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A.A. Nurpeisova[1,*], Sh.U. Niyazbekova[2], Z.K. Yessymkhanova[3]

[1]Financial Academy, Kazakhstan
[2]Moscow Witte University, Russian Federation
[3]Turan-Astana University, Kazakhstan

[1]nurpeisova.ardak81@gmail.com, [2]shakizada.niyazbekova@gmail.com, [3]z.yesymkhanova@gmail.com

[1]https://orcid.org/0000-0002-1245-8313, [2]https://orcid.org/0000-0002-3433-9841,
[3]https://orcid.org/0000-0001-5552-5849

[2]Scopus Author ID: 56530857900, [1]Researcher ID: AAV-3919-2020,
[2]Researcher ID: E-7112-2015, [3]Researcher ID: P-7337-2014

Factors of innovative development of the economy of the Republic of Kazakhstan: analysis and assessment

Abstract

Object: To study the correlation analysis of GDP indicators and factors of innovative developmentof the economy of Kazakhstan.

Methods: We have applied the method of quantitative data processing, which is correlation analysis. Correlation analysis is one of the most effective tools for statistical research of the economy. It allows for identification of cause-and-effect relationships between various phenomena in economy, management, and social sphere. We have processed the obtained data mathematically using a multitude of software titles and the Microsoft Excel and StatSoft Statistica 10 suites.

Results: The article describes retrospective statistical data of a research object, assesses the relationship between GDP and factors of innovative development using a set of variables.

The article conducts correlation analysis of indicators that characterize the amount of R&D and GDP costs. It presents main indicators of enterprise innovation for 2014—2018, displays the share of innovative products (goods, services) in GDP for 2006—2018, reveals sources of financing of domestic R&D (million KZT) for 2014—2018, discloses correlation matrix of indicators characterizing the introduction of innovations into the Republic of Kazakhstan economy. The matrix includes the following variables: number of employees engaged in R&D, number of innovative enterprises, domestic R&D expenditures, share of innovative products, expenditures on technological innovations, trademark registration and patent issuance, and R&D. We have built an exponential equation of the correlation-regression model, and found the coefficient of determination.

Conclusions: Innovative development of the state's economy depends heavily on the use and implementation of high-performance technologies and latest developments. There is a close relationship with innovation and science and technology development. Economy's way to innovative development requires effective expenditures on areas related to innovation and scientific research.

Keywords: innovation; economic development; innovation activity; global innovation index; competitiveness.

Introduction

Innovation is one of the most important components of a modern economy, a "stepping stone" to improving the quality of life and a stable, environmentally safe future. Innovation is an essential part of social and economic life and human activity in all its manifestations. So far, there are over a hundred different definitions and interpretations of the term "innovation." In recent decades, innovation has become one of the most intensively researched topics in both economics and management. World practice shows that innovation development is not only the main tool for improving an individual entity's competitiveness, but also acts as a serious incentive for the economic development of the country as a whole (Chesbrough, H.W. et al., 2006).

Innovation has been recognized as a very important engine of renewal in today's rapidly changing and competitive business environment. Innovation is a process aimed at creating or developing a new product, regardless of type or degree, that increases the company's profit and strengthens its market posi-

* Corresponding author.
E-mail address: nurpeisova.ardak81@gmail.com

tion. Competition is the main reason for enterprise innovation, so different businesses innovate in different ways. Understanding "innovation" depends widely on why and where it is located. Innovations are developed in various businesses or systems. In order to succeed and create value, innovative businesses and other bodies must evaluate the tools and resources to achieve the expected results. Economic and technological innovations have changed our lives for the better (Cohen, W. M., 2010).

The experience of successful developing countries shows that science and technology research policies can be well integrated into national development strategies and, combined with institutional and organizational changes, can contribute to improving productivity, improving business competitiveness, supporting faster growth and creating jobs. To achieve this goal, policies need to consider specific features of innovation in developing countries.

Innovation is one of the most important components of the modern economy (Damanpour, F., Aravind, D., 2012).

Research hypothesis

To test the hypothesis, we need to resolve the following issues:

1. To identify main features of innovative development factors based on theoretical study of economic literature.

2. To build a correlation-regression model between GDP and domestic R&D expenditures.

3. To construct a correlation matrix between R&D expenditures and the share of innovative products in GDP using correlation analysis.

