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The Role of Universities in Driving Innovation through Human Capital in Kazakhstan

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ABSTRACT

This research aims to assess the impact of human capital elements, including graduates, postgraduate students, and educational expenditures, on the level of innovation activity in the regions of Kazakhstan. Research is based on a quantitative panel analysis of Kazakhstani regions, namely correlation and regression, from the National Bureau of Statistics in the years 2000-2023. The empirical results show that Gross Regional Product (GRP) and the number of PhD students significantly and positively affect innovation activity. A 1% increase in GRP corresponds to a 0.75% rise in the number of innovative enterprises, while a 1% rise in the number of PhD students leads to a 0.23% increase in innovation. In contrast, the number of university graduates and educational expenditures did not demonstrate statistically significant effects. The findings suggest the need for targeted policy interventions, including support for doctoral research, the creation of innovation clusters, and region-specific strategies. The research highlights the importance of economic capacity and advanced research personnel in fostering regional innovation while also pointing to institutional and structural barriers that may inhibit the effective translation of educational investments into innovation outcomes. Policy implications include the need for region-specific innovation strategies and greater alignment between academic institutions and enterprise needs. Future research should incorporate mixed methods, explore intra-regional differences, and investigate time-lag effects in educational investments on innovation performance.

KEYWORDS: Human Capital, Education, Higher Education, Innovation Policy, Knowledge, Economy, Business Development

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1. INTRODUCTION

In the current context of rapid technological change, including the advancement of artificial intelligence and the global shift toward a green economy, human capital has become a strategic asset for a country's innovative competitiveness (Bai & Li, 2011; Garlick, 2014). Human capital is particularly crucial for developing countries such as Kazakhstan, where sustainable development and economic modernization depend on the quality of human resources. Universities serve as educational institutions and centres of scientific research and platforms for industry collaboration. They foster knowledge transfer, stimulate innovative activity, and contribute to developing regional innovation ecosystems by producing qualified human capital, conducting research, and engaging in partnerships with industry (Destefanis et al., 2023).

However, despite the existence of regulatory frameworks and strong political will, Kazakhstan continues to face a range of structural and institutional barriers that hinder the effective integration of the academic sector into the innovation-driven economy (Jonbekova et al., 2025). The main challenges include weak institutionalization of university-industry collaboration, limited incentives for faculty engagement in applied research, low levels of student involvement in real-world innovation projects, and a persistent mismatch between graduates' competencies and labor market needs. Furthermore, technology transfer offices and other structures within the higher education system have yet to fully fulfil their intended roles in facilitating knowledge transfer and the commercialization of research outputs (Kireyeva et al., 2020). The gap between academic knowledge production and its practical application in the economy remains substantial, an issue of particular concern as Kazakhstan seeks to compete globally and integrate into international scientific and innovation networks. While the importance of university-industry collaboration for innovation is widely recognized, there is a limited empirical understanding of how different components of academic human capital, namely, faculty, students, and graduates, contribute to collaboration in the context of emerging economies, particularly in Kazakhstan.

Despite national policies to foster innovation and strengthen partnerships between higher education institutions and industry, Kazakhstan has not yet achieved a sustainable or institutionalized model of university and industry engagement. Existing efforts often lack depth, continuity, and strategic alignment with labor market and innovation system needs. Moreover, the role of human capital within Higher education institutions is frequently underutilized or fragmented, with insufficient integration of faculty research, student involvement, and graduate employment into industry.

The research employs correlation and a fixed effects panel regression model using data from 16 regions over the period 2000-2022. By focusing on key indicators such as the number of faculty members, students, PhD graduates, and government expenditures on education, the analysis aims to capture the extent to which academic human capital influences innovation outcomes at the regional level.

The findings of this research carry important implications for policy, higher education, and regional development in Kazakhstan. First, the demonstrated link between academic human capital and regional innovation activity suggests that investments in higher education, particularly in faculty development and advanced graduate training, can serve as strategic levers for innovation-driven growth. Policymakers should consider increasing funding for universities and creating incentives for research collaboration and knowledge transfer between academia and industry. Second, the results emphasize the need to strengthen institutional mechanisms, such as technology transfer offices, to facilitate the practical application of academic research. Finally, the research underscores the value of regional differentiation in innovation policy: supporting universities based on their specific capacities and local economic contexts can enhance the overall effectiveness of national innovation strategies. Addressing these issues could significantly improve Kazakhstan's ability to integrate into global knowledge networks and transition toward a sustainable, knowledge-based economy.

