“Intellectual capital of universities and regional socio-economic imbalances in Kazakhstan: A quantitative assessment”

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INTELLECTUAL CAPITAL OF UNIVERSITIES AND REGIONAL SOCIO-ECONOMIC IMBALANCES IN KAZAKHSTAN: A QUANTITATIVE ASSESSMENT

Abstract

In the context of the knowledge economy and globalization, one key factor in regional economic development is universities' intellectual capital. In this regard, the purpose of this article is to analyze the relationship between universities' intellectual capital and socio-economic differences across Kazakhstan's regions. The research used an integrated index of universities' intellectual capital developed in the authors' previous study, factor and cluster analysis, and regression modeling. The research database includes data from the National Bureau of Statistics for 20 regions of Kazakhstan for 2015, 2020–2023. The findings suggest that an increase in the universities' intellectual capital index is associated with an increase in gross regional product per capita (β = 87.32). The results demonstrate that the population's nominal incomes were statistically insignificant, indicating no clear short-term association with income redistribution. Instead, the Gini coefficient increases significantly, suggesting higher levels of observed inequality and a possible concentration of benefits among higher-income groups in regions with high levels of university intellectual capital. More specifically, a 1-unit increase in universities' intellectual capital is associated with a 0.371-point increase in the Gini coefficient. Moreover, the results of the cluster analysis show a high level of socio-economic imbalance between regions with high and low levels of university intellectual capital. The quantile regression suggests that universities' intellectual capital is positively associated with economic growth but is also related to higher levels of social inequality. The results suggest the need for a differentiated regional policy to support the development of regional universities and ensure inclusive development.

Keywords regional economic development, intellectual capital, higher education, integral index, factor analysis, regional imbalances

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INTRODUCTION

In the context of the knowledge economy, universities' role in regional development is recognized as extremely important, as high economic competitiveness can be achieved through their well-developed intellectual capital. In this regard, universities' intellectual capital is an important factor in the development of the country and its regions. The economic development of regions through universities' intellectual capital is linked to expanding the knowledge base, promoting scientific research, stimulating innovation, increasing labor productivity, and improving employment opportunities. In this context, the region's quality of life improves, and its innovation potential grows. However, the relationship between universities' intellectual capital and the region's social development is complex and not fully clear. In particular, the concentration of universities' intellectual capital in some regions may be associated with social inequality across the country. Social inequality is more visible in underdeveloped regions,

as the benefits of knowledge creation tend to be concentrated in more developed regions. In peripheral regions, knowledge concentration is lower, associated with lower universities' intellectual capital intensity and greater regional differentiation. Although the role of university intellectual capital in regional development is widely recognized, empirical evidence on its relationship in transition economies is limited. Kazakhstan, with its pronounced regional differences and rapidly developing university education sector, provides a unique case for studying how universities' intellectual capital is related to socio-economic development and regional inequality.

1. LITERATURE REVIEW AND HYPOTHESES

Not a few studies have been devoted to intellectual capital and its impact on the economy and economic processes. A knowledge-based economy is based on the ability of human resources and their intellectual capital. However, it should also be borne in mind that the distribution of intellectual capital is uneven, as is the distribution of universities, which raises questions about its impact on the region's social development. In this context, intellectual capital generated within universities and research institutes can be associated with the creation and implementation of innovations, higher productivity, and broader economic and social development, thereby increasing the incomes of the population (Mukayev et al., 2023) and employment (Sum & Jessop, 2013; Kabylkairatkyzy et al., 2025; Kakizhanova et al., 2026). These processes operate through interconnected mechanisms, including knowledge transfer, human capital formation, innovation and technology development, and the commercialization of research outputs, which collectively enhance university–industry collaboration. To effectively leverage intellectual capital and maximize its benefits, attention should be paid to its components, including intangible assets, knowledge, skills, innovation potential, and relationships with external stakeholders. Initially, the concept of intellectual capital originates from the research of P. Drucker, who in the middle of the 20th century noted the importance of knowledge as the main factor of production (Drucker, 1946). Later, Stewart (1997) and Edvinsson and Malone (1997) systematized the approach to intellectual capital, dividing it into three key components: human, structural, and relational capital (Secundo et al., 2017). Although this approach was developed before the emergence of the innovation-driven, digital economy, it is not fully universal; it still provides a useful framework for describing the basic structure of intellectual capital. According to this approach, intellectual capital includes human capital, characterized by employees' qualifications, research productivity, academic mobility of teaching staff, and the level of training of students and doctoral students. Similar studies show that a high level of human capital is positively associated with academic productivity and regional innovation activity (Uden et al., 2017; Sugianto et al., 2023; Guerrero & Menter, 2024). Another important component is structural capital, which encompasses internal processes and resources, including the availability of research laboratories, digital infrastructure, participation in global rankings, and R&D funding. This component reflects the university's ability to generate and transmit knowledge (Sánchez & Elena, 2006; Ramírez & Gordillo, 2014; Diaz-Vega & Gutierrez-Rincon, 2024), which is important for supporting knowledge creation and innovation processes. Also, it is necessary to consider a component of intellectual capital, formed through university relations with business, government institutions, and international partners. Thus, in the study of intellectual capital, it is possible to identify approaches to managing it and the methods implementing them, which serve as guidelines for public administration. However, it is necessary to take into account external factors, such as regional development levels, the presence of industry in the territories, and the institutional and regulatory framework, which may influence universities' intellectual capital.

