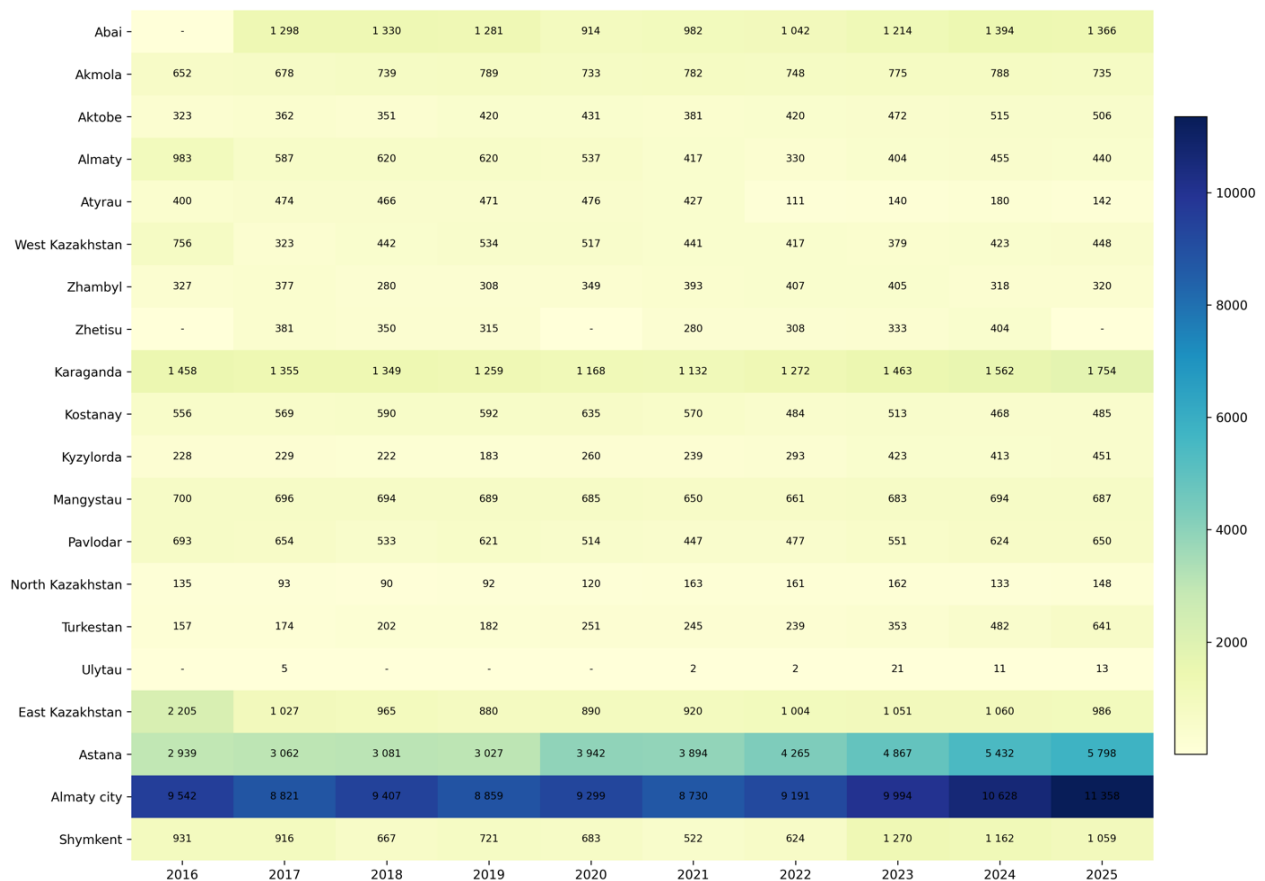
Note: Compiled by the authors based on data from the BNS RK

Figure 6 shows a continuing regional imbalance with the concentration of research organizations in the two largest cities, Almaty and Astana. Almaty consistently maintains the largest number (approximately 130-140 organizations each year), accounting for about one-third of the national total throughout the period, while Astana demonstrates steady growth – from 55 in 2016 to over 100 by 2025. Together, these two centers constitute the dominant core of the country's research infrastructure. Industrial regions such as the Karaganda region and the East Kazakhstan region occupy a secondary position, with rather small but relatively stable numbers (no more than 20-40 organizations). Overall, most other regions exhibit low, virtually stable numbers

(ranging from 5 to 15 organizations), indicating a weak institutional base for R&D development. However, in some regions with fragmented dynamics (for example, the Turkestan region or the North Kazakhstan region), this level of growth is not systemic and does not affect the overall distribution structure. On the other hand, in new or small regions like Ulytau and Zhetysu regions, indicators remain minimal, reinforcing spatial polarization. Thus, overall, research organizations are distributed according to a core-periphery model of the innovation system, in which research activity has institutional anchors in a few leading agglomerations, but most regions remain on the periphery, with limited opportunities to generate and implement innovation.