The research paper is organized as follows. Section 2 provides a theoretical framework for the innovation system and the role of higher education in regional development. Section 3 outlines the methodological approach, including data sources, variable selection, and the fixed effects panel regression model. Section 4 reports the main empirical findings, interprets their significance, and offers a discussion of the results, linking them to broader policy and institutional implications. Finally, Section 5 concludes the paper, summarizing key insights and proposing directions for future research.

This research aims to assess the impact of human capital elements, including graduates, postgraduate students, and educational expenditures, on the level of innovation activity in the regions of Kazakhstan. The research focuses on four hypothese

H_1: Gross Regional Product (GRP) significantly affects innovation activity.

H_2: The number of university graduates affects innovation activity.

H_3: Government expenditure on education affects innovation activity.

H_4: The number of PhD students influences regional innovation.

2. LITERATURE REVIEW

Innovation is widely recognized as a fundamental driver of economic growth and sustainable development, where human capital and universities are central actors (Wozniak, 1984; Florax & Folmer, 1992). Thus, this section considers the influence of innovation on economic development, human capital for innovation, the role of universities, and university-industry relationships. Innovative activity and Gross regional product play pivotal roles in regional economic development. According to the endogenous theory of economic growth (Lucas, 1988; Romer, 1990), innovations are a key factor for sustainable regional development that increases productivity and impacts GRP. Regions with a developed innovation infrastructure, active research and development, and strong links between universities and businesses tend to show higher economic growth rates. Moreover, innovation contributes to improved productivity in enterprises, increasing the probability of survival and sustainable growth amid increasing global competition (Florida et al., 2008). Empirical studies demonstrate a stable positive correlation between a region's innovation activity level and its economic indicators, primarily GRP (Crescenzi & Rodríguez-Pose, 2012).

Innovation is a key driver of economic growth and sustainable development, where new technologies, products, and business models are created that reshape national and regional economies (Gómez & Sequeira, 2012). It also enhances the social well-being of the population and the national economy's competitiveness, especially in developing countries, where innovation is a driver of accelerated development (Maksimovic et al., 2012; Algan & Cahuc, 2014). It forms the foundation for knowledge creation and innovation spillovers, enhancing productivity and ensuring the competitiveness of the national economy (Bottazzi & Peri, 2003; Feng et al., 2012; Islam et al., 2014). Contemporary research confirms that human capital combines knowledge, skills, and competencies primarily accumulated within the higher education system (Teslenko et al., 2021; Pereira et al., 2025).

Innovative, social, and economic development of regions depends on forming, accumulating and using human capital (Kato et al., 2015). The ability of regions to create and retain human capital varies significantly, directly affecting their innovation dynamics and social and economic development (Sánchez-Barrioluengo & Consoli, 2016; Kozhushko, 2021). Students, graduates, and academic staff constitute a critical component of this capital, directly contributing to innovation outputs. Empirical evidence shows that the share of university graduates positively affects the number of patent applications (Leten et al., 2014), while regions with a higher concentration of university researchers demonstrate more intensive technological activity (Intarakumnerd, 2017). At the same time, human capital serves as a central resource that determines the innovative capacity of both individual organizations and entire regions (Norasingh & Southammavong, 2017; Crescenzi & Jaax, 2017).

The development and design of innovative solutions are primarily driven by the level of academic human capital accumulated within universities, as it provides the foundation for knowledge generation, technological advancement, and research-based approaches to innovation and development (Passaro et al., 2018). In addition, universities form high-quality human capital that will continue to work in enterprises in the future (van den Berge, 2018; Jackson et al., 2022). Companies that engage in joint R&D activities with universities tend to employ graduates, particularly PhD holders, with advanced research training and specialized knowledge (Buenstorf & Heinisch, 2020). This is because doctoral students have technical and research competencies and are familiar with the logic of academic knowledge production.

