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Article

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Innovative Development of Kazakhstan's Raw Material (Oil and Gas) Regions: Multifactorial Model for Empirical Analysis

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ABSTRACT

The following paper reveals the applied aspects of multi-factor analysis allowing identifying patterns of innovative development of Kazakhstan's raw material (oil and gas) regions in connection with modernization transformations. Initial signs of indicators for the period between 2008 and 2020 are currently under investigation using factor analysis. All data have been analyzed with IBM SPSS 23. In considerable detail, authors describe the methodology of this study and provide the results of statistical analysis. The analysis has revealed factors determining implementation of modernization transformations and taking effect on innovative development of Kazakhstan's raw material regions, which are as follows: Regional Economic Development and Agglomeration Effects, Market Potential and Infrastructure, Structural Factor of Innovative Development, Human Factor of Innovative Development, and Investment Factor of Innovative Development. It is concluded that stimulation of innovation activity can be based on the following public policy measures: increasing investment in fixed assets; growth of gross regional product and product and process innovation costs; regional development of information and communication technologies; expansion of lifelong learning programs; poverty reduction; increase in the share of R&D employees; development of small businesses; increasing investment in education and in the number of technical and STEM students. The obtained results also allowed us to conclude about the completeness of identified factors of innovative development of Kazakhstan's raw material (oil and gas) regions and the need for further research in the context of studying the stated issue.

Keywords: Raw Material (Oil and Gas) Regions, Resource Curse, Innovations, Factor Analysis, Kazakhstan
JEL Classifications: O31, Q30, R11

1. INTRODUCTION

Back in 2020 and 2021, the share of mineral raw materials and products would account for 66% in the structure of Kazakhstan's exports. This shows that Kazakhstan's economic power directly depends on sales of natural resources, i.e. revenues from oil and gas exports form a significant part of the republican budget of the country.

The raw material factor interpreted in the scientific literature (Wang et al., 2021; Rahim et al., 2021; Khan et al., 2020; Li et al., 2020) as a "resource curse" for the countries with economies in transition and rich in mineral resources, is determining the country's socio-economic development. The processes of institutional transformations are being hindered in the raw materials economy (Aljarallah, 2021; Haque, 2020; Pelzman et al., 2018; Vakulchuk and Overland, 2018), since raw material factor in the economy contributes to the obscurity of social distribution of natural resource rent. An inefficient institutional environment hinders economic growth by reducing quality indicators, which in turn has a negative impact on the quality of life, which manifests itself in an increase in social stratification and in socio-economic inequality.

Raw material specialization determines regional imbalances in the level of economic development. Raw material (oil and gas) regions attract mobile and skilled labor resources; attract investments thereby turning into leading centers on certain socio-economic indicators. Concurrently, adverse weather conditions and the high cost of infrastructure maintenance form an obstacle to their sustained socio-economic development.

In our previous studies (Kurmanov et al., 2020), results of the analysis of Kazakhstan's raw material regions indicate a low level of innovation activity, instability of regional development, which predetermines the strengthening of the search for factors and new tools and measures to ensure the boost of the existing potential for the creation and implementation of regional innovation with oil and gas production's predominance in the economy.

2. LITERATURE REVIEW

Various studies (Zemtsov et al., 2017; Crescenzi and Jaax, 2017; Ó hUallacháin and Leslie, 2007; Bottazzi and Peri, 2003; Feldman and Florida, 1994; Jaffe, 1989) show that R&D costs, investment climate, availability and quality of human capital, the level of economic diversification, the flow of knowledge positively influence the effective regional innovation activity.

In addition, scientific literature reveals a link between the level of economic development and the level of innovative activity of regional enterprises; however, its direction is definitely impossible to assume something of. Development of regional innovative entrepreneurship is facilitated by the growth of GRP and, particularly, GRP per capita as an indicator of the volume of consumer markets, the solvency of the population and the quality of life (Reynolds et al., 1994). A number of studies have revealed that startup activity take an effect on GRP per capita (Fritsch and Storey, 2014; Audretsch and Keilbach, 2004).

Research in Kazakhstan conditions requires taking into consideration the characteristics of the economic structure of a raw material (oil and gas) region. On the one hand, extractive industry's dominance in the structure of the regional economy can cause a "Dutch disease:" a decrease in the economic activity of enterprises and monospecialization, ultimately leading to a decrease in the level of entrepreneurial and innovative activity (Egert and Leonard, 2008). On the other hand, regions with a raw-material economy enjoy higher incomes of the population; accordingly, the purchasing power is growing as well, ultimately contributing to the growth of mass entrepreneurship in the service sector.

In their empirical study, Reynolds et al. (1994) conclude that investments take a positive effect on innovative activity of regional enterprises. Global technology giants (Samsung, HP, Apple, Huawei, Google, etc.) invest heavily in R&D, support startups, maintain research units, and implement joint innovative projects.