Figure 7

The number of employees engaged in R&D by region for 2016-2025



Note: Compiled by the authors based on data from the BNS RK

While the number of enterprises carrying out R&D provides important insight into the institutional capacity of regional innovation systems, it does

not fully capture the human resources underpinning these activities. The regional distribution of human resources in the research and development sector is

presented in Figure 7, illustrating differences in the number of employees engaged in R&D across regions.

The results of the table show that there is a clear spatial differentiation in the extent to which research personnel can be found in Kazakhstan, which follows through to 2016–2025. Another feature of the map is the concentration of staff within the largest agglomerations. Almaty city has been accumulating the most researchers (around 9,000–11,000), very much as it overtakes other areas while Astana continues to grow (about 3,000 to almost 5,800) and establishes itself as the second scientific hub in Kazakhstan. This is a classic “core-periphery” model, where human capital is concentrated in regions where infrastructure, finance, and academic institutions already exist. Highly developed regions (e.g., Karaganda or East Kazakhstan) have a relatively high but less constant level of R&D employment. This is because there are industries and universities, but without robust innovation ecosystems, growth in this part of Kazakhstan is more inertial. Meanwhile, the regions with abundant natural resources (Atyrau and Mangystau regions) also exhibit a paradox: The amount of research personnel is low or even decreasing (although the resource is high).

This is attributed to the industry’s particularity; the extractive industry has historically been less knowledge-intensive and has been more oriented through technology imports than domestic R&D. Certain regions, such as the Atyrau region, or the North Kazakhstan region have sudden changes that require special attention. This might reflect either isolated initiatives and changes in administrative accounting or the lack of good institutional stability of regional research structures. New territories (Abai, Zhetysu and Ulytau) show low starting values that follow “institutional development” – a serious scientific and educational cluster has not yet been established there. Taken together, the current pattern of such trends reflects a structural problem: for example, the expansion in national R&D indicators doesn’t correlate with a flattening level but with an increase in the territorial concentration of human resources. This means that access to scientific resources remains uneven and that systems of regional innovation develop asymmetrically.

Table 2 presents the regional differentiation of access to R&D in Kazakhstan, highlighting disparities in the distribution of research funding and the uneven development of innovation capacity across regions.

Table 2
Regional classification of access to R&D in Kazakhstan

Regions	Statistical characteristics (based on data)	Category of access to R&D
Almaty city, Astana	The maxima for all indicators: >9,000–11,000 researchers, up to 140+ organizations, and a dominant share of expenditures (>50–60% of total expenditures). Sustainable growth 2016–2025. Form the core of the national innovation system.	Very high
Karaganda, East Kazakhstan	1,000–1,700 researchers, 20–40 organizations, steady growth in expenditures (up to 13 trillion tenge by region). Strong university-industry link.	High
Mangystau, Atyrau	Very high expenditures (up to 17 trillion tenge), but a limited number of researchers (600–700) and organizations (<10). R&D is industry-concentrated (oil and gas).	Resource-driven
Akmola, Aktobe, Pavlodar, West Kazakhstan, Almaty, Shymkent	500–800 researchers, 10–15 organizations. Moderate growth, but without sharp increases. Dependence on industrial structure and government programs.	Medium level
Zhambyl, Turkestan	Rapid growth in indicators (e.g., Turkestan: personnel and expenditures increased 2–3 times), but a low starting point. Signs of catch-up development.	Emerging / catch-up regions
Kostanay, Kyzylorda, North Kazakhstan	100–500 researchers, 5–10 organizations. Limited infrastructure, weak innovation activity, and unstable growth.	Low level
Abai, Zhetysu, Ulytau	Low values and missing data (–), reflecting the region’s formative stage. R&D infrastructure is virtually nonexistent or still developing.	Minimal

Note: Compiled by the authors based on data from the BNS RK, 2025; OECD Reviews of Innovation Policy: Kazakhstan, 2023

Despite the overall increase in R&D spending (almost 4-fold since 2016), regional development remains unbalanced. These findings are due to structural factors. First, there is a strong agglomeration effect: the largest cities accrue universities, research centers, and financial resources, creating a “critical mass” of knowledge and enabling more creativity at the same time to reinforce the positive phenomenon but aggravate interregional inequality. Second is the specialization of raw materials in some regions like Atyrau and Mangystau, where the heavy investment in R&D is not effectively translated into diversified innovation as the research is sector-specific and dependent on imported technologies. Third, most regions demonstrate institutional weaknesses in their

regional innovation systems due to insufficient relationships between universities, businesses, and the government at the level appropriate to optimize their scientific resources. Lastly, several regions like Zhambyl and Turkestan display a “catch-up growth” effect, where success is mostly fueled by government support initiatives. Yet, no sustainable foundation of science and innovation in these regions leaves them structurally vulnerable.

