INNOVATION, INNOVATION AND TECHNOLOGICAL DEVELOPMENT, DIGITALIZATION

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Relationship between Innovation and Economic Growth in the Example of the Republic of Kazakhstan

Miyatbek A. Altynbekov[a]*, Raushan A. Yesbergen [b], Murat S. Aimurzinov [c], Onaikhan Zh. Zhadigerova [d], Almagul Zh. Ibrasheva [e]

[a] *Esil University, 7 Zhubanov str., 010010, Astana, Kazakhstan;* [b] *Branch of the Academy of Public Administration under the President of the Republic of Kazakhstan in Aktobe region, 10 Tileu batyr str., 030000, Aktobe, Kazakhstan;* [c] *Kostanay Socio-Technical University named after Academician Z.Aldamzhar, 27 Kobylandy Batyr ave., Kostanay, Kazakhstan;* [d] *Al-Farabi Kazakh National Research University, 71 Al-Farabi ave., 050040, Almaty, Kazakhstan;* [e] *K. Zhubanov Aktobe Regional University, 34 A.Moldagulova ave., 030000, Aktobe, Kazakhstan*

ABSTRACT

This article examines the relationship between innovation, education and economic growth in the Republic of Kazakhstan. Many empirical studies have proved a positive relationship between innovation and economic growth, that innovation has become a major component of global economic growth. Despite the acceleration of economic growth in various countries, including Kazakhstan, the relationship between economic growth and innovation in the country remains unclear. This study examined the impact of three factors: R&D, academic staff and innovation spending on economic growth in the Republic of Kazakhstan. The identified groups of indicators of economic development consist of sub-indicators. A regression analysis was done based on statistical data from 2009 to 2021. SPSS software was used for data processing. Three pairs of hypotheses were developed. The results of the first and third groups of hypotheses are similar only in those indicators that represent the total number of participants in innovative development, whose influence on economic development becomes strong. Thus, we can conclude that there is a strong relationship between GDP and indicators of educational and innovation factors. There is a relationship between the indicators of the academic staff in R&D and all enterprises that are involved in the process of development and implementation of innovations in Kazakhstan. The proposed hypotheses were accepted. Government agencies can use the results of this study in the development of innovation policy in the country.

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* Corresponding author: Altynbekov M.A. – PhD, Associate Professor, Esil University, 7 Zhubanov str., 010010, Astana, 87016042430, email: miatbek@mail.ru

Қазақстан Республикасының мысалында инновациялар мен экономикалық өсу арасындағы өзара байланыс

Алтынбеков М.А.[a]*, Есберген Р.Ә.[b], Аймурзинов М.С.[c], Жадигерова О.Ж.[d], Ибрашева А.Ж. [e]

[a] *Esil University, көш. Жұбанов 7, 010010, Астана, Қазақстан;* [b] *Қазақстан Республикасы Президентінің жанындағы Мемлекеттік басқару Академиясы Ақтөбе облысы бойынша филиалы, көш. Тілеу батыр 10, 030000, Ақтөбе, Қазақстан;* [c] *Академик З.Алдамжар атындағы Қостанай әлеуметтік-техникалық университеті, даң. Қобыланды Батыр 27, Қостанай, Қазақстан;* [d] *аль-Фараби атындағы Қазақ ұлттық зерттеу университеті, даң. эл-Фараби 71, 050040, Алматы, Қазақстан;* [e] *Қ.Жұбанов атындағы Ақтөбе өңірлік университеті, даң. А.Молдагулова 34, 030000, Ақтөбе, Қазақстан*

ТҮЙІН

Бұл мақалада Қазақстан Республикасындағы инновация, білім беру мен экономикалық өсудің өзара байланысы зерттеледі. Көптеген эмпирикалық зерттеулер инновация мен экономикалық өсу арасында оң байланыс бар екенін және инновация қазіргі уақытта жаһандық экономикалық өсудің негізгі құрамдас бөлігі екенін дәлелдеді. Қазақстанды қоса алғанда, әртүрлі елдердегі экономикалық өсудің жеделдеуіне қарамастан, елдегі экономикалық өсу мен инновациялар арасындағы өзара байланысы түсініксіз болып қалуда. Бұл зерттеуде үш фактордың, мысалы, зерттеулер мен әзірлемелерге жұмсалатын шығыстардың, профессорлық-оқытушылық құрамы мен инновациялардың Қазақстан Республикасындағы экономикалық өсу арасындағы өзара байланыс зерттелді. Экономикалық дамуға әсер ететін көрсеткіштердің анықталған топтары субиндикаторлардан тұрады. 2009 жылдан 2021 жылға дейінгі статистикалық мәліметтер негізінде регрессиялық талдау жүргізілді. Деректерді өңдеу үшін SPSS бағдарламалық жасақтамасы қолданылды. Үш жұп гипотеза жасалды. Гипотезалардың бірінші және үшінші топтарының нәтижелері экономикалық дамуға әсері күшті болатын инновациялық дамуға қатысушылардың жалпы санын білдіретін көрсеткіштерде ғана ұқсас. Осылайша, білім беру факторы мен инновациялық факторы ЖІӨ-мен арасында күшті байланыс бар деген қорытынды жасауға болады. Яғни, ҒЗТКЖ саласындағы ПОҚ-ның көрсеткіштері мен Қазақстанда инновацияларды әзірлеу және енгізу процесіне тартылған барлық кәсіпорындар арасында өзара байланыс бар. Ұсынылған гипотезалар қабылданды. Осы зерттеудің нәтижелерін мемлекеттік органдар елдегі инновациялық саясатты дамытуда пайдалана алады.