Educational level of the population serves as an indicator of concentration and quality of human capital. This rate also indicates informal rules and norms in society. Through the education system, the government can influence the development of creative entrepreneurship and innovation (Abad-Segura and González-Zamar, 2019). Training and introduction of advanced training courses for the population contribute to the acquisition by individuals of necessary competencies to engage in innovative entrepreneurship. Therefore, the study should consider this indicator.

The scientific literature (Zemtsov et al., 2021; Fritsch and Wyrwich, 2018; Lee et al., 2004; Audretsch and Fritsch, 1994) demonstrates that regions with major markets, agglomerations and adjacent territories with high incomes (and therefore, high purchasing power) show increased demand for new products and services. This opens up market niches for creating and implementing innovations in them.

The smaller the average size of one regional entity, the higher the barriers to entry to the local market and the lower the density of innovative enterprises in it (Plummer, 2010; Lee et al., 2004).

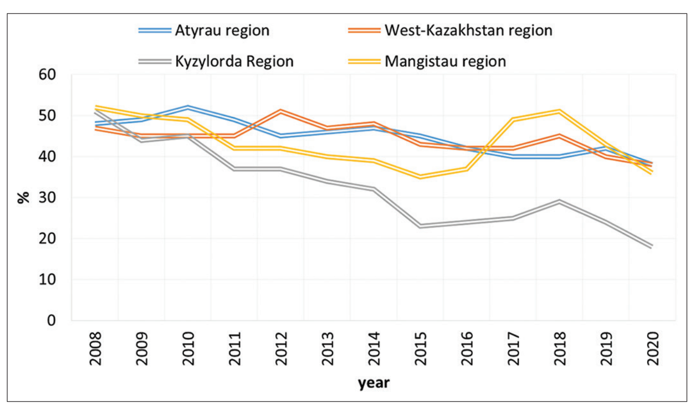
Chepurenko et al. (2017), Audretsch and Belitski (2017) note that the regional development of innovation activities requires high-quality information, communication, and innovation infrastructure including access to digital resources and online markets. Modern digital platforms provide access to global consumers, technologies, and the labor market.

3. DATA SOURCES AND METHODS

Singling out "raw regions" is not customary in the practice of classification of Kazakhstan regions. As a key criterion in the study, a comprehensive analysis of socio-economic development, development of mechanisms for managing the innovative development of Kazakhstan's raw material (oil and gas) regions use the share of gross value added from oil and gas production in the structure of gross regional product for the period between 2008 and 2020 (Figure 1).

To assess the level of organization of innovation activity in selected regions, we shall use the following research methods: panel data (Appendix A), and a factor analysis.

Figure 1: Share of gross value added from oil and gas production in the regions's Gross Regional Product for the period between 2008 and 2020



Source: Bureau of National statistics, Agency for Strategic planning and reforms of the Republic of Kazakhstan

Table 1 shows the main variables for factor analysis.

After collecting statistical data, we initiated the next stage of the study, which was to evaluate the data with the statistical analysis software, SPSS 23. Then we applied the method of reducing the amount of data. This method of factor analysis is used primarily to compress information and reduce the number of variables based on their classification. Concurrently, variables that strongly correlate with each other are grouped. For factor analysis, we used eighteen variables influencing innovation activity in the raw material region. According to the analysis conditions, all signs of variables were expressed quantitatively.

The factor analysis was performed on the basis of its main stages, which were the following:
1. Assessment of model quality and verification of data suitability for analysis using indicators of the Kaiser-Meyer-Olkin sample adequacy measure and the Bartlett criterion,
2. Calculation of initial factor loadings using the principal component method,
3. Varimax factor selection and rotation. Coefficients are rotated to find factors facilitating interpretation, and
4. Data interpretation. As a hypothesis of the study, we have identified the following confirmatory (confirming) provisions, which factors are currently important in the innovation activity of the raw material region and how complete they are in determining them.

Table 1: Variables selected for factor analysis

Legend	Variables	Source
GRP	Gross Regional Product, million tenge	BNS
GRP_capita	Gross Regional Product per Capita, thousand tenge	BNS
Oil&gas_produc	Share of Crude Oil and Natural Gas Production in GRP, %	BNS
Organiz_size	Average Organization Size, people (employment to organization ratio)	Calculations
Popul	Population at the End of the Period (Year), thousand people	BNS
R&D_Employed	Population Engaged in Professional, Scientific and Technical Activities, thousand people	BNS
Invest	Fixed Asset Investments, million tenge	BNS
Edu_invest	Education Investments, million tenge	BNS
Educ	Average Expected Education during the Coming Life, years	HDI
Stud	Students per 1.000 Population, people.	Calculations
Innov_costs	Product and Process Innovation Costs, million tenge	BNS
Vol_IP	Innovative Production Volume, million tenge	BNS
Innov_activ	Innovation Activity Level, %	BNS
R&D_empl	R&D Employment, people.	BNS
Poverty_rate	Proportion of the Population with Incomes below the Subsistence Minimum (Poverty Level), %	BNS
City_residents	Region's Central City Residents, %	Calculations
Internet1	Internet User Organizations (Incl. Public Administration Bodies), units	BNS
Internet2	Share of Internet Users Aged 16-74, %	BNS