Although the prior analysis concentrated on the spatial distribution of R&D resources, more thorough insight into regional innovation potential needs to be reached from the actual transformation of resources into innovative results, as reflected in the following Figure 8.

Figure 8

Level of activity in the field of innovation for 2015-2024, in %



Note: Compiled by the authors based on data from the BNS RK

The relationship between R&D inputs and innovation outputs across regions of Kazakhstan is uneven and reflects strong structural differentia-

tion. The most consistent and quantitatively strong link is observed in regions like Almaty city, Astana and Karaganda, where, high amounts of R&D ex-

penditures (ranging as much as 113,000 mln tenge in Almaty and above 50,000 mln tenge in Astana), high amount of research staff (more than 11,000 and 5,700 people respectively) and a rich network of R&D-performing organizations have been associated with stable level of innovation activity of about 14-16%. This substantiates the existence of a “critical mass” effect, with the combination of financial, human and institutional resources to convert R&D inputs into innovation outputs.

Whereas resource-based regions such as Atyrau and Mangystau have a clear efficiency gap where even in a relatively high or very high R&D outlay (the level of Mangystau is more than 17,000 mln tenge), innovation activity is very low, often a ratio less than 4-6%, this is a sign of the narrow specialization in all categories of industry and weak diversification and low spillover of R&D.

In industrial areas such as East Kazakhstan and Pavlodar stand somewhere between the extremes, where minimal R&D inputs (10-12,000 mln tenge and at least 600-1,000 of researchers) result in medium, but sometimes extremely turbulent, innovation outcomes, and with Pavlodar having short-term peak up to 18.4%: it is likely the result of selective policy inputs, rather than an institutional capacity.

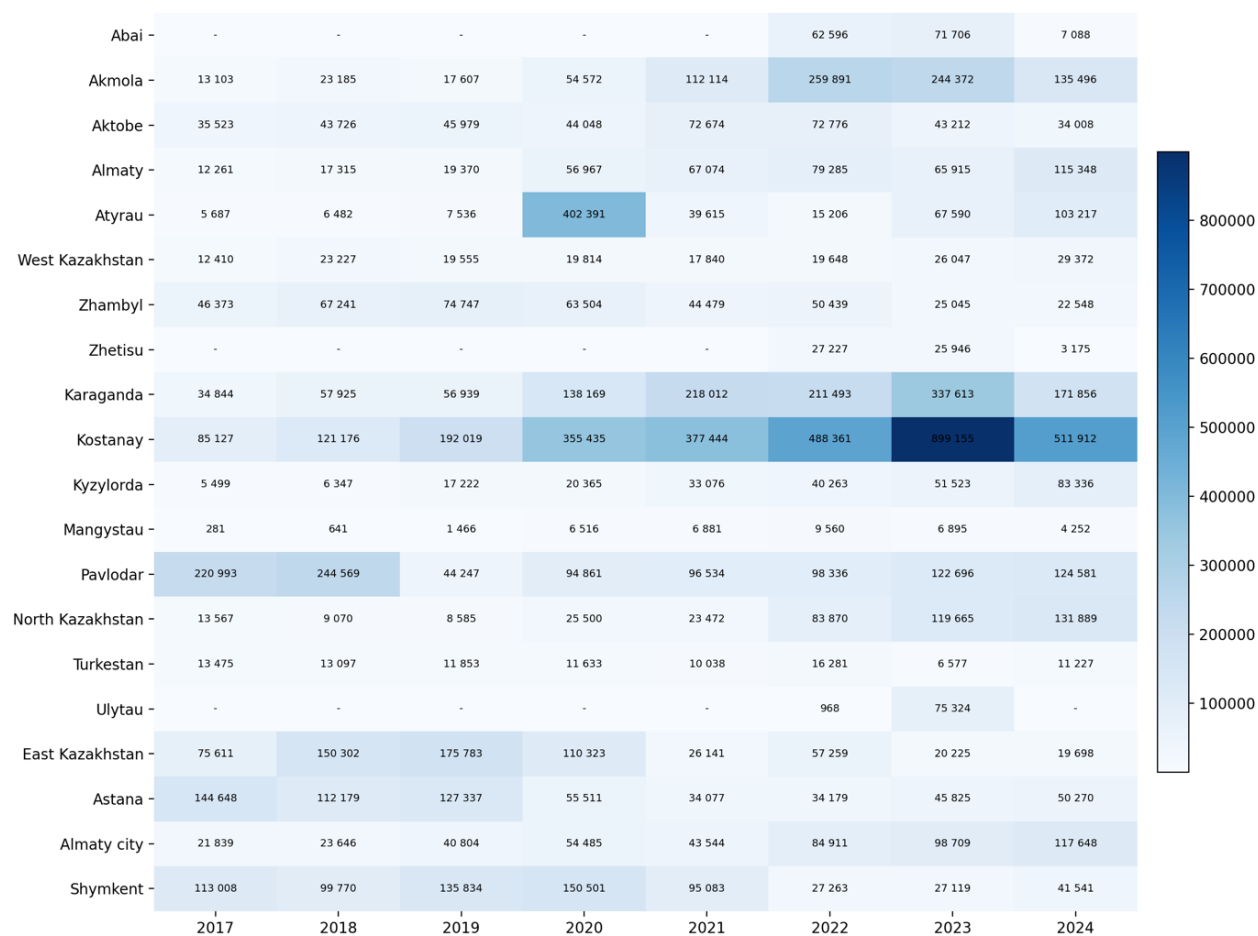
Catch-up areas, particularly in Turkestan, Aktope, and Zhambyl continue to increase, with their innovation capacities reaching 10-14%, albeit with relatively low levels of R&D inputs, implying that external policy support and low base effects may temporarily promote innovation, but this will not be sustained without the accompanying upswing in R&D capacity. Peripheral areas, such as Akmola, West Kazakhstan and Almaty region have low overall levels of innovation (approx 5-8%), corresponding to the relatively small R&D infrastructure, small number of R&D workers and poor institutional environment. Thirdly, and most importantly, newly born or structurally poor regions such as Ulytau, Zhetisu and Abai reveal disorganized and unstable measures, highlighting a lack of an established innovation system. The overall findings show that high R&D inputs are not only more likely to elicit high innovation outputs, but that the phenomenon is mediated by structural issues such as agglomeration effects, highlighting that innovation performance is not a function only of supply of resources but of the degree to which resources integrate with regional innovation systems. Further the volume of sold innovative products is shown on Figure 9.

