Research Article

Received: 7 September 2023 / Accepted: 19 October 2023 / Published: 5 November 2023

Transformation of Human Capital as a Driver of Innovative Economy

Renata Gimranova

Yerkara Aimagambetov

Karina Nevmatulina

Albina Garipova

Saule Mazhitova

Saltanat Kudaybergenova

Karaganda University of Kazpotrebsoyuz,
Academic st. 9, Karaganda, 100009,
Kazakhstan

DOI: https://doi.org/10.36941/ajis-2023-0164

Abstract

The purpose of this study was to identify key factors that have a significant impact on the level of high-tech production in the region and the development of human capital in seven countries of the Caucasus and Central Asia. A comprehensive literature analysis was carried out to achieve this goal, including data from several countries of the Caucasus and Central Asia, including demographic data, education levels, labor market indicators, health indicators, and research activities. The authors constructed a model of multiple spatial regression, including seven spatial objects and a 5-time series. A qualitative model of cumulative panel regression without signs of multicollinearity was obtained as a result of the step-by-step elimination of collinear and nonessential variables. The results of the study revealed three key factors that are closely and directly related to the level of production of high-tech products. Two relate to the education sector – "the number of university graduates in the field of science and technology", and "the number of researchers per 1 million inhabitants" and one indicator characterizes the labor market – "the employment level in the economy". The authors did not identify a close relationship between the level of high-tech production and economic factors, such as cost and productivity, which contradicts the results of other research and requires more careful study. The results of the research can be useful in the development of measures to promote human capital and innovation policy of the countries of the Caucasus and Central Asia.

Keywords: *human capital, labor market, innovative development, R&D, high-tech production*

1. Introduction

There is a large number of studies that have described the role of knowledge and innovation in ensuring economic growth. The expansion of opportunities for access to innovation and knowledge has a positive and significant impact on economic growth (Trujillo and Lacalle-Calderon, 2020).

Human capital is a key element of the knowledge-based economy, which influences innovation and positive economic growth (Barkhordari et al., 2019; Kamilova, 2022).

The high-tech sector (industries with high R&D intensity are considered (Galindo-Rueda and Verger, 2016)) of production, with modern technologies, acts as a driver of innovative development of national economies (Kryukov, 2021). The development of high-tech industries is conditioned by the need to increase the competitiveness of manufacturers in foreign and local markets. The results of scientific research are commercialized through the development of high-tech sectors of the economy (Astakhova et al., 2019).

Researchers identify the following resources as the most important ones necessary for the development of high-tech industries (González-Varona et al., 2023; Hall and Lerner, 2009; Serebryakova et al., 2020; Tirelli and and Spinesi, 2018): R&D expenditures, human capital, ICT and general infrastructure, R&D financing and lending, business environment, intellectual property, and export and import of high-tech products.

Based on this, the study of the relationship between the indicators characterizing the development of human capital and the level of high-tech production as one of the resultant indicators of the innovativeness of economies seems to be an urgent direction for this empirical study.

The focus of this study is focused on the Caucasus and Central Asia (CCA), which unites eight post-Soviet countries, five of which belong to Central Asia (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan) and three to the Caucasus (Armenia, Azerbaijan, and Georgia), formed as a result of the collapse of the Soviet Union in 1991.

Currently, the region is a capacious sales market with a growing potential for labor resources, which demonstrates significant growth in socio-economic development and has prospects for the development of human capital and the introduction of innovations.

Based on this, the purpose of the research is to study the main trends in the qualitative and quantitative transformation of the human capital of the CCA region, to determine the level and dynamics of innovative development of the countries of the region, as well as to identify the strength and nature of the relationship between the indicators of human capital development and the level of high-tech production of industrial products.

1.1 Theoretical Foundations of the Formation of an Innovative Economy and High-Tech Production

A significant part of theoretical works in the literature is devoted to the study of the role of human capital as one of the most important resources of the innovative economy and the development of high-tech industries (Gwon, 2023; Munjal and Kundu, 2017; Qureshi et al., 2020; Tukhtarova and Vlasov, 2021).

In particular, researchers have identified a close positive relationship between the human development index and the economic development level (Al-Marzouki et al., 2022; Budilova and Lagutin, 2023; Diebolt and Hippe, 2019). In addition, there is a sufficient amount of research on the impact of certain socio-demographic factors on the quality of human capital. For example, education and R&D as part of human capital are extremely important for achieving high rates of economic growth (Mohamed et al., 2022). The level of GDP per capita, the development of innovation, and the competitiveness of economies. The results of an extensive number of studies confirm the importance of education for innovation (Boțoroga et al., 2022; Marcin, 2021; Ziberi et al., 2022), in particular the number of students and researchers in the country.

A certain part of the researchers cites convincing evidence of the primacy of socio-demographic factors in the formation and development of human capital (Chistyakova, 2022; Iontsev and Magomedova, 2015; Lutz et al., 2018). Currently, the hypothesis is that an increase in life expectancy increases the motivation to accumulate knowledge and acquire the best skills of human capital.

The state of the labor market is considered a significant factor in the development of human capital in the scientific literature. For example, researchers note that the fundamental prerequisite for the accumulation of human capital is the age (Prenzel and Yammarino, 2021) and mobility of the workforce (Bliznyuk and Yatsenko 2023), the level of employment and self-employment (Hazaimeh et al., 2023; Novruzov, 2023; Rahman et al., 2022), as well as the average wage in the region.

However, the influence of individual components of human capital on the level of high-tech production as one of the key indicators of the innovative economy is not universal. It depends on the methodology used in the study, the level of socio-economic development of the region, the geopolitical situation, and other factors that researchers identify in their research, the significance of which may be ambiguous. For example, R&D intensity is the ratio of R&D expenditure to output, usually gross value added. Many studies confirm the presence of a statistically significant impact of R&D expenditures on economic growth (Freimane and Balina, 2016; Hafeez et al., 2019; Sezgin, 2020). Therewith, several other studies do not find sufficient evidence to make an unambiguous conclusion that there is a close positive relationship between R&D spending and economic growth (Canbay, 2020; Huseynli, 2023).

This study will fill the existing gaps in scientific knowledge by proposing a methodology for collecting data and evaluating individual components of human capital at the level of high-tech production, focusing on a group of developing countries in the Caucasus and Central Asia, historically interconnected, having socio-cultural and economic ties.

1.2 Research Background

Despite the successes achieved in economic development in recent years, the driving force behind the growth of most CCA countries is the export of raw materials with a low level of complexity, such as minerals, grains, and low-tech industrial goods, as well as remittances from migrant workers.

Despite the ongoing reforms, the knowledge-intensive and high-tech industries of most CCA countries are at the stage of development. The only two countries in the CCA region that are characterized by a relatively high technological component of industrial production are Azerbaijan and Kazakhstan.

The structure of the manufacturing industry of the region's countries is still dominated by medium- and low-tech industries, and medium-high-tech and high-tech industries account for from 2% in Kyrgyzstan to 21% in Uzbekistan of the value added to GDP (UNIDO Statistical Data Portal, n.d.). Thus, the share of high-tech exports in the total volume of exports of industrial products in the region varies from 1 to 8.8% (except for Kazakhstan, where this indicator reaches 33%) (World Integrated Trade Solution, n.d.).

Currently, none of the CCA countries plays a significant role in the international markets of knowledge-intensive and high-tech products, and the level of innovation in the economies of the region remains low.