ТҮЙІН СӨЗДЕР: экономика, стратегия, цифрлық экономика, экономикалық өсу, білім беру шығындары, инновациялар, инновациялық индикаторлар

* Хат-хабаршы авторы: Алтынбеков М.А. – PhD, қауымдастырылған профессор, Esil University, көш. Жұбанов 7, 010010, Астана, Қазақстан, 87016042430, email: miatbek@mail.ru

Взаимосвязь между инновациями и экономическим ростом на примере Республики Казахстан

Алтынбеков М.А.[a]*, Есберген Р.Ә.[b], Аймурзинов М.С.[c], Жадигерова О.Ж.[d], Ибрашева А.Ж.[e]

[a] Esil University, ул. Жубанова 7, 010010, Астана, Казахстан; [b] Филиал Академии Государственного управления при Президенте Республики Казахстан по Актюбинской области, ул. Тилеу батыра 10, 030000, Актобе, Казахстан; [c] Костанайский социально-технический университет имени академика З.Алдамжар, пр.Кобыланды Батыра 27, Костанай, Казахстан; [d] Казахский национальный исследовательский университет им. аль-Фараби, пр. аль-Фараби 71, 050040, Алматы, Казахстан; [e] Актюбинский региональный университет имени К. Жубанова, пр. А. Молдагуловой 34, 030000, Актобе, Казахстан

АННОТАЦИЯ

В данной статье изучается взаимосвязь инновациями, образованием и экономическим ростом в Республике Казахстан. Многие эмпирические исследования доказали, что существует положительная взаимосвязь между инновациями и экономическим ростом и что инновации в настоящее время стали основным компонентом глобального экономического роста. Несмотря на ускорение экономического роста в различных странах, включая Казахстан, взаимосвязь между экономическим ростом и инновациями в стране остается неясной. В данном исследовании было изучено влияние трех факторов, таких как расходы на исследования и разработки, профессорско-преподавательского состава и инноваций на экономический рост в Республике Казахстан. Выявленные группы показателей, влияющих на экономическое развитие, состоят из субиндикаторов. Был проведен регрессионный анализ на основе статистических данных с 2009 по 2021 годы. Для обработки данных использовалось программное обеспечение SPSS. Были разработаны три пары гипотез. Результаты первой и третьей групп гипотез схожи только в тех показателях, которые представляют общее число участников инновационного развития, влияние которых на экономическое развитие становится сильным. Таким образом, можно сделать вывод, что есть сильная взаимосвязь между ВВП и показателями образовательного фактора и инновационного фактора, то есть взаимосвязь между показателями профессорско-преподавательского состава в области НИОКР и всех предприятий, которые вовлечены в процесс разработки и внедрения инноваций в Казахстане. Выдвинутые гипотезы были приняты. Результаты данного исследования могут использоваться государственными органами в развитии инновационной политики в стране.

КЛЮЧЕВЫЕ СЛОВА: экономика, стратегия, цифровая экономика, экономический рост, расходы на образование, инновации, инновационные индикаторы

* **Корреспондирующий автор: Алтынбеков М.А. –** PhD, ассоциированный профессор, Esil University, ул. Жубанова 7, 010010, Астана, Казахстан, 87016042430, email: miatbek@mail.ru

Introduction

At the present stage, the socio-economic development of any state is mainly determined by the level of investment in scientific and technical research and development, the creation and implementation of new and the use of existing progressive technologies.

Today, the key competitive advantage of Kazakhstan in the world market is resource leadership. Economic growth is associated with the use of energy and raw materials, in terms of reserves of some of them, Kazakhstan ranks first in the world. However, in recent decades, the world has been changing, and the country has been losing its uniqueness as a supplier of raw materials and energy resources since the theory of the "resource curse" is triggered, which reduces business activity and characterizes Kazakhstan as a developing state. In addition, Kazakhstan's dependence on commodity exports and limited innovation activity have made the country's economy vulnerable to external shocks. The experience of recent crises shows that Kazakhstan needs to stimulate innovation in order to increase its economic resilience and accelerate recovery from COVID-19. After the global financial crisis 2008 2009 and the sharp drop in oil prices in 2015, Kazakhstan's economy recovered, but growth was slower (Kurmanov et al., 2016).

At the same time, the main limitation of economic growth is the contradiction between supply and demand. Demands are increasing and resources remain limited. Therefore, the task is to maximize the use of limited resources to produce goods that will most fully satisfy the needs in a given period of time and the long term. Increasing investment in research and development, strengthening the financial system, especially capital markets, and increasing public spending on education is essential to promoting innovation. This in turn, will help support more robust economic growth.

It is also important to note that the innovative potential of the state is a crucial indicator, since the result of its use, in the end, is an increase in the efficiency of production activities and capital, an increase in labor productivity, an increase in the share of high-tech products, which in their cumulative impact leads to an increase in the economic power of the state.

At the same time, in the conditions of Kazakhstan, this problem was emphasized as a priority back in 1997, when the Strategy "Kazakhstan-2030" was adopted, and 2003 can be designated as the beginning of the innovative development of the republic when the «Strategy for Industrial and Innovative» was adopted (Kudaibergenova, 2015; Ibadildin et al., 2020).

It is also important to note that the course adopted to strengthen innovative trends in the development of the economy continues today, including the development program until 2050, where more and more attention is paid to innovative development and optimal conditions are created for the formation and effective management of the innovation ecosystem of the republic.