The concentration of intellectual capital is positively related to the region's socio-economic and innovative development. Thus, Carayannis and Morawska-Jancelewicz (2022) show that the concentration of intellectual capital in universities is associated with the creation of start-ups, increased labor productivity, and the modernization of the regional economy. At the same time, the concept of inclusive growth emphasizes the need for the

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benefits of innovation and knowledge to spread to all population groups and territories, rather than being concentrated only in developed centers. This means that universities' intellectual capital should work for the benefit of a wide range of stakeholders, ensuring sustainable and equitable development (Trequattrini et al., 2012; Trequattrini et al., 2018; Tarí et al., 2024). Thus, the intellectual development of universities should not only foster innovation, the commercialization of scientific knowledge, and industry development, but also be considered in relation to social equality across regions.

Of particular interest is the impact of university intellectual capital on smoothing or, conversely, deepening regional imbalances. Some studies indicate that intellectual capital contributes to inclusive growth (Rodríguez-Pose, 2018), but others emphasize that, in the absence of effective regional policies, the concentration of intellectual capital in large cities can increase socio-economic inequality (Martin, 2012; Alcaraz et al., 2019). There is much debate in this context; it is like two sides of a coin: one side says that universities' high level of intellectual capital can become a driving force of the economy in some regions. The other side is that such an imbalance in development will further increase social inequality among the population. Such trends are observed in many countries; for example, in China, technological innovation is mainly developing in eastern megacities, leading to a growing economic development gap between regions (Zhang et al., 2021; Jiao & Sun, 2021). Similar trends are observed in Kazakhstan: the bulk of research, development, and innovation activity falls on the cities of national importance, Almaty and Astana, while peripheral regions lag significantly behind (Kangalakova & Rakhmetova, 2021). In particular, financial and scientific resources are concentrated in large cities, and there is also a well-developed infrastructure to enhance universities' intellectual capital. On the contrary, in remote regions, there is a shortage not only of financial resources but also of highly qualified personnel for university work, and the infrastructure has not been modernized in recent years.

This geographical concentration of knowledge and investment creates risks of increasing inequality and contradicts the goals of inclusive growth. In this context, the role of universities in developing human capital and equalizing territorial imbalances is of particular importance. Existing research shows that having strong universities alone does not guarantee positive economic effects for the local economy without supportive policies, institutional linkages, and demand for knowledge-based services (Yusuf & Nabeshima, 2007; Trippl et al., 2015; Lima et al., 2021). At the same time, the literature highlights the risks of increasing inequality in knowledge-based development. If some regions concentrate the majority of leading universities and research centers, this may increase the gap with peripheral territories (Adilkhanov & Sabden, 2021; Cota et al., 2023; Cortinovis et al., 2024; Hartmann & Pinheiro, 2024). Highly qualified youth are attracted to innovation clusters (capital cities, technopolises), leading to an outflow of talent from depressed regions (Gennaioli et al., 2011; Farhi & Werning, 2014; Etzo et al., 2025). Consequently, there will be a shortage of capable personnel in remote regions, further exacerbating the socio-economic imbalance between regions. For example, a study in Italy showed that the outflow of talented graduates from the southern provinces (where there are fewer prestigious universities) slows economic growth (Cannari et al., 2000). Thus, regions with high intellectual capital attract human capital, thereby widening the disparity between regions.