Thus, the development of new knowledge-intensive and high-tech sectors of the economy is a prerequisite for sustainable economic growth and is among the priorities of the state policy of the countries of the CCA region.

The formation of a highly productive economy, in turn, requires certain professional competencies and high-quality human capital. Despite significant differences between countries, human capital remains a strong point of the CCA region compared to the level of its economic development.

The CCA countries are characterized by a high level of primary education, have a common tradition of state scientific research, and show a strong commitment to innovation, which indicates that there is significant potential for sustainable growth.

However, the professional skills of the workforce of most CCA countries do not fully meet the needs of the market, and innovation-related competencies are not sufficiently developed, which is the main cause of problems for successful innovation.

2. Methods

Statistical observation of indicators characterizing the demographic situation, the state of labor markets, the level of education, public health, productivity, and labor costs in the Caucasus and Central Asia (CCA) region was used to analyze the processes of transformation of human capital. The CCA region includes 8 countries Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Uzbekistan, Tajikistan, and Turkmenistan. However, our study does not consider the indicators of Turkmenistan due to the lack of statistical data for this country. The databases of the United Nations on Labor Statistics, the UNESCO Institute for Statistics in Education, Research and Development (R&D), the World Bank, the UNECE, and the CIS statistics database serve as information sources for data collection.

We use a set of panel data reflecting annual observations over 5 years for 7 countries of the CCA region to assess the degree and nature of the relationship between the factors of transformation of human capital and the level of production of innovative products and services.

Based on the available knowledge about the concept of human capital, 10 variables characterizing the demographic, educational, and economic potential of the workforce and public health of the population have been identified (Table 1).

Table 1. A system of indicators for assessing the transformation of human potential

Factors	Variables	Source of information
Labor market	X1 The number of people employed in the economy, people per 1 thousand population	ILOSTAT https://ilostat.ilo.org/data/country-profiles/
	X2 Labor force participation rate (an indicator of labor force activity in the economy)	
	X3 Age dependence coefficient (% of the working-age population)	The World Bank https://data.worldbank.org/indicator/SP.POP.DPND
Education	X4 The number of university students per 10 thousand people of the population, people.	CIS State Committee http://new.cisstat.org/web/guest/cis-stat-home
	X5 The share of all graduates of higher educational institutions in the field of natural sciences, mathematics, statistics, information and technology, manufacturing, engineering, and construction, in % of all graduates of higher educational institutions.	Global Innovation Index https://www.globalinnovationindex.org/analysis-economy
	X6 Number of researchers per million inhabitants, people.	UNESCO Institute of Statistics (SIU) http://data.uis.unesco.org/
Health	X7 Life expectancy at birth, years	UN Population Division Data Portal https://population.un.org/dataportal/home
	X8 Probability of death of the population aged 15-50 years.	
Economy	X9 GDP per 1 employed person, USD in international US dollars by PPP	World Bank, a database of world development indicators https://data.worldbank.org/indicator/SL.GDP.PCAP.EM.KD?view=chart
	X10 Average salary, USD per 1 employee	UNECE Statistical Database UNECE https://w3.unece.org/PXWeb2015/pxweb/ru/STAT/STAT__20-ME__3-MELF/60_ru_MECCWagesY_r.px/

As a dependent variable Y, the level of development of high-tech types of production in the economy is chosen as the most informative indicator of the effectiveness of innovation activity in the country. According to the OECD classification of industries by technological intensity, high-tech sectors include the pharmaceutical industry, the production of computers, electronic and optical products, and the production of aircraft and spacecraft (UNIDO n.d.). The medium-technology sector includes the production of weapons and ammunition, automobiles, medical and dental instruments, chemicals and chemical products, electrical equipment, railway and other transport equipment.

The information sources are the interactive database of GII indicators (WIPO 2022) and the database of the United Nations Industrial Development Organization (UNIDO) (UNIDO Databases, n.d.).

We chose the least squares regression analysis to study the interdependence of the level. We applied panel regression since there are no statistical data on the indicator of graduates in the field of science and technology in the Republic of Uzbekistan in 2017-2018. Unlike standard regression models, which, in the absence of some variables, lead to distortion of estimates of cause-and-effect relationships, panel regression makes it possible to mitigate the bias of unobserved independent variables and objectively assess the interdependence of dependent and independent variables.

3. Analysis Results

3.1 Indicators of the Transformation of Human Capital in the CCA Region

According to UN estimates, the current population of the CCA region is about 86567.6 million people, which is about 1.1% of the world population.

The CCA is one of the youngest regions, the average age of the population in 2021 was 29.08 years (this indicator is 30 years in the whole world, 31.19 years in the Asian region, 41.7 years in Europe).

The CCA is among the leaders in population reproduction: the average fertility rate in the CCA countries in 2021 was 19.11, which is more than 2 times higher than in European countries and 1.4 times higher than in the Asian region as a whole. The net reproduction rate of the CCA population is almost 1.8 times higher than in Europe and 1.4 times higher than in the Asian region as a whole.

The characteristics of the demographic situation in the CCA region are presented in Table 2.

Table 2. Characteristics of the demographic situation in the CCA countries in 2021

	Total population, million people.	The average age of the population, years	Fertility rate	Net reproduction rate
Azerbaijan	10,233,798	31.44	12.33	0.76
Armenia	2,971,243	34.40	12.05	0.74
Georgia	3,944,474	36.37	13.41	0.99
Kazakhstan	18,953,799	29.53	21.54	1.47
Kyrgyzstan	6,578,177	23.74	24.13	1.42
Tajikistan	9,641,343	21.47	26.75	1.49
Uzbekistan	33,723,529	26.59	23.55	1.35
Overall for CCA	86,046,363	29.08	19.11	1.17

Despite the strong migration outflow, over the past 5 years, the population of the region has increased by almost 4.74 million people over this period, increasing by 1.2% annually. The population growth of the CCA in 2017-2021 amounted to more than 5.8%, which is considered quite high (for example, in China this figure was only 2.36%, in Russia – 0.58%, in the EURO area -27 – 1%). Note: Calculated according to the UN Population Division portal. https://population.un.org/dataportal /home.

Thus, the favorable demographic situation in the CCA countries allows us to preserve identity and increase the potential of human resources.

However, against the background of the continuing population growth, the problem of employment of the population, and first of all, youth, remains extremely urgent for most CCA countries. According to the World Bank, unemployment in the countries of the region ranges from 4.77% in Kyrgyzstan to 12.73% in Armenia, the youth unemployment rate ranges from 3.73% in Kazakhstan to 36.08% in Armenia. The labor market indicators of the CCA region in 2021 are presented in Table 3.

Table 3. *Labor market indicators of the CCA region in 2021*

Countries	Unemployment rate, %	Youth unemployment rate, %	Several employees, people. Per 1 thousand population	Labor force activity coefficient in the economy
Azerbaijan	5.95	14.3	492.9	66.659
Armenia	12.73	24.8	479.9	62.442
Georgia	12.21	30.9	330	63.818
Kazakhstan	5.16	4	466.5	69.411
Kyrgyzstan	4.77	9.2	417.2	59.18
Tajikistan	7.74	17	255.1	41.168
Uzbekistan	6.02	13.6	391.8	56.435

In 2021, 35.224 million people were employed in the economy of 7 countries of the CCA region (excluding Turkmenistan).