Literature Review

Authors consider innovation as the most important factor of social and economic development (Chesbrough, Vanhaverbeke, West, 2006, Schumpeter, 1934, William,1942).Share a similar view (Cohen, 2010,Damanpour, 2012, Golubkin, Kleva, 2008). A multitude of analytical papers consider correlation analysis in detail (Polyakov, 1971, Anderson, 1963, Sokolov, 2016, Sokolov, 2012).

A number of scientists argue that innovative development refers to the transformation of all the economy and social system spheres based on scientific and technical achievements (Chesbrough, Vanhaverbeke, West, 2006, Cohen, 2010, Damanpour, 2012, Golubkin, Kleva, 2008, Satpayeva, 2017, Spanova, 2015).

Methods

We applied the method of quantitative data processing-correlation analysis. Correlation analysis allows to identify cause-and-effect relationships between various phenomena in the economy, management, and social sphere.

Results

Analysis of the research object's current state. Innovation is an essential part of social and economic life and human activity in all its manifestations. So far, there are over a hundred different definitions and interpretations of the term "innovation."

World practice shows that innovation development is not only the main tool for improving an individual entity's competitiveness, but also acts as a serious incentive for the economic development of the country as a whole.

In 2019, rising by four positions, Kazakhstan took the 34th place out of 61 leading world economies in the annual competitiveness rating compiled by the Swiss business school IMD. Russia received 70.4 points out of 100 possible and went up from 40th to 38th place. The United States, Singapore, Sweden and Denmark lead this rating.

According to the report "Global Innovation Index 2019," leading innovative countries are Switzerland, Sweden, the United States, and the Netherlands. According to the results of the Global Competitiveness Index in 2019, Kazakhstan took 79th place (74th place in 2018) out of 129 countries landing between Bahrain and Oman, while Russia took 46th place.

Innovation activity of Kazakhstan's businesses is at a low level of 10,6%, share of innovative products is 1,91% of GDP (Table 1, Figure 1). Kazakhstan's R&D expenditures as a % of GDP were: 0,17 in 2015, 0,14 in 2016, 0,13 in 2017, and 0,12 in 2018 (World Bank OECD Reviews of School Resources: Kazakhstan, 2018).

Table 1.Key indicators of innovative activity of enterprises for 2014-2018

Companies	2014	2015	2016	2017	2018
Number of enterprises, units	24068	31784	31077	30854	30501
among them: having innovations for all types of innovations, units	1940	2585	2879	2974	3230
level of innovation activity for all types of innovations, as a percentage	8,1	8,1	9,3	9,6	10,6
having product and process innovations, units	1303	1781	1743	1770	2019
level of innovation activity by product and process innovation, as a percentage	5,4	5,6	5,6	5,7	6,6
share of innovative products (goods, services) to GDP, as a percentage	2,61	1,80	1,81	3,18	3,78
Note: Ministry of national economy of the Republic of Kazakhstan					

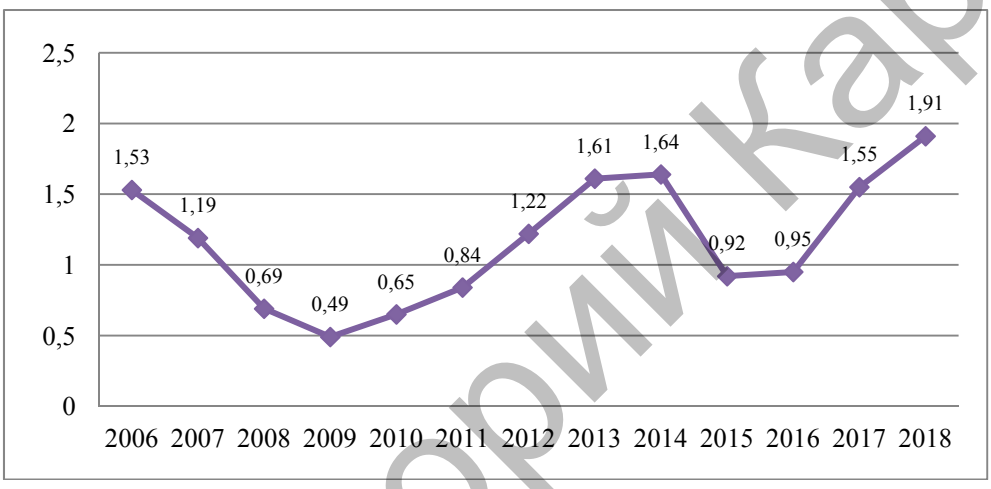

Figure 1. Share of innovative products (goods, services) to GDP for 2006 – 2018 [6]