The economic growth of any country depends on many factors. For example, phenomena and processes that determine the pace and extent of a long-term increase in actual output and opportunities to improve the efficiency and quality of growth. There are direct and indirect factors according to the way they influence economic growth. Direct factors are factors that make growth physically possible. For example, supply factors are associated with the material ability of the economy to grow: the quantity and quality of labor and natural resources, the amount of fixed capital, technology, etc. But the physical ability of the economy to increase production is not enough to ensure economic growth. Applying an increasing amount of resources and their efficient distribution is necessary. Thus, in addition to supply factors, demand and efficiency factors are essential, which are indirect factors of economic growth. Growth, development and competitiveness in both developing and developed countries are an example of innovation.

When it comes to lowering production costs, countries and companies should increase the use of local innovation and knowledge transfer. Thus, innovation is critical to increasing productivity, obtaining competitive advantages, economic progress and, most importantly, achieving economic growth (Acs et al., 2017).

Many empirical studies have proven that there is a positive relationship between innovation and economic growth and that innovation has now become a significant component of global economic growth.

Using macro and microeconomic indicators, the literature points to the relationship between economic growth, and innovation (defined as R&D spending, patents and trademarks) in industrialized and developing countries. Despite the acceleration of economic growth in various countries, including Kazakhstan, the relationship between economic growth and innovation in the country remains unclear. Most of these studies used average econometric estimates: error

correction vector model, combined ordinary least squares, and fully modified ordinary least squares. These scoring methods use averages to predict outcomes but do not allow relationships to be observed over time. In many cases, inconclusive conclusions may result from the author's use of different approaches and methods based on averages.

The current research quantitatively analysed the relationship between economic development, innovation, and education factors. This study aims to explore the impact of research and development, academic staff and innovation on economic growth in the Republic of Kazakhstan. This study adds to the literature on innovation and economic growth.

Literature review

Various studies consider different factors as drivers of economic growth. There could be distinguished innovation development, which is divided into two sub-factors: R&D development, investment, and business development. Consequently, innovation has become a driver for economic growth and business development. Mainly innovation is quite often in demand in the financial sector as the banking system. According to the study of Uchupalanan (2000), the services innovation process undergoes three stages, which have particular goals efficiency improvement, quality improvement, and services diversification by developing new ones. Moreover, the author states that all three stages are interdependent and compares the service innovation process to a product's life cycle. Ramadani & Gerguri (2011) discussed that innovation could be divided into the delivery launching of new ideas as a new product delivery to the market, a new method of goods production or resources processing etc. Next, innovation development leads to an increase in sales by enlarging the market scale. In other words, it contributes to businesses operating in new markets. Finally, innovation development leads to an increase in the number of operating businesses in the market by developing appropriate conditions and business environments. Users, who tend to develop new service, which brings profit or much gain, their services, play a significant role in the process of innovation development. The current innovation penetration process in the private sector development is ensured by applying innovative products, mainly digital tools (Afonasova et al., 2019). Apart from that enterprises I run for sustainable development apply innovative products as unique solutions to

existing socio-economic issues (Banacu et al., 2019; Hysa et al., 2020).

Investment in R&D is one of the ways of innovation improvement, which consequently affects economic growth. Moreover, innovations in technology have a set of advantages. They are mobile, the innovation effect eventually becomes available to society, and innovative ideas are not attempting to replace existing ones. Nevertheless, not all regions have the innovation capacity to transform investments in R&D into technologically valuable innovations. The regions, which are not ready to develop R&D, lack specialists, especially in information and technology, and high rate of unemployment (Bilbao-Osorio & Rodríguez-Pose, 2004). It must be mentioned that technological innovation development through R&D investments is expensive. In this regard, the preference is given to foreign investments, as they are interested in training qualified personnel, designing and developing new ideas, and use of foreign innovation technologies. From this perspective, entrepreneurship can be regarded as an innovation factor, as they develop new ideas and deliver new products to the market (Wong et al., 2005; Melane-Lavado & Alvarez-Herranz, 2020).

In addition, R&D, GDP, and the human factor (including the population in general, qualified personnel, labor force, etc.) are taken as the main variables in studies of the relationship between economic growth and innovation capacity. Moreover, development and investment in R&D are regarded as the prerequisite for innovation technologies development through businesses (Gao & Guan, 2009).

Thus, innovation technology development contributes to business development. Therefore, the regional level of innovation capacity can also be analyzed through the availability or presence of several factors. First of all, the availability and variety of technology in the region. Next, qualified personnel, especially the labour force ready to receive knowledge and be open to new ideas. This develops the business environment within a company and is the environment for innovation development. The third significant factor is urbanization. These areas attract people with creative thinking and boost the development of innovations. Moreover, innovation development in central regions could be spread to other regions as they consider general and more common issues. When innovations are developed in less urban areas, they are more applicable in the place of location. The fourth is the business

relationship between organizations. It becomes more productive or easy to develop when companies have common cultural characteristics or interests and are physically located at a close distance (Gössling & Rutten, 2007; Awan, 2020).

The leading importance of scientific and technological progress characterizes modern economic growth. According to Franco & de Oliveira (2017), the share of new knowledge embodied in technologies, equipment, human capital, and production organization in developed countries accounts for 80 to 95% of GDP growth. Innovation is the foundation of scientific and technological progress, which is a continuous uneven process of the emergence and implementation of new scientific and technical ideas, entailing qualitatively new changes in society. In addition, it determines the creativity and competitive advantages of the firm and the country.