International practice shows that universities' intellectual capital is a key factor in mitigating regional disparities (Pedro et al., 2020; Toma & Laurens, 2024). The EU countries have developed aggregated indices of regional development (e.g., RICI), which allow consideration of human, structural, and innovative potential in shaping regional policy (Januškaitė & Užienė, 2018). Research in Poland confirms that human capital is the basis of regional economic development, and its conversion into economic results depends on infrastructure and institutional conditions (Lubacha-Sember, 2016). In Italy and Canada, the concept of an "entrepreneurial university" is being introduced, in which universities act as generators of local innovation, contributing to the growth of start-ups, industrial relations, and local gross regional product (GRP) (Trequattrini et al., 2017). In China, 30% of regional differences in gross regional product are explained by the level of universi-

ties' intellectual capital, mainly structural and innovative capital (Liu et al., 2015). Similar results were obtained in studies of Russia and Eastern European countries, where the presence of strong universities and research centers correlates with high regional competitiveness and investment inflows (Maltseva et al., 2018). Thus, international practice shows that the relationship between universities' intellectual capital and regional development largely depends on context and is determined by the quality of the institutional environment and regional policy. However, many studies examine the impact of university intellectual capital on the economic development of countries and regions. However, only a few consider its relationship with social development and regional disparities. In particular, there is no quantitative assessment of the impact of regional disparities in transition economies, which this study addresses. Based on this, the purpose of this article is to analyze the relationship between universities' intellectual capital and socio-economic differences across regions of Kazakhstan. To achieve this goal, the following hypotheses were formulated:

H1: The intellectual capital of universities is positively correlated with the gross regional product per capita.

H2: The intellectual capital of universities is associated with the growth of social inequality, measured by the Gini coefficient.

H3 The relationship between universities' intellectual capital and regional economic outcomes is heterogeneous across regions with different levels of socio-economic development.

2. METHODS

This study provides a quantitative assessment of the relationship between universities' intellectual capital and regional socio-economic indicators in Kazakhstan. The empirical base includes panel data for 2015 and 2020–2023 for 20 regions of the Republic of Kazakhstan. In particular, 2015 was used as the base period, and 2020–2023 as the period for assessing the relationship between the accumulated intellectual capital, since there is a positive connection between the university's intellectual capital and economic growth and social inequality in the time lag. Since investments in education manifest in the labor market for 3-5 years, the optimal analysis period is 2020–2023. At the time of the study, data for 2024 were unavailable. The following were used as dependent variables: gross regional product per capita (GRP per capita), an indicator of regional economic growth; and the Gini coefficient, an indicator of socio-economic inequality. The key independent variable is the author's university's intellectual capital index. This study is a logical continuation of previous work, in which the integral intellectual capital index for universities in Kazakhstan was calculated, and a fundamental regression analysis was conducted (Zhangaliyeva et al., 2025). This study is complemented by new analytical methods, such as quantile and cluster regression, which enable an in-depth assessment of the linkage between information technology in universities across different levels of regional development. Thus, the work expands and deepens the empirical base of previous studies, moving from a general assessment of the relationship to a structural analysis of the distribution and stability of effects.

Furthermore, the analysis was conducted in several stages. The first stage was the construction of an integrated intellectual capital index of the university using Principal Component Analysis (PCA) for factor analysis. This approach allows to aggregate multidimensional data into a single index, eliminating multicollinearity and highlighting key latent factors. The university's Intellectual Capital (IC) Index was developed based on three main components, as outlined in the conceptual model (Veltri et al., 2014; Secundo et al., 2015). Appropriate quantitative indicators were selected for each component to characterize the university's scientific and educational potential, its infrastructure, and its financial and partner resources. The indicators were selected based on available statistical data (to obtain information on the number of students, the proportion of teaching staff with academic degrees, the total number of universities, etc.), official university reports (to analyze the university's structural capital, the presence of commercialization offices) and open sources (to obtain data on international partnerships, participation in Erasmus+, Horizon Europe et al., for the QS level rating, etc.) (Kianto et al., 2014) (Table 1).