1) Compiled by the authors. 2) BNS is Bureau of National statistics, Agency for Strategic planning and reforms of the Republic of Kazakhstan. 3) HDI is the United Nations' Human Development Index

4. RESULTS AND DISCUSSION

4.1. Indicators of Development of Kazakhstan's Oil and Gas Regions

The indicator of the share of gross value added from oil and gas production in the GRP identifies four raw material regions of Kazakhstan: Atyrau, West Kazakhstan, Mangystau, and Kyzylorda regions. Oil and gas production dominates over the extraction and export of other types of natural resources in the socio-economic development of these regions (Figure 1).

Let us take a closer look at the economic indicators of the development of Kazakhstan's oil and gas regions (Appendix A).

Over the period from 2008 to 2020, the GRP of raw material regions of Kazakhstan would increase by 330% in Atyrau region, by 231% in West Kazakhstan region, by 140% in Kyzylorda region, and by 180% in Mangystau region. The GRP per capita increased over the same period by 227% in Atyrau region, by 209% in West Kazakhstan region, by 89% in Kyzylorda region, and by 65% in Mangystau region. At the same time, population of the studied raw material regions has grown over the analyzed period. However, a significant increase in the population is observed in Mangystau region (71%), in Atyrau region (31%), and in Kyzylorda region (27%); and only West Kazakhstan's population has grown only by 6%.

Changes for 2008-2020 in terms of regions' central city population are as follows:
- The center of Atyrau region (the city of Atyrau): population increased by eleven pp;
- The center of West Kazakhstan (the city of Uralsk): population increased by nine pp;
- The center of Kyzylorda region (the city of Kyzylorda): population increased by six pp;
- The center of Mangystau region (the city of Aktau): population decreased by nine pp.

The level of poverty of the population in the regions in question has been significantly reducing over a thirteen-year period. Accordingly, Atyrau region saw the reduction in the poverty level by 9.9%, West Kazakhstan region by 6.3%, Kyzylorda region by 18.5%, and Mangystau region by 26.7%. However, we feel important to note that the average poverty level in Kazakhstan for 2020 was 5.3%. Kyzylorda and Mangystau regions exceed this level with indicators of 5.8 and 5.7, respectively.

Accordingly, we can conclude that among Kazakhstan's oil and gas regions, Atyrau and West Kazakhstan are developing most rapidly. It should be noted that from oil and gas companies pay the profits from oil and gas sector exports to state budget in two ways. First, tax payments including special subsoil user payments (redirected to the National Fund of the Republic of Kazakhstan). Second is export customs duties on crude oil and oil products (to the republican budget). Specifics of Kazakhstan's financial system consist in the following: regional budgets are formed from certain types of taxes and fees (IIT, social tax, environmental charges, etc.). Insufficient funds to finance the expenses of regional budgets with their own revenues push them to use transfers from the state budget as a source of missing funds. Consequently, if budget revenue redistribution is inefficient, there may be a situation where regions with a great potential receive less subsidies than regions with less capacity for economic development, which in the long term may slow down the economic growth of the state as a whole.

Let us consider the indicators characterizing the ability of raw material regions of Kazakhstan to create and implement innovations.

Innovation Activity Level performance trends for Kazakhstan's oil and gas regions for the years in question are heterogeneous. This indicator has a negative correlation (−0.67) with the Share of Gross Value Added from Oil and Gas Production in the GRP. Over the period of 2008—2020, Innovation Activity Level has increased by 7.4 pp in Atyrau region, by 1 pp in West Kazakhstan region, by 9.4 pp in Kyzylorda region, and by 6 pp in Mangystau region.

Innovative Production Volume during the period in question has increased as follows: by 25076% in Atyrau region, by 5448% in West Kazakhstan region, by 65661% in Kyzylorda region, and by only 6% in Mangystau region.

In 2020 compared to 2008, Fixed Asset Investments increased by 285% in Atyrau region, by 113% in West Kazakhstan region, by 70% in Kyzylorda region, and by only 52% in Mangystau region. Over the same period, Education Investments in Atyrau, West Kazakhstan and Kyzylorda regions increased by 152%, 245%, and 28%, respectively, and decreased by 36% in Mangystau region. In 2008—2020, Product and Process Innovation Costs increased in Atyrau, West Kazakhstan and Kyzylorda regions, and decreased in Mangystau region.

The Average Organization Size by region for 2020 was as follows: 32 in Atyrau region, 38 in West Kazakhstan region, 40 in Kyzylorda region, and 27 in Mangystau region. In Kazakhstan, the Average Organization Size is more associated with the number and role of budgetary institutions, while correlation with the number of innovative enterprises in the raw material region requires verification.

