DOI 10.52260/2304-7216.2023.1(50).35
UDC 001.3:330.5(574)
SCSTI 12.21.25

Z. Satpayeva*, PhD[1]
D. Kangalakova, PhD[1]
A. Mukayev, PhD student[2]
Institute of economics of the Committee of science of the Ministry of science and higher education the Republic of Kazakhstan, Almaty, Kazakhstan[1]
Al-Farabi Kazakh national university, Almaty, Kazakhstan[2]
* – main author (author for correspondence)
e-mail: satpayeva.zaira@ieconom.kz

R&D AS A FACTOR OF KAZAKHSTAN'S SOCIO-ECONOMIC DEVELOPMENT

Science is the main element in the formation and development of a knowledge-based and innovative economy with high level of the quality of life of population. The aim of the study is to analyze R&D expenditures as a factor of Kazakhstan's socio-economic development based on dynamic and econometric analysis of statistical data of the Bureau of National Statistics of the ASPR from 2011 to 2020. The study revealed that the level of science intensity of the economy in Kazakhstan is very low. Science parameters are still not the most significant factors in the country's socio-economic development. The results obtained indicate the need to improve the efficiency of science in order to establish a knowledge-based and innovative economy and increase the well-being of the population in Kazakhstan. The study results can serve as substantiation for key directions of developing scenarios and mechanisms to improve the efficiency of scientific-technological policy of the Republic of Kazakhstan.

Keywords: *science, technology, economy, society, impact, R&D expenditure, science intensity of the economy, development factors, economic growth, welfare.*
Кілт сөздер: *ғылым, технологиялар, экономика, қоғам, әсер, ҒЗТКЖ шығындары, экономиканың ғылым сыйымдылығы, даму факторлары, экономикалық өсу, әл-ауқат.*
Ключевые слова: *наука, технологии, экономика, общество, влияние, расходы на НИОКР, наукоемкость экономики, факторы развития, экономический рост, благосостояние.*

JEL classification: O11, O33

Introduction. Technological growth has an important impact on improvement of competitiveness, social welfare and economic growth [1] through the R&D development. Especially in developing countries, the benefits of scientific and technological innovation can have a significant impact on social and economic problems such as unemployment and skills development [2].

Science is the main element in the post-industrial society development, a knowledge-based and innovative economy that is confirmed by the experience of technological leaders where research and development (R&D) is an important factor in economic development and social progress of the country [3]. An analysis of R&D expenditures clearly shows how developed the country is in terms of technological potential. Therefore, many developed countries pay great attention to the development of research infrastructure, spending significant financial and human resources on this. Besides, those countries that have actively invested in their own R&D, as a rule, begin to assess and evaluate their impact on the socio-economic development level for a long time after investment. Thus, world economic development is characterized by increasing gap between high-developed countries and low-developed ones. Post-industrial development of high-developed countries based on the inexhaustible resource - information and scientific knowledge. Their economic development can be characterized by the increasing influence of non-production factors, technological changes, research and development that indicates the high role of science in the socio-economic development of these countries.

The science development becomes a priority in Kazakhstan [4]; state budget expenditures for science increase annually. The need for statistical studies of assessment and evaluation of the science contribution to the country's socio-economic development in these conditions. So, the aim of the research is to analyze R&D expenditures as a factor of Kazakhstan's socio-economic development.

Literature review. According to endogenous growth theories economic growth depends on private and public R&D investment. These investments contribute to generation of new technologies, increase labor

productivity and country competitiveness within national innovation systems [5]. At the same time, science has an impact in different ways on different stages of economic development of countries. The R&D impact spending on economic growth is positive for upper middle-income countries but negligible for low-income countries. GDP per capita is higher in countries with higher per capita R&D expenditures [6].

The positive impact on economic growth of both government subsidies is widely recognized [7], and private sector investment in R&D [8]. In turn, public funding has a positive effect on private funding [9]. It was found that when R&D expenditures in the commercial enterprise sector exceed R&D expenditures in the public sector, labor productivity in developed countries tends to grow, while in developing countries where science intensity is quite low, there is an effect of "inertia" [10].

The most widely used indicator of the science contribution to the country's socio-economic development is a science intensity of economy as the share of domestic R&D expenditures in the GDP structure. But it may show the spontaneous development of science and does not give a clear answer to the question of how sufficient the allocated resources for R&D are for stable economic growth [11]. Moreover, some studies confirm that the use of the level of science intensity could be of great importance to determine the financing of science [12]. However, increasing R&D funding must be based on strong science and innovation policies aimed at increasing the return on R&D and optimizing its role in economic growth [13].

