JOURNAL OF SECURITY AND SUSTAINABILITY ISSUES
ISSN 2029-7017 print/ISSN 2029-7025 online
2020 September Volume 10 Number 1
https://doi.org/10.9770/jssi.2020.10.1(20)

Scopus®

INNOVATION ECONOMY MANAGEMENT AS A FACTOR OF NATIONAL SECURITY

Lidiia Karpenko[1], Anatoliy Rachynskyi[2], Hennadii Dmytrenko[3], Anatolii Akhlamov[4], Nataliia Oliinyk[5]

[1,4]Odessa Regional Institute for Public Administration of the National Academy for Public Administration under the President of Ukraine Genuezka, 22, 65009, Odessa, Ukraine*
[2, 5]National Academy for Public Administration under the President of Ukraine, 20, Ezhena Pottier st., 03057 Kyiv, Ukraine
[3]Institute for Personnel Training of the State Employment Service of Ukraine, 8/10, Esplanade str., Kiev, 01601, Ukraine

E-mail: [1]koaduep@gmail.com*

Received 15 February 2020; accepted 10 July 2020; published 30 September 2020

Abstract. As a result of the conducted study, there has been solved an important scientific problem of development of theoretical and methodological foundations of building international competitiveness in the conditions of globalization of innovation activity and creation of organizational and economic tools for support of national innovation system safety in global scientific and technological space. It has been established that innovation activity in Poland is characterized by structural deformation, institutional incompleteness, inconsistency and imbalance of technological, economic, social and value aspects, as a result of which innovation processes in the country have not gained sufficient scale and are not a significant factor of GDP growth. Problems of development of national innovation systems in Poland are caused, first of all, by an unsatisfactory state of financing of the scientific sphere, as a result of which the country has lost the system capable to effectively concentrate resources on priority strategic directions of innovation development. Based on a comparative economic and mathematical analysis of the impact of variables that determine the degree of inclusion of the country in global value chains, as well as diagnostics of the competitive environment of some countries, it has been stated that, except for IT, today Poland has no competitive advantages and preconditions for inclusion in global value chains. Considering the importance of the human development index, the Chinese model of innovation development is most acceptable for the country. Considering that in addition to the financial component, one of the main reasons for slowing down innovation activity in Poland is the lack of effective links between government, business and science, there has been justified the need to develop a government innovation policy based on a combination of direct and indirect methods of innovation support. There has been stressed the importance of building a common information and scientific space with Europe, which is possible in the conditions of creation of an open national innovation system.

Keywords: national security; national innovation system; global value chains; international competitiveness; regression statistics

Reference to this paper should be made as follows: Karpenko, L., Rachynskyi, A., Dmytrenko, H., Akhlamov, A., Oliinyk, N. 2020. Innovation economy management as a factor of national security. *Journal of Security and Sustainability Issues* 10(1), 277-289. https://doi.org/10.9770/jssi.2020.10.1(20)

JEL Classifications: E69; F17; H39

1. Introduction

Currently, the development of the world economy is characterized by the promotion of the processes of technology and information exchange, the creation and spread of which is gaining a global nature and has a significant impact on mainstreaming the processes of international competition and provision of national security. Under these conditions, the creation of international competitive advantages based on innovation as the main factor in the transformation of world economic development becomes especially important.

Continuous technological innovations in all spheres of management are the driving force of change of technological practices, which is accompanied by the formation of an integrated system of technologically related processes that go beyond national economies. The growth of interaction and interdependence of national economies has gained a special character in the field of creation and spread of innovations at the level of national innovation systems (NIS) under the influence of the trend of globalization of scientific and technological space.

The creation of the national innovation system is a significant factor of the scientific and technological development of the state and strengthening its international competitiveness, which requires a thorough methodological study of these issues taking into account the globalization stage of the world economy.

2. Literature Survey

The corresponding processes create challenges for all participants of global innovation development, which forces them to compete with high-quality imported products not only in foreign but also in domestic markets (Rudskaia, I., & Rodionov, D. (2018)). The most important economic problem is the problem of competitiveness at the national, regional and international levels, the determining factors of which are the scientific, technical and educational potential of society, new technologies and innovations (Resele, L. (2015)).

The role of innovations in achieving competitiveness is that they give economic actors the opportunity to achieve technological dominance in the market and thus ensure competitiveness at all levels. As evidenced in practice (Suzuki, J., Tsukada, N., & Goto, A. (2015)), the most important condition for economic growth of leading countries was to increase their competitiveness by ensuring a leading position in international markets for science-intensive production, which they were able to achieve by transferring the economy to innovation way of development and creating a national innovation system (NIS).

The national specifics of the innovation system are formed within the framework of the general model of NIS and depend on the following factors:

the size of the country and the level of its development. Large and highly developed countries create markets in order to save money at the expense of the scale of scientific research activity (Drobyazko, S., et al. (2019a), Drobyazko, S., et al. (2019b)). Small, high-income countries-innovators tend to faster internationalize innovation and focus on a narrower range of innovation areas to reap the corresponding benefits (for example, mobile communication in Finland and Sweden) (Acs, Z. J., Audretsch, D. B., Lehmann, E. E., & Licht, G. (2017)). They benefit most from free technological flows across borders, and their innovative systems are often based on the benefits of technology absorption. At the same time, they have high expenses on the support of education and science organizations, which disciplinary boundaries are wider than those in industry;