Innovation development has an impact on the business environment as it directs the process of economic growth. Moreover, the innovation develops necessary characteristics depending on the geographical location, labour force potential, and type of industry. Consequently, it helps to increase the competitiveness of a region (Akinwale et al., 2012). Based on the fact that innovation in the region could be specific to the

place of location, that is, developed ideas or new approaches can be specific. Therefore the results of the investigation of the relationship between economic growth and innovation vary as well. Most works take investments in R&D as one of the critical factors for innovation development (Pece et al., 2015; Papanastassiou et al., 2020).

To conclude, economic development is affected by various factors. Most studies state that innovation and education indicators have a substantial impact or relationship with economic development. The current study will focus on human resources and private entities in the education and private sectors. It is necessary to understand if academic staff and private sector involvement strongly impact economic development separately instead of sub-components as presented in existing studies.

Methodology

In most of the works, correlation or regression analyses were conducted. Therefore the research is based on the works of Akinwale et al. (2012) and Pece et al., (2015). They included regression analysis and studied the impact of innovation through higher education students and academic staff on economic growth. According to the conducted literature review, three groups of factors were identified, which impact the economy development (see Figure 1).
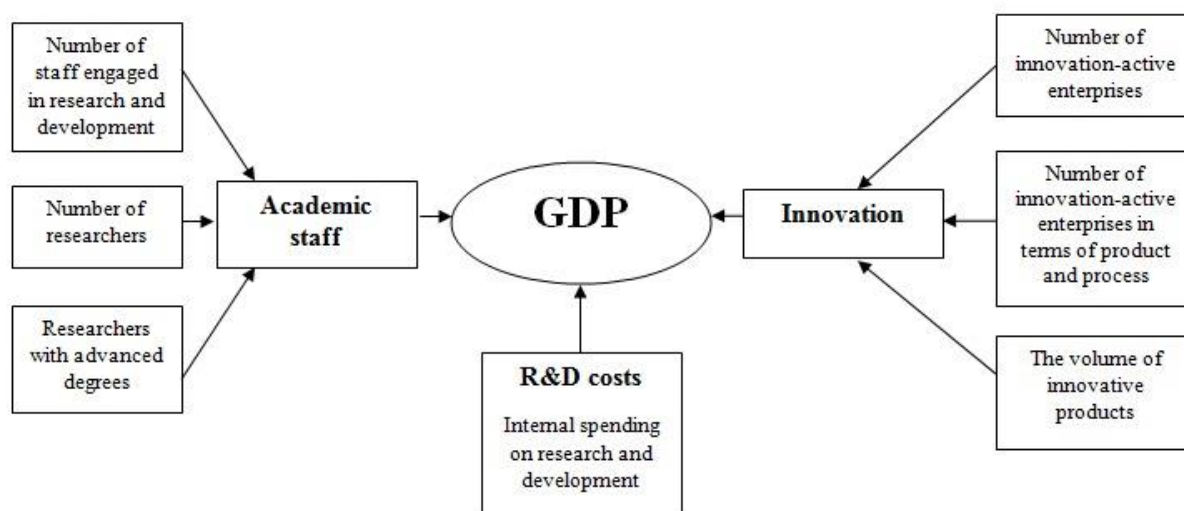

Figure 1 - Economy development factors: academic staff, R&D costs and Innovation

Note: compiled by the authors

The identified groups of indicators affecting economic development consist of sub-indicators. The academic staff consists of three sub-indicators: the number of staff, researchers and researchers with advanced degrees (PhD, Doctors) engaged in R&D. Innovation includes three sub-indicators: the number of innovation-active organizations active in product and process innovations and the volume of innovative products. R&D costs include internal expenses on R&D, which comprise the public budget, private and foreign direct investment.

In order to identify the impact of the factors mentioned above on economic development, a regression analysis was conducted. SPSS software was used for data processing. In Table 1 there is shown a list of used variables in the analysis and their coding.

Table 1 - Economy development factors used variables

No.	Group of indicators	Indicators	Coding
1	Academic staff	Number of staff engaged in research and development	RD_Staff
		Number of researchers	Num_Res
		Researchers with advanced degrees	Res_wDegree
2	R&D costs	Internal spending on research and development	Int_EXP_RD
3	Innovation	Number of innovation-active enterprises	Enterp_InnovAct
		Number of innovation-active enterprises in terms of product and process innovations	Enterp_InnovAct_PPI
		The volume of innovative products	Vol_InnovProd
4	Economy development	Gross domestic product	GDP

Note: compiled by the authors

The analysis included three groups of factors: academic staff, R&D costs and innovation. The data was collected from the official open data sources Agency for Strategic planning and Reforms of the Republic of Kazakhstan Bureau of National Statistics for the period from 2010 to 2021.

Accordingly, the following three pairs of hypotheses were developed:
- First pair:
- Hypothesis 0: Economic development is influenced by educational factors
- Hypothesis 2: Economic development is not influenced by educational factors
- Second pair:
- Hypothesis 3: Economic development is influenced by R&D costs
- Hypothesis 4: Economic development is not influenced by R&D costs
- Third pair:
- Hypothesis 5: Economic development is influenced by innovation factors
- Hypothesis 6: Economic development is not influenced by innovation factors.

Results and analysis

In the context of the globalization of the world economy, creating and developing a competitive, innovative economy is one of the priority tasks for Kazakhstan. However, the current indicators of innovation development demonstrate weak dynamics.

Figure 2 presents Research and development costs as a percentage of GDP in different countries from 2008 to 2021.