Over the period between 2008 and 2020, Population Engaged in Professional, Scientific and Technical Activities in Atyrau region has decreased by 10%, and has grown in other regions: by 30% in West Kazakhstan region, by 100% in Kyzylorda region, and by 31% in Mangystau region. Concurrently, the R&D Employment has been decreasing in three regions, except for Kyzylorda region where the indicator has increased by 250%.

The Average Expected Education during the Coming Life in all regions has increased by 6%. Number of Students per 1.000 Population in all studied regions decreased over the analyzed period by 47% in Atyrau region, by 2% in West Kazakhstan region, by 44% in Kyzylorda region, and by 50% in Mangystau region.

Indicators characterizing accessibility of Internet in all oil and gas regions of Kazakhstan have increased significantly: on average, by 220% for Internet User Organizations, and by 330% for the Share of Internet Users Aged 16-74.

Accordingly, selected regions show the following common features:

- High endowment of natural resources in demand on the world market,
- Primary natural resource allocation in areas with adverse weather conditions,
- Poor regional infrastructure (social, industrial, transportation, innovation),
- Region's landlocked location increasing transportation and logistical costs,
- Low population density and underdevelopment of the settlement system, and
- Regional technological backwardness.

4.2. Factor Analysis Results

Following statistical data collection, first thing to do is to check their suitability for factor analysis. The results have shown the following. The first indicator is a Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy, a value that characterizes the degree of applicability of factor analysis to this sample. High values (0.5 to 1.0) usually indicate that factor analysis is applicable to these data (IBM Knowledge Center). The value below 0.50 shows the impropriety of the factor analysis. In our case, KMO is 0.577 > 0.5, which is a good result. The second indicator, the Bartlett's test, is used to verify sufficiency of correlation of initial variables. This test should be significant ($P < 0.05$), otherwise factor analysis will be inappropriate. In the model we built, this indicator is 0.000, which also indicates reliability of the model. Table 2 shows the results of both KMO measure of sampling adequacy and Bartlett's criterion.

For the next stage, we calculated initial factor loadings using the method of principal components to obtain certain data:

- Initial communalities are estimates of each variable's variance considered by all components or factors. In correlation analysis for extraction of the main components, their values of 1.0 are always the same,
- Extraction communalities are estimates of each variable's variance considered by the components (IBM Knowledge Center). Low values indicate variables not suitable for a factor solution and may need to be excluded from the analysis.

The communality value of 0 tells that the factor does not affect the variable. Value of 1 implies the variance of the variable is determined by the selected factor in its entirety.

The analysis showed that generalities in this table are high. This indicates that the extracted components represent the variables

Table 2: KMO and Bartlett's test

Kaiser-Meyer-Olkin measure of sampling adequacy		0.577
Bartlett's test of sphericity	Approx. Chi-square	1101.091
	df	153
	Sig.	.000

Compiled by the authors based on IBM SPSS 23 data well. Table 3 shows variable names and their communalities (Table 3).

The next step of the study was the Varimax factor selection and rotation. The purpose of factor extraction is to reduce a larger set of variables to a smaller set of "artificial" variables called principal components, which account for most of the variance of the original variables. To decide which factors to keep for further analysis, we use formal criteria. These are all factors whose individual values are greater than one.

The leftmost section of the Table 4 shows the variance explained by the initial solution of factor extraction. Only five factors at the initial stage of the solution have eigenvalues exceeding 1. These factors will serve as the basis further. Together, they account for almost 83% of the variability of the baseline variables. This suggests that innovation activity in the raw material regions of Kazakhstan is influenced by five hidden factors; however, there is also room for many unexplained variations. The second section of this table shows the variance explained by the extracted factors before rotation.

The rightmost section of this table shows the deviations explained by the extracted factors after rotation. The rotated factor model introduces changes to all factors.

To confirm the factors found, we used the method of factor extraction – the Rocky Scree criterion by R. Kettell. It consists in finding the point where the decrease in eigenvalues slows down the most. Figure 2 shows five main factors that have eigenvalues greater than one. We can also see the importance of each factor by comparing them with each other.

After extracting the factors, for a more apparent interpretation of the solution, we used the Varimax rotation method of the initials, which allowed us to trace a clear factor structure and to identify variables marked by high values of correlation coefficients with a given factor. Correlation is considered strong if the correlation coefficient value exceeds 0.7.

The rotated component matrix helps to determine what the components are. Table 5 shows that the first, i.e., the general component correlates most strongly with Fixed Asset Investments, Gross Regional Product per Capita, Population Engaged in Professional, Scientific and Technical Activities, Gross Regional Product, Product and Process Innovation Costs, and Region's Central City Residents. The second component correlates most strongly with Share Internet Users Aged 16-74, Average Expected Education during the Coming Life, and Proportion of the Population with Incomes below the Subsistence Minimum (Poverty Level). It also has an average connection with Internet User Organizations (Incl. Public Administration Bodies).