A review of scientific literature shows the high role and place of science in country's technological and socio-economic development. At the same time, depending on the scientific potential of countries, R&D expenditures have a different impact degree on economic and social development. In countries with low scientific potential, the effect of R&D is less than in countries with a medium and high level of scientific potential.

Main part. The main idea of the study that the state of science funding determines its scientific potential and socio-economic development. The main methods were the dynamic analysis of Kazakhstan's science development parameters based on statistical data for 2011 to 2020 from the Bureau of National Statistics of ASPR, and the econometric method for quantifying the impact of science on the socio-economic development of a country, where the dependent variable is GDP or GDP per capita, and the independent variables are indicators describing the scientific and technological development of the country. The main variables used are domestic expenditures on science, and the number of scientists and the number of organizations involved in R&D [14]. At the same time, within the framework of this method, correlation and regression analysis are distinguished. The essence of correlation analysis is the calculation of correlation coefficients that determine the measure and degree of the relationship between variables - indicators of scientific-technological and socio-economic development.

In 2020, in Kazakhstan the total volume of domestic R&D expenditures amounted to 89,028.7 million tenge, an increase of 2 times compared to 2011, while the peak of the science intensity of economy decreased from 2013 to 2015, and amounted to 0.17%, after which it decreased to 0.13% in 2020 (Figure 1).

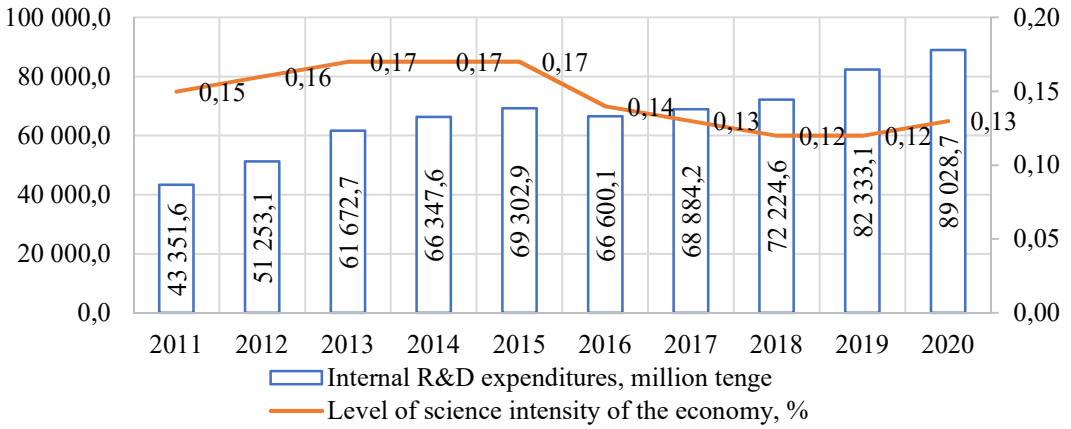
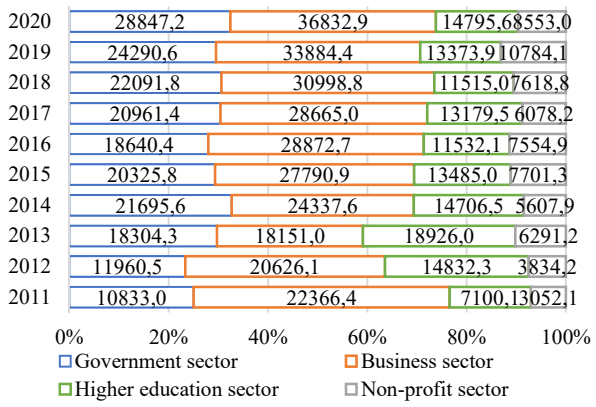


Figure 1. **Domestic R&D expenditures and level of science intensity of the economy, 2011-2020***