The role of higher education institutions in shaping human capital and driving regional innovation has become a central focus in contemporary research and policy discussions. Research emphasizes that human capital is mainly formed in the higher education system (Leonchuk & Gray, 2019;). In this regard, a special role is given to universities, which, in addition to the educational function, perform a research and innovation mission, actively participating in the creation of knowledge, the development of skills and the formation of the infrastructure necessary for the growth of regional capacity (Peters, 2020). Modern universities are strategic players in regional innovation ecosystems that generate positive externalities, including knowledge spillovers into business, thereby facilitating the technological renewal of companies (Kong et al., 2022).

Historically, universities and industry have maintained strong ties in education and research, allowing them to effectively combine resources and efforts to implement innovative projects (Albats et al., 2020). University-industry relations foster knowledge spillover, develop human capital and research commercialization. It develops the innovative capacity of regions and increases competitiveness (Toth et al., 2020; Zapata-Cantu, 2020). Moreover, university and industry partnerships adapt and shape educational programs in line with labour market demand (Berbegal-Mirabent et al., 2020).

Kazakhstan also pays attention to the significant role of innovation in economic development, which is supported by a range of studies (Nurpeisova et al., 2020; Dinzhanova & Bayetova, 2022), where innovative activity correlates with economic growth. Furthermore, human capital positively impacts the development of innovations (Doshmanova et al., 2024). Despite policy efforts to develop university-industry partnerships to stimulate innovation and improve the alignment of human capital training with labor market requirements (Yembergenova et al., 2020; Jonbekova et al., 2025), Kazakhstan has not yet achieved a sustainable and effective model of academic-industry integration. The lack of institutionalized interaction mechanisms and the limited effectiveness of technology transfer offices indicate a persistent gap between universities and industry (Kireyeva et al., 2020). Kuchumova et al. (2023) emphasize that the active involvement of academic staff in university-industry partnerships is a key condition for effectively implementing joint research projects and increasing the applied value of academic research. The participation of academic staff not only helps strengthen the links between science and industry but also ensures the transfer of knowledge adapted to the real needs of the economy. However, there is a lack of research impact of graduates on innovation. Despite the availability of research on innovation in Kazakhstan, there is no systematic review of Kazakhstani and Central Asian studies on the topic of universities and innovation that comprehensively addresses the above-mentioned themes.

To sum up, it can be noted that modern empirical literature consistently emphasizes the importance of human capital as an intermediary between universities and industry in the innovation process. In international practice, there is a tendency to strengthen interactions through personnel, research, and institutional channels.

3. RESEARCH METHODS

The research is based on secondary data from 2000 to 2023 from the Bureau of National Statistics of the Republic of Kazakhstan. A quantitative research design is employed to analyze regional-level data across Kazakhstan. Correlation analysis examines the strength and direction of relationships between variables and identifies potential multicollinearity issues. Subsequently, panel regression analysis is applied to assess the impact of selected economic and educational indicators on the level of regional innovation activity. The analysis covers 16 regions of Kazakhstan. Regions that formed recently, namely Abay, Zhetisu, and Ulytau, were omitted due to unrepresentativeness and lack of data (was formed in 2022).

The selection of variables for this research is grounded in theoretical reasoning and empirical literature on the determinants of regional innovation. After clearing data, the following variables are used in Table 1.

TABLE 1. Descriptive statistics

Variable	Code	Obs.	Mean	Std Dev	Min	Max
Year	YEAR	304	2013,61	6,06	2000	2023
Level of innovative activity	INNOV ACT	304	119,36	1131,18	0,11	13173
Number of faculty members	FACULTY	304	2222,45	3055,86	32	14599
Number of students	STUD	304	32289,79	38485,31	3815	228838
Gross regional product	GRP	304	2677878,9	3122792,91	119500,4	24895989,6
Number of graduates (students)	GRAD	304	8098,16	9231,43	841	55281
Public expenditure on education	EXP	304	17612894,8	36979711,5	53012	246341662
PhD students	PHD	304	176,59	505,12	0	3482
Number of enterprises with innovations	INNOV ENTERP	304	125,22	188,99	1	1182
Number of higher educational institutions	HEI	304	8,05	11,05	1	69

Note: compiled by authors

The choice of these variables allows a comprehensive analysis of factors influencing innovation activity at the regional level. The research takes into account economic indicators and characteristics of human capital and institutional infrastructure, which allows for identifying systemic relationships between the development of the higher education system and the level of innovation capacity of the regions of Kazakhstan.

Figure 1 displays the core steps of the research.

The research consists of the following stages: data collection, data clearing, data analysis, and recommendation development. The initial stage consists of obtaining statistical data.

