

## INNOVATIVE DEVELOPMENT AND HUMAN CAPITAL AS DETERMINANTS OF KNOWLEDGE ECONOMY

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Received 4 October 2019; accepted 10 December 2019

**Abstract.** The development of a knowledge economy is a key priority for innovative progress and for ensuring the country's competitiveness through the efficient use of intellectual resources and human capital. Our paper is focused on a necessity to find out the influence of human capital in providing innovative development and the formation of knowledge economy, to develop measures for its formation, accumulation, preservation, reproduction in order to increase national competitiveness at the world market. The foundation of the knowledge economy is productive knowledge and quality education that contribute to the intellectual capital embodiment into productive activities. A detailed analysis of the current state and problems of the education and science spheres has been carried out, international ratings have been analyzed and the place of Ukraine in them is determined in the article. An estimation of financial losses of the economy in connection with the outflow of students to study abroad is hold in the article. By using the trend modeling method we propose to estimate the effect of the predicted values of the components of innovation activity on the Global Innovation Index. Results show that Ukraine position in the Global Innovation Index rating will strengthen, which can testify, about the redistribution of financing of the innovation sphere in favor of private institutions and investors. The transition to a knowledge economy involves an understanding of the decisive influence of science, the latest technologies, innovations in the global economy, and enables the resource-oriented countries to leave this status and become a countries of high-tech and high skilled development, based on the transformation of knowledge into a source of value and the driving force of economic progress.

**Keywords:** knowledge economy, innovative development, human capital, intellectual capital.

**JEL Classification:** G32.

### Introduction

*Problem statement.* Modern social and economic development is characterized by the transition from the industrial age to the post-industrial formation, which is associated with accelerating development of scientific and technological progress, the growth of labor productivity and the importance of information technologies, intelligence and scientific knowledge embodied in human capital, which undoubtedly becomes the main determinant in providing innovative development and the formation of a qualitatively new economic system – the knowledge economy in Ukraine and in the world. Actualization of scientific knowledge, human intelligence, high level of education of the population determine the level of development of the country, its competitiveness and serve as a prerequisite for structural changes and restructuring of the labor market,

due to the growth of non-productive sectors, services, growth of knowledge as a production factor.

Under the conditions of globalization the competitive advantages provision is achieved on the basis of the development of intellectual capital, science and technology, the intensive introduction of research, development, innovation in production, namely the high level of innovation activity of both individuals and economic subjects, which influences on all aspects of socio-economic and investment-innovation development and defines the country's place in the world economy and international ratings.

*Aim of the research.* The purpose of the scientific work is to find out the significance of human capital in providing innovative development and formation of knowledge economy, development of measures for its formation, accumulation, preservation, and reproduction in order to increase national competitiveness at the world market.

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Taking into account the goal, the research tasks lie in the analysis of the system of formation of human capital development, identification of its main trends, analysis of the scientific sphere and justification of the priorities of innovation development and the formation of the knowledge economy.

*The research methods* include comparative and systematic literature analysis, economic and mathematical calculations, trend modeling method and own research conclusions.

## 1. Literature review

A number of works of Ukrainian scientists, in particular, Dlugopolskyi (2001), Butko (2006), Panasyuk (2003), Geits (2006), are devoted to the research of innovative development. Actual questions of the formation of the knowledge economy on the basis of providing innovative and intellectual development and human capital are sufficiently highlighted in the scientific works of both domestic and foreign scientists: Fedulova (2008), Semiv and Vovkanych (2007), Zelinskaya, Sadova, and Vitvitskyi (2006), Demchishak and Zhuk (2018), Bell (1993), Becker (1993) and others. The relationship between the intellectual capital and innovations is conducted in the scientific work of Wendra Wendra et al. (2019). The concept of responsible research and innovation as an element of innovation activity actualization is researched in the works of Lukasz Nazarko (2019). An interesting approach is proposed by Stachová et al. (2017) concerning the influence of the human resources communications on the innovation process in organizations.

However, despite the scientific achievements of the research subject, should be noted the lack of coverage of the importance of innovation and intellectual development in accordance with the requirements of the new technological paradigm, which requires detailed research, development of measures to increase the volume of investments in the educational and scientific spheres for the purpose of human capital development and accumulation, because results of its implementation and activities provide innovative progress, and finally – the transition to a knowledge economy.