Over the past ten years, the share of R&D expenditures in the structure of GDP has decreased from 0.3% to 0.17%. This indicator is one of the lowest in comparison with other countries. So, for example, we lag behind the neighboring country of the Russian Federation, and developed countries like Sweden, and Switzerland in these countries spend more on R&D than 2.5% and reach 3.5%. In developing countries and countries with transit economies, the share of costs is no more than 1.5% (Figure 2).

Figure 3 presents the share of innovative products (goods, services) in relation to GDP in Kazakhstan, 2004 - 2021.
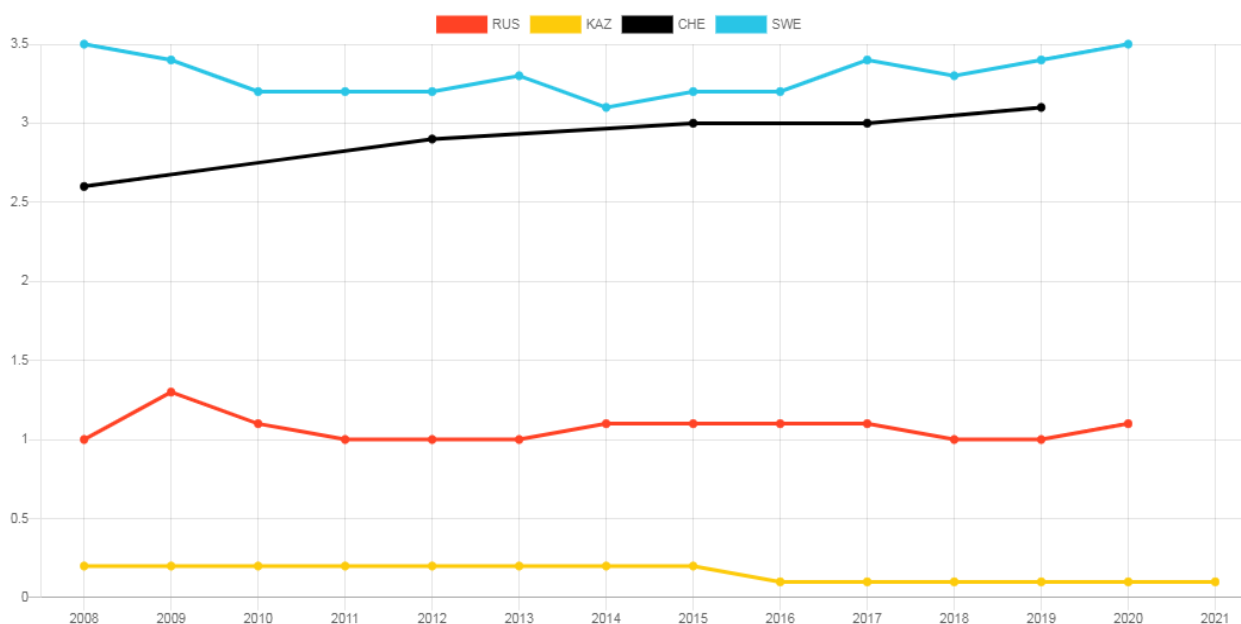
Figure 2 - Research and development costs as a percentage of GDP in different countries, %

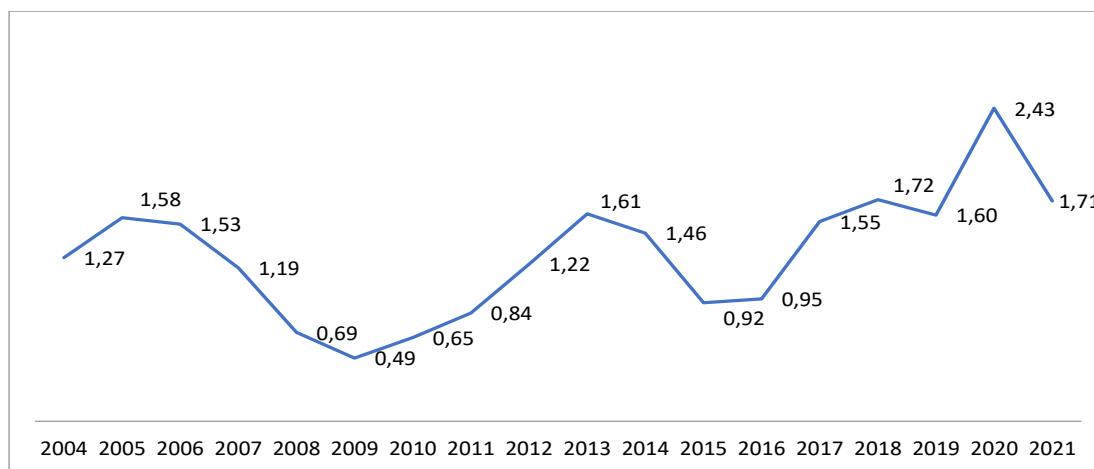Note: complied based on the source (UNECE, 2021)

Figure 3 - The share of innovative products (goods, services) in relation to GDP in Kazakhstan, %

Note: complied based on the source (Bureau of National Statistics, 2021)

Nevertheless, the volume of innovative production continued to grow steadily - the share about GDP increased from 1.27% to 1.71% over seventeen years. The maximum share of innovative products in GDP was 2.43% in 2020, while the lowest figure was in 2009 at 0.49%. These indicators are related to the economic crises that took place in 2008 and the consequences of the coronavirus (Figure 3).