The third component has a strong relationship with Population Engaged in Professional, Scientific and Technical Activities,

Table 3: Communalities

	Initial	Extraction
Innov_activ	1.000	0.789
GRP	1.000	0.922
GRP_capita	1.000	0.938
Oil&gas_produc	1.000	0.841
Organiz_size	1.000	0.853
Popul	1.000	0.905
R&D_Employed	1.000	0.796
Invest	1.000	0.851
Edu_invest	1.000	0.824
Educ	1.000	0.888
Stud	1.000	0.927
Innov_costs	1.000	0.566
Vol_IP	1.000	0.741
R&D_empl	1.000	0.784
Poverty_rate	1.000	0.764
City_residents	1.000	0.899
Internet1	1.000	0.774
Internet2	1.000	0.853

Compiled by the authors based on IBM SPSS 23 data. Extraction method: Principal component analysis.

Table 4: Total variance explained

Component	Initial eigenvalues			Extraction sums of squared loadings			Rotation sums of squared loadings		
	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	5,803	32,236	32,236	5,803	32,236	32,236	4,420	24,554	24,554
2	3,783	21,017	53,253	3,783	21,017	53,253	3,701	20,560	45,113
3	2,330	12,947	66,200	2,330	12,947	66,200	3,209	17,826	62,939
4	1,674	9,302	75,502	1,674	9,302	75,502	1,803	10,018	72,957
5	1,324	7,354	82,857	1,324	7,354	82,857	1,782	9,899	82,857
6	,679	3,770	86,626						
7	,556	3,089	89,715						
8	,468	2,601	92,316						
9	,407	2,263	94,578						
10	,287	1,596	96,174						
11	,228	1,268	97,442						
12	,183	1,019	98,461						
13	,139	,773	99,234						
14	,074	,409	99,642						
15	,032	,177	99,819						
16	,023	,129	99,948						
17	,009	,051	99,999						
18	,000	,001	100,00						

Extraction method: Principal component analysis.

Figure 2: The scree plot eigenvalues

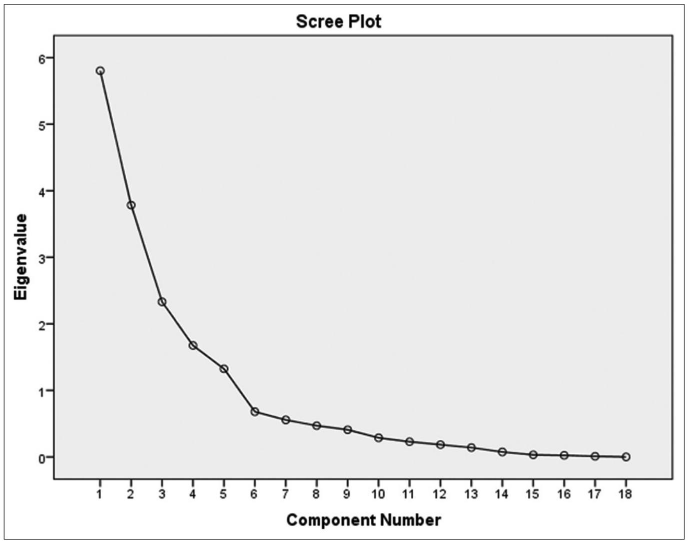


Table 5: Rotated component matrix[a]

	Component				
	1	2	3	4	5
Invest	0.858				
GRP_capita	0.854				
R&D_Employed	0.853				
GRP	0.820				
Innov_costs	0.742				
City_residents	0.717				
Internet2		0.899			
Educ		0.894			
Poverty_rate		−0.766			
Internet1		0.693			
R&D_empl			0.840		
Innov_activ			−0.782		
Popul			−0.770		
Oil&gas_produc			0.709		
Organiz_size			−0.613	0.540	
Stud				0.946	
Edu_invest					0.885
Vol_IP					0.791

Extraction method: Principal component analysis. Rotation method: Varimax with kaiser normalization. [a]Rotation converged in 9 iterations

Innovation Activity Level, and Population at the End of the Year. It also has an average relationship with Share of Crude Oil and Natural Gas Production in GRP, and Average Organization Size. The fourth component has a relationship with Average Organization Size, and Students per 1.000 Population. The last fifth component is closely related to Education Investment, and Innovative Production Volume (Table 5).

As a result of the analysis, we have identified five main factors affecting innovation activity in the raw material regions of Kazakhstan. In general, these factors explain 83% of the total variance.

Next, let us give an interpretation of these factors according to the results of which officials and interested persons can make appropriate tactical and strategic decisions (Table 6).

The above matrix shows that the "strength" of factors presented, or the weight of all identified factors is 83%, which confirms the possibility and necessity of considering them as priorities for the innovation activities of oil and gas regions of Kazakhstan. We could not identify the remaining 17% of factors; this is the scope for future research.

The most important value is an assessment of interrelationships of the initial indicators with the obtained factors. The conducted assessment allows us to establish an economic rationale to the factors identified as a result of the analysis.