The results reveal an extremely uneven distribution of innovation activity throughout Kazakhstan’s regions, with significant concentration in specific “growth points.” The regional distribution of the volume of sold innovative products confirms that R&D inputs explain innovation outcomes, but unevenly across Kazakhstan. In core regions, the relationship is strong and stable: Almaty city increases from about 21,800 mln tenge in 2017 to 117,600 mln tenge in 2024, Astana reaches around 50,200 mln tenge, and Karaganda grows to 171,800 mln tenge, all supported by high R&D expenditures and large research personnel. In contrast, regions such as Pavlodar (124,600 mln tenge) and Kostanay (over 511,900 mln tenge) achieve high outputs despite moderate R&D inputs, indicating the role of large enterprises or one-off projects rather than a развитая инновационная система. Resource-based regions show the clearest inefficiency: Mangystau maintains low output (around 4,200 mln tenge) despite very high R&D spending (over 17,000 mln tenge), while Atyrau exhibits extreme volatility, peaking above 402,000 mln tenge in 2020 but falling to 103,200 mln tenge in 2024. Peripheral regions (Akmola, West Kazakhstan, Kyzylorda) display moderate but constrained outputs (30,000–135,000 mln tenge), reflecting weak R&D capacity, while catch-up regions (Zhambyl, Turkestan) show unstable growth driven mainly by policy support. Newly formed regions (Abai, Zhetisu, Ulytau) demonstrate fragmented dynamics due to underdeveloped R&D systems. Overall, the results indicate that higher R&D inputs generally lead to higher innovation outputs, but only in regions with sufficient institutional capacity, diversified economies, and strong science–business linkages, confirming that the effectiveness of R&D depends on the quality of regional innovation systems rather than on resource volume alone.

Assessing the Impact of Regional Inequality in Access to R&D Resources on Innovation Output Disparities

The previous analysis was informative, documenting large disparities in innovative outputs and R&D inputs across regions of Kazakhstan. However, assessing the impact of regional inequality in access to R&D resources on differences in innovation results requires we go beyond descriptive statistics.

To examine the relationships between R&D inputs and innovation outcomes, a Pearson correlation analysis for the period 2017–2024 is first conducted (Table 3).