Figure 4 there is presented – R&D costs from 2009 to 2021.

During the study period, research and development costs increased by almost 70.3 billion tenge, which is 180.5% of the base year (Figure 4). In this indicator, a positive trend is noticeable.

Figure 5 there is presented the dynamics of academic staff from 2009 to 2021.
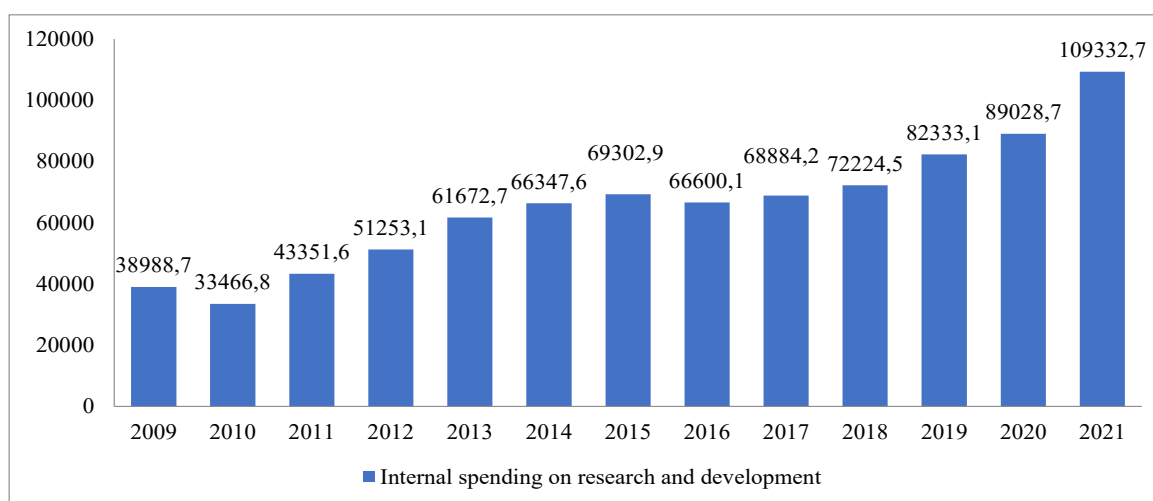
Figure 4 – R&D costs, 2009-2021

Note: complied based on the source (Bureau of National Statistics, 2021)
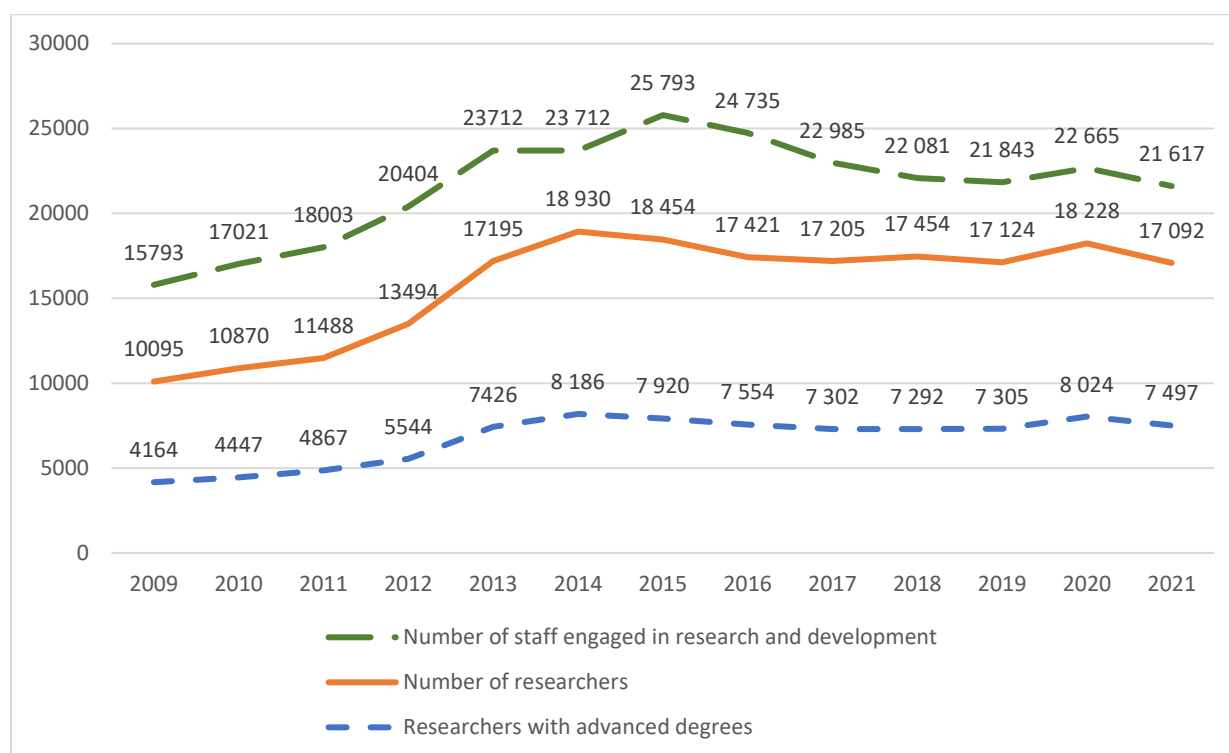
Figure 5 - Academic staff, 2009-2021

Note: complied based on the source (Bureau of National Statistics, 2021)

The number of employees in the R&D segment at the end of 2021 amounted to 21.6 thousand people, which is 4.6% less compared to the end of 2020. Of these, women accounted for 11.6 thousand, over the year, their number decreased by 3.4%. But 36% more than in 2009 (Figure 5). The maximum figure was in 2015 and amounted to 25,798 employees. Compared to the base year, this indicator has grown significantly by 36%, which indicates the scientific community's interest in the development of innovation in the country.