In terms of employment from the countries under consideration, Azerbaijan is leading with an indicator of 492.9 people / thousand population, Armenia – 479.9 people / thousand population, and Kazakhstan – 466.5 people /thousand population. The lowest employment rate is observed in the Republic of Tajikistan 255.1 people/thousand of the population.

Only two of the seven countries under consideration (Azerbaijan and Armenia) show an increase in employment over the past five years. The most impressive increase in employment occurred in the Republic of Armenia, where this indicator increased by more than 40%.

Over the past five years, the total number of officially unemployed in the CCA region has increased from 2202.3 thousand people to 2854.4 thousand people, i.e. by almost 30%. The share of the population actively participating in the labor market is steadily decreasing (except for Azerbaijan and Armenia). In many ways, this trend can be explained by the economic downturn caused by the COVID-19 pandemic.

The youth unemployment rate among the countries of the region varies from 4% to 30.9%. The low activity of young people in the labor market of Armenia and Georgia is of concern, where this indicator significantly exceeds the global average (14.7%).

The proportion of young people who do not work, do not receive education and professional skills in the region remains quite high, although there is a slight decrease in this indicator. Thus, this indicator was 23.5% in Armenia in 2021, in Kyrgyzstan – 15.9%, in Georgia – 24.9%

The current trend in the labor market in most CCA countries leads to increased tension in local markets and to an aggravation of the problem of imbalance of supply and demand for labor, which is largely explained by the discrepancy between the education system and the professional training of the workforce.

The share of the working-age population with higher and secondary vocational education in Central Asia is significantly lower than in Russia or European countries.

The level of education has improved somewhat but remains relatively low in most CCA countries. Georgia and Kazakhstan are leaders in the level of education (Figure 1).

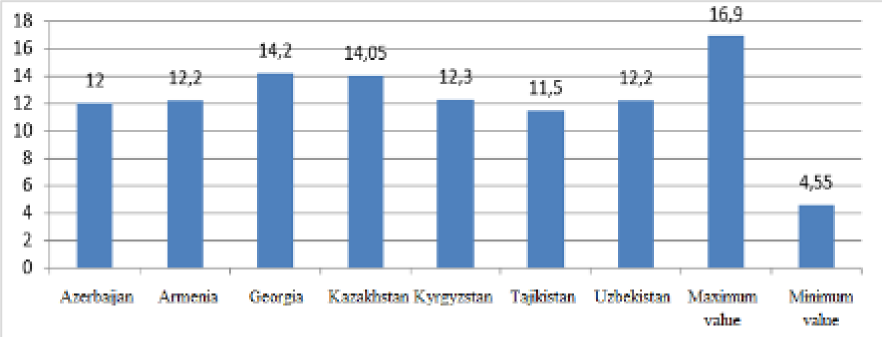

Figure 1. Education level ranking 2022
Note: Ranking of the countries of the world according to the education level index. United Nations Development Programme: Education Index 2022. https://gtmarket.ru/ratings/education-index

In 2021, the total enrollment rate of higher education ranges from 21.25% in Uzbekistan, and to 78.83% in Georgia. The positive dynamics of this indicator in all countries of the region over the past five years should be noted, which indicates an increase in the educational level of the region's population.

The quality of education is of concern. According to the results of the Best Global Universities ranking (U.S. News n.d.), only 5 CCA universities were included in the list of 2000 best universities in the world. The leading system of higher education in the CCA region is Georgia (2 universities that ranked 776 and 801), and Kazakhstan (2 universities ranked 1275 and 1664). In addition, Armenia is represented in the ranking of the best universities in the world: the Yerevan Institute of Physics ranked 826 in the ranking of the best universities in the world by the end of 2022. The universities of the rest of the CCA countries were not included in the ranking of the 2000 best universities.

In addition, in the CCA countries, the level of orientation of educational programs in the CCA remains low for teaching skills necessary for innovation, such as analytical and critical thinking, the ability to self-development, creativity, etc.

Thus, the Global Skills Index ranking Coursera Global Skills Report 2022 included 5 out of 7 CCA countries. Armenia (22nd place), Kazakhstan (24th place), and Georgia (32nd place) occupy quite high places in the ranking.

These countries are leaders in terms of technology proficiency (81%, 96%, and 82%, respectively). Only Armenia has achieved a high level of proficiency in data science (84%), while this indicator is significantly lower in Kazakhstan and Georgia and amounts to 55% and 49%, respectively.

Azerbaijan and Uzbekistan, on the contrary, occupy low – 74th and 84th lines of the ranking, respectively. These countries are characterized by a low level of technology proficiency (12% and 19%, respectively). The skills of working with data are more developed: in Azerbaijan – 25%, in Uzbekistan – 29%.

In general, it should be noted that over the past decade, all CCA countries have demonstrated progress in the transformation of human capital, but this progress is taking place at a moderate pace. This is confirmed by the dynamics of the human development index over the past decade (Figure 2)

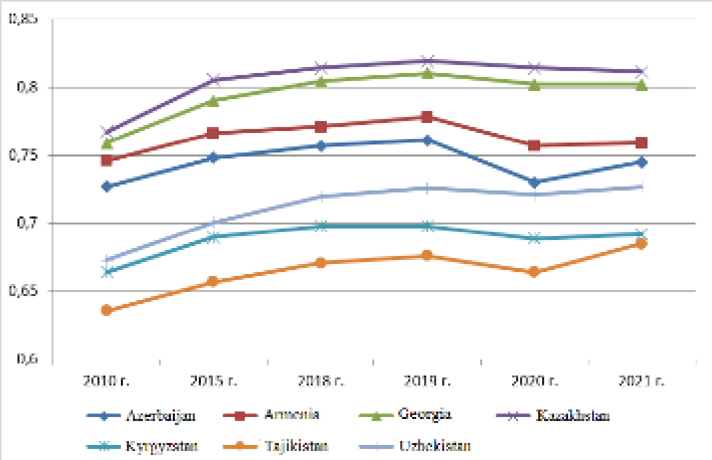

Figure 2. Dynamics of the Human Development Index of CCA countries
Note: Human Development Report for 2021-2022

Georgia and Kazakhstan are the leaders of human development in the CCA region and are included in the category of countries with a very high human development index, demonstrating positive dynamics of its growth.

The category of countries with a high level of human development includes Azerbaijan, Armenia, and Uzbekistan with an HDI of 0.745, 0.759, and 0.727, respectively.

Kyrgyzstan and Tajikistan are in the second hundred of the ranking and retain positions in the group with an average level of human capital.

By 2021, Uzbekistan and Tajikistan have made the greatest progress in improving their positions in the human development ranking: The growth of HDI value for 2010-2021 amounted to 8.02 and 7.7%, respectively.

Thus, the shortage of qualified personnel, the low level of education of the able-bodied population, the withdrawal of the able-bodied population from the formal employment sector, and the underdevelopment of the labor market due to the immaturity of market relations in most CCA countries leads to a decrease in the quality of human capital. In addition, the active outflow of highly skilled labor and knowledge from CCA countries leads to a decrease in the competitiveness of their innovation processes and systems.

3.2 Results of Innovative Development of CCA Economies

In recent years, awareness of the importance of scientific and technological development and innovation has been actively formed in the CCA countries, work has been carried out to strengthen local capacity for innovation.