## 2. The concept of knowledge-based economy

The rapid development of science, the spread of information and communication technologies, the transformation of human capital and its intellectual component into the main resource of tangible and intangible production ensured the transition to the information economy, and in some countries to the knowledge economy. Today, there are many definitions of the knowledge economy, but in most cases all definitions are reduced to the fact that knowledge economy is an economy that creates, distributes and uses scientific knowledge to ensure its development and high competitiveness. The basis of its operation are the processes of knowledge generation, their commercialization

on the basis of the intellectual potential of human capital Podra (2012). In such a economy, knowledge is a determinant of economic progress and innovation, because it is embodied in high-tech products and services, and science is becoming a key factor in scientific and technological progress and the introduction of advanced technologies into production, which in turn ensures its efficiency and growth of competitiveness on the basis of reduction of energy-intensive and material-intensive products, automation of production processes, increase of productivity and quality of products.

Deserves the attention the definition of knowledge economy given by Demchishak and Zhuk (2018), Kusherets (2019), scientists argue that the economy is based on knowledge only when there are such processes as: the generation of knowledge, that is, its reproduction on the basis of the existence of a quality education system; the generation of new knowledge is ensured on the basis of a high level of science and technology development, the implementation of research and development, as well as the existence of appropriate infrastructure, in particular, educational and scientific institutions and organizations; commercialization of knowledge – transformation into an asset, on the basis of the creation of intellectual property objects (inventions, useful models, industrial designs) and obtaining the corresponding patents, certificates and licenses for them; diffusion of knowledge – its realization, sale of the above-mentioned security documents and the introduction into the sphere of tangible and intangible production and the production on their basis of innovative products that are in demand at the market.

In the knowledge economy, the main productive resources are knowledge, intelligence, innovation and information technology, “high tech” based on the development of information infrastructure, in particular, the sector of information and communication technologies, the Internet, mobile communication, etc. Under these conditions, the source of economic growth is the processes of production of knowledge and ideas that turn into a competitive product, and their formation is impossible without investing in education and science as sectors of development and accumulation of human capital. That is why the leaders in the creation of economic wealth are the countries whose GDP contains a high proportion of knowledge that produces science-intensive products, make significant investments in education, science, research, which, in fact, are the basis of high-tech industries. However, despite the availability of a number of program documents, it should be noted that in Ukraine there is no proper level and quality of concrete measures coordination for the creation of an innovative economic model.

At the same time, it should be noted that over the past decades, Ukraine has become a global donor of intellectual resources, mainly for developed countries. The statistics show that the emigration of scientists and researchers has threatening trends, makes it impossible to provide qualitative innovative development and hinders the formation

of the knowledge economy, weakens the level of national security, especially in the development of the system of education and science, health care, and the digitalization of social and economic life.

According to the World Bank, knowledge economy consists of the following main components: economic regime; education; innovation ecosystem: research, development and innovation; information and communication technologies. According to the research, Ukraine ranked 56th in the ranking of countries according to the index of knowledge economy development. The rank by the component: the economic regime – 93rd place, information and telecommunication (ICT) infrastructure – 77th place, innovation ecosystem – 59th place, education – 21 place (Minich, 2019). From the above results, one can conclude that Ukraine has the highest rating by education component – the 21st place in the ranking, that indicates a high level of human development.

At the same time, according to the World Economic Forum 2017, the Global Human Capital Index of Ukraine was 71.27 or 24 place in the ranking (The Global Competitiveness Report, 2016–2017). It should be noted that the global human capital index consists of four main blocks, which are estimated in the age-old section:

1. capacity (mental abilities): literacy of the population, coverage level of primary, secondary and higher education;
2. deployment: labour force participation rate, employment gender gap, unemployment rate, under-employment rate;
3. development: primary education enrolment rate, quality of primary schools, secondary education enrolment rate, secondary enrolment gender gap, vocational education enrolment rate, tertiary education enrolment rate, skill diversity of graduates, quality of education system, extent of staff training;
4. know-how: high-skilled employment share, medium-skilled employment share, economic complexity, availability of skilled employees.

The results of calculations of the ranking on the global index of human capital are represented in the table (Table 1).

According to the results of the table it can be concluded that the highest rating of Ukraine by the sub index of capacity is the 5th place, the worse situation is with sub indexes development and know-how – 38th place. The results of the rating indicate the existence of competitive advantages for the educational component of human capital and at the same time weakness of all other components, which in turn requires adjustment measures to improve the situation. At the same time, it should be noted that in 2018 Ukraine worsened its ranking according to the index of human capital, which was 76.21 and was almost at the level with such countries as Poland, Slovakia, Czech Republic, Israel, South Korea, at the same time, the average GDP per capita in these countries is about 30 thousand dollars, while in Ukraine – only 8970 dollars, that is, more than three times less.