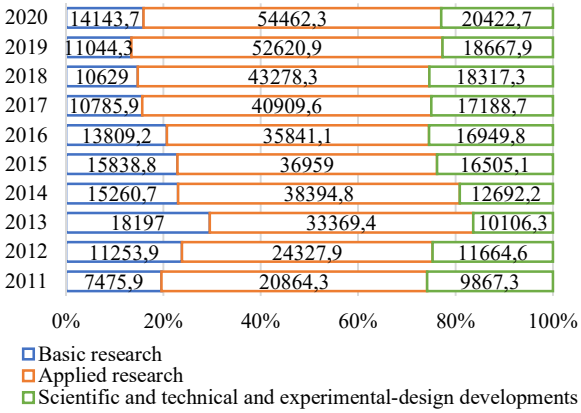
** compiled by the authors*

Kazakhstan's level of science intensity of economy is below 1% that indicates its critical level in order to ensure country's scientific and technological security. So, for economically developed countries and technological leaders, this parameter is at the level of 2.1-4.9%.

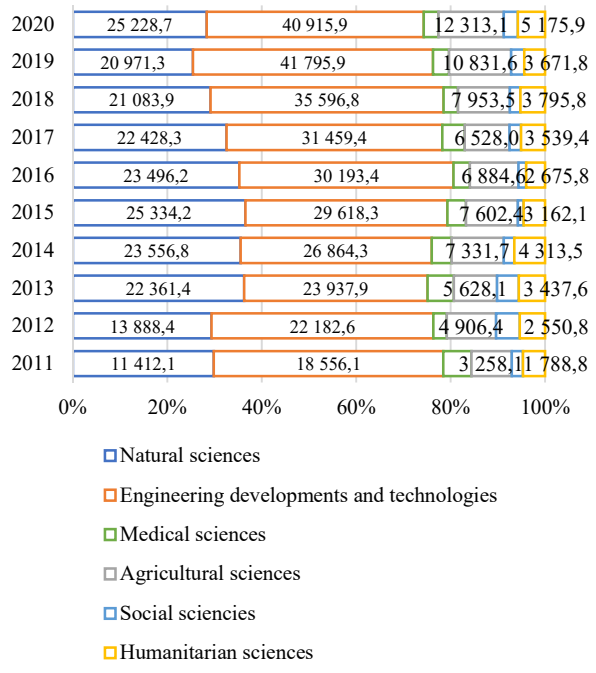
From 2011 to 2020 domestic R&D expenditures increased on several times in all sectors: in the non-profit - 3.53 times, in the public - 2.24, in the higher education - 1.88, in the private (business) - 1.51. The largest share of domestic R&D expenditures is in the business sector (41.37%), then in the government sector (32.4%) and then in the higher education sector (16.62%). Compared to 2011, the share of the government sector (by 7.41 percentage points (p.p.)) and the non-profit sector (by 2.57 p.p.) increased against the background of a decrease in the share of the business sector (by 10.22 p.p.). The share of the higher education sector practically remained unchanged (Figure 2a).



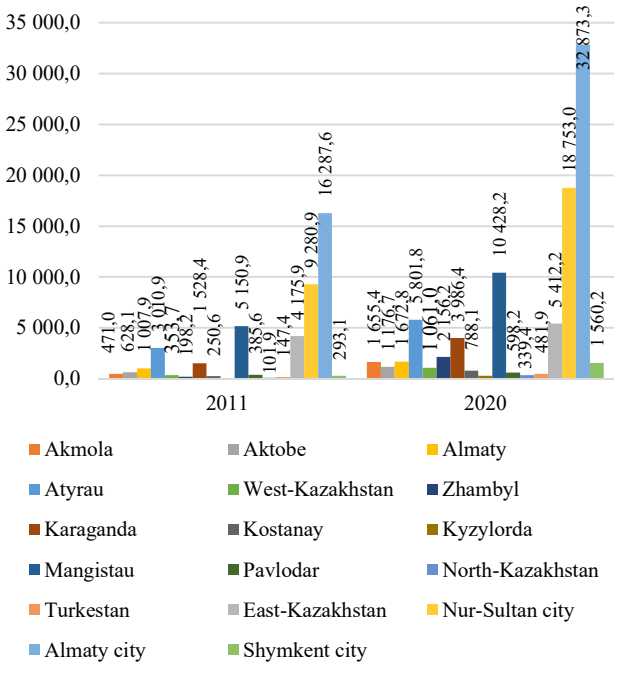
a) by sector of activity



b) by work type



c) by branches of science



d) by regions

Figure 2. **Domestic R&D expenditures, million tenge, 2011-2020***

** Compiled by the authors*

In different countries the funding structure for various types of R&D is rather heterogeneous. So, in Argentina, Bulgaria, Croatia, Germany, Italy, Latvia, the R&D sector is more focused on applied science, in China, Denmark, Israel, Japan, South Korea - on experimental studies [15]. In Kazakhstan's structure of domestic R&D expenditures by work type, the largest share is occupied by expenditures on applied research, it increased from 54.61% (2011) to 61.17% (2020) that is largely due to the rapid development of production, the complication of technological processes. While the share of fundamental research and scientific and technical and experimental-design developments decreased by 3.68 percentage points. and