R&D expenditure in the CCA region has increased by 86.258 million US dollars over the past five years, or by 18.5% (Table 4).

Table 4. R&D expenditures in the CCA region, USD million

CCA countries	2017	2018	2019	2020	2021	Change 2021/2017	
						+/-	%
Azerbaijan	75.472	86.762	96.411	95.782	114.707	39.235	52.0%
Armenia	26.269	23.516	24.316	26.448	29.109	2.84	10.8%

CCA countries	2017	2018	2019	2020	2021	Change 2021/2017	
						+/-	%
Georgia	43.893	49.37	49.753	47.666	46.741	2.848	6.5%
Kazakhstan	211.293	209.523	215.112	215.598	255.653	44.36	21.0%
Kyrgyzstan	8.248	8.36	7.998	6.951	7.689	-0.559	-6.8%
Tajikistan	8.258	7.3	7.775	7.242	7.872	-0.386	-4.7%
Uzbekistan	92.091	65.528	68.157	83.361	90.011	-2.08	-2.3%
Total	465.524	450.359	469.522	483.048	551.782	86.258	18.5%

Note: Calculated by the author according to the statistical data of the Asian Development Bank. https://kidb.adb.org/

The highest growth rate of R&D expenditures is observed in Azerbaijan (+52%) and Kazakhstan (+21.0%). R&D expenditures in Tajikistan and Uzbekistan in 2021 increased compared to the previous year, however, they did not reach the indicator of 2017.

Despite the growth of R&D expenditures in absolute terms, their share in GDP remains low compared to the leading countries in innovation output (Figure 3).

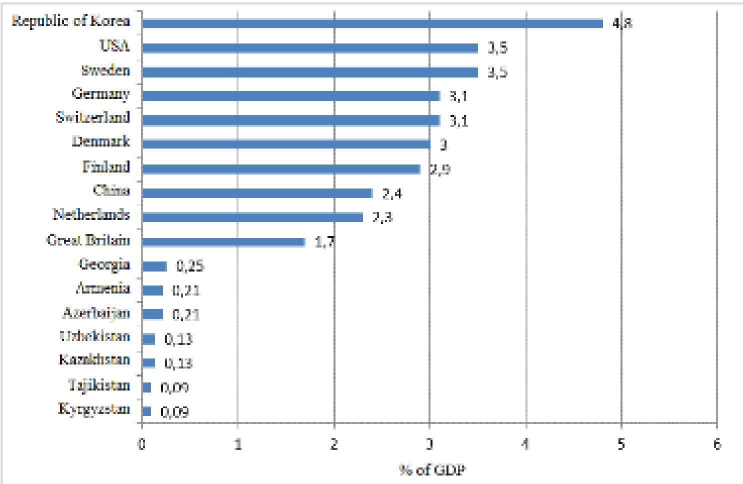

Figure 3. Level of R&D expenditures of GDP, %, 2021
Note: According to the economic reports from the GII 2022. https://www.globalinnovationindex.org /analysis-economy

To form knowledge-based societies, countries are making efforts to intensify scientific research and increase their technological potential by increasing the number of employees in the field of R&D. Thus, the total number of researchers per 1 million population of the CCA has increased by 287 people over the last five years.

In three countries of the region – Azerbaijan, Kazakhstan, and Kyrgyzstan – researchers decreased by 5.1%, 5.7%, and 1.7%, respectively, while in other CCA countries, their number increased from 3.9% in Uzbekistan to 24.2% in Georgia. The leaders in the number of researchers in the equivalent of full employment among the CCA countries are Georgia, Azerbaijan, and Armenia. These indicators lag significantly behind the innovation-leading countries (Figure 4).

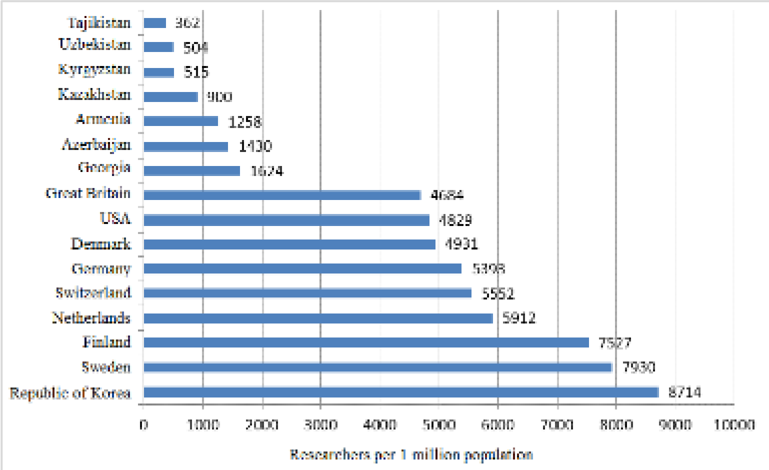

Figure 4. Number of researchers per 1 million population, 2021
Note: According to the economic reports from the GII 2022. https://www.globalinnovationindex.org/analysis-economy

The focus of the attention of the public authorities of the CCA countries is the problem of the development of medium- and high-tech industries as one of the significant results of innovation activity. However, significant progress in this area has not yet been achieved by the CCA countries. Thus, the level of medium- and high-tech production in the total volume of industrial production is several times lower than the indicators of the leading countries of innovation output (Figure 5).

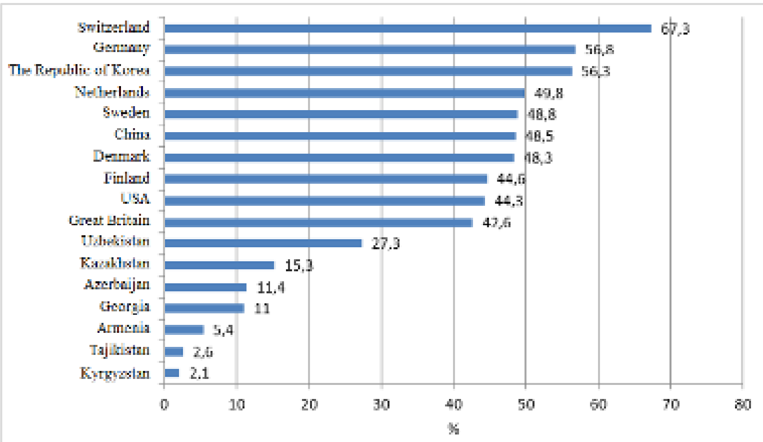

Figure 5. High-tech and medium-high-tech output, % of total industrial production

The leader of high-tech production is Uzbekistan among the CCA countries, which has made significant progress in carrying out the most important transformations of the manufacturing sectors of the economy in recent years.

The indicators of innovation in the economies of the CCA countries remain quite low despite the high priority of high-tech development. Thus, the positions of most countries in the region are stable and are in the second half of the Global Innovation Index ranking of the country on the horizon of five years (Figure 6).