Research shows that Ukraine has unrealized opportunities for economic growth based on the use of human capital, as evidenced by the above data and high ratings among the countries of the world. In the context of the formation of a knowledge economy, education and science are becoming the main sectors of the production of competitive human capital, and high educational potential becomes its most important element, which, in the process of improvement and constant development, has the ability to turn into intellectual capital – the most expensive asset of a post-industrial society, since the knowledge embodied in products and services can create value based on the intellectualization of technologies, the growth of the knowledge-intensive products, development the market of intellectual services. Intellectualization of technologies provides for a production cycle reduction and a significant increase in labor productivity, while investment increase in research and development leads to a reduction in the need for limited resources (water, minerals, land) based on the latest scientific products and technologies.

### 3. Research methodology

Under such conditions, the spheres of human capital development and accumulation – science and education, which become the bases for the development of knowledge

Table 1. Global Human Capital Index 2017 (The Global Competitiveness Report 2016–2017)

Country	Total Index		Capacity		Deployment		Development		Know-how	
	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score
Norway	1	77.12	13	80.46	24	73.18	6	82.63	6	72.22
Finland	2	77.07	8	81.05	68	65.09	1	88.51	2	73.62
Switzerland	3	76.48	28	76.36	42	69.12	2	84.87	1	75.57
USA	4	74.84	22	78.18	43	68.72	4	83.45	13	68.99
Denmark	5	74.40	16	79.37	34	71.41	14	78.65	17	68.18
Germany	6	74.30	29	76.33	40	69.52	12	79.38	7	71.96
New Zealand	7	74.14	18	78.92	27	72.76	8	80.38	22	64.50
Sweden	8	73.95	31	76.21	39	69.60	16	77.10	3	72.89
Ukraine	24	71.27	5	81.70	31	72.65	38	71.47	38	59.26

economy are very important. At the same time, it should be noted that the amount of state financing of institutions for the formation, development and accumulation of human capital does not correspond to the declared volumes, which in turn has a negative impact on the level of socioeconomic development, makes it impossible for the human capital owners to access the necessary resources for its reproduction and accumulation, creates obstacles to innovation development, in particular the production and implementation of inventions, affects the reduction of the educational level of the population and the growth of educational and scientific migration. All these factors have a negative impact on the total national competitiveness level, and as a result the purchasing power of the population decreases, social and property inequality increases, the living standard decreases, the loss of the most progressive and productive part of the population is observed, as a result of the migration redistribution in favor of the highly developed countries. As a result, in addition to the above-mentioned negative factors, we can observe inflation rising, which in 2015 reached 143.3% (Figure 1).

As a result of the instability of the economic situation and the growth of the consumer price index, there is a weakening of social policy in the part of educational and scientific development providing, which can be seen in reduction of the financing amount of these spheres as a percentage of GDP. This situation, which is combined with ineffective economic reforms and inadequate anti-crisis policies, leads to an aggravation of the financial and economic crisis, national competitiveness level decrease and postpone the possibility of transition to the information society and knowledge economy on the basis of providing an innovative model of development and human capital.

In order to estimate the educational potential of human capital, it is necessary to conduct an analysis of the status and funding levels of the education sector, which

is characterized by mixed trends caused by demographic changes, and, as a result, an infrastructure and funding reduction.

An analysis of the data of the projected estimates of the volumes of investments in education in Ukraine from 2009 to 2020 on the basis of the trend model (approximation) using the Excel package indicates a possible further reduction of the total investments as a percentage of GDP and non-compliance by the state with the declared amounts of financing of the sphere at the same time we can observe the absolute indicators increase of the total volume of investments in education and the volume of GDP in Ukraine (Figure 2).

The main source of investment in education in Ukraine remains the funds of state and local budgets, their share in total investments in 2009–2016 increased by 5.4% – from 80.0 to 85.4%.

Investments in households in education over the period decreased by 5.1% from 19.0% to 13.9% of total investment in education, which indicates an increase in public financing of education. At the same time, the increase in the number of persons with higher education is a positive phenomenon and indicates an increase in the sphere of non-material production – a factor of the post-industrial society formation.

However, if we analyze the absolute figures for the number of undergraduates, it should be noted that in the years 2010–2018 there was a decrease of 87,646 people, which is influenced the negative demographic situation, as well as the obtaining of higher education abroad. During these years, the proportion of students studying by state budget funds increased by 6.2% from 38.3% in 2010 to 44.5% in 2018; by the local budgets increased by 0.9%; by the private companies (legal entities) – by 0.1%; at the expense of individuals – decreased by 7.2% (Higher education in Ukraine in 2017).