Note: compiled by the author

In 2018, domestic R&D expenditures totaled KZT 72224.5 million, which was an increase of 10%, while in 2014, this figure was KZT 66347.6 million (Table 2).

Table 2.Sources of financing of internal R & d expenditures (KZT million)

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R&D costs	2014 г.	2015 г.	2016 г.	2017 г.	2018 г.
Domestic expenditure on R&D	66 347,6	69 302,9	66 600,1	68 884,3	72 224,5
Including own funds	19 858,3	25 356,6	26 388,8	28 187,6	34 251,0
Republican budget	43 052,6	40 424,7	35 186,3	35 338,3	31 635,5
Local budget	290,9	294,5	254,2	641,7	510,3
Foreign investment	489,6	1254,6	1018,7	272,3	x
Other funds	2 656,2	1 972,5	3 752,1	3 444,3	3 904,4
Note: Ministry of national economy of the Republic of Kazakhstan					

n recent decades, innovation has become one of the most intensively studied economics and management issues. A multitude of analytical papers consider in detail both current state of innovative development of Kazakhstan's economy and the history of its development. An important result of the study of the state of affairs is the conclusion that, even being an essential branch of the economy, the country's innovative development has not yet fully realized its potential (Schumpeter, J. A., 1934).

Discussions

Let us consider the dependencies of key factors of Kazakhstan economy's innovative development, which include the following:

- number of employees engaged in R&D by form of company ownership, thousand people;
- number of innovatively active enterprises, units;
- domestic R&D expenditures, million KZT;
- domestic R&D expenditures from the public sector, million KZT;
- share of innovative products (goods, services) in GDP;
- expenditures on technological innovations by form of company ownership, million KZT;
- registration of trademarks and service marks;
- number of entities engaged in R&D, units;
- scientific R&D.

Let us analyze the above data on innovation implementation in the country's economy (Table 3) (Sokolov G.A., 2016).

Table 3.Introduction of innovations in the economy of the Republic of Kazakhstan

Indicators	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Number of employees, have completed R&D, according to the form of ownership of organizations, thousand people	16,3	15,7	17	18	20,4	23,7	25,7	24,7	22,9	22	22,3
Number of innovative and active enterprises, units	447	399	467	614	1622	1774	1940	2585	2879	2974	3230
Internal R&D expenditures, KZT million	34761,6	38988,7	33466,8	43351,6	51253,1	61672,7	66347,6	69302,9	66600,1	68884,2	72224,5
Domestic R&D expenditures of the public sector, KZT million	11180,6	15015,9	12372,1	10833	11960,5	18304,3	21695,6	20325,8	18640,4	20961,4	22091
Share of innovative products (goods, services) in GDP	0,69	0,49	0,65	0,84	1,22	1,61	1,64	0,92	0,95	1,55	1,91
Expenditures on technological innovations of enterprises by form of ownership, KZT million	11531,1	82597,4	142166,8	235962,7	325639,3	431993,8	438488,9	662972,3	1533765,3	907231,2	861915
Registration of trademarks and service marks	3432	3658	4035	6185	9104	10427	11078	10164	10499	9096	11045
Number of organizations performing research and development work, units	438	421	414	424	412	345	341	392	383	386	384
Research and development	81810	90925	103571	121395	148530	153567	171626	184940	208752	228385	240717
Note: Compiled by the authors											

For the purpose of analyzing the relationship between GDP indicators, the table shows paired correlation coefficients.