Accordingly, such indicators as Fixed Asset Investments, Gross Regional Product per Capita, Gross Regional Product, Product and Process Innovation Costs, and Region's Central City Residents that formed Factor 1 are advised to interpret as regional economic development and agglomeration effects.

Indicators forming Factor 2 reflect the state of innovation infrastructure in the region. In particular, Share of Internet Users Aged 16-74, Average Expected Education during the Coming Life, Proportion of the Population with Incomes below the Subsistence Minimum (Poverty Level), and Internet User Organizations (Incl.

Table 6: Factor interpretation

Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Regional economic development and agglomeration effects	Market potential and infrastructure	Structural factor of innovative development	Human factor of innovative development	Investment factor of innovative development
Important factor: Shows the importance of investment for the innovative development of the raw material region	Important factor: Access to information and communication technologies and an increase in the education duration	Important factor: R&D employees	Important factor: Students per 1000 population	Important factor: Education investments
The main focus is on the economic indicators of regional development: • On investments to a greater extent, • On GRP growth, and • On innovation costs	Directions for effective innovation activity: • ICT development, • Expansion of lifelong education programs, and • Poverty reduction	Measures to encourage innovation: • Increasing the share of R&D employees, and • Small business development	The main direction is increasing the number of technical and STEM students	Increasing education investments
Factor weight: Only 83%				
24.554	20.560	17.826	10.018	9.899

Further research: Which factors are undetected, totaling at approx. 17%. Compiled by the authors

Public Administration Bodies) depend on market potential and infrastructure development.

Indicators forming Factor 3 are mainly presented in the form of structure and shares and include such indicators as R&D Employment, Innovation Activity Level, Population at the End of the Year, Share of Crude Oil and Natural Gas Production in GRP, and Average Organization Size. Based on the content of these indicators, we define Factor 3 as a structural component of innovative development.

The set of indicators that determined the economic content of Factor 4 characterize the human factor of innovative development of the oil and gas region. Such indicators as Average Organization Size and Students per 1.000 Population characterize the quality of human capital. Therefore, this group is interpreted as a human factor of innovative development of the oil and gas region.

Indicators forming Factor 5 reflect investment support for innovation. In particular, Education Investments and Innovative Production Volume significantly depend on large-scale investment support. This explains the investment factor of innovative development.

5. CONCLUSIONS AND RECOMMENDATIONS

The raw material structure of the economy of Kazakhstan's oil and gas producing regions hinders innovative development due to low demand for new technologies and other aspects of the "resource curse." The existing literature has yet to analyze this dependence further.

Indicatively, raw material (oil and gas) regions establish relatively weak demand for new technologies and, accordingly, for innovations. Their number, as Fritsch and Wyrwich (2018)'s example of Germany shows, is historically lower in the lands adjacent to the coal mining regions due to the "resource curse" squeezing local capital and personnel out to a more profitable raw materials sector. Dependence on natural rents leads to destruction of local institutions and corruption depriving technological entrepreneurs of incentives to initiate new projects. Unlike large commodity companies, which, as a rule, are not happy with the emergence of competitors, large diversified agglomerations see higher innovation activity due to player concentration and competition, market scale and diversity, etc. (Zemtsov et al., 2021; Beaudry and Schiffauerova, 2009; Audretsch and Fritsch, 1994). Regional high-tech clusters (Belitski and Desai, 2015) provide entrepreneurs with access to the appropriate infrastructure and knowledge and generate the effect of knowledge flow from large companies and universities to innovative startups.

This study was conducted with a goal to determine the main factors affecting the ability of raw material (oil and gas) regions of Kazakhstan to encourage innovation processes. In the course of the work, we used a statistical research method and factor analysis. Factor analysis allowed us to identify five main factors taking effect on innovation activity in the raw material regions of Kazakhstan: Regional Economic Development and Agglomeration Effects, Market Potential and Infrastructure, Structural Factor of Innovative Development, Human Factor of Innovative Development, and Investment Factor of Innovative Development. Accordingly, for the innovative development of raw material (oil and gas) regions of Kazakhstan, state bodies need to focus mainly on the following measures:

- Increasing fixed asset investment,
- Growth of gross regional product and product and process innovation costs,
- Regional development of information and communication technologies;
- Expansion of lifelong educational programs;
- Poverty reduction,
- Increasing the share of R&D employees,
- Small business development, and
- Increasing education investment and the number of technical and STEM students.

This research provides a basis for further research that could focus on the following:

- First, on expanding the scope of this study to obtain more accurate results,
- Second, on increasing the variables for analysis, since the factors we have obtained explain only 83% of the total variance. The remaining 17% of the variance are factors yet to be found, and
- Third, confirmation of the reliability of the results obtained requires different statistical analysis methods.