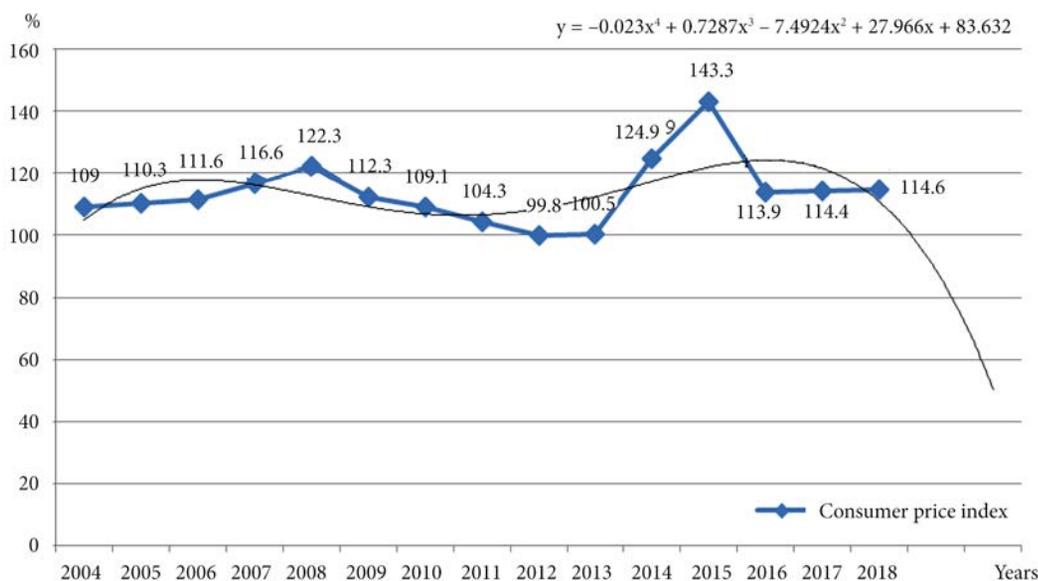


Figure 1. Forecasted estimates of the consumer price index in Ukraine, % (compiled by authors on the basis of the Official website of the State Statistics Service of Ukraine)

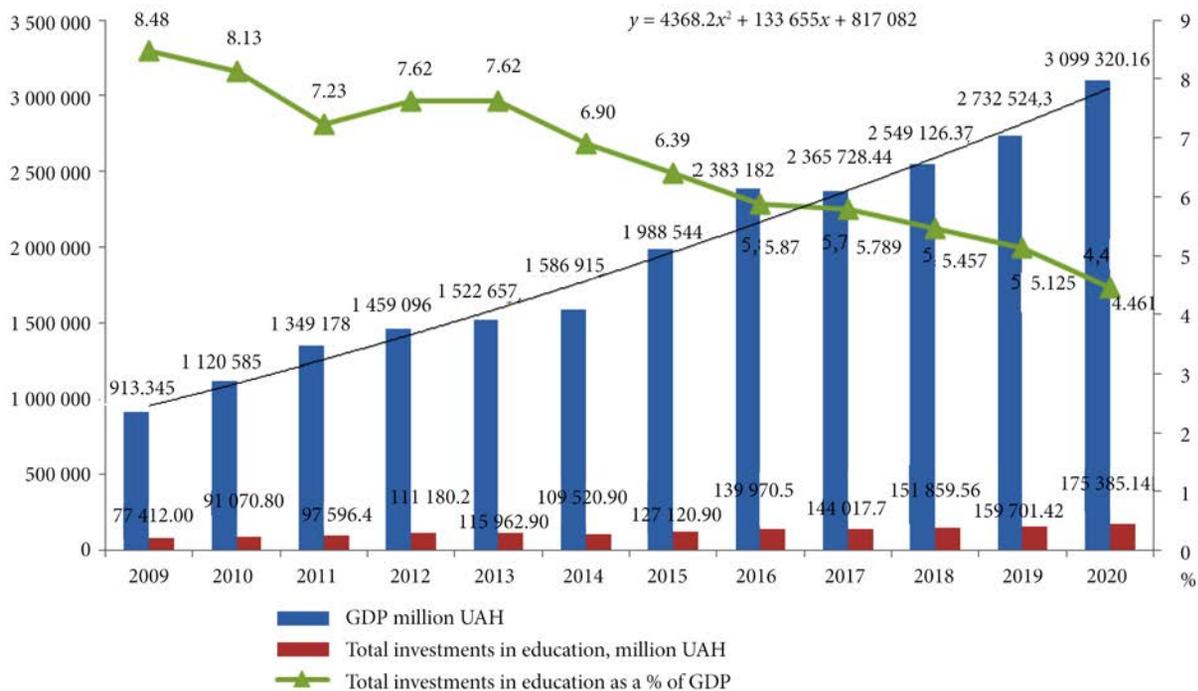


Figure 2. Forecasted estimates of investment in education in Ukraine for 2009–2020 (compiled by authors on the basis of (Higher education in Ukraine in 2017))