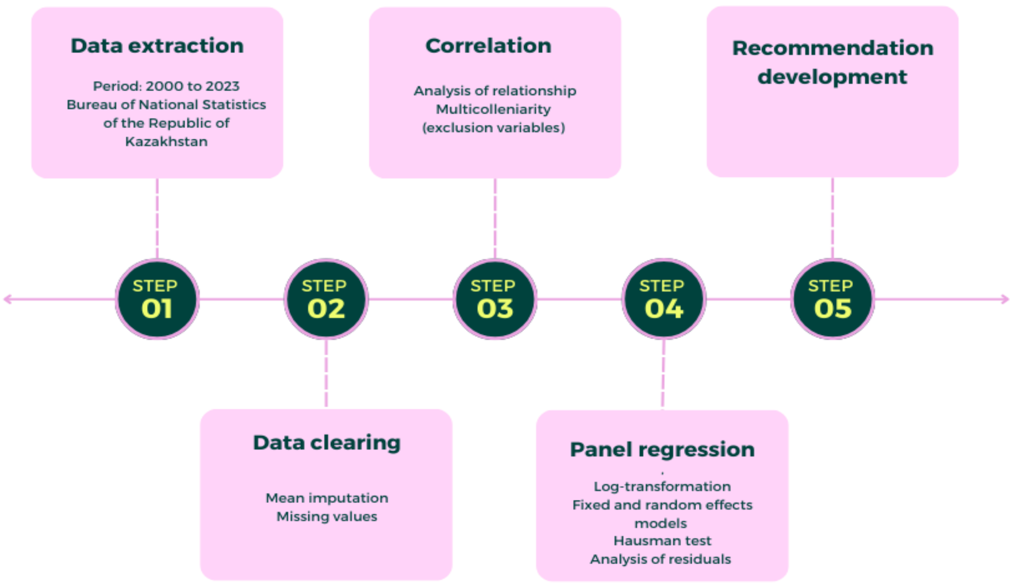

Figure 1. Stages of research

Once collected, the data undergoes a cleaning process to enhance analytical accuracy. During this phase, missing values are addressed by applying mean imputation, and the dataset is cleaned to ensure consistency and accuracy for subsequent analysis.

Pearson correlation is used to detect the impact between two variables and calculated through the following formula (1)

$$r_{xy} = \frac{\sum_{i=1}^{n}(x_i-\bar{x})(y_i-\bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i-\bar{x})^2 \sum_{i=1}^{n}(y_i-\bar{y})^2}} \qquad (1)$$

where:

x_i, y_i – the individual values of the variables x and y;

$\bar{x}, \bar{y}$ – the mean values of variables x and y, respectively;

n – number of observations.

Correlation determines multicollinearity between variables. As a result, the number of faculty members, students, and HEIs was excluded. Also, the variable level of innovative activity is excluded because of statistical insignificance ($p > 0,05$).

Regression of panel data helps to consider time and region peculiarities. The regression models are built with fixed and random effects models through Rstudio (version 2024.12.1+563). The choice of regression is motivated by the aim of the research to determine the impact of social, economic, and educational factors on the level of innovation activity among enterprises at the regional level. All continuous quantitative variables used in the regression model were transformed using the natural logarithm to ensure statistical robustness and interpretability.

To avoid undefined values due to zero logarithm, variables such as graduate and PhD were log-transformed using the adjustment ln(x+1), which retains zeros in the data while maintaining transformation integrity.

Regression calculated through formula (2):

$$\ln(y_{it}) = \beta_0 + \beta_1 \ln(GRP_{it}) + \beta_2 \ln(graduate_{it}) + \beta_3 \ln(exp_{it}) + \beta_4 \ln(PhD_{it}) + u_{it} \qquad (2)$$

where:

y_{it} – number of innovative enterprises in region i at time t;

GRP_{it} – Gross Regional Product;

$graduate_{it}$ – number of university graduates;

exp_{it} – government expenditure on education;

PhD_{it} – number of PhD students;

u_{it} – error term.