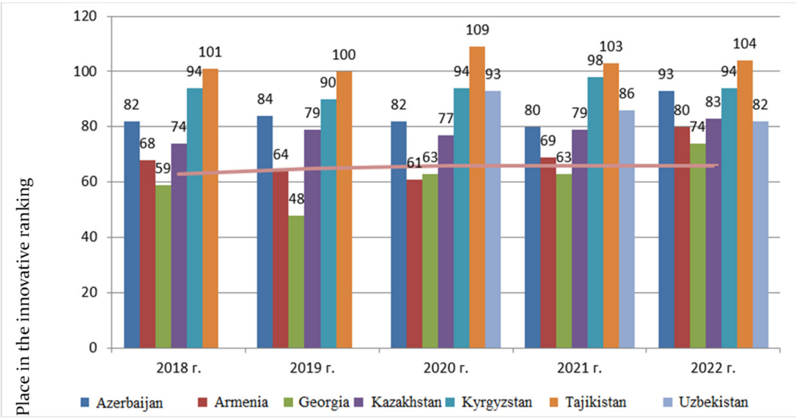

Figure 6. CCA countries' positions in the Global Innovation Index ranking in 2018-2022

According to the results of 2021, the ranking of the effectiveness of innovative systems among the CCA countries is headed by Georgia. It should be noted that Georgia has significantly lost its position in the innovation ranking in five years. Georgia performed best in 2019, demonstrating significant success in high-tech import-export of information and communication services. However, since 2020, Georgia's position in the ranking has weakened somewhat, and by the end of 2021, the country ranked 74 out of 132 countries.

The last place in the ranking among the CCA countries is occupied by Tajikistan, ranking 104th in 2022. Although Uzbekistan was not represented in the Global Innovation Index ranking until 2020. Therewith, since 2020, Uzbekistan has steadily strengthened its position, ranking 82nd place by the end of 2022, overtaking Kazakhstan, Azerbaijan, Kyrgyzstan, and Tajikistan (Table 5). Except for Armenia and Tajikistan, investments in innovations in CCA countries are higher than the results obtained.

Table 5. Ranking of CCA countries by contribution and results of innovation

CCA countries	2018		2019		2020		2021		2022	
	Contribution to innovation	Innovation results	Contribution to innovation	Innovation results	Contribution to innovation	Innovation results	Contribution to innovation	Innovation results	Contribution to innovation	Innovation results
Azerbaijan	76	87	77	90	76	86	74	91	79	110
Armenia	94	50	85	50	83	47	85	56	82	73
Georgia	53	62	44	60	54	71	49	74	61	82
Kazakhstan	55	91	64	92	60	94	61	101	65	97
Kyrgyzstan	85	101	78	111	88	107	81	119	85	108
Tajikistan	104	88	107	83	108	99	104	96	104	101
Uzbekistan	N/A	N/A	N/A	N/A	81	118	75	100	68	91

Thus, the level of innovative development of the economies of the CCA countries remains low despite the ongoing reforms. According to key indicators of the effectiveness of innovation activities, such as the share of medium- and high-tech output in the total volume of industrial production, the share of exports of high-tech products, the share of creative goods in the total volume of foreign trade, the volume of income from the sale of intellectual property rights, the countries of the region occupy low places in the world innovation ranking.

3.3 *Panel Regression Results*

The initial data for constructing a panel regression model are presented in Table 6.

Table 6. Initial data for the panel regression model

	Y	X1	X2	X3	X4	X-5	X-6	X7	X8	X9	X-10
Azerbaijan	13.1	491.5	65.18	43.7	171	41.3	1,507	72.25	64.83	29,614.8	313.2
	11.4	493	65.68	43.96	179	40.8	1,461	72.76	61.08	29,626.9	307.1
	10.8	494.8	65.53	44.21	189	38.2	1,521	73.1	59.62	30,196.3	320.4
	15.1	484.4	67.54	44.29	199	47.1	1,499	66.87	113.76	30,845.5	373.6
	11.4	492.9	66.66	44.18	211	49.6	1,430	69.37	77.83	31,837.4	416.1
Armenia	2.4	338.8	61.72	45.59	305	14.3	1,204	74.91	46.82	34,307.3	363.1
	3.8	444.9	61.65	46.69	271	15.9	1,140	75.06	46.01	38,493.5	368.4
	4.4	462.8	62.78	47.77	253	15.3	1,135	75.44	43.89	40,650.1	357.6
	4.7	460.9	62.00	48.7	269	22.1	1,178	72.17	55.46	41,515.9	380.2
	5.4	479.9	62.44	49.63	265	17.1	1,258	72.04	56.61	43,431.6	388
Georgia	9.7	345.1	66.21	52.22	292	34.1	1,307	73.57	63.38	29,858.8	397.2
	7.1	348.1	63.93	53.21	298	25.9	1,464	73.34	64.38	32,093.1	398.1
	7.6	348.7	62.93	54.1	301	41	1,699	73.47	63.38	33,971.8	421.5
	9.8	333	63.40	54.82	316	43.2	1,712	72.77	64.88	36,526.0	400.6
	11	330	63.82	55.4	315	30.9	1,624	71.69	71.47	37,281.4	383
Kazakhstan	10.1	479.1	70.23	54.73	273	38.3	954	71.40	84.30	52,475.8	417.6
	9.9	477	70.13	56.23	295	44.2	955	71.47	82.84	53,541.1	462.7
	9.6	476.2	70.08	57.65	324	41.5	925	71.57	81.69	55,545.7	471.9
	13.5	468.7	69.20	58.95	305	41.8	972	70.03	88.54	54,460.7	488.1
	15.3	466.5	69.41	59.95	301	49.3	900	69.36	88.20	56,411.5	514.9
Kyrgyzstan	2.6	421.3	60.08	59.46	269	27	524	70.59	85.35	13,530.9	212.4
	2.1	418.9	58.81	60.72	268	31.9	555	70.73	84.65	14,145.3	227.5
	2.7	412.9	60.17	61.97	293	30.7	527	71.23	81.36	14,620.8	238.6
	2.4	408.9	59.27	62.92	336	29.4	534	69.63	87.41	14,107.7	246.9
	2.1	417.2	59.18	63.53	355	32.7	515	69.98	85.23	14,306.8	244.9
Tajikistan	1.4	275.3	41.94	65.64	219	35	324	69.9	69.58	13,113.8	122.8
	1.4	271.6	41.46	65.71	232	36.4	328	70.35	66.49	13966.3	134
	2.8	269.9	41.01	65.85	249	34.1	374	70.87	63.26	14,834.2	135.2
	2.8	269.1	40.62	65.92	261	36	351	67.99	74.95	15,376.3	140.1
	2.6	255.1	41.17	65.94	244	42.4	362	71.59	57.36	16,502.3	135
Uzbekistan	23.6	420.9	56.85	50.06	91	N/A	485	71.01	69.82	17,072.8	436.3
	29.2	406.5	56.71	50.88	108	N/A	470	71.15	68.73	17,817.6	282.1
	26.9	407.2	56.55	51.91	130	70	407	71.34	67.19	18,646.9	225.8
	24.4	390.4	55.77	52.99	165	71.5	411	70.33	68.74	19,518.8	262.8
	22.8	391.8	56.44	53.97	229	92.9	504	70.86	65.33	20,640.0	265.1

The results of constructing the least squares model 1, which includes 33 observations, are presented in Table 7.