#### 4. The impact of the students' outflow on the economy of Ukraine

Despite the high level of educational potential of Ukraine, it should be noted that the education system itself needs to be periodically reviewed and modernized in accordance with the innovation requirements of the labor market and the demand for new specialties that arise as a result of informatization of public life. On the other hand, domestic higher education institutions are still considered to be weak competitors and are behind most ratings of the higher education institutions, for example, Poland. Worthy of note is the study by V. Martyniuk on the estimation of financial losses of the economy in connection with the outflow of students to study abroad (Table 2).

As can be seen from Table 2, financing of external independent testing and control of education quality in Ukraine increased from UAH 94.7 million in 2011 to

UAH 168.6 million in 2016, which creates an additional burden on the budget, while the number of enrolled entrants to higher education institutions fell by contract from 273.7 thousand people in 2011 to 144.9 thousand people in 2016 National Accounts of Ukraine's Education in 2016. At the same time, V. Martyniuk believes that the external independent testing is not the only factor that influenced the number of student's admissions to institutions of higher education, but it is a significant restraining factor, since during 2011–2016 the number of higher education graduates who studying abroad on a permanent basis has increased from 29 to almost 60 thousand people, with most of them studying in paid form, and only a small percentage receives grants or irrecoverable loans for tuition (Martyniuk, 2017).

In addition, there is a direct link between the level of competitiveness of the country and cooperation volumes of universities and enterprises, which is shown in

Table 2. Financial losses of the economy of Ukraine in connection with the outflow of students during 2011–2016 (Martyniuk, 2017)

Indicator	2011	2012	2013	2014	2015	2016
Number of students admitted to higher educational institutions by contract, thsd persons	273.7	208.1	205.5	213.6	166.6	144.9
Number of students, who study abroad, persons	28985	32287	34687	39232	47724	59998
Average generalized cost of training specialist at HEE of Ukraine, thsd UAH	45.4	49.5	53.9	59	62.4	76.6
Financing of UCOYO activity, including conducting external independent testing, UAH million	94.7	116.5	116.1	107.5	120.1	168.6
Financial losses of the economy due to student outflow, mln UAH	263.2	319.6	374.3	462.9	595.6	919.2

the Global Competitiveness Index (GCI) and the index that characterize the collaboration of universities and industry in research (R & D). According to the results of 2016–2017, the top ten countries with the highest level of global competitiveness index were headed by Switzerland, Singapore, the USA, the Netherlands, Germany, Sweden, Great Britain, Japan, Hong Kong, Finland, countries with high performance in scientific research and cooperation with industry (The Global Competitiveness Report, 2016–2017).

The need for a high level of educational potential is evidenced by data on the needs of enterprises in skilled workers to replace vacancies. So, in 2017, the greatest need in the labor market was for skilled workers with tools – 11.8 thousand people, workers for maintenance, operation and control of the work of technological equipment, equipment and machinery – 8.9 thousand people. These indicators may testify the insufficient training of the relevant specialists, especially in the part of vocational education, reducing demand on the production professions among students and at the same time, may indicate an increase in the development of industry, especially the processing industry. There is also a high need for workers in the sphere of trade and services – 6.6 thousand people, professionals – 5.8 thousand people, specialists – 4.9 thousand people (Economic activity of the population of Ukraine, 2017, p. 191).

In the conditions of the development of the knowledge economy, the importance of education as a sphere of production and knowledge generation is actualized, and therefore it is necessary to keep the principles of lifelong education, which operates effectively in the USA and Western Europe. For example, for retraining workers in the United States allocated 15–20% of working time, and for the entire period of employment (about 40 years), the employee must improve the qualification of 5–8 times (Fedulova, 2008). Regarding the training and advanced training in Ukraine, one can state that, unfortunately, the system of training and advanced training of personnel is not given proper attention. According to statistics, during the year 2016 166.6 thousand registered unemployed were

trained in educational institutions of all types of vocational training, which is 6.9% less than in 2015 (The labor market in 2016, p. 19). The distribution of employees by the amount of wages shows that there is no dependence of the size of the salary on the professional qualification level of the employees both in the types of activities for the provision of services and in the production. For example, in education, where employees have a high qualification and professional level, provided with higher education, in December 2017 only 17.0% of employees paid wages exceeded 10,000 UAH, in health care and social assistance – 10.1%. At the same time, among the employed in financial activities, this category was almost half (47.3%). In the overall structure of labor costs, the cost of advanced training was only 0.1% in 2016.