2.89 p.p. respectively (Figure 2b). Expenditures for all types of work in the period under review increased: fundamental research - by 6,667.8 million tenge, applied research - by 33,598 million tenge, scientific and technical and experimental-design developments - by 10,555.4 million tenge.

The structure of domestic R&D expenditures by branches of science in Kazakhstan is practically unchanged. In 2020, almost two-thirds of domestic R&D spending (74.3%) was in natural sciences and engineering and technology (Figure 2c). From 2011 to 2020 domestic R&D expenditures in agricultural sciences increased by 3.78 times, from 3,258.1 million tenge in 2011 to 12,313.1 million tenge that resulted in an increase in their share in the structure by 5.3 p.p. The minimum amount of expenditure falls on R&D in medical and social sciences and humanities (5.81%, 3.08% and 2.98% respectively in 2020). Within the period from 2012 to 2018, the cost of research in the area of social sciences decreased by 2.5 times that means a decrease in funding and economic research aimed to increase the efficiency of resources used, including scientific, for social development and economic growth. All this time, the share of the humanities and social sciences in the structure of expenditures practically did not change, while the situation in medical sciences noticeably deteriorated: although costs in this area for 2011–2020 increased, their share in the structure of costs decreased by 2.85 percentage points. While in the context of the COVID-2019 pandemic, the trend in the of medical science development only strengthening and plays an extraordinary role in the system intended to increase the quality of healthcare and improve the health of the population.

From 2011 to 2020 domestic R&D expenditures increased in all regions of Kazakhstan, with the highest average annual growth rates observed in Zhambyl region and Shymkent city (26.96% and 18.2%, respectively). The regions with high rates of domestic expenditures include the Mangistau, Atyrau and East-Kazakhstan regions. The growth of this parameter in 2020 compared to 2011 was 102.45%, 92.69% and 29.61% respectively (Figure 2d).

Domestic expenditures on R&D has a positive strong relationship with all indicators of socio-economic development, including GDP, with the exception of the general birth rate, with which there is no statistically significant relationship (Table 1). So it is the most significant indicator of scientific-technological development that affect the socio-economic development of Kazakhstan. Also, there is the export of high-tech goods which has a positive strong relationship with the indicator «total fertility rate», a negative strong relationship with the other indicators, with the exception of the indicator «life expectancy at birth», with which the relationship is negative moderate, and GDP and industrial production, with which there is no statistically significant connection. The indicators «technicians in R&D» and «number of employees performing R&D» do not have a statistically significant relationship with any indicator of socio-economic development, and the indicator «patent applications (residents)» has a positive moderate relationship only with the indicator «total fertility rate». The indicator «share of innovative products» has a positive strong relationship with the indicators «employed population» and «industrial output».

Table 1

Correlation between indicators of scientific-technological and socio-economic development of Kazakhstan*

Indicator	SE1	SE2	SE3	SE4	SE5	SE6	SE7
ST1	-0,731*	-0,671*	0,844**	-0,727*	-0,43	-0,720*	-0,64
ST2	-0,67	-0,63	0,696*	-0,64	-0,31	-0,61	-0,48
ST3	0,827**	0,861**	-0,678*	0,773*	0,57	0,758*	0,63
ST4	0,39	0,57	0,21	0,29	0,37	0,28	0,08
ST5	0,927**	0,941**	-0,50	0,898**	0,823**	0,888**	0,725*
ST6	0,52	0,50	-0,47	0,54	0,790**	0,59	0,718*
ST7	0,31	0,50	0,32	0,20	0,26	0,18	-0,03

** Notes: 1) SE - indicators of social and economic development: SE1 - population, thousand people; SE2 - life expectancy of the population at birth, years; SE3 - total fertility rate, per 1000 people; SE4 - average per capita nominal cash income of the population, tenge; SE5 - employed population, thousand people; SE6 - gross domestic product, million tenge; SE7 - volume of industrial production (goods, services), million tenge.*

2) ST - indicators of scientific-technological development: ST1 - export of high-tech goods, USD; ST2 - patent applications, residents; ST3 - scientific publications, units; ST4 - technicians in R&D, per million people; ST5 - domestic expenditure on R&D, million tenge; ST6 - share of innovative products (goods, services) in relation to GDP, %; ST7 - number of employees performing R&D, people.