Figure 9*Volume of sold innovative products (goods, services) for 2017-2024, in mln tg**Note: Compiled by the authors based on data from the BNS RK***Table 3***Pearson correlation results*

Relationship between variables	r	p-value	Interpretation
log(1+R&D enterprises) + Innovation activity	0.382***	<0.001	Moderate positive, statistically significant
log(1+R&D enterprises) + log(1+innovative products)	0.344***	<0.001	Moderate positive, statistically significant
log(1+R&D staff) + Innovation activity	0.213**	0.010	Weak positive, statistically significant
log(1+R&D staff) + _log(1+innovative products)	0.249**	0.003	Moderate positive, statistically significant
log(1+R&D expenditure) + Innovation activity	0.144*	0.082	Weak, marginally significant
log(1+R&D expenditure) + log(1+innovative products)	0.108	0.199	statistically inconclusive

*Note: *** $p < 0.001$; ** $p < 0.05$; * $p < 0.10$*

The effects generated show the heterogeneous nature of such influence in which R&D components are present on innovation activity: the strongest and significant correlation is reached with the number of organizations performing R&D ($r=0.34-0.38$; $p<0.001$), suggesting that the research infrastructure development and institutional density are important factors affecting the innovative outcome. Put differently, with higher number “players” in system, effect of knowledge agglomeration, of ideation and of competition is developed which directly leads to higher innovation output. The number of research workers shows a weaker but still significant positive relationship ($r=0.21$ to 0.25), which is attributed to the quality and efficiency of human capital, only the employees are not sufficient to produce high outcome unless the research establishment provides a suitable ecosystem or financial basis. On the other hand, R&D expenditures have weak and statistically unstable link with innovation indicators ($r=0.10-0.14$), pointing to issues in efficiency of resource allocation, that is in a resource-based economy, investment does not necessarily lead to an innovation output due to administrative redistribution or there may be interval between investment and the return. Combined, this means, for Kazakhstan, the importance is not so much the volume of resources as the structural organization of its innovation system, established research organizations and effective human capital use, while increased expenses without institutional changes can only enhance the efficiency.

The results of the Pearson correlation analysis highlight the heterogeneous impact of different R&D components on innovation activity. The strongest and statistically significant relationship is observed with the number of organizations engaged in R&D ($r = 0.34-0.38$; $p < 0.001$), indicating that the development of research infrastructure and institutional density plays a key role in driving innovation outcomes. In other words, a higher number of participants within the system fosters knowledge agglomeration, idea generation, and competitive dynamics, all of which contribute to increased innovation output.

The number of research personnel demonstrates a weaker, yet still significant, positive correlation ($r = 0.21-0.25$). This suggests that while human capital is important, its effectiveness depends on quality and efficiency; simply increasing the number of employees is insufficient without a

supportive research environment and adequate financial backing.

In contrast, R&D expenditures show only a weak and statistically unstable relationship with innovation indicators ($r = 0.10-0.14$).

This may reflect inefficiencies in resource allocation, particularly in resource-based economies where investments do not automatically translate into innovation outcomes due to administrative redistribution or time lags between funding and results.

Overall, these findings suggest that in Kazakhstan, the structure and organization of the innovation system – especially the presence of strong research institutions and the effective utilization of human capital – are more critical than the sheer volume of financial resources. Without corresponding institutional improvements, increased R&D spending alone is unlikely to substantially enhance innovation performance.

$$\begin{aligned} InnovationActivity_{it} = & \\ = \alpha_i + \beta_1 \ln(1 + RD_Expenditure_{it}) + & \\ + \beta_2 \ln(1 + RD_Staff_{it}) + & \\ + \beta_3 \ln(1 + RD_Enterprises_{it}) + \varepsilon_{it} & \quad (1) \end{aligned}$$

where,

i – region,

t – year,

α_i – regional fixed effects

ε_{it} – random error term.

This model is used to estimate how changes in R&D resources (expenditures, personnel, and enterprises) affect the level of innovation activity within regions over time, while controlling for unobserved regional characteristics through fixed effects.

Model 2:

$$\begin{aligned} \ln(1 + InnovativeProduct_{it}) = & \\ = \alpha_i + \beta_1 \ln(1 + RD_Expenditure_{it}) + & \\ + \beta_2 \ln(1 + RD_Staff_{it}) + & \\ + \beta_3 \ln(1 + RD_Enterprises_{it}) + \varepsilon_{it} & \quad (2) \end{aligned}$$

where,

i – region,

t – year,

α_i – regional fixed effects

ε_{it} – random error term.

Table 4 reports the results of two fixed-effects models assessing how different dimensions of access to R&D resources are associated with regional innovation performance.