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Table 1. Components of university intellectual capital

No.	Components	Content	Indicators	Impact on regional development
1	Human capital	It reflects the qualitative characteristics of the teaching staff, including the proportion of employees with academic degrees, academic mobility, and publication activity	• Percentage of teaching staff with an academic degree • Number of teachers per 100 students • The number of doctoral students • The number of students • Academic mobility of teaching staff. • The number of universities	Improves workforce quality and supports local employment
2	Structural capital	It includes the availability and level of development of scientific and educational infrastructure, investments in R&D, and digital resources and internal processes	• Availability of laboratories and research centers • The volume of R&D investments • Digital infrastructure (LMS, online platforms, repositories) • Participation in the QS / Times HE ratings • Availability of a commercialization office	Improves innovation potential, attracts investments
3	Relational capital	It characterizes the external relations of universities, including participation in partnership projects with business and government organizations, as well as the level of commercialization of scientific developments	• Partnerships with businesses and government agencies. • Participation in international projects (Erasmus+, Horizon, etc.) • The share of international students in institutions of higher and/or postgraduate education	Stimulates entrepreneurship, supports local ecosystems

To ensure comparability of the indicators, the "maximum-minimum" method was used to standardize the data to a single scale from 0 to 1. Based on the normalized values, a principal component analysis (factor analysis) was performed, which allows combining many initial variables into a composite indicator. This was done to identify a latent factor reflecting the overall IC level of universities in the regions (Costello & Osborne, 2005).

At the second stage, a panel regression analysis was conducted to assess the relationship between the university's IC and the regions' socio-economic indicators:

$$IC = 0.84 \cdot HC_{norm} + 0.82 \cdot SC_{norm} + 0.47 \cdot RC_{norm}, \quad (1)$$

where HC_{norm} – the normalized human capital index; SC_{norm} – normalized structural capital index; RC_{norm} – normalized relational capital index.

Next, the third stage is a quantile regression analysis to identify heterogeneity in the relationship between universities and regions with different levels of economic development. This is done to determine the strength and direction of the IC relationship among universities, which vary across regions with low, medium, and high levels of GRP or inequality. The final stage was k-means clustering. This was done to identify typological groups of regions in Kazakhstan based on universities' intellectual capital and socio-economic development. Statistical data processing and linear regression model construction were performed in Stata 17. After carrying out econometric calculations, the models were diagnosed. Multicollinearity, heteroscedasticity, and residual autocorrelation were tested. Reliable standard errors, grouped by region, and random effects based on panel data were used to account for the identified effects. Diagnostic tests confirmed the validity of the model specification and the stability of the estimates.

3. RESULTS AND DISCUSSION

The map (Figure 1) shows the regional distribution of the integrated intellectual capital index for universities of the Republic of Kazakhstan as of 2023, displayed on a color scale from light green (low values) to dark blue (high values). The average annual growth rate of the university's IC index for the period 2015–2023 is also shown for each region, allowing assessment not only of the current level of development but also of its dynamics over the past eight years. Some of the results of the assessment of universities' intellectual capital in the Republic of Kazakhstan were presented in our previous study (Zhangalieva et al., 2025). In this arti-