*3) ** Correlation is significant at 0.01 level (bilateral); * Correlation is significant at 0.05 level (bilateral).*

Regression analysis showed that despite the presence of a correlation between R&D expenditures and GDP, the coefficients of the regression model are not statistically significant (Table 2).

Table 2

Regression analysis results*

Model	R	R^2	Adjusted R^2	SEE	Changed statistics					Durbin-Watson
					Changed R^2	Changed F	df1	df2	Changed significance F	
1	0,996[a]	0,993	0,9417	3405231,7	0,993	19,297	7	1	0,174	3,617

a. Predictors: (constant), ST7, ST2, ST6, ST5, ST1, ST4, ST3

b. Dependent variable: SE6

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Significance
1	Regression	1566298077348776,0	7	223756868192682,3	19,297	0,174[b]
	Residual	11595602925762,7	1	11595602925762,7		
	General	1577893680274538,8	8			

a. Dependent variable: SE6

b. Predictors: (constant), ST7, ST2, ST6, ST5, ST1, ST4, ST3

Coefficients

Model		Unstandardized coefficient		Standardized coefficient	t	Significance
		B	Standard error	Beta		
1	(constant)	1648462,909	57696245,378		0,029	0,982
	ST1	-0,004	0,011	-0,183	-0,337	0,793
	ST2	-4847,812	40792,712	-0,121	-0,119	0,925
	ST3	-1555,608	27585,164	-0,076	-0,056	0,964
	ST4	-70559,533	190818,226	-0,259	-0,370	0,775
	ST5	1111,092	342,006	0,910	3,249	0,190
	ST6	8561566,476	20594667,240	0,208	0,416	0,749
	ST7	-546,711	6770,609	-0,090	-0,081	0,949

a. Dependent variable: SE6

Thus, the analysis of the potential, structure and dynamics of Kazakhstani science development in 2011-2020 showed that R&D expenditures are growing. There is a significant increase in expenditures from the non-profit sector. Despite the growth in funding for all types of R&D over the period under review, funding for applied research predominates in Kazakhstan, with two-thirds of domestic R&D spending accounted for by natural sciences and engineering developments and technologies. Humanities, social and medical sciences remain the lowest-funded branches of science in the Republic. Scientific personnel have no statistically significant relationship with any parameter of socio-economic development. Domestic R&D expenditures are low and do not have a sufficiently strong impact on GDP which is largely uncorrelated with scientific-technological parameters. R&D parameters are still not the most significant factors of the socio-economic development of the country.

Conclusion. According the literature review there are a positive science impact on the country's socio-economic development, contributing to the emergence of new technologies, the development of human potential, and an improvement in the quality of life. But today, the scientific potential of Kazakhstan is still not revealed, and R&D results are not used to solve the applied problems of republic's socio-economic development.

The following main trends in Kazakhstani science development from 2011 to 2020 are observed:

1) R&D expenditures increased. The state budget plays the main role in R&D financing in the Republic, despite the fact that in the period 2011-2020 there is a decrease in the level of state support of science to 43.6% which is still significant, in the structure of domestic R&D expenditures. At the same time, there is a significant growth of expenditure on the part of the non-profit sector;

2) priority direction of R&D is research in the field of engineering development and technology. The humanities, social and medical sciences remain the most underfunded branches of sciences in the republic;

3) there is an uneven development of science in the regions in the country. Scientific activity is concentrated in Almaty and Astana which have significant infrastructure and R&D personnel potential.

Kazakhstani science is still at the formation stage. Kazakhstan's level of science intensity of economy indicates its critical level in order to ensure country's scientific and technological security. The relationship between parameters of scientific-technological and socio-economic development has an unstable and uneven character. Scientific-technological parameters are still not the most significant factors in the country's social and economic development. So, GDP growth and R&D expenditures are not interconnected, the scientific potential does not correspond to the economic one in the conditions of Kazakhstan.