Table 7. Parameters of panel model No. 1

	Coefficient	*St. error*	*t-statistics*	*P-value*
const	102.686	60.0654	1.710	0.1014
X1	-0.047	0.017	-2.809	0.0102
X2	0.877	0.333	2.632	0.0152
X3	-0.041	0.189	-0.2163	0.8307

	Coefficient	*St. error*	*t-statistics*	*P-value*
X4	-0.058	0.019	-3.091	0.0053
X5	0.233	0.042	5.560	1.37e-05
X6	-0.004	0.002	-2.042	0.0533
X7	-1.44893	0.87	-1.665	0.1102
X8	-0.199	0.12	-1.665	0.1100
X9	4.021	0.000	0.3922	0.6987
X10	0.003	0.023	0.1395	0.8903

The indicators characterizing the quality of the constructed model are presented in Table 8.

Table 8. Statistical model quality indicators

Mean of dependent variables	8.578788	Standard deviation of dependent variables	6.754524
Sum of quadratic remainders	112.4670	St. model error	2.261003
R-square	0.922965	Rev. R-square	0.887950
F(10, 22)	26.35861	P-value (F)	5.78e-10
Logarithmic plausibility	-67.05648	Akaike criterion	156.1130
Schwarz Criterion	172.5746	Hannan-Quinn information criterion	161.6518
Rho parameter	0.088304	Durbin-Watson Statistic	1.179896

In the obtained model, the actual Fisher value = 26.35861 at α =0.05 significantly exceeds the critical value equal to 2.2967, which allows us to conclude the significance of the obtained model. Therefore, in general, the model is significant. For variables X3, X9, and H10, the regression parameters are zero and the hypothesis of the insignificance of these coefficients is accepted concerning them.

As a result, a second-panel regression model was obtained, the parameters of which are presented in Table 9.

Table 9. Parameters of panel model No. 2

	Coefficient	*St. error*	*t-statistics*	*P-value*
const	123.558	50.9541	2.425	0.0229
X1	-0.049	0.014	-3.383	0.0024
X2	1.024	0.205	4.994	3.79e-05
X4	-0.057	0.012	-4.591	0.0001
X5	0.230	0.038	6.063	2.46e-06
X6	-0.004	0.002	-2.323	0.0286
X7	-1.802	0.684	-2.632	0.0143
X8	-0.256	0.085	-2.998	0.0061
Mean of dependent variables	8.578788	Standard deviation of dependent variables		6.754524
Sum of quadratic remainders	118.2389	St. model error		2.174755
R-square	0.919012	Rev. R-square		0.896335
F(7, 25)	40.52678	P-value (F)		4.29e-12
Logarithmic plausibility	-67.88227	Akaike Criterion		151.7645
Schwarz Criterion	163.7366	Hannan-Quinn Information Criterion		155.7928
Rho parameter	0.027966	Durbin-Watson Statistic		1.291890

Checking model No. 2 for the presence of multicollinearity showed that the variables of the VIF criterion for variables X2, X7, and X8 exceed 10, i.e., they are collinear (Table 10).

Table 10. Results of checking the model for multicollinearity

Variables	VIF value	Presence of a multicollinearity sign
X1	8.595	Absent
X2	23.033	Present
X4	3.051	Absent
X5	2.583	Absent
X6	4.467	Absent
X7	11.589	Present
X8	10.911	Present

After excluding factors with signs of collinearity from further consideration, a third-panel regression model was obtained, including four variables independent of each other, three of which are significantly below the established significance level of 0.05. The p-value of the variable X4 exceeds 0.05 and is 0.148, which gives reason to accept the null hypothesis concerning it and recognize it as insignificant.

A qualitative model of cumulative panel regression without signs of multicollinearity was obtained as a result of the step-by-step elimination of collinear and nonessential variables (Table 11).

Table 11. Parameters of panel model No. 2

	Coefficient	*St. error*	*t-statistics*	*P-value*
const	-16.0493	3.10266	-5.173	1.57e-05
X1	0.0181176	0.00759713	2.385	0.0238
X5	0.362085	0.0344177	10.52	2.06e-011
X6	0.00362414	0.00128589	2.818	0.0086

Mean of dependent variables	8.578788	Standard deviation of dependent variables	6.754524
Sum of quadratic remainders	269.9912	St. model error	3.051236
R-square	0.815069	Rev. R-square	0.795938
F(3, 29)	42.60503	P-value (F)	9.43e-11
Logarithmic plausibility	−81.50602	Akaike Criterion	171.0120
Schwarz Criterion	176.9981	Hannan-Quinn Information Criterion	173.0262
Rho parameter	0.528302	Durbin-Watson Statistic	0.573071

The linear two-factor regression model has the following form:

$Y = -16,0 + 0,0181*X1 + 0,362*X5 + 0,00362*X6$

$n = 33$, $R\text{-squared} = 0.815$

Thus, the volume of production of high-tech products largely depends on the education sector. Thus, with an increase in the number of graduates in the field of science and technology by 1%, the volume of production of high-tech products increases by 0.362 p.p. with constant employment and maintaining the number of researchers per million inhabitants. The appearance of 1 new researcher per 1 million inhabitants, while maintaining the current employment rate and the number of graduates in the field of science and technology, will lead to an increase in the share of high-tech production by 0.004 percentage points.

In addition, the level of innovative production is influenced by the level of employment of the population. With an increase in employment by 0.1%, the volume of high-tech production increases by an average of 0.0181 percentage points with the same number of university graduates in the field of science and technology and the same number of researchers.

4. Discussion

In this article, the main attention was paid to the study of the interdependence between the indicators of human capital and the level of high-tech production, as a priority indicator of the innovativeness of the national economy.

We confirm the conclusions of earlier studies that, although the CCA countries differ significantly in demographic indicators and labor force, the CCA region has significant potential for human capital growth (Capannelli and Kanbur, 2019; Rehman et al., 2018).

We believe that the CCA remains one of the youngest regions, and the high birth rate will allow this region to remain among the leaders in population reproduction. The results of our study allow us to agree with the statement that the strengths of the human capital of the CCA are a high level of literacy, and the rate of admission of children to primary and secondary education institutions (OECD/UNICEF, 2021).

Nevertheless, the higher education systems of the countries of the region are at different stages of development with significant differences in the proportion of university students in the general population, the proportion of students who have completed their studies, the level of public spending on education and the employment rates of graduates.

An acute problem for most countries in the region is low employment combined with a shortage of qualified personnel and low-quality human capital. The results obtained allow us to note the presence of a discrepancy between the requirements of the labor market and the available skills of employees, as well as an extremely low level of investment in the development of human capital, which limits the increase in labor productivity in the region.

We agree with the results of the study (Ernst & Young (EY), 2022) that the availability of young and educated personnel with specialized skills is a key factor of competitiveness in an innovative economy. According to the UNCTAD Technology and Innovation Report for 2021, most CCA countries (except for Kazakhstan and Georgia) are in the "low" point group and the "below average" group according to the advanced technology readiness index (UNCTAD, 2021).

We analyzed the relationship between the level of high-tech production and indicators of human capital development using a large set of up-to-date statistical data. The results of our research have shown the existence of a close relationship between the number of university graduates in the field of science and technology and the level of high-tech production. The results obtained confirm the results of other studies on the significant contribution of scientific organizations and universities to the technological development of production (Repina, 2023). We support the opinion of the authors (Hatakenaka, 2015; Nadjib, 2022) that university graduates represent an important part of human resources that can produce creative and innovative products in the form of technologies. Therewith, the structure of education and vocational training should meet the future needs of the community following the competencies and professional experience necessary for innovation (Efe, 2023).