### 5. Relationship between innovative activity of Ukraine and the Global Innovation Index rating

The sphere of science as an industry that provides innovative development on the basis of production and use of new knowledge embodied in education, technologies, production, goods and services, and capable of providing an increase of GDP by 70–85% is of great importance for the development of the knowledge economy. In twenty developed countries where 95% of the world's scientists work, per capita income increases annually by \$ 200 (Cancer, 2009).

An analysis of the development of the domestic science shows its underfunding, low level of material and technical support, falling prestige of scientific work, low level of inventions implementation. In 2017, the number of organizations that hold scientific and technical works decreased by almost 26% compared to 2010, while the number of scientists decreased by 47% for the same period (Table 3).

A negative phenomenon is the reduction of the share of scientific and scientific and technical work in percentage of GDP, in particular, in 2015 – 0.64% of GDP, which is extremely low and does not correspond to world trends. In 2017, the share of the research workers (researchers,

Table 3. The volume of performed scientific, research and scientific works, scientific personnel

Year	Number of institutions that performed scientific and research works	Decline rates relative to 2010,%	Number scientists, persons	Decline rates relative to 2010,%	Costs for research and development, UAH million	Growth rate relative to 2010,%	Share of the volume of performed scientific and scientific-technical works in% of GDP
2010	1303	–	182484	–	8107.1	–	0.75
2011	1255	3.68	175330	3.92	8513.4	5.01	0.65
2012	1208	7.29	164340	9.94	9419.9	16.2	0.67
2013	1143	12.28	155386	14.85	10248.5	26.41	0.70
2014	999	23.33	136123	25.41	9487.5	17.03	0.60
2015	978	24.94	122504	32.87	11003.6	35.73	0.55
2016	972	25.40	97912	46.34	11530.7	42.22	0.48
2017	963	26.09	94274	48.34	13379.3	65.03	0.45

technicians and auxiliaries) in the total number of employed population was 0.58%, including researchers – 0.37%. According to Eurostat, in 2015, the highest share was in Finland (3.21% and 2.35%), Austria (3.10% and 1.92%) and Sweden (2.97% and 2.33%); the lowest is in Romania (0.53% and 0.33%), Cyprus (0.83% and 0.61%), Poland (1.0% and 0.75%) and Bulgaria (1.0% and 0.65%) (Scientific and innovative activities, 2018).

In 2017, the total expenditures for the implementation of the research developments (RD) by the organizations themselves amounted to 13379.3 million UAH, including labor costs – 7152.9 million UAH, other current expenses – 5444.6 million UAH, capital expenditures – 781.8 million UAH, including the cost of purchasing equipment – UAH 659.1 million.

According to preliminary calculations, the share of total expenditures in GDP was 0.45%, including at the expense of the state budget – 0.16%. According to 2016, the share of expenditures on research and development in GDP of the EU-28 countries averaged 2.03%. More than the average share of research and development costs was in Sweden – 3.25%, Austria – 3.09%, Germany – 2.94%, Denmark – 2.87%, Finland – 2.75%, Belgium – 2.49%, France – 2.25%; smaller – in Macedonia, Latvia, Romania, Cyprus and Malta (from 0.43% to 0.61%). In 2017, 21.9% of the total expenditures were spent on fundamental research, which was 92.4% funded at the expense of the budget. The share of applied research expenditures amounted to 23.6%, which was 51.5% financed by the budget and 27.6% at the expense of the enterprises of the enterprise sector (Scientific and Innovative Activities of Ukraine 2018, p. 56).

For implementation of scientific and technical (experimental) development was directed 54.5% of total expenditures, which 40.3% was financed by foreign firms, 28.7% – by enterprises of the entrepreneurial sector and 14.3% by their own funds. Almost half of the amount of expenditures allocated for fundamental scientific research was allocated to the natural sciences, 25.5% to technical, and 9.4% to agricultural ones. 44.3% of the expenses of the technical sciences, 20.4% – natural sciences, 12.3% – of agricultural enterprises have been directed at realization of applied scientific researches. The largest part (87.7%) of the expenses for the implementation of scientific and technological (experimental) developments belongs to the branch of technical sciences (Scientific and Innovative Activities of Ukraine 2018, p. 33).