Table 4
Fixed Effects Regression Results

Variables	β (for M1)	p-value	β (for M2)	p-value
$\log(1+\text{R\&D expenditure})$	-0.41	0.021	-0.37	0.004
$\log(1+\text{R\&D staff})$	0.22	0.091	0.31	0.012
$\log(1+\text{R\&D enterprises})$	2.47	0.001	0.88	0.003
R^2 (within)	0.31		0.37	

Note: $p < 0.001$; $p < 0.05$; $p < 0.10$ statistically significant; β – estimated coefficients of the fixed effects model

The results show that R&D enterprises are the strongest and most statistically robust determinant of innovation outcomes, because the coefficient is positive and highly significant in both models ($\beta = 2.47$, $p < 0.001$; $\beta = 0.88$, $p = 0.003$). This means that regions with a larger institutional base of R&D activity tend to demonstrate higher innovation performance.

The effect of R&D staff is also positive, but weaker ($\beta = 0.22$, $p = 0.091$; $\beta = 0.31$, $p = 0.012$). This suggests that human capital contributes to innovation performance, but its effect depends on the specific innovation indicator used. Researchers and technical personnel are important, yet their contribution becomes meaningful only when supported by appropriate institutional structures and commercialization mechanisms.

The most unexpected result concerns R&D expenditure. In both models, the coefficient is negative and statistically significant ($\beta = -0.41$, $p = 0.021$; $\beta = -0.37$, $p = 0.004$). This demonstrates that, in the regional context of Kazakhstan, increased R&D spending does not always automatically lead to improved innovation performance. This may indicate inefficient financial allocation, time gaps between investments and measurable achievements, low capacity to absorb new technologies in certain regions, or the concentration of expenditures in areas with insufficient innovation capacity.

Results and discussion

Empirical data support hypothesis H1, which posits that regional inequality in access to R&D resources in Kazakhstan is characterized by a high degree and spatial concentration in large urban and economically developed regions. Descriptive analysis demonstrates an uneven distribution of access to R&D across regions, with central regions accumulating a significant share of R&D organizations, associated personnel, and financial resources. This

pattern aligns with the literature on regional innovation systems, which posits that innovation potential is rarely distributed evenly across space, but rather is concentrated in regions with more developed institutional infrastructure, the presence of universities, research organizations, a skilled workforce, and strong science-industry linkages. Similar findings are presented in the OECD (2017) Innovation System Review of Kazakhstan, which notes the country's progress in developing its scientific and innovation system but also points to remaining challenges in strengthening innovation capacity and improving the effectiveness of knowledge commercialization.

Research results partially support H2, which states that expanding access to R&D contributes to improved innovation performance. The most compelling evidence for this is the relationship between the number of organizations engaged in R&D and innovation performance. This relationship was positive and statistically significant in both models. This underscores the key role of the institutional R&D infrastructure (research institutions, universities, laboratories, etc.) in transforming research potential into real innovation. This finding is consistent with a systems view of innovation, which emphasizes not only investment but also the quality and interaction of institutions involved in the creation, dissemination, and commercialization of knowledge. The World Bank (2010) also notes that to achieve economic results from innovation, developing countries need not only money but also strong institutions, company capabilities, and well-designed policies.

At the same time, data analysis reveals that the relationship between R&D investment and innovation performance is not linear and depends on the type of resources involved. Specifically, although the presence of R&D specialists has a positive impact, it is weaker than the influence of organizations directly conducting R&D. This underscores the im-

portance of human capital, but also indicates that researchers alone are unable to ensure sustainable innovation growth without a favorable institutional environment that fosters collaboration, commercialization, and knowledge transfer. This finding supports the arguments of Crescenzi and Rodriguez-Pose (2017), who argue that R&D resources exhibit stronger regional effects when integrated into effective innovation systems supported by diffusion mechanisms, networking, and knowledge absorptive capacity.

The unexpected results of the study demonstrate the negative and statistically significant correlation between R&D expenditures and innovation performance. This result does not completely refute hypothesis H2 but requires a more nuanced interpretation. The negative coefficient should not be interpreted as evidence of harm from R&D funding. Rather, it indicates that financial investment alone is insufficient when regions lack a developed institutional infrastructure, knowledge absorption capacity, and effective commercialization mechanisms. This is consistent with the findings of Crescenzi and Rodriguez-Pose (2013), who suggest that such “peripheral” regions often fail to benefit from knowledge-based development because they are hampered by various barriers and are unable to convert their investments into real profit.

Overall, a regional analysis revealed three key trends. First, central regions exhibit more developed innovation ecosystems, which facilitates a more effective transformation of R&D investments into tangible innovative results. Second, resource-rich regions exhibit a gap between invested funds and innovative achievements. This is due to weak economic diversification and the limited impact of R&D on the region’s overall economic potential. Third, peripheral and developing regions exhibit unstable innovation activity, often dependent on temporary political support rather than a solid institutional foundation. This confirms hypothesis H1 and deepens our understanding of hypothesis H2: inequality among Kazakhstan’s regions is due not only to differences in funding but also to heterogeneity in institutional capacity for the effective implementation of scientific developments.