Another significant factor in the development of innovation is the number of researchers. The results of our analysis showed a close positive relationship between this independent variable and the level of high-tech production. This confirms the conclusions of earlier studies that the presence of a sufficient number of researchers in the country makes possible the innovative development of the economy through the creation of new scientific knowledge (Silifonova, 2016).

We agree with the conclusions of researchers (Rahman et al. 2022) on the importance of the labor market and indicators of public health for human capital accumulation. We have not found convincing evidence of the strong influence of the labor market on the innovative development of the economy. Only one of the three indicators – "the number of people employed in the economy" – is in a strong direct relationship with the level of high-tech production. We also did not find a close relationship between the health indicators of the population and the level of innovative development. Thus, even though these factors are significant for the development of human capital, they do not have a significant impact on the level of high-tech production in the country.

Contrary to the authors' expectations, our results did not show a significant relationship between the level of average wages and the level of high-tech production. This finding contradicts the conclusions of other authors (Barinova et al., 2018; Smirnova, 2020), who provide convincing evidence of a direct and close relationship between these variables. Based on this, we concluded that the impact of economic factors, such as the cost and productivity of labor on the level of high-tech industries, remains ambiguous and requires more careful study.

There is an additional factor that was not considered in our study, since it is only being formed due to the current geopolitical situation. On the one hand, they suffered from the ongoing military events in Ukraine, and on the other hand, they are trying to consider the situation as a time of new opportunities.

5. Conclusion

This study enriches the existing literature and has practical significance. We considered the transformation of human capital as the dynamics of quantitative and qualitative indicators of the education level, the health of the population, the labor market, as well as the productivity and cost of labor. The nature and strength of their impact on the level of high-tech production as an important result of the innovative economy were investigated.

Having studied a wide range of scientific literature, we can state with a high degree of confidence that our study is one of the few attempts to assess the impact of human capital on the level of production of high-tech products with a wide coverage of panel data from seven CCA countries.

Our results show that the CCA countries differ significantly in demographic indicators, the number, education, and productivity of the labor force. We also believe that the region has human capital potential due to the advanced development in terms of population reproduction.

We conclude that the most significant influence on the level of production of high-tech products is exerted by factors of the educational level of the population, such as the growth of university graduates in the field of science and technology, as well as the number of researchers per 1 million inhabitants. In addition, the presence of researchers in the population demonstrates a significant positive correlation with the high-tech production level.

However, the underdevelopment of the labor market in most CCA countries, the low level of investment in the development of human capital, and the low level of quality of higher education hinder the development of high-tech sectors of the economy.

The results obtained by us are of practical importance since they can be useful in the formation of a policy for the development of human capital and a strategy for the development of high-tech production in the CCA countries.

References

Al-Marzouki, S. M., Al Dulaimi, A. M. Z., Lubis, A., Siren, N. B. H., and Kassim S. B. (2022). Human development index and innovation opportunities in the UAE health sector: human development index in health. *Journal of Population Therapy and Clinical Pharmacology*, 29(3). https://doi.org/10.47750/jptcp.2022.959

Astakhova, E. V., Reshetnyak, E. I., & Ilchenko, V. V. (2019). The Analysis of Trends and the Assessment of the Worldwide High-Tech Production Development. In IOP Conference Series: Earth and Environmental Science (Vol. 272). Institute of Physics. https://doi.org/10.1088/1755-1315/272/3/032218

Barinova, V. A., Zemtsov, S. P., Semenova, R. I., and Fedotov, I. V. (2018). *High-Tech Business in the Regions of Russia. National Report*. Moscow: RANEPA, AIRR.

Barkhordari, S., Fattahi, M., & Azimi, N. A. (2019). The Impact of Knowledge-Based Economy on Growth Performance: Evidence from MENA Countries. Journal of the Knowledge Economy, 10(3), 1168–1182. https://doi.org/10.1007/s13132-018-0522-4

Bliznyuk, V., and Yatsenko, L. (2023). Labor mobility enhancement as a factor of human capital development. *Economy of Ukraine* 2: 73-95. https://doi.org/10.15407/economyukr.2023.02.073

Boțoroga, C.-A., Horobet, A., Belascu, L., Popoviciu, A., and Gîrlovan, A. 2022. "Assessing the nexus between education, economic growth, and innovation: an empirical analysis." *Studies in Business and Economics* 17 (3): 18-34. https://doi.org/10.2478/sbe-2022-0043

Budilova, E. V., and Lagutin, M. B. (2023). Relationship between human development and the level of innovative development of the economy. *Bulletin of Moscow University. Series 23. Anthropology*, 1, 90-101.

Canbay, Ş. (2020). Examining the relationship between research and development expenditures (R&D) and economic growth by Kónya causality analysis test in G7 countries. In *Interdisciplinary Research in Public Finance, Business, and Economics Volume III*, edited by A. Akinci, 89-99. Berlin: Peter Lang Verlag.

Capannelli, G., and Kanbur, R. eds. (2019). *Good Jobs for Inclusive Growth in Central Asia and the South Caucasus: Regional report*. Mandaluyong City: Asian Development Bank.

Chistyakova, N. (2022). Demographic component of human capital formation for sustainable development of regions. *The Economy of the North-West: Problems and Prospects of Development*, 4(67), 103-111. https://doi.org/10.52897/2411-4588-2021-4-103-111

Diebolt, C., and Hippe, R. (2019). The long-run impact of human capital on innovation and economic development in the regions of Europe. *Applied Economics*, 51(5), 542-563. https://doi.org/10.1080/00036846.2018.1495820

Efe, A. (2023). Comprehensive development of human capital as an aspect of the innovative economiesy. *International Journal of Humanities and Education*, 9(19), 69-96. https://doi.org/10.59304/ijhe.1189232

Ernst & Young (EY). (2022). Central Asia Attractiveness Report. Retrieved from: https://assets.ey.com/content/dam/ey-sites/ey-com/en_kz/topics/attractiveness/ey-central-asia-attractiveness-survey-2022.pdf

Freimane, R., and Balina, S. (2016). Research and development expenditures and economic growth in the EU: a panel data analysis. *Economics and Business*, 29(1), 5-11. http://dx.doi.org/10.1515/eb-2016-0016

Galindo-Rueda, F., and Verger, F. (2016). OECD taxonomy of economic activities based on R&D intensity. OECD Science, Technology and Industry Working Papers, 2016/04. Paris: OECD Publishing. http://dx.doi.org/10.1787/5jlv73sqqp8r-en

González-Varona, J. M., Martín-Cruz, N., Acebes, F., & Pajares, J. (2023). How public funding affects complexity in R&D projects. An analysis of team project perceptions. Journal of Business Research, 158. https://doi.org/10.1016/j.jbusres.2023.113672

Gwon, S. H. (2023). The Relationship between Human Capital and Technology Innovation: The Moderating Effect of Firm Internationalization. The Academic Society of Global Business Administration, 20(2), 130–152. https://doi.org/10.38115/asgba.2023.20.2.130

Hafeez, A., Shah Syed, K. B., & Qureshi, F. (2019). Exploring the Relationship between Government R & D Expenditures and Economic Growth in a Global Perspective: A PMG Estimation Approach. International Business Research, 12(4), 163. https://doi.org/10.5539/ibr.v12n4p163

Hall, B. H., and Lerner, J. (2009). Funding for research and development and innovation. NBER Working Paper No. w15325. Cambridge: National Bureau of Economic Research. https://doi.org/10.3386/W15325

Hatakenaka, S. (2015). The Role of Higher Education Institutions in Innovation and Economic Development. International Higher Education, (47). https://doi.org/10.6017/ihe.2007.47.7961

Hazaimeh, S. A., Elbanna, S., & Fatima, T. (2023). Education and employment reforms toward developing human capital: the case of Qatar. The CASE Journal, 19(2), 252–272. https://doi.org/10.1108/tcj-09-2021-0153

Huseynli, N. (2023). Examination of the Relationship Between Economic Growth and Research and Development Expenditures in Azerbaijan, Kazakhstan and Kyrgyzstan. Finance: Theory and Practice, 27(2), 28–37. https://doi.org/10.26794/2587-5671-2023-27-2-28-37.