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Appendix A: Data for analysis

Region	Year	GRP	GRP_ capita	Oil&gas_ produc	Organiz_ size	Popul	R&D_ Employed	Invest	Edu_ invest	Educ	Stud	Innov_ costs	Vol_IP	Innov_ activ	R&D_ empl	Poverty_ rate	City_ residents	Internet1	Internet2
Atyrau region	2008	1798475	3626,0	48,0	40	490369	12	826373	8038	14,5	36,0	73,0	1598,4	2,7	633,0	12,9	44,0	749	18,7
	2009	1969924	3824,7	49,0	38	509123	11	1094394	3359	14,5	31,0	-	55,3	2,9	554,0	10,0	44,0	1982	25,0
	2010	2843649	5401,0	52,0	40	520988	13	1105401	7172	14,4	30,0	323,8	126,1	3,7	582,0	5,9	48,0	2497	28,0
	2011	3791564	7054,0	49,0	41	532033	16	1076933	4455	14,7	29,0	14265,6	1828,1	6,6	609,0	5,2	48,0	1789	66,0
	2012	3613411	6580,7	45,0	44	542959	20	1033961	7525	15,0	24,0	9371,8	4772,2	4,4	605,0	3,3	49,0	1647	85,0
	2013	3977355	7083,0	46,0	44	555199	15	1038438	5429	14,9	20,0	20488,1	38078,2	5,1	400,0	3,3	49,0	2042	82,8
	2014	4340623	7553,3	47,0	41	567831	17	1129627	5128	15,0	19,0	18522,1	18655,3	8,1	398,0	2,8	49,0	1741	82,9
	2015	4216774	7171,2	45,0	40	581389	24	1470262	2528	15,0	17,0	332144,0	7506,1	8,0	462,0	2,8	50,0	2455	71,6
	2016	5200673	8653,1	42,0	43	594511	21	2036852	5796	15,0	19,0	11600,8	7419,4	8,5	400,0	3,1	51,0	2303	74,2
	2017	5947654	9685,1	40,0	40	607528	16	2468570	6187	15,1	20,0	139204,4	5768,0	8,0	474,0	2,8	52,0	2346	75,0
	2018	7818812	12465,5	40,0	35	620684	12	3691401	4131	15,3	21,0	85383,7	8819,8	8,3	466,0	2,5	53,0	2656	80,4
	2019	9327263	14584,4	42,0	33	633791	13	4328236	8489	15,4	21,0	44270,6	7536,3	9,0	471,0	2,5	54,0	3127	83,3
	2020	7738259	11883,2	38,0	32	645280	11	3178960	20265	15,4	19,0	141304,4	402420,3	10,1	476,0	3,0	55,0	2727	78,6
West-Kazakhstan region	2008	826546	1339,4	47,0	58	615310	6	225963	4244	14,5	42,0	1296,2	390,6	4,9	542,0	10,2	39,0	751	16,6
	2009	822978	1369,1	45,0	56	598342	6	244842	3765	14,5	43,0	366,1	728,7	4,5	170,0	8,2	41,0	1738	13,8
	2010	1048780	1730,4	45,0	58	603858	7	233599	4555	14,4	47,0	-	-	4,6	459,0	6,7	42,0	1669	35,2
	2011	1358389	2225,4	45,0	60	608334	7	170439	7892	14,7	51,0	46888,2	24804,9	12,7	500,0	4,8	43,0	1453	59,4
	2012	1762702	2865,9	51,0	54	612581	6	164652	5819	15,0	45,0	1364,3	4399,3	7,5	516,0	4,1	43,0	1440	72,2
	2013	1780552	2868,1	47,0	53	617735	7	193869	2185	14,9	41,0	8203,7	9009,5	5,3	600,0	3,7	44,0	1957	70,8
	2014	1987706	3170,4	48,0	51	624085	6	270092	4484	15,0	45,0	1698,8	5996,5	6,6	425,0	2,9	45,0	1743	71,0
	2015	1709953	2699,6	43,0	48	630056	7	365963	5085	15,0	43,0	2326,4	3316,7	4,1	540,0	3,1	45,0	1769	93,9
	2016	2032670	3179,8	42,0	47	636980	6	401646	3172	15,0	47,0	4685,9	3407,1	3,6	756,0	2,8	45,0	2418	69,4
	2017	2337506	3628,4	42,0	42	641513	7	407589	11233	15,1	49,0	6491,0	18122,1	5,3	323,0	2,7	46,0	2352	75,6
	2018	2790662	4295,8	45,0	40	646927	7	450382	11650	15,3	47,0	12001,7	23398,7	5,3	442,0	3,2	47,0	2120	78,8
	2019	2946389	4501,2	40,0	38	652325	8	586265	5823	15,4	49,0	8982,0	24713,4	5,3	534,0	3,7	47,0	2410	81,3
	2020	2735953	4151,2	38,0	38	656844	8	481485	14646	15,4	41,0	11185,9	21671,3	5,9	517,0	3,9	48,0	2326	84,2
Kyzylorda Region	2008	685211	1075,9	51,0	62	632234	4	172339	9531	14,5	25,0	185,0	30,3	3,0	74,0	24,3	33,0	703	12,8
	2009	641576	938,8	44,0	58	677734	5	171034	13049	14,5	22,0	28,3	66,7	1,5	79,0	10,4	31,0	1009	11,6
	2010	859148	1236,5	45,0	61	689011	7	246867	9899	14,4	25,0	17760,0	-	6,1	98,0	6,7	34,0	1009	21,6
	2011	1139143	1611,9	37,0	64	700511	8	222004	6765	14,7	22,0	2673,5	2281,3	8,0	147,0	6,2	34,0	1172	32,7
	2012	1269984	1764,4	37,0	63	712899	8	255979	8946	15,0	22,0	3738,5	3645,0	5,3	192,0	3,8	35,0	1227	72,1
	2013	1454015	1983,0	34,0	59	726692	9	371935	11296	14,9	19,0	4325,5	6641,7	12,0	205,0	3,6	35,0	1235	76,6
	2014	1380132	1848,9	32,0	50	739726	7	262583	11219	15,0	15,0	555,7	4761,2	10,1	253,0	3,2	35,0	1385	76,7
	2015	1164800	1534,3	23,0	46	753001	8	236995	6594	15,0	13,0	1883,3	6930,2	11,7	236,0	3,5	36,0	1719	77,7
	2016	1308295	1701,1	24,0	47	765058	8	215920	4277	15,0	13,0	1766,1	6295,2	11,2	228,0	3,1	36,0	1695	80,7
	2017	1430980	1839,0	25,0	45	773143	9	243100	9420	15,1	13,0	5744,2	5505,8	11,4	229,0	3,0	37,0	1635	79,4
	2018	1647016	2088,1	29,0	43	783157	8	332655	6536	15,3	14,0	19029,7	6401,7	12,2	222,0	4,9	38,0	1894	81,8
	2019	1828865	2289,1	24,0	41	794335	8	400209	4511	15,4	14,0	11445,9	16425,2	12,3	183,0	4,9	38,0	1909	81,9
	2020	1645067	2033,3	18,0	40	803531	8	292344	12192	15,4	14,0	4685,9	19925,7	12,4	260,0	5,8	39,0	1999	82,7