The key policy solution for Kazakhstan should not simply be increasing R&D spending, but rather creating a comprehensive system that will facilitate the bridging of the innovation gap between regions. To achieve this, it is necessary to strengthen regional R&D structures, stimulate collaboration between universities and industry, support the infrastructure

for commercializing ideas, and create sustainable innovation ecosystems outside major cities. Without this, additional funding risks remaining a mere statistic without significantly increasing innovation activity.

Conclusion

This study analyzed uneven access to R&D as a driver of the organizational capacity for innovation in the regions, taking Kazakhstan as case in a comparative context. While innovation-related indicators generally increased, the results indicate that regional disparities are persistent and on some dimensions worsen. Such a concentrated focus in the R&D resources, innovation infrastructure, and produced outputs shows that the national innovation system is one of structural asymmetry instead of convergence. Empirical analyses also confirm that R&D spends, although positive in influencing innovation activity, is not always linked to a better innovation output, revealing shortcomings of transforming inputs into a concrete outcome.

The findings have relevance for innovation policy in Kazakhstan. Policymakers should be concerned that simply increasing R&D expenditures are unlikely to reduce disparities between regions unless they are complemented by measures aimed at strengthening local innovation ecosystems. This in particular emphasizes the need for stronger regional research institutions and collaboration between universities and industry, as well as enhancing the absorptive capacity of firms. So a shift towards a more place-based approach to innovation policy may be required, which pays more attention to developing institutional capacity and enabling networks in lagging regions.

There are a number of limitations that must be recognized. The study is limited by the availability and comparability of regional data, in particular regarding innovation outputs and institutional indices. Official statistics do not measure some of the differences, such as the kind of innovation quality or the level in which universities-industry partnerships operate. Another limitation of the study is the use of slightly different time periods across selected descriptive tables and figures due to data availability and comparability constraints. Last, the econometric models do not consider the potential for endogeneity between R&D expenditure and actual innovation, indicating a need for more sophisticated modeling procedures on R&D investment and innovation in future studies.

Future research could include micro-level data as well as causal mechanisms driven by panel instrumental variable measures of the digitalization and globalization of value chains in regional innovation capacity. In addition, as new official data become available, the analysis can be updated and supplemented with robustness checks across alternative time windows to verify the stability of the results. Further examination of institutional quality and governance issues would also help to contribute towards a better understanding of the relations of innovation policy to regional development impacts.

Funding

This research has been funded by the Science Committee of the Ministry of Science and Higher Education of the Republic of Kazakhstan (Grant

No. AP26198249 An exploration of innovative approaches to overcoming regional inequality in access to R&D in the interest of boosting the intellectual vanguard of Kazakhstan).

Acknowledgements and Conflict of Interest

The authors declare that there are no acknowledgements and no conflicts of interest related to this study.

Author Contributions

TAN – conceptualization of the study, literature review, critical revision of the manuscript for important intellectual content, and approval of the final version of the manuscript for publication.

KAK – collection of statistical data, data analysis, interpretation of research results, editing of the manuscript, and manuscript formatting.