Of the total number of R&D employees, 79% were specialists-researchers. Their number decreased over the year by 6.2% to 17.1 thousand people. Also, the number of advanced-level researchers has slightly decreased compared to 2020. However, these figures have increased significantly compared to the base year 2009 and amounted to 6997 (69%) and 3333 (80%) employees, respectively.

Table 2 - Composition of the Innovation Indicator, from 2009 to 2021

Year	Number of innovation-active enterprises	Number of innovation-active enterprises in terms of product and process innovations	The volume of innovative products
2009		399	82 597,40
2010	572	467	142 166,80
2011	762	614	235 962,70
2012	1622	1215	379 005,60
2013	1774	1062	578 263,10
2014	1 940	1 303	580 386,00
2015	2 585	1 781	377 196,70
2016	2 879	1743	445 775,70
2017	2 974	1 770	844 734,90
2018	3 230	2 019	1 064 067,40
2019	3 206	2 131	1 113 566,50
2020	3 236	2 402	1 715 500,10
2021	2 960	1 808	1 438 708,50

Note: complied based on the source (Bureau of National Statistics, 2021)

An analysis of the presented Table 2 allows us to conclude that the number of enterprises with innovations of all types is more than twice as fast as the growth rate of the total number of enterprises. So, if the total number of enterprises increased by 17%, then the number of enterprises with innovations increased by 67% compared to the base year data.

Accordingly, the relative indicator of innovative activity of enterprises increased by 42%, reaching a value of 10.6% of the total number of enterprises.

As a positive factor, one can regard the fact that there is an increase in indicators for all of the above indicators, which indicates a growing understanding of the importance of innovation in improving the efficiency of enterprises.

Next, a regression analysis of the described indicators will be carried out.

Conducted regression analysis revealed the following results. First of all, according to the model summary, the R-square is ,998, which shoes that 99% of the change in the dependent variable is explained by the independent variables Vol_InnovProd, RD_Staff, Enterp_InnovAct, Int_EXP_RD, Num_Res, Enterp_InnovAct_PPI, Res_wDegree. Next, there are results for ANOVA analysis in Table 3.

The results of ANOVA analysis show that there is a high difference between variables as F-value is 373,053, which is more than 30. P-is less than 0,001 (p<.000), which proves that the model is significant and can be accepted. The coefficient results are presented in table 4.

Table 3 – Regression analysis: ANOVA

	Square sum	df.	Mean Square	F	Sig.
Regression	4117315635839857,000	7	588187947977122,400	373,053	,000[b]
Residual	6306749136849,949	4	1576687284212,487		
Total	4123622384976707,000	11			

Table 4 – Regression analysis: Coefficients

	B	STND.ERR	Beta	T.	Sig.
(Constant)	56949890,651	8496931,314		6,702	,003
RD_Staff	-3964,605	765,478	-,526	-5,179	,007
Num_Res	-4008,299	2205,638	-,563	-1,817	,143
Res_wDegree	11580,525	5286,294	,754	2,191	,094
Int_EXP_RD	547,238	58,595	,572	9,339	,001
Enterp_InnovAct	16129,707	2246,299	,798	7,181	,002
Enterp_InnovAct_PPI	-6562,643	3344,339	-,203	-1,962	,121
Vol_InnovProd	-,683	3,266	-,017	-,209	,845

Hypothesis, first pair. The results showed a strong relationship between RD_Staff and GDP as the P-value = ,003 less than the significance level (α = 5 %). The rest education indicators Num_Res and Res_wDegree relationship is insignificant as P-value is = ,143 and ,094, which is higher than 5%. The first pair of hypotheses were accepted mainly as the results showed a significant relationship only for one indicator, the number of R&D staff, which includes all members of the working process. Separately the indicators do not have an influence on economic growth.

Hypothesis, second pair. The results for R&D costs show that there is a significant relationship between dependent and independent variables. The P-value for the variable Int_EXP_RD =,001, less than the significance level (α = 5 %). Hypothesis 3 is accepted.

Hypothesis, third pair. The innovation indicators results showed a strong relationship between Enterp_InnovAct and GDP indicators as P-value is =,002. The P-value for the rest indicators Enterp_InnovAct_PPI and Vol_InnovProd are higher than the significance level (α = 5 %), which is ,121 and ,845. The third pair hypothesis is accepted partially as the results showed a significant relationship only for one indicator of the innovation activity of enterprises.

The results of the first and third groups of hypothesis are similar in those only indicators representing the general number of participants in innovation development the influence on economic development becomes strong. Let's consider some elements as the number of researchers with advanced degrees or enterprises, which provide R&D in the product and process industry. This has no effect or insignificant relationship with economic development.

Therefore, it can be concluded that hypotheses 1 and 5 are accepted as the indicators which reflected a strong relationship with GDP representing the general structure of academic staff in R&D and all enterprises which are involved in the process of innovation development and introduction in Kazakhstan. Thus, all three hypotheses are accepted.

Conclusion

The current research aimed to analyse the impact of academic staff, innovation activity of enterprises and R&D costs on economic development. The results revealed a significant relationship between economic development and the number of academic staff who are involved in the development of science, provision of scientific studies and development of innovations in Kazakhstan.