Table 4. Correlation matrix of indicators that characterize the introduction of innovations in the economy of the Republic of Kazakhstan

Variables		v1	v2	v3	v4	v5	v6	v7	v8	v9
Number of employees, have completed R&D, according to the form of ownership of organizations, thousand people	v1	1,00	0,80	0,91	0,81	0,73	0,62	0,95	-0,87	0,76
Number of innovative and active enterprises, units	v2		1,00	0,96	0,84	0,72	0,87	0,87	-0,60	0,98
Internal R&D expenditures, KZT million	v3			1,00	0,90	0,77	0,78	0,94	-0,75	0,94
Domestic R&D expenditures of the public sector, KZT million	v4				1,00	0,70	0,65	0,78	-0,78	0,84
Share of innovative products (goods, services) in GDP	v5					1,00	0,41	0,81	-0,75	0,75
Expenditures on technological innovations of enterprises by form of ownership, KZT million	v6						1,00	0,70	-0,45	0,85
Registration of trademarks and service marks	v7							1,00	-0,81	0,86
Number of organizations performing research and development work, units	v8								1,00	-0,59
Research and development	v9									1,00

Note - developed by the authors

Table 4 shows calculations made and the matrix of correlation coefficients. Of interest here is the value of matching correlation coefficient between the number of innovatively active enterprises and domestic expenditures on R&D, which is 0,96. Thus, the number of innovative enterprises and domestic R&D expenditures are basically closely correlated interdependent variables. High correlation coefficients between the registration of patent applications and the issuance of patents in Kazakhstan and the number of employees engaged in R&D, domestic R&D expenditures, share of innovative products in GDP (r = 0,95, r = 0,78, r = 0,81) indicate favorable economic situation, so increased intensity of state regulation leads to increased scientific activity. There is a strong but negative relationship between the number of entities engaged in research and development and the rest (r = −0,87, r = −0,75, r = −0,81, r = −0,78). Some of these entities probably exist only nominally and their economic activity is minimal.

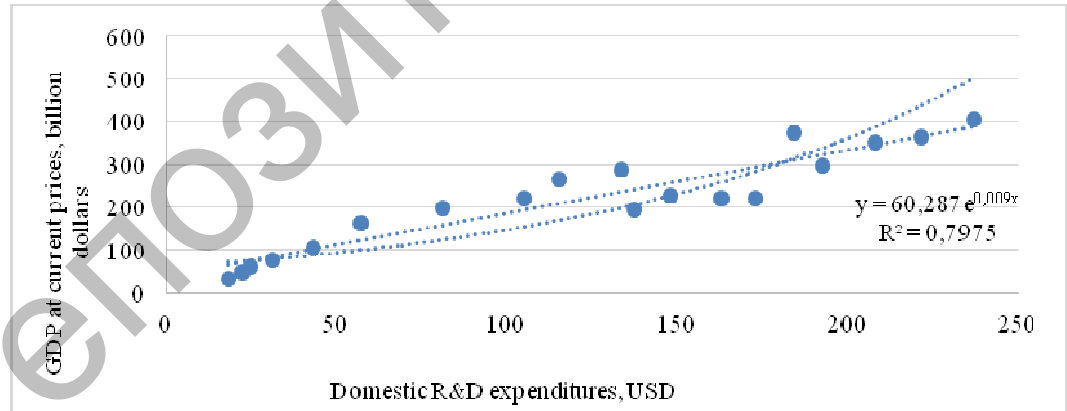

Figure 2. Correlation and regression model of GDP on domestic spending on R&D

Note - developed by the authors

As is known, matching correlation coefficient shows the degree of tightness of the relationship between only two variables with the indirect influence of other variables (Sokolov G.A., 2012).

Exponential equation of the correlation-regression model is as follows:

$$y = 60{,}287e^{0{,}009x},$$

where y is GDP at current prices, and x is domestic R&D expenditure. The coefficient of determination is 0,79.

Calculated correlation-regression model shows a strong positive impact of GDP on domestic R&D expenditures (Figure 2).

Figure 2 shows a comprehensive statistical method for point projecting of a system of economic indicators. Its main features are:

1. Method allows for comprehensive consideration of various useful information on a projected system of economic indicators: trends in indicators over time, statistical patterns of relationships between indicators, balance ratios, etc.

2. When making projection calculations of economic indicators using integral method, one can simultaneously use any number of private statistical models for each projected indicator. These models may differ in the number and composition of their independent factors of the economic process, structure of the relationship between dependent and independent variables of both external and internal environment of the company.