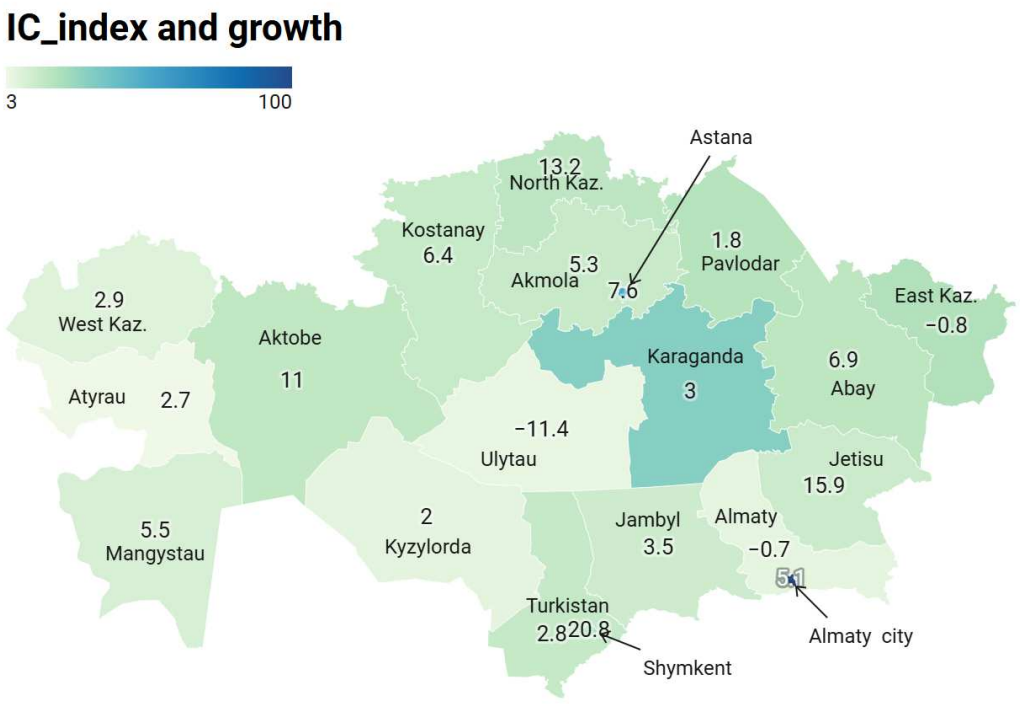

Figure 1. Regional distribution of university intellectual capital index in Kazakhstan, 2015–2023

cle, the analysis is significantly expanded through the use of additional methodological tools, including cluster analysis and updated calculations. According to the calculations of the integral intellectual capital index for universities, the regions of Kazakhstan show significant differentiation. The highest index value is observed in Almaty (over 90 points), Astana, and Karaganda (about 40 points). Most regions show an average level of university development (15-30 points). Several factors may be associated with the observed differences; one of them is financing. In Kazakhstan, universities are funded by both national and local budgets, and funding levels depend on the region's economic development. Therefore, regions with low economic development are associated with low levels of university funding. A similar situation is observed in the provision of university infrastructure and academic resources, which are unevenly distributed across regions.

Figure 1 shows the growth rates of university development, which enable the identification of regional potential and opportunities to reduce socio-economic disparities. Shymkent (+20) and Zhetysu (+15.9) regions have significant potential for university development and for reducing regional disparities. Active development was also noted in the North Kazakhstan Region (+13.2), Aktobe (+11), and Akmola (+5.3) regions. Such regions have a high potential return on investment in education. At the same time, several regions demonstrated either low growth rates (Kyzylorda (+2), Pavlodar (+1.8), Atyrau (+2.7)), or negative dynamics (Ulytau (–11.4), East Kazakhstan Region (–0.8), Almaty region (–0.7)), which indicates a low level of potential in the field of university professional education. Thus, in Kazakhstan, the development of universities' intellectual capital is diverse and has significant potential, and its relationship with socio-economic development varies. Based on this, to determine its relationship with socio-economic development, a regression analysis was carried out using gross regional product per capita (as an indicator of the economic component), nominal income per capita, and the Gini index (as an indicator of the social component) as the dependent variable. The calculated IC index of universities was used as an independent variable.

The models were evaluated using the random effects method, confirmed by the Haussmann test ($p = 0.1783$), which did not reveal a significant difference between the fixed and random models. However, this model was chosen for several reasons. First, the fixed-effects model excludes vari-

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Table 2. Panel regression results