The results revealed that there is a significant relationship between innovation activity and economic development. Enterprises that provide innovation activity in all fields of industry have a strong impact on economic development.

The results revealed a strong impact of R&D costs on economic development. Internal expenses to support local science through various sources of financing, including the state budget, private organizations, and foreign direct investment, contribute to economic development.

At the same time, the result of the regression analysis showed an insignificant relationship between economic development with academic staff and the innovation activity of organizations in the following. Firstly, the results will be insignificant considering academic staff separately, as it was conducted in the analysis. That is, research scientists or researchers separately contribute insignificantly to economic development. Secondly, enterprises considered as separate groups which conduct the application of innovative products in product and process industries showed insignificant relationship. The results showed that considering all participants of academic staff and organizations which have innovation activity as single indicators has a strong impact on economic development.

Therefore it is necessary for policymakers and the government to provide balanced support to higher educational institutions in the provision of R&D development support. Balanced development of science among the academic staff and students will contribute to ensuring well-qualified generation.The government must develop a policy for private individuals and medium and large organisations to develop innovation activities. Balanced development in all directions of the industry will help boost the country's economic development.

Future studies might provide include in their studies the number of students and divide them into categories to analyse if students considered as separate groups have the same contribution or impact as if considered as a single indicator. The main limitation of current research was limited data on chosen indicators.

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Information about the authors

*Miyatbek A. Altynbekov – PhD, Associate Professor, Esil University, Astana, Kazakhstan, email: miatbek@mail.ru, ORCID ID: https://orcid.org/0000-0002-1042-8065

Raushan A. Yesbergen – Cand. Sc. (Econ.), Professor, Branch of the Academy of Public Administration under the President of the Republic of Kazakhstan in Aktobe region, Aktobe, Kazakhstan, email: r.esbergen@apa.kz, ORCID ID: https://orcid.org/0000-0003-3894-8254

Murat S. Aimurzinov – Cand. Sc. (Econ.), Associate Professor, Kostanay Socio-Technical University named after Academician Z.Aldamzhar, Kostanay, Kazakhstan, email: ams-66@mail.ru, ORCID ID: https://orcid.org/0000-0003-1287-8913

Onaikhan Z. Zhadigerova – Cand. Sc. (Econ.), Senior Lecturer, Al-Farabi Kazakh National Research University, Almaty, Kazakhstan, email: olia_kz@mail.ru, ORCID ID: https://orcid.org/0000-0003-2208-0913

Almagul Z. Ibrasheva – Master of Economic Science, Senior Lecturer, K.Zhubanov Aktobe Regional University, Aktobe, Kazakhstan, email: ibrasheva1975@mail.ru, ORCID ID: https://orcid.org/0000-0002-6998-762X

Авторлар туралы мәліметтер

*Алтынбеков М.А. – PhD, қауымдастырылған профессор, Esil University, Астана, Қазақстан, email: miatbek@mail.ru, ORCID ID: https://orcid.org/0000-0002-1042-8065

Есберген Р.Ә. – э.ғ.к., профессор, Қазақстан Республикасы Президентінің жанындағы Мемлекеттік басқару Академиясы Ақтөбе облысы бойынша филиалы, Ақтөбе, Қазақстан, email: r.esbergen@apa.kz, ORCID ID: https://orcid.org/0000-0003-3894-8254

Аймурзинов М.С. – э.ғ.к., доцент, Академик З.Алдамжар атындағы Қостанай әлеуметтік-техникалық университеті, Қостанай, Қазақстан, email: ams-66@mail.ru, ORCID ID: https://orcid.org/0000-0003-1287-8913

Жадигерова О.Ж. – э.ғ.к., аға оқытушы, Аль-Фараби атындағы Қазақ ұлттық зерттеу университеті, Алматы, Қазақстан, email: olia_kz@mail.ru, ORCID ID: https://orcid.org/0000-0003-2208-0913

Ибрашева А.Ж. – экономика ғылымдарының магистрі, аға оқытушы, Қ.Жұбанов атындағы Ақтөбе өңірлік университеті, Ақтөбе, Қазақстан, email: ibrasheva1975@mail.ru, ORCID ID: https://orcid.org/0000-0002-6998-762X

Сведения об авторах

*Алтынбеков М. А. – PhD, ассоциированный профессор, Esil University, Астана, Казахстан, email: miatbek@mail.ru, ORCID ID: https://orcid.org/0000-0002-1042-8065

Есберген Р.Ә. – к.э.н., профессор, филиал Академии Государственного управления при Президенте Республики Казахстан по Актюбинской области, Актобе, Казахстан, email: r.esbergen@apa.kz, ORCID ID: https://orcid.org/0000-0003-3894-8254

Аймурзинов М. С. – к.э.н., доцент, Костанайский социально-технический университет им. академика З.Алдамжар, Костанай, Казахстан, email: ams-66@mail.ru, ORCID ID: https://orcid.org/0000-0003-1287-8913

Жадигерова О. Ж. – к.э.н., старший преподаватель, Казахский национальный исследовательский университет им. аль-Фараби, Алматы, Казахстан, email: olia_kz@mail.ru, ORCID ID: https://orcid.org/0000-0003-2208-0913

Ибрашева А.Ж. – магистр экономических наук, старший преподаватель, Актюбинский региональный университет имени К.Жубанова, Актобе, Казахстан, email: ibrasheva1975@mail.ru, ORCID ID: https://orcid.org/0000-0002-6998-762X