The novelty is determined by the lack of development of the topic in economic science and consists in the substantiation and description of retrospective statistical data of the research object, in assessing the relationship between GDP and factors of innovative development using a set of variables.

Significance of the results obtained for the theory consists in the development of both theory and methodology for studying innovations and state economy's innovative development.

Conclusion

Thus, the state generally supports the implementation of scientific developments and innovative implementations. This is confirmed by an increase in the real value of internal research expenditures from the state budget. Despite the increase in expenditures from the state budget, the number of entities performing research and development is decreasing (Satpayeva Z. T., 2017).

It is necessary to develop competitive mechanisms to stimulate not just the supply, but also the demand for innovation.

We need to pay more attention to new forms of innovative activity: clusters, technology parks, industrial zones, etc. The fact that not only real assets are important, but also institutional and social interaction of all participants and an atmosphere of mutual trust is also not to be ignored (Golubkin V.N., Kleva L.P., 2008).

In the last decade, much attention has been paid to improving the quality of implementation of educational and research programs by merging universities and reorganizing their educational and scientific activities (SpanovaL.K., 2015).

The following indicators were analyzed: number of employees engaged in R&D by form of company ownership; number of innovatively active enterprises; domestic R&D expenditures; domestic R&D expenditures from the public sector; share of innovative products (goods, services) in GDP; expenditures on technological innovations by form of company ownership; registration of trademarks and service marks; number of entities engaged in research and development; number of scientific developments.

Thus, the statistical analysis has shown the following:

– calculated correlation-regression model has shown a strong positive impact of GDP on domestic R&D expenditures;

– a correlation matrix of indicators characterizing introduction of innovation in the Kazakhstan economy has shown closely correlated interdependent variables, which are a matching correlation coefficient of a number of innovative enterprises and domestic expenditures on research and development equal to 0,96;

– in the study of indicators characterizing introduction of innovations in the economy of the Republic of Kazakhstan, depending on the cost of technological innovations and the share of innovative products in GDP, has shown a positive relationship as "not strong" (0,41);

– high correlation coefficients between the registration of patent applications and the issuance of patents in Kazakhstan and the number of employees engaged in R&D during the study period, domestic R&D expenditures, share of innovative products in GDP ($r = 0,95$, $r = 0,78$, $r = 0,81$);

– a strong but negative relationship between the number of entities engaged in research and development and the rest ($r = -0,87$, $r = -0,75$, $r = -0,81$, $r = -0,78$). Some of these entities probably exist only nominally and their economic activity is minimal.

Thus, based on the analysis, we can note the importance of innovations, but they are not the only management tools in GDP growth, which is proved by the research conducted for this paper. A multitude of studies of innovation's impact on GDP dynamics have shown that the level of relationship between innovation and economic development varies from country to country. The results of the study have shown a positive

relationship between GDP growth and R&D expenditures in the country. Analyzing the relationship between the dynamics of GDP growth and innovation variables in Kazakhstan, in most cases, one can observe a rather weak association of innovation and economic development. It is important to ensure a proper level of growth in the costs of technological innovations in order to increase activity in Kazakhstan.

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А.А. Нурпейсова, Ш.У. Ниязбекова, З.К. Есымханова

Қазақстан Республикасы экономикасының инновациялық даму факторлары: талдау және бағалау

Аңдатпа

Мақсаты: Қазақстан экономикасының инновациялық даму факторлары мен ЖІӨ көрсеткіштеріне корреляциялық талдау жасау.

Әдісі: Деректерді сандық өңдеу әдісі, яғни корреляциялық талдау қолданылды. Корреляциялық талдау экономиканы статистикалық зерттеудің тиімді құралдарының бірі болып табылады, ол экономикадағы, басқарудағы және әлеуметтік саладағы әртүрлі құбылыстар арасындағы себеп-салдарлық байланыстарды анықтауға мүмкіндік береді. Алынған мәліметтерді математикалық өңдеу "Excel", "Statistica 10" пакеттерін қолдана отырып, компьютерлік бағдарламалар арқылы жүзеге асырылды.