The Hausman test was employed, which tests for the presence of correlation between individual effects and the regressors, to determine whether the fixed effects or random effects model is more appropriate. Hausman test calcualted through formula (3):

$$H = \left(\widehat{\beta_{RE}} - \widehat{\beta_{FE}}\right)^{\top}\left[Var\left(\widehat{\beta_{RE}}\right) - Var\left(\widehat{\beta_{FE}}\right)\right]^{-1}\left(\widehat{\beta_{RE}} - \widehat{\beta_{FE}}\right) \qquad (3)$$

where:

$\widehat{\beta_{RE}}$ – the estimated coefficient from the random effects model;

β_{FE} – the estimated coefficient from the fixed effects model.

Test results (χ^2 = 23.864, df = 4, p = 0.000085) indicate about statistical significant difference between fixed and random effect models. Thus, the random effect model is inconsistent, which is why the fixed effect model is chosen.

This research is subject to several limitations, including (1) data due to an unbalanced panel structure, (3) potential endogeneity of some explanatory variables, and (3) absence of lagged variables, which could help capture delayed effects, particularly in the case of education-related investments.

4. FINDINGS

As an initial step in the empirical analysis, pairwise correlations were examined to assess the interrelationships among the core variables. Table 1 presents the Pearson correlation matrix, which assesses the degree and direction of relationships between the selected indicators.

TABLE 2. Correlation matrix

Code	INNOV ACT	FACUL	STUD	GRP	GRAD	EXP	PHD	INNOV ENTERP	HEI
INNOV ACT	1	0.012	0.02	-0.075	-0.018	-0.041	-0.031	0.484	0.035
FACUL	0.012	1	0.974	0.528	0.957	0.693	0.737	0.545	0.965
STUD	0.02	0.974	1	0.478	0.958	0.647	0.688	0.502	0.968
GRP	-0.075	0.528	0.478	1	0.463	0.779	0.786	0.679	0.409
GRAD	-0.018	0.957	0.958	0.463	1	0.61	0.635	0.449	0.925
EXP	-0.041	0.693	0.647	0.779	0.61	1	0.907	0.745	0.57
PHD	-0.031	0.737	0.688	0.786	0.635	0.907	1	0.765	0.619
INNOV ENTERP	0.484	0.545	0.502	0.679	0.449	0.745	0.765	1	0.448
HEI	0.035	0.965	0.968	0.409	0.925	0.57	0.619	0.448	1

Note: compiled by authors

Correlation analysis determined a statistically significant and weak relationship between indicators of human capital, economic development and innovative activity in the regions of Kazakhstan. The highest relationship was defined between components of higher education. For instance, the number of faculty members correlated with students(r = 0.974) and graduates (r = 0.957), which reflected a balanced growth in the number of faculty and students in universities.

There was a significant positive correlation between the number of PhD students and educational expenditures (r = 0.907), indicating that regions investing significantly in education also tended to support the development of doctoral programs. Interestingly, a significant interaction between the number of PhD students and the number of innovative enterprises (r = 0.765) was also observed. The most likely cause of this was the critical role of highly qualified research personnel in driving regional innovation activity.

The correlation between overall innovation activity (INNOV ACT) and the number of innovative enterprises (INNOV ENTERP) is $r = 0.484$, reflecting a moderate positive relationship. At the same time, the correlations between innovation activity and other variables such as GRAD ($r = -0.018$), STUDENT ($r = 0.02$), GRP ($r = -0.075$), and EXP ($r = -0.041$) were either extremely weak or negative. These findings suggest the absence of an apparent linear influence of these factors on the level of innovation in the regions during the period under research.

To further investigate the determinants of regional innovation activity, a fixed effects regression model was used to estimate the impact of selected economic and educational indicators on the number of innovative enterprises, as presented in Table

TABLE 3. Results of fixed effect model

Variable	Coefficient	Standard error	P-value
ln_GRP	0.752	0.105	<0.001
ln_graduate	-0.091	0.170	0.600
ln_exp	0.027	0.086	0.750
ln_PhD	0.230	0.054	<0.001

Note: compiled by authors

The regression results indicate that a 1% increase in the gross regional product (GRP) is positively associated with a 0.75% increase in the number of innovative enterprises, suggesting a strong linkage between regional economic performance and innovation capacity.

Similarly, the number of PhD students also has a positive and statistically significant effect on the innovative activity of enterprises at the 1% significance level ($\beta = 0.23$). In contrast, the variables ln_exp (public expenditure on education) and ln_graduate (the number of graduates) did not have a statistically significant effect on the number of innovative enterprises.