Iontsev, V. A., & Magomedova, A. G. (2015). Demographic aspects of human capital development in Russia and its regions. Economy of Regions, (3), 89–102. https://doi.org/10.17059/2015-3-8

Kamilova, N. (2022). Human capital as the main factor of innovative development of the modern economy. *Web of Scholars: Multidimensional Research Journal*, 1(5), 136-140.

Kryukov, I. A. (2021). Theoretical and practical aspects of the development of high-tech production. Business Strategies, 9(12), 357–363. https://doi.org/10.17747/2311-7184-2021-12-357-363

Lutz, W., Goujon, A., Samir, K. S., Stonawski, M., and Stilianakis, N., eds. (2018). *Demographic and Human Capital Scenarios for the 21st Century*. Luxembourg: Publications Office of the European Union. https://doi.org/10.2760/41776

Marcin, G. (2021). The impact of educational factor on innovation and competitiveness of middle-income countries. *European Research Studies Journal*, 24(S1), 171-186. http://dx.doi.org/10.35808/ersj/2036

Mohamed, M. M. A., Liu, P., and Nie, G. (2022). Causality between technological innovation and economic growth: evidence from emerging economies. *Sustainability,* 14(6), 3586. http://dx.doi.org/10.3390/su14063586

Munjal, S., and Kundu, S. (2017). Exploring the connection between human capital and innovation in a globalizing world. In *Human Capital and Innovation: Exploring the Role of Globalization,* edited by S. Kundu, and S. Munjal, 1-11. London: Palgrave Mcmee.

Nadjib, A. (2022). The role of universities in preparing local governments for the era of 5.0 Society. *AL-ISHLAH: Jurnal Pendidikan,* 14, 5229-5240. https://doi.org/10.35445/alishlah.v14i4.2225

Novruzov, N. (2023). Human capital as a factor of employment. *Alma mater. Vestnik Vysshey Shkoly*, 4, 86-92. https://doi.org/10.20339/AM.04-23.086

OECD/UNICEF. (2021). *Education in Eastern Europe and Central Asia: Findings from PISA, PISA*. Paris: OECD Publishing. https://doi.org/10.1787/ebeeb179-en

Prenzel, P., and Yammarino, S. (2021). Aging workforce and the structure of regional human capital. *Economic Geography,* 97(2), 140-163.

Qureshi, M. A., Qureshi, J. A., Ahmed, A., Qaiser, S., Ali, R., and Sharif, A. (2020). The dynamic relationship between technology innovation and human development in technologically advanced countries: fresh insights from quantiles-on-quantile approach. *Social Indicators Research*, 152(2), 555-580. https://doi.org/10.1007/s11205-020-02451-3

Rahman, M. M. A., Adeniyi, A., and Hamidu, Y. A. (2022). Does human capital have an impact on employment in Turkey? *An ARDL Analytical Perspective*, 11, 18-27.

Rehman, Z. U., Tariq, M., and Khan, M. A. (2018). The role of human capital in economic development in the selected Central Asian countries. *The Dialogue*, 13(3), 235-244.

Repina, A. A. (2023). Tekhnologicheskoe razvitie proizvodstva: vklad nauchnykh organizatsii i vuzov [Technological development of production: the contribution of scientific organizations and universities]. Retrieved from: https://issek.hse.ru/news/835863126.html

Serebryakova, N. A., Solomatina, E. D., Dorokhova N. V., Salikov, Yu. A., Isaenko, M. I., and Vitruk, L. Yu. (2020). Resources for innovative development of the region in the context of digital economy. In *Proceedings of the Russian Conference on Digital Economy and Knowledge Management (RuDEcK 2020)*, 253-256. Atlantis Press. https://doi.org/10.2991/aebmr.k.200730.047

Sezgin, F. (2020). Analysis of the relationship between R&D expenditure and economic growth: comparison between developing and developed countries. In *The Effects of Technological Innovations on Competitiveness and Economic Growth*, edited by E. Sarıdoğan, B. Güloğlu, and C. Hannum, 41-56. Istanbul: Istanbul University Press. http://dx.doi.org/10.26650/B/SS10.2020.001.03

Silifonova, E. V. (2016). The role of researchers in the innovative development of socio-economic systems. *Innov: electronic scientific journal*, 4(29). http://www.innov.ru/science/economy/rol-issledovateley-v-innovats ionnom

Smirnova, T. L. (2020). The impact of structural shifts on the dynamics of labor productivity and wages in Russia. *Labor Economics*, 7(10), 913-932. https://doi.org/10.18334/et.7.10.110940

Tirelli, M., and Spinesi, L. (2018). Financing and Growth of R&D. *The Economics of Innovation and New Technologies,* 30, 24-47.

Trujillo, M. P., and Lacalle-Calderon, M. (2020). The impact of knowledge diffusion on economic growth across countries. *World Development*, 132, 104995. https://doi.org/10.1016/j.worlddev.2020.104995

Tukhtarova, E. Kh., and Vlasov, M. V. (2021). Influence of human capital on innovative development. *Vestnik NSUEM*, 1, 89-111. https://doi.org/10.34020/2073-6495-2021-1-089-111

U.S. News. (n.d.). Search U.S. News Best Global Universities. Retrieved from: https://www.usnews.com/ education/best-global-universities/search?country=kazakhstan&country=georgia&country=armenia

UNCTAD. (2021). Technology and Innovation Report 2021. Retrieved from: https://unctad.org/publication /technology-and-innovation-report-2021

UNIDO Databases. (n.d.). Retrieved from: https://stat.unido.org/database/INDSTAT%202%202022,%20I SIC%20Revision%203;jsessionid=FB10FB95D5DB4747DA5AB5B58ADE8595

UNIDO Statistical Data Portal. (n.d.). Retrieved from: https://stat.unido.org/database/CIP%20-%20Competitive %20Industrial%20Performance%20Index

UNIDO. (n.d.). Classification of manufacturing sectors by technology level (ISIC Rev. 4). Retrieved from: https://stat.unido.org/content/learning-center/classification-of-manufacturing-sectors-by-technological-intensity-%28isic-revision-4%29

WIPO. (2022). Global Innovation Index. Retrieved from: https://www.globalinnovationindex.org/analysis-indicator

World Integrated Trade Solution. (n.d.). Comtrade database via WITS platform. Retrieved from: https://wits .worldbank.org/country-indicator.aspx

Ziberi, B. F, Reksha, D., Ibraimi, H., and Avdiy, B. (2022). An empirical analysis of the impact of education on economic growth. *Economy*, 10(4), 89. https://doi.org/10.3390/economies10040089