Қорытынды: Зерттеу объектісінің ретроспективті статистикасы сипатталған, ЖІӨ мен инновациялық даму факторларының өзара байланысы көптеген айнымалыларды қолдана отырып бағаланған және факторлық талдау сияқты көп өлшемді статистикалық талдау әдісін қолдана отырып зерттелген.

Мақалада зерттеу мен әзірлеу шығындарының мөлшерін және жалпы ішкі өнімді сипаттайтын көрсеткіштердің корреляциялық талдауы қарастырылды. 2006–2018 жылдардағы ЖІӨ-ге инновациялық өнімнің (тауарлардың, қызметтердің) үлесі көрсетілді, 2014–2018 жылдары ҒЗТКЖ-ға ішкі шығындарды қаржыландыру көздері берілді (млн.теңге), Қазақстан Республикасының экономикасына инновацияларды енгізуді сипаттайтын көрсеткіштердің корреляциялық матрицасы ашылды. Матрицаға мына айнымалыларға енгізілді: ҒЗТКЖ-ны жүзеге асыратын қызметкерлер саны, инновациялық белсенді кәсіпорындар саны, зерттеу мен әзірлеудің ішкі шығындары, инновациялық өнімдердің үлесі, кәсіпорындардың технологиялық инновацияларына шығындар, тауарлық белгілерді тіркеу және патенттер беру, зерттеу және әзірлеу. Корреляциялық-регрессиялық модельдің экспоненциалды теңдеуі салынды, анықтау коэффициенті табылды.

Тұжырымдама: Мемлекет экономикасының инновациялық дамуы жоғары тиімді технологиялар мен жаңа әзірлемелерді пайдалану мен енгізуге байланысты, инновациялармен, сондай-ақ ғылым мен техниканың

дамуымен тығыз байланыс бар. Экономиканың инновациялық даму жолына қалыптасуы инновациялар мен ғылыми зерттеулерге байланысты салаларда тиімді шығындарды талап етеді.

Кілт сөздер: инновация, экономиканың дамуы, инновациялық белсенділік, жаһандық инновациялық индекс, бәсекеге қабілеттілік.

А. А.Нурпейсова, Ш. У. Ниязбекова, З. К. Есымханова

Факторы инновационного развития экономики Республики Казахстан: анализ и оценка

Аннотация

Цель: Изучить корреляционный анализ показателей ВВП и факторов инновационного развития экономики Казахстана.

Методы: Применен метод количественной обработки данных, а именно корреляционный анализ. Корреляционный анализ один из эффективных инструментов статистического исследования экономики, он позволяет выявить причинно-следственные связи между различными явлениями в экономике, управлении, социальной сфере. Математическая обработка полученных данных осуществлялась с помощью компьютерных программ и с применением пакетов «Excel», «Statistica 10».

Результаты: Описаны ретроспективные статистические данные объекта исследования, дана оценка взаимосвязи ВВП и факторам инновационного развития с помощью множества переменных.

В статье рассмотрен корреляционный анализ показателей, характеризующих количество затрат на исследования, разработки и валовый внутренний продукт. Представлены основные показатели инновационной деятельности предприятий за 2014–2018 годы. Показана доля инновационной продукции (товаров, услуг) к ВВП за 2006–2018 гг., даны источники финансирования внутренних затрат на НИОКР (млн KZT) за 2014–2018 гг., раскрыта корреляционная матрица показателей, характеризующих внедрение инноваций в экономику Республики Казахстан. В матрицу были включены следующие переменные: количество работников, выполнявших НИОКР, количество инновационно-активных предприятий, внутренние расходы на исследования и разработки, доля инновационной продукции, расходы на технологические инновации предприятий, регистрация товарных знаков и выдача патентов, исследования и разработки. Построено экспоненциальное уравнение корреляционно-регрессионной модели, найден коэффициент детерминации.

Выводы: Инновационное развитие экономики государства сильно зависит от использования и внедрения высокоэффективных технологий и новейших разработок, наблюдается тесная связь с инновациями, а также развитием науки и техники. Становление экономики на инновационный путь развития требует эффективных затрат в сферы, связанные с инновациями и научными исследованиями.

***Ключевые слова**:* инновация, развитие экономики, инновационная активность, глобальный инновационный индекс, конкурентоспособность.

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