The model explains 64% of the within-group variance ($R^2 = 0.641$), indicating that the included predictors account for a substantial proportion of the variability in the dependent variable. The F-statistic value of 126.64 with $p < 0.001$ confirms the model's high overall statistical significance, underscoring the selected variables' reliability in explaining regional differences in innovative activity.

A fixed effects panel regression model was employed to predict the logarithmic number of innovative enterprises (ln(y)) across Kazakhstan's regions, using average values of GRP, number of graduates, public education expenditures, and PhD student enrollment. While the model demonstrates strong overall explanatory power ($R^2 \approx 0.64$), residual analysis revealed consistent deviations between actual and predicted values at the regional level, as presented in Table 4.

TABLE 4. Regional predicted vs actual ln(y) based on fixed effects model

Region	Average ln(y)	Predicted ln(y)	Residual (Actual - Predicted)
Akmola	3.36	10.48	-7.12
Aktobe	3.96	10.97	-7.01
Almaty	3.91	11.05	-7.15
Atyrau	3.46	11.11	-7.65
West Kazakhstan	3.19	10.73	-7.54
Zhambyl	3.79	10.46	-6.67
Karaganda	4.82	11.76	-6.94
Kostanay	4.12	10.71	-6.59

Kyzylorda	3.52	10.50	-6.98
Mangystau	3.03	10.86	-7.83
Pavlodar	3.99	11.12	-7.13
North Kazakhstan	3.75	10.19	-6.44
Turkestan	3.25	10.88	-7.64
East Kazakhstan	5.15	11.15	-6.00
Astana city	4.82	12.18	-7.37
Almaty city	5.71	12.90	-7.19

Note: compiled by authors

The residuals for all regions are negative, indicating that the predicted values of ln(y) systematically exceed the actual observed values, which suggests that although the explanatory variables are strong predictors nationally, regional-level conditions may be inhibiting the transfer of resources into innovation. Residuals range from –7.00 to –7.65. For example, Akmola region has an average ln(y) of 3.36, but the model predicts 10.48 (residual = –7.12). Atyrau region shows the most significant discrepancy, with a predicted ln(y) of 11.11 and an actual of 3.46 (residual = –7.65).

5. DISCUSSION

This study investigated the impact of human capital elements, including graduates, postgraduate students, and educational expenditures, on the level of innovation activity in the regions of Kazakhstan. While earlier studies have explored the impact of graduates and postgraduate students on the level of innovation activity in international contexts, there has been limited attention to these dynamics within Kazakhstan's regional framework. Moreover, few studies have systematically analyzed how human capital indicators contribute to regional disparities in innovation performance.

We found that economic development and PhD students are statistically significant predictors of innovative activity in the regions. Strong correlations were defined between indicators of the higher education system. Also, PhD students showed a strong and significant relationship with innovational enterprises, while other human capital indicators indicated a weak or insignificant correlation. Our study suggested that the higher education system had structural consistency, which did not translate into innovative outcomes. At the same time, PhD student indicators highlighted the role of research capacity in innovative ecosystems.

Regarding H_1, the finding showed a strong correlation between regional economic performance and innovation capacity that aligned with the findings of Crescenzi and Rodríguez-Pose (2012), who argued that economically dynamic regions are more likely to generate and sustain innovation due to greater availability of resources, better infrastructure, and stronger institutional support. Thus, economic capacity is critical in fostering innovation, likely due to greater accessibility of resources, investment, and infrastructure (Peters, 2020). Thus H_1 is confirmed.

Regarding H_2, contrary to previous research, this study did not find a significant relationship between the number of university graduates and innovation activity (Yao et al., 2023; Evers & Ostergaard, 2025). Insignificant impact might indicate structural delays in the implementation of educational policies, a weak link between the education system and the innovation market, or their limited involvement in research and entrepreneurship. Thus, H_2 is rejected.

Concerning H_3, government expenditure on education does not affect innovation activity. It is crucial to acknowledge that educational investments have a significant long-term effect on both economic growth and innovative capacity development. While the immediate impact of such investments on specific innovation metrics may appear limited, the underlying enhancement of human capital translates into meaningful outcomes over an extended period. Thus, H_3 is rejected.