Variable	Ratio	St. mistake	p-value	Interpretation
GRP per capita	87.32	26.05	0.001	A 1-point increase in the IC index of universities. GRP is expected to increase by 87.32 thousand tenge
Coef Gini	0.371	0.14	0.008	The increase in university IC is associated with a higher Gini coefficient. reflecting a greater concentration of advantages between the groups

ables that change little over time, such as the university IC index. Moreover, it allows you to save this data during analysis. Secondly, it allows for the possibility that different regions may have different characteristics that affect the results without interfering with the analysis of the main factors. Thus, the random effects model is suitable for estimating goals and is statistically reliable for analysis. The university's IC index has a positive, statistically significant relationship with GRP per capita. With an increase in the IC index of universities by 1 point (Table 2), GRP is expected to increase by 87.32 thousand tenge (first half of the year). The interregional contribution (rho) is 0.75, indicating significant differences between regions and the importance of each region's specifics in the formation of GRP. Consequently, the interconnection of intellectual capital is heterogeneous across the entire space, which justifies further analysis of its distribution and regional heterogeneity. If the university IC index increases by 1 point, the Gini coefficient is expected to increase by 0.371 points (H2). The positive association between the index and the Gini coefficient is interpreted as an increase in universities' participation in the formation of structural inequality in access to knowledge and social elevators. Thus, an increase in universities' intellectual capital is associated with regional economic development and greater benefits for certain groups of the population. On the one hand, the development of the region can provide several advantages in the socio-economic life of the population in the territory, but on the other hand, in conditions of insufficient inclusivity, scientific and educational resources created in the university environment can only be available to a limited number of groups, which will contribute to improving the socio-economic stratification.

Further, to deepen understanding of social stratification, clustering using the k-means method was performed in Stata based on data on universities' levels of intellectual capital across regions of the Republic of Kazakhstan. Based on clustering of Kazakhstan's regions according to the normalized intellectual capital index of universities, three stable groups were identified. The first group includes regions with low index values, characterized by weak university infrastructure and limited access to intellectual resources. The second category includes regions with moderate indicators and growth potential. The third group consists of the largest cities and regional centers, home to leading universities and scientific institutions

Figure 2. Distribution of the university intellectual capital index by clusters

that offer high-quality education. The distribution of the normalized index across the three clusters obtained from the cluster analysis is shown in the boxplot (see Figure 2).

The results of the cluster analysis show a significant gap in the levels of intellectual capital of universities in different regions. Clusters 1 and 2 are similar in terms of values, indicating the proximity of the levels of university development and socio-economic development across the regions. Cluster 3, characterized by a high level of intellectual capital of universities, demonstrates stable socio-economic development and a relatively high level of social security. To analytically expand on cluster analysis, an additional indicator was added to the k-means method – GRP per capita. This additional indicator will enable identification of typological models of regional development, accounting for both educational potential and economic development. This approach provides a more comprehensive assessment of the relationship between universities' intellectual capital and the economic characteristics of Kazakhstan's regions (Table 3).

The results of the cluster analysis allow to identify 3 types of regions based on economic development and the level of intellectual capital at universities. The first type includes regions with resource-based economic development, characterized by high regional gross product, which is poorly correlated with the level of universities' intellectual capital development. The second type includes regions with economies in transition, where the relationship between regional economic development and the level of intellectual capital at universities is more pronounced, and the third type includes regions that generate knowledge intensively. Based on this, it can be concluded that although the region has a high level of GRP, this is not solely due to universities' intellectual capital. In general, the results of the cluster analysis complement the conclusions of the regression model and confirm that the intellectual capital of universities has a heterogeneous relationship with regional development, which is significantly influenced by the regional economy's structural features.

To identify heterogeneity in the relationship between universities' intellectual capital at different levels of regional development, a quantile regression was conducted. The results show that universities' intellectual capital is related to quantiles in different ways. It is significantly higher for regions with low and medium levels of GRP but decreases in the upper quantiles (rich regions). Figure 3 shows the correlation level of the university's IC index with GRP per capita (GRP per capita) using distribution quantiles. A positive, statistically significant relationship is observed in all quantiles. However, it is most pronounced at the central quantile (τ = 0.5), indicating the greatest correlation between universities' intellectual capital in regions with an average level of economic development. In more developed regions (τ = 0.9), bond strength decreases, suggesting a weaker relationship at higher levels of economic development. Figure 4 shows the relationship between the university's IC index and the Gini coefficient, where

Table 3. Clustering of Kazakhstan's regions by the index of IC universities and GRP per capita, 2023