(Contd...)

Appendix A: ***(Continued)***

Region	Year	GRP	GRP_ capita	Oil&gas_ produc	Organiz_ size	Popul	R&D_ Employed	Invest	Edu_ invest	Educ	Stud	Innov_ costs	Vol_IP	Innov_ activ	R&D_ empl	Poverty_ rate	City_ residents	Internet1	Internet2
Mangistau region	2008	1095816	2631,0	52,0	26	407403	7	383199	9909	14,5	22,0	6749,9	5002,9	1,9	841,0	32,4	37,0	830	27,7
	2009	1108521	2248,8	50,0	24	482631	7	314724	9261	14,5	16,0	1630,6	133,0	1,4	404,0	22,6	32,0	2183	20,9
	2010	1484848	2890,4	49,0	26	503241	5	372039	8163	14,4	17,0	-	233,1	1,1	474,0	11,6	34,0	2002	37,4
	2011	1867945	3491,7	42,0	31	524185	6	369598	9007	14,7	17,0	414,9	618,6	1,1	548,0	10,4	34,0	2035	51,6
	2012	1764791	3169,8	42,0	35	545789	8	396385	7414	15,0	13,0	0,0	3609,0	1,1	569,0	3,3	33,0	2182	61,9
	2013	2075084	3592,7	40,0	38	567770	7	440025	6995	14,9	10,0	5962,0	1395,4	2,4	590,0	2,6	32,0	3124	77,7
	2014	2418215	4049,6	39,0	37	587431	4	532239	7448	15,0	6,0	2898,0	1546,8	3,4	583,0	3,0	31,0	1979	77,9
	2015	2123786	3443,0	35,0	38	606843	7	458956	8813	15,0	7,0	3596,7	1234,6	4,0	648,0	2,6	30,0	2079	71,4
	2016	2463408	3880,6	37,0	35	626774	8	405604	2157	15,0	8,0	0,0	506,4	4,1	700,0	2,8	30,0	1744	74,8
	2017	3296137	5058,8	49,0	31	642824	8	434446	1059	15,1	8,0	4045,5	294,9	3,5	696,0	3,3	29,0	2667	75,0
	2018	3803063	5682,5	51,0	31	660317	9	504649	6604	15,3	9,0	1409,4	651,0	4,0	694,0	4,9	28,0	2956	82,5
	2019	3685384	5352,8	43,0	29	678199	10	556558	3473	15,4	15,0	3129,7	7971,3	3,4	689,0	4,3	28,0	2780	86,0
	2020	3074393	4335,1	36,0	27	698796	10	582279	6353	15,4	11,0	1766,1	5317,2	7,9	685,0	5,7	28,0	2840	86,5