Referring to H_4, the PhD-students relationship supports the view that advanced academic expertise contributes significantly to knowledge creation, technology transfer, and innovation uptake at the regional level. The training of highly qualified scientific personnel contributes to the development of regional innovative capacity, probably due to the strengthening of the research environment, the involvement of PhD students in R&D projects and their integration into the higher education system and industry cooperation (Buenstorf & Heinisch, 2020; Yang et al., 2025). H_4 is confirmed.

In line with García-Estévez & Duch-Brown (2020), HEIs positively affected innovative enterprises (0.448). Innovative activity in the regions did not directly depend on the level of economic development and resources of the higher education system. There were institutional barriers, weak integration of science and business, and an insufficient level of innovative infrastructure. These findings reflect the structural interdependence between higher education capacity and regional economic strength. Economically developed regions invest more heavily in education and have more PhD students.

The consistent overestimation of predicted innovation activity across all regions, as revealed by the regression residuals, highlighted such persistent regional barriers as (1) weak university-industry collaboration, (2) limited R&D infrastructure, and (3) inefficient policy mechanisms that hinder the effective transformation of resources into innovation.

This research had several limitations. Firstly, the model used is based on aggregated regional data, which did not allow for the analysis of intra-regional differences. Secondly, the study relied solely on quantitative data and did not include a qualitative dimension, for example, institutional culture, the level of R&D management, or the nature of relationships between industry and research institutions. Thirdly, the time lags between investments in human capital and their actual impact on innovation activity may not have been fully captured by the chosen model. Therefore, further research is needed using mixed-method approaches and more granular data to gain a more accurate understanding of the mechanisms through which human capital influences innovation.

6. CONCLUSION

The research aimed to assess the impact of human capital, namely, students, graduates, PhD students, and faculty, on the development of innovative activity in Kazakhstan. Firstly, the literature review indicated that human capital is critical in driving innovation and regional economic development. Universities are key intermediaries linking education, research, and industry needs. While international evidence highlights the success of strong university-industry collaborations, Kazakhstan still faces structural barriers in fostering such partnerships, limiting the full potential of its innovation ecosystem.

Secondly, the study employed correlation and panel regression analysis using data from 2000 to 2023. Correlation analysis was also conducted to identify relationships between variables and structural dependencies. Logarithmic transformations were applied, multicollinearity was addressed, and a fixed effects model was implemented to assess within-group differences.

Thirdly, the results show that Gross Regional Product and the number of PhD students exert the most significant impact on the development of innovative enterprises. In contrast, variables such as the number of graduates and educational expenditures did not show statistically significant effects in the short term. This indicates that developing academic research and training highly qualified personnel are more critical factors for fostering innovation growth.

Based on the results, the following measures are proposed:

(1) increase government investment in education, particularly in regions with low

innovation activity, focusing on the development of research infrastructure and the support of promising educational programs;

(2) create incentives to train and retain researchers, including grant programs, academic mobility opportunities, and additional remuneration for research activities;

(3) expand access to specialized educational programs and research infrastructure (laboratories, research centers);

(4) implement a system of grants and additional scholarships to motivate talented PhD students and support their research work;

(5) organize joint research projects with businesses and industrial enterprises to foster practical skills and accelerate the implementation of scientific developments;

(6) enhance collaboration between universities and enterprises through the formation of scientific and educational clusters, shared laboratory facilities, and targeted research initiatives;

(7) provide targeted support for innovative companies in regions with high scientific potential by offering tax incentives, subsidies, and establishing specialized development funds;

(8) introduce a system for monitoring and regularly evaluating innovation policy, involving the collection and analysis of relevant data and the participation of specialized research institutes and experts in refining strategic priorities.

Thus, the research highlights the significance of a complex approach for fostering innovative activity. The offered measures reveal innovative capacity and make the basis for economic prosperity and technological renovation.

Future studies should focus on exploring the mechanisms that enhance the effectiveness of university-industry collaborations. Additionally, further investigation is needed into the specific barriers to R&D funding and knowledge commercialization, employing qualitative or mixed-method approaches. Comparative studies across regions with varying innovation capacities would help policymakers better understand context-specific requirements, enabling more targeted and effective innovation policy interventions.

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Visualization: Gulbakhyt Olzhebayeva, Temirlan Abdykadyr, Madina Rakhimberdinova.
Writing review and editing research: Gulbakhyt Olzhebayeva, Temirlan Abdykadyr.

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