Cluster	Regions	Interpretation
Cluster1	Atyrau	A low university IC index (3) characterizes the region, yet it also has the highest possible GRP per capita (47802 dollars). This indicates a resource-based model of economic development in which high economic performance is not associated with the development of the university community
Cluster 2	Ulytau, Almaty, Kyzylorda, West Kazakhstan region Mangystau, Zhambyl, Zhetysu Akmolinskaya, Kostanay, Turkestan, Aktobe, North Kazakhstan region, Abai Pavlodar, East Kazakhstan region, Shymkent, Karagandy	It includes most regions with an average level of university intellectual capital (from 5 to 31) and low or average GRP per capita (from 3940 to 15911 dollars). This cluster reflects the middle- and least-developed territories, where intellectual capital is formed at universities, but so far it has not demonstrated a connection to the economy
Cluster 3	Astana and Almaty	They are characterized by high IC index values at universities (49.63 and 99.00) and high GRP per capita (20400 and 25186 dollars). These are clusters of the most developed and intellectually saturated regions, where universities and innovative infrastructure are well connected to the regional economy

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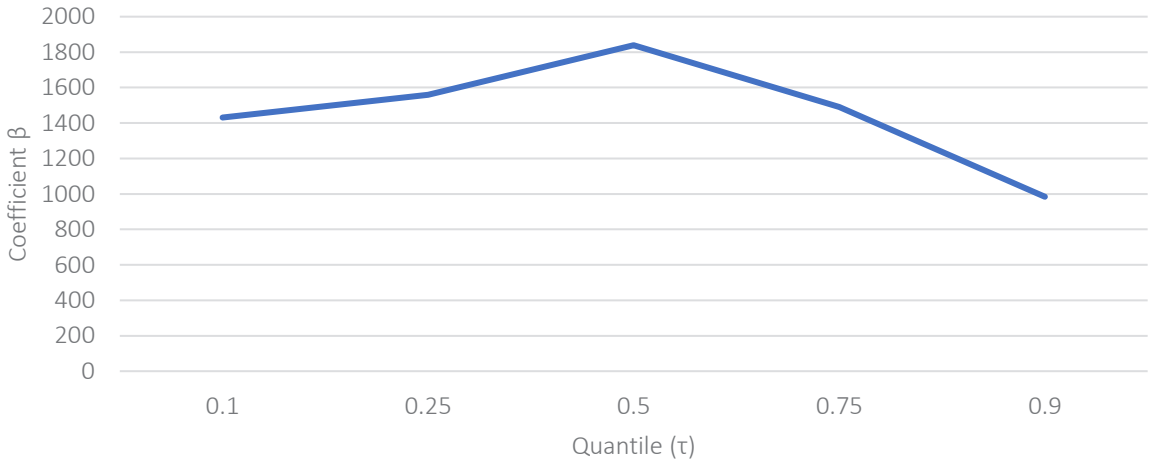

Figure 3. Quantile relationship between universities' intellectual capital and GRP per capita

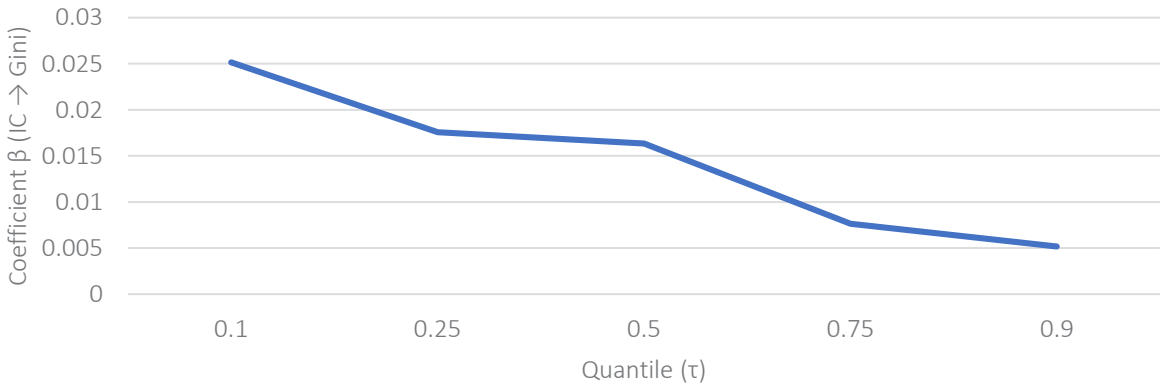

Figure 4. Quantile relationship between universities' intellectual capital and the Gini coefficient

the index is positively associated with inequality in lower quantiles. However, it decreases as incomes in the region grow, indicating a weaker relationship in higher-income regions. One possible explanation for this pattern is the concentration of intellectual and economic resources in the most developed territories.