The study results can serve as substantiation for key directions of developing scenarios and mechanisms to improve the efficiency of scientific-technological policy of the Republic of Kazakhstan. So, increasing R&D funding and the capacity of scientific personnel, developing scientific infrastructure, raising the quality of research and development requirements and other measures to increase the R&D efficiency can increase the of Kazakhstani science impact on country's socio-economic development.

This research article has been supported by the Science Committee of the Ministry of Education and Science of the Republic of Kazakhstan within the project «Scientific and technological space of the EAEU countries: structure, development mechanisms, ensuring the economic interests of Kazakhstan» (IRN AP09259768).

REFERENCES

1. Cohen W. M., Levinthal D. A. Innovation and learning: the two faces of R&D // The Economic Journal. – 1989. – № 99 (397). – P. 569-596.

2. Van Rensburg N. J., Telukdarie A., Dhamija P. Technology in Society 4.0 applied in Africa: Advancing the social impact of technology // Technology in society. – 2019. – № 59. – Art. 101125.

3. Wu M., Zhao M., Wu Z. Evaluation of development level and economic contribution ratio of science and technology innovation in eastern China // Technology in society. – 2019. – № 59. – Art. 101194.

4. State of the Nation Address by President of the Republic of Kazakhstan K.-J. Tokayev «Unity of the people and systemic reforms are a solid foundation for the nation's prosperity» (September 1, 2021). – https://primeminister.kz/en/addresses/01092021

5. Coccia M. Theorem of not independence of any technological innovation // Journal of economics bibliography. – 2018. – № 1(5). – P. 29-35.

6. Inekwe J.N. The contribution of R&D expenditure to economic growth in developing economies. Social indicators research. – 2015. – № 3. – P. 727-745.

7. Walwyn D. Finland and the mobile phone industry: A case study of the return on investment from government-funded research and development // Technovation. – 2007. – № 6-7. – P. 335-341.

8. Pop Silaghi M.I., Alexa D., Jude C., Litan C. Do business and public sector research and development expenditures contribute to economic growth in Central and Eastern European Countries? A dynamic panel estimation // Economic modelling. – 2014. – № 36. – P. 108-119.

9. Lee C-Y. The differential effects of public R&D support on firm R&D: theory and evidence from multi-country data // Technovation. – 2011. – № 5-6. – P. 256-269.

10. Coccia M. Political economy of R&D to support the modern competitiveness of nations and determinants of economic optimization and inertia // Technovation. – 2012. – № 6. – P. 370-379.

11. Pinto T., Teixeira A.A. The impact of research output on economic growth by fields of science: a dynamic panel data analysis, 1980–2016 // Scientometrics. – 2020. – № 123. – P. 945-978.

12. Jones Ch.I., Williams J.C. Measuring the social return to R&D // The quarterly journal of economics. – 1998. – № 113. – P. 1119-1135.

13. Tsipouri L. Can we benchmark the contribution of research and development investment to growth and competitiveness // Science and public policy. – 2001. – № 4(28). – P. 295-302.

14. Fursov K., Roshina Ya., Balmush O. Determinants of research productivity: an individual-level lens // Foresight and STI governance. – 2016. – № 2(10). – P. 44-56.

15. Manual for statistics on scientific and technological activities. – http://www.uis.unesco.org/Library/Documents/STSManual84_en.pdf

REFERENCES

1. Cohen W. M., Levinthal D. A. Innovation and learning: the two faces of R&D // The Economic Journal. – 1989. – № 99 (397). – P. 569-596.

2. Van Rensburg N. J., Telukdarie A., Dhamija P. Technology in Society 4.0 applied in Africa: Advancing the social impact of technology // Technology in society. – 2019. – № 59. – Art. 101125.

3. Wu M., Zhao M., Wu Z. Evaluation of development level and economic contribution ratio of science and technology innovation in eastern China // Technology in society. – 2019. – № 59. – Art. 101194.

4. State of the Nation Address by President of the Republic of Kazakhstan K.-J. Tokayev «Unity of the people and systemic reforms are a solid foundation for the nation's prosperity» (September 1, 2021). – https://primeminister.kz/en/addresses/01092021

5. Coccia M. Theorem of not independence of any technological innovation // Journal of economics bibliography. – 2018. – № 1(5). – P. 29-35.

6. Inekwe J.N. The contribution of R&D expenditure to economic growth in developing economies. Social indicators research. – 2015. – № 3. – P. 727-745.