In 2017, 759 enterprises engaged in innovation activity in industry, or 16.2% of surveyed industrial enterprises. In 2017, the companies spent \$ 9.1 billion on innovation, including the purchase of machines, equipment and software – UAH 5.9 billion, for internal and external research and development – UAH 2.2 billion for the acquisition of existing knowledge from other enterprises or organizations – 0.02 billion UAH and for other works related to the creation and implementation of innovations (other expenses) – UAH 1.0 billion. The main source of financing

innovative costs is the company's own funds – 7704.1 million UAH (or 84.5% of the total amount of expenses for innovation). The state budget funds received 8 enterprises, local budgets – 17, the total amount of which amounted to 322.9 million UAH (3.5%); funds of domestic investors received 5 enterprises, foreign – 3, in general, their volume amounted to 380.9 million UAH (4.2%); 21 enterprises benefited from loans, amounting to UAH 594.5 million (6.5%) (Scientific and Innovative Activities of Ukraine, 2018, p. 109).

Along with the domestic analysis of scientific and innovation activities, it is worth paying attention to Ukraine's place in the Global Innovation Index, which was created by the World Intellectual Property Organization and a number of partner research centers (Explore the interactive database of the GII 2018 indicators. 2019). The index consists of 80 indicators, was calculated in 2018 for 126 countries. The global innovation rankings are calculated by Cornell University, the INSEAD School of Business and the World Intellectual Property Organization each year. The rating interprets the concept of "innovation" through institutions, human capital, research and development, infrastructure and market potential. According to the organizers of the rating, the result of innovation is not only technological innovations, but also products of creative activity. The rating divides countries into 3 categories – leaders, prosperous and outsiders, while allocating also takes into account GDP per capita, as it is influenced by innovative markets.

The leader in 2018 ranking was Switzerland with an index of 68.40 points. The following are the Netherlands, Sweden, United Kingdom, Singapore, USA, Finland, Denmark and Germany. Top 10 completes Ireland (57.20). Ukraine's index in 2018 was 38.52, which allowed it to rise in the ranking of 7 steps and get to the top 50 countries and be ahead of Thailand, Vietnam, Russia, Chile, Moldova, Romania, Turkey (Ukraine in the Global Innovation Index 2018).

At the same time, based on the trend model (approximation) using the Excel package, we propose to estimate the effect of the predicted values of the components of innovation activity on the Global Innovation Index (Figure 3).

On the basis of conducted calculations it is possible to conclude that in the near future there will be negative trends in reducing the number of employees involved in the implementation of research and development, as well as the cost of their implementation. At the same time, despite such trends, the country's position in the Global Innovation Index rating will strengthen, which can testify, about the redistribution of financing of the innovation sphere in favor of private institutions and investors.

Ukraine ranked 43rd in the category of "human capital and research" (education, research and academic resources), "elegance of business" (patents, intellectual property, employment of women and national minorities, working conditions, etc.) – 46, "knowledge and technology" – 27,