References

- Adner, R. (2017). Ecosystem as structure: An actionable construct for strategy. *Journal of Management*, 43(1), 39–58. <https://doi.org/10.1177/0149206316678451>
- Asheim, B., & Gertler, M. S. (2005). The Geography of Innovation: Regional Innovation Systems. In: The Oxford Handbook of Innovation. <https://doi.org/10.1093/oxfordhb/9780199286805.003.0011>
- Audretsch, D. B., & Feldman, M. P. (2004). Knowledge spillovers and the geography of innovation. In *Handbook of Regional and Urban Economics*, Vol.4, 2713–2739. [https://doi.org/10.1016/S1574-0080\(04\)80018-X](https://doi.org/10.1016/S1574-0080(04)80018-X)
- Audretsch, D. B., Belitski, M., & Chowdhury, F. (2024). Knowledge investment and search for innovation: Evidence from the UK firms. *The Journal of Technology Transfer*, 49(4), 1387–1410. <https://doi.org/10.1007/s10961-023-10045-7>
- Autio, E., Thomas, L. (2022). Researching ecosystems in innovation context. *Innovation & Management Review*, 19(1), 12–25. <https://doi.org/10.1108/INMR-08-2021-0151>
- Bureau of National Statistics of the Republic of Kazakhstan. (2023). National Accounts. <https://stat.gov.kz/ru/industries/economy/national-accounts/publications/182291/>
- Bronzini, R., & Piselli, P. (2016). The impact of R&D subsidies on firm innovation. *Research Policy*, 45(2), 442–457. <https://doi.org/10.1016/j.respol.2015.10.008>
- Crescenzi, R., & Rodríguez-Pose, A. (2017). Innovation and regional growth in the European Union. *Journal of Economic Geography*, 17(4), 709–742. <https://doi.org/10.1093/jeg/lbw028>
- Crescenzi, R. and Rodríguez-Pose, A. (2013). R&D, Socio-Economic Conditions and Innovation in U.S. *Growth Change*, 44, 287–320. <https://doi.org/10.1111/grow.12011>
- Cohen, W. M., & Levinthal, D. A. (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly*, 35(1), 128–152. <https://doi.org/10.2307/2393553>
- Cooke, P., Uranga, M.G., Etxebarria, G. (1997). *Regional innovation systems: Institutional and organisational dimensions*. *Research Policy*, 26(4), 475–491. [https://doi.org/10.1016/S0048-7333\(97\)00025-5](https://doi.org/10.1016/S0048-7333(97)00025-5)
- Cooke, P. (2002). *Regional Innovation Systems: General Findings and Some New Evidence from Biotechnology Clusters*. *Journal of Technology Transfer*, 27 (1), 33–45. <https://doi.org/10.1023/A:1013160923450>
- Edeh, J., & Prévot, F. (2024). Beyond funding: The moderating role of firms' R&D human capital on government support and venture capital for regional innovation in China. *Technological Forecasting and Social Change*, 203, 123351. <https://doi.org/10.1016/j.techfore.2024.123351>
- Filippopoulos, N., & Fotopoulos, G. (2022). Innovation in economically developed and lagging European regions: A configurational analysis. *Research Policy*, 51(2), 104424. <https://doi.org/10.1016/j.respol.2021.104424>
- Fritsch, M., & Slavtchev, V. (2011). Determinants of the efficiency of regional innovation systems. *Regional Studies*, 45(7), 905–918. <https://doi.org/10.1080/00343400802251494>
- Granstrand, O., & Holgersson, M. (2020). *Innovation ecosystems: A conceptual review and a new definition*. *Technovation*, 90. <https://doi.org/10.1016/j.technovation.2019.102098>
- OECD (2011). *Regions and Innovation Policy*. OECD Reviews of Regional Innovation, OECD Publishing, Paris, <https://doi.org/10.1787/9789264097803-en>

- OECD. (2017). *OECD Reviews of Innovation Policy: Kazakhstan*. OECD Publishing. <https://doi.org/10.1787/9789264270008-en>
- OECD/Eurostat. (2018). *Oslo Manual 2018: Guidelines for collecting, reporting and using data on innovation* (4th ed.). OECD Publishing. <https://doi.org/10.1787/9789264304604-en>
- Porter, M. E. (1998). Clusters and the new economics of competition. *Harvard Business Review*, 76(6), 77-90.
- Rodríguez-Pose, A., & Crescenzi, R. (2008). Research and Development, Spillovers, Innovation Systems, and the Genesis of Regional Growth in Europe. *Regional Studies*, 42(1), 51-67. 10.1080/00343400701654186
- World Bank. (2010). *Innovation policy: A guide for developing countries*. World Bank. <https://doi.org/10.1596/978-0-8213-8269-1>

Information about the authors:

Ardak Turginbayeva – d.e.s, Professor of Management Department at al-Farabi Kazakh National University (Almaty, Kazakhstan, e-mail: ardakt@illinois.edu); Visiting Scholar at University of Illinois Urbana-Champaign (Champaign, USA).

Assel Kozhakhmetova – PhD, Assistant Professor of Business School at Kazakh-British Technical University (Almaty, Kazakhstan, e-mail: a.kozhakhmetova@kbtu.kz).

Авторлар туралы мәлімет:

Ардак Тургинбаева – д.э.н., «Менеджмент» кафедрасының профессоры, әл-Фараби атындағы ҚазҰУ (Алматы, Қазақстан, e-mail: ardakt@illinois.edu); Урбана-Шампейн Иллинойс университетінің зерттеушісі (Шампейн, АҚШ).

Әсел Қожахметова – PhD, Бизнес мектебінің профессор-ассистенті, ҚБТУ (Алматы, Қазақстан, e-mail: a.kozhakhmetova@kbtu.kz).

Сведения об авторах:

Ардак Тургинбаева – д. э. н., профессор кафедры менеджмента КазНУ имени аль-Фараби (Алматы, Казахстан, e-mail: ardakt@illinois.edu); исследователь Университета Иллинойса Урбана-Шампейн (Шампейн, США).

Асель Кожухметова – PhD, ассистент-профессор Бизнес-школы КБТУ (Алматы, Казахстан, e-mail: a.kozhakhmetova@kbtu.kz).

Received: 21 April 2026
Accepted: 20 September 2026