7. Walwyn D. Finland and the mobile phone industry: A case study of the return on investment from government-funded research and development // Technovation. – 2007. – № 6-7. – P. 335-341.

8. Pop Silaghi M.I., Alexa D., Jude C., Litan C. Do business and public sector research and development expenditures contribute to economic growth in Central and Eastern European Countries? A dynamic panel estimation // Economic modelling. – 2014. – № 36. – P. 108-119.

9. Lee C-Y. The differential effects of public R&D support on firm R&D: theory and evidence from multi-country data // Technovation. – 2011. – № 5-6. – P. 256-269.

10. Coccia M. Political economy of R&D to support the modern competitiveness of nations and determinants of economic optimization and inertia // Technovation. – 2012. – № 6. – P. 370-379.

11. Pinto T., Teixeira A.A. The impact of research output on economic growth by fields of science: a dynamic panel data analysis, 1980–2016 // Scientometrics. – 2020. – № 123. – P. 945-978.

12. Jones Ch.I., Williams J.C. Measuring the social return to R&D // The quarterly journal of economics. – 1998. – № 113. – P. 1119-1135.

13. Tsipouri L. Can we benchmark the contribution of research and development investment to growth and competitiveness // Science and public policy. – 2001. – № 4(28). – P. 295-302.

14. Fursov K., Roshina Ya., Balmush O. Determinants of research productivity: an individual-level lens // Foresight and STI governance. – 2016. – № 2(10). – P. 44-56.

15. Manual for statistics on scientific and technological activities. – http://www.uis.unesco.org/Library/Documents/STSManual84_en.pdf

Сатпаева З.Т., Кангалакова Д.М., Мұқаев А.Н.

ҒЗТКЖ ҚАЗАҚСТАННЫҢ ӘЛЕУМЕТТІК-ЭКОНОМИКАЛЫҚ ДАМУ ФАКТОРЫ РЕТІНДЕ

Аңдатпа

Халықтың өмір сүру сапасының жоғары деңгейі бар ғылымды қажетсінетін және инновациялық экономиканы қалыптастыру мен дамытудың негізгі элементі ғылым болып табылады. Аталған зерттеудің мақсаты - СЖРАнің ұлттық статистика бюросының 2011 жылдан 2020 жылға дейінгі кезеңдегі статистикалық деректерін серпінді және эконометриялық талдау арқылы Қазақстанның әлеуметтік-экономикалық даму факторы ретінде ҒЗТКЖ-ға арналған шығыстарды талдау. Зерттеу барысында Қазақстандағы экономиканың ғылымды қажетсіну деңгейі өте төмен екені анықталды. Ғылымның параметрлері әлі де елдің әлеуметтік-экономикалық дамуының маңызды факторлары болып табылмайды. Алынған нәтижелер ғылымды қажетсінетін және инновациялық экономика құру және Қазақстан халқының әл-ауқатын арттыру мақсатында ғылымның тиімділігін арттыру қажеттілігі туралы куәландырады. Зерттеу нәтижелері Қазақстан Республикасының ғылыми-техникалық саясаттың тиімділігін арттыру бойынша сценарийлерді және тетіктерді әзірлеудің басты бағыттарына негіздеме бола алады.

Сатпаева З.Т., Кангалакова Д.М., Мукаев А.Н.

НИОКР КАК ФАКТОР СОЦИАЛЬНО-ЭКОНОМИЧЕСКОГО РАЗВИТИЯ КАЗАХСТАНА

Аннотация

Наука является основным элементом формирования и развития наукоемкой и инновационной экономики с высоким уровнем качества жизни населения. Цель данного исследования – проанализировать расходы на НИОКР как фактор социально-экономического развития Казахстана посредством динамического и эконометрического анализа статистических данных Бюро национальной статистики АСПР за период с 2011 по 2020 годы. В ходе исследования выявлено, что уровень наукоемкости экономики в Казахстане очень низкий. Показатели науки все еще не являются наиболее значимыми факторами социально-экономического развития страны. Полученные результаты свидетельствуют о необходимости повышения эффективности науки в целях создания наукоемкой и инновационной экономики и повышения благосостояния населения Казахстана. Результаты исследования могут служить обоснованием ключевых направлений при разработке сценариев и механизмов по повышению эффективности научно-технологической политики Республики Казахстан.