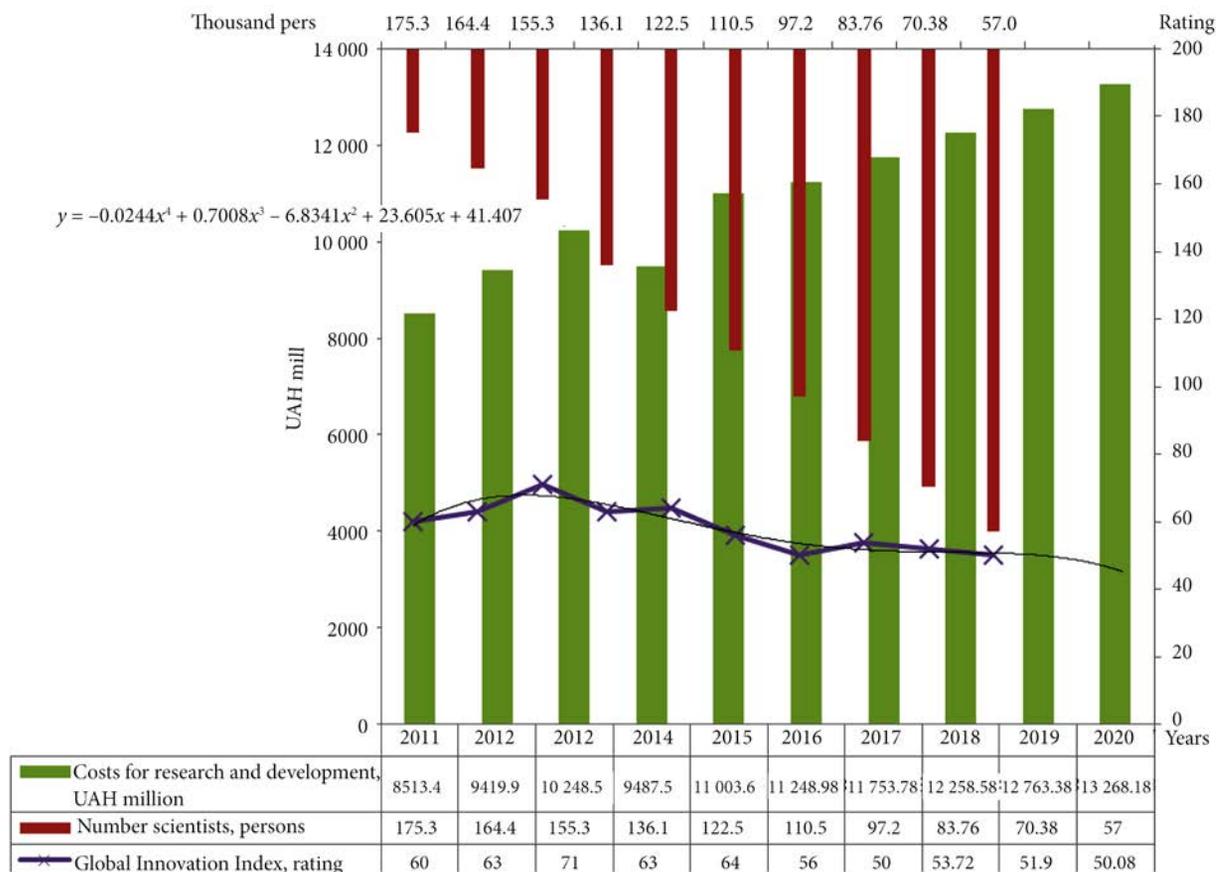


Figure 3. The forecasted values of the innovation activity components and the Global Innovation Index

“creativity” – 45. Ukraine’s lowest rates on “sophistication of the market” (loans, investments, competition) – 89th place, “infrastructure” (access to government services, cost of resources, energy saving indicators) – 89, “institutions” ( regulatory policy and business conditions) – 107 place.

That is another rating, which confirms the considerable educational potential and at the same time not very favorable economic conditions for development, financing and business, formation of an innovative economic model. However, the analysis shows that the innovation of the Ukrainian economy continues to grow. Ukraine ranked 50th in 2017 ranking, 56 in 2016, 63 in 2014. Over the last decade, Ukrainians registered more than 140,000 patents for inventions and models. This is the level of Poland, which, unlike us, is part of the European Union, has four times bigger economy and state programs to support innovation development. In addition, inventors from Ukraine have sponsored and co-sponsored more than 4,600 patents and applications for patents abroad, in particular with Bayer, BASF, Dupont, General Electric, Qualcomm, Samsung, Syngenta, etc. Most Ukrainian citizens register patents in the field of construction, pharmaceuticals, medicine, metallurgy and transport (Ukraine in the Global Innovation Index, 2018).

In our opinion, the weak place of the domestic innovation system on the way of developing an innovative model and formation of the knowledge economy is the lack of

necessary funding from the release of innovation to its implementation, and commercialization. In developed countries, each educational or research institute has units involved in patenting and selling licenses. For example, the Israel Research Institute named after Weitzmann receives from the state roughly the same funds as the National Academy of Sciences of Ukraine, but it is only 25% of its budget. Another three quarters are the proceeds from the sale of patents and licenses that were developed at the Institute.

### Conclusions and suggestions

In today’s competitive and information-mobile world, the one who sells his products better wins, and an appropriate system is needed to effectively commercialize inventions. Unfortunately, in Ukraine it is absent, because the government, universities, venture capital investors and other entities engaged in scientific and innovative activities or its financing have problems of interaction with each other and are characterized by low development.

In order to improve the situation, provide an innovative model of development and the formation of a knowledge economy, it is proposed to develop such measures as the increase of research and development costs to 1.5% of GDP with a prospect of 2.5–3%, stimulation of the development of world class universities on the basis

of consideration international ratings, the formation of a national innovation system with a market mechanism, creation of high-tech clusters and zones, integration of the national innovation system into a global one.

The achievement of Ukraine's competitiveness on the world market is determined by its ability to quickly adapt its own potential in creating and disseminating knowledge to the needs of the world economy and finding its own place in it. The transition to a knowledge economy involves an understanding of the decisive influence of science, the latest technologies, innovations in the global economy, and enables the resource-oriented countries to leave this status and become a countries of high-tech and high skilled development, based on the transformation of knowledge into a source of value and the driving force of economic progress. Under such conditions, education and science become crucial areas for the development and growth of competitive human capital, and in particular its intellectual component, which becomes the most valuable asset in the knowledge economy, because knowledge embodied in products and services creates value based on the intellectualization of technologies, the growth of the knowledge of manufactured products, development of the market of intellectual services.

### Author contributions

The authors contributed equally.

### Disclosure statement

The authors do not have any conflict of interest.

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