Thus, the results of the quantile regression confirm that universities' intellectual capital is positively associated with economic growth. However, it is also associated with higher levels of inequality if regional policies are not aimed at the inclusive dissemination of knowledge and innovation. Quantile regression also shows that in regions with a high level of university intellectual capital, the relationship with socio-economic development is relatively lower; in regions with an average level of university intellectual capital, the relationship is stronger. Summing up, it can be argued that in less developed regions, an increase in universities' intellectual capital is associated with relatively stronger relationships with regional development indicators, due to lower initial levels of human capital and greater potential for catch-up growth. On the contrary, in highly developed regions, the strength of the relationship tends to decrease**,** which may be associated with saturation and lower marginal returns, as well as with the already high level of institutional and innovation infrastructure (H3). These structural differences may help explain the non-linear relationship between intellectual capital and regional development outcomes.

To assess the reliability of the regression results, a series of diagnostic tests was conducted to verify the specification and the stability of the esti-

mates. First, a multicollinearity check was performed using the VIF coefficient, which showed that the average VIF did not exceed 1. This indicates the absence of a significant correlation between the independent variables and, consequently, the correct specification of the model. Further, using the modified Wald test (xttest3), heteroscedasticity in the residuals was detected, which is typical for regional panel data reflecting differences in the socio-economic scales of the regions. To eliminate this effect, robust standard errors clustered by region (vce cluster region_num) were used, which helped compensate for heteroskedasticity and improve the accuracy of statistical conclusions.

Verification using the Breusch-Pagan test (xttest0) indicated the presence of significant random effects, which justifies the use of the random effects (RE) model in the primary analysis. An autocorrelation test using the xtregar command showed moderate positive autocorrelation ($r \approx 0.7$-0.8), typical of panel data with time lags reflecting the inertia of socio-economic processes. After applying robust standard errors with clustering, the coefficient estimates remained statistically significant at $p < 0.01$, indicating the robustness of the main findings. Collectively, the tests performed suggest that, despite heteroscedasticity and moderate autocorrelation, the models remain adequately specified after adjustment, and the results obtained provide a sufficiently robust basis for interpreting the relationship between universities' intellectual capital and socio-economic indicators of the regions of Kazakhstan.

CONCLUSION

The purpose of this article was to analyze the relationship between university intellectual capital development and socio-economic differences in regions. The study's results demonstrate a positive relationship between the university's intellectual capital and key regional indicators, including gross regional product per capita and the Gini coefficient. The data indicate a dual association of intellectual capital: it is positively associated with economic growth while simultaneously being associated with higher income inequality. This suggests that the benefits of intellectual capital may be unevenly distributed among regions and social groups. The combination of panel regression, quantile regression, and cluster analysis suggests that these associations are spatially heterogeneous and vary significantly across levels of regional economic development. In particular, higher values are observed in less developed regions, while the strength of the relationship decreases in highly developed territories. Based on this, it may be appropriate for policymakers to consider reviewing the mechanisms for developing universities' intellectual capital, considering social equality and its potential role in supporting regional economic development. It is important to pay attention to effective mechanisms for integrating universities into regional economies and ensuring equal access to educational and research resources across all regions of Kazakhstan, which are important for supporting sustainable, balanced development. Such mechanisms include developing educational tools, creating research centers integrated with technology transfer centers, offering business incentives for cooperation with the university, and expanding digital educational infrastructure and interregional scientific cooperation. When implementing these mechanisms, it is important to consider the principles of social equality and ensure equal access to educational and research resources. This may improve the quality of life and support the country's social development. In general, ensuring equal access to knowledge, opportunities, and infrastructure is not only a matter of social justice but also a key factor in sustainable and balanced territorial development.

CONFLICT OF INTEREST STATEMENT

The authors reported no conflict of interest.

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