the role of the main participants of innovation processes (firms, public and private research organizations, government agencies), as well as the forms, quality and intensity of their interaction. These actors are influenced by various factors that determine the specifics of the country (Hekkert, M. P., Janssen, M. J., Wesseling, J. H., & Negro, S. O. (2020)): financial system and corporate management, legal and regulatory framework, level of education and skills, degree of staff mobility, workforce, prevailing management practices, etc. A defining characteristic is the role of government in financing R&D. In "catching up" countries (Greece, Hungary, Mexico, Poland, Portugal, Turkey), the government accounts for the largest share of R&D expenditures (Lundvall, B. (2015)). These countries have inefficient innovation infrastructure and weak links between the public and business sectors. The developed countries, where the business sector provides the bulk of R&D funding (Belgium, Ireland, Japan, Switzerland, USA), also differ in the disciplinary focus of public R&D funding (Wonglimpiyarat, J. (2018));

the role of market and non-market institutions in the country, which influence the direction and speed of innovation spread, which is also a defining characteristic of the national innovation system. There are global, regional or local networks of firms and industries that are not limited to national borders, but national specifics always play a certain role in their formation (Kwon, S., & Motohashi, K., 2017). This also applies to the internationalization of innovation technologies, which largely reflects the perception of foreign investors about the strengths of NIS (for example, the existence of research centers of excellence or the availability of qualified scientists (Fagerberg, J., Lundvall, B. A., & Srholec, M., 2018).

Given that innovation development and globalization occur in parallel and are interrelated processes, no NIS can be effective without its integration into the regional innovation system (Nesterenko, S. et. al., 2019).

The purpose of the paper is to develop the theoretical and methodological foundations for the study of the national innovation system at the stage of globalization and the development of scientific and practical recommendations for ensuring the competitiveness of the national innovation system under the conditions of formation of global scientific and technological space.

3. Methods

The theoretical and methodological foundations of the study are the principles of modern economic theory, the concept of competitiveness, the theory of innovation development, scientific works of leading scientists in the field of competitiveness, globalization, international innovation, innovation systems.

To achieve the set goal there was used a dialectical method of scientific cognition, as well as a complex of general and special research methods: the method of scientific generalization; analysis and synthesis (for the analysis of methodological foundations of formation of the national innovation system); comparative analysis (for the study of trends in the formation of the competitiveness of national innovation systems in the context of globalization of scientific and technological space); methods of economic and mathematical analysis and modeling (for the analysis of the relationship between the global competitiveness index and the global innovation index, as well as for determining the leading areas of inclusion of the innovation system in global value chains), etc.

To estimate the parameters of the linear regression, we use the method of least squares (LSXY). In accordance with LSXY, the search for the best approximation of a set of observations by a linear function is reduced to minimizing the functionality (Maloney, W. F. (2017)):

$$h=\sum_{i=1}^{m}(x_i-(b+ay_i))^2 \tag{1}$$

The verification of the significance of the regression equation is carried out on the basis of analysis of variance. We represent by $\hat{x}=b+ay$ (Gokhberg, L., & Roud, V. (2016)) the values theoretically calculated using the formula, then (Fukugawa, N. (2017)):

$$x_i-\bar{x}=x_i-\bar{x}+\hat{x}_i-\hat{x}_i=(x_i-\hat{x}_i)+(\hat{x}_i-\bar{x}) \tag{2}$$

We transform the variance formula taking into account the above sum:

$$\sum_{i=1}^{m}(x_i-\bar{x})^2=\sum_{i=1}^{m}[(\hat{x}_i-\bar{x})+(x_i-\hat{x}_i)]^2=\sum_{i=1}^{m}(\hat{x}_i-\bar{x})^2+\sum_{i=1}^{m}(x_i-\hat{x}_i)^2+2\sum_{i=1}^{m}(\hat{x}_i-\bar{x})(x_i-\hat{x}_i) \tag{3}$$

Farther on:

$$\begin{aligned}\sum(\hat{x}_i-\bar{x})(x_i-\hat{x}_i)&=\sum(x_i-\hat{x}_i)(b+ay-\bar{x}\pm a\bar{y})=\sum(x_i-\hat{x}_i)(b-\bar{x}+a\bar{y})+\\&+a\sum(x_i-\hat{x}_i)(x_i-\bar{x})=a\sum(x_i-b-ay_i)y_i-a\bar{y}\sum(x_i-b-ay_i)=0\end{aligned} \tag{4}$$

As there is equality $(b - \bar{x} + a\bar{y} = 0,$

Then with LSXY we have the proportion:

$$\sum (x_i - b - ay_i)y_i = 0$$

$$\sum (x_i - b - ay_i) = 0$$

Accordingly,

$$\sum_{i=1}^{m}(x_i - \bar{x})^2 = \sum_{i=1}^{m}(\hat{x}_i - \bar{x})^2 + \sum_{i=1}^{m}(\hat{x}_i - \bar{x})^2 + \sum_{i=1}^{m}(x_i - \hat{x}_i)^2 \quad (5)$$

$\sum_{i=1}^{m}(x_i - \bar{x})^2$ – TSS (total sum of squares) – total variance: the sum of squares of deviations from the mean.

$\sum_{i=1}^{m}(\hat{x}_i - \bar{x})^2$ – RSS (regression sum of squares) – explained part of the total variance (due to regression).

$\sum_{i=1}^{m}(x_i - \hat{x}_i)^2$ – ESS (error sum of squares) – residual sum or residual variance.

The estimation of the quality of the built model can be determined through the coefficient (index) of determination, as well as using the average approximation error.

The average approximation error is the average deviation of the estimated values from the actual ones as a percentage:

$$\bar{B} = \frac{1}{m}\sum \left| \frac{x - x_y}{x} \right| \cdot 100\% \quad (6)$$

The limit of values of $B \le 0{,}08 - 0{,}1$ (8-10%) is acceptable when building a model.

The average coefficient of elasticity shows by how many % on average per totality the result y will change from its average value when the factor y changes by 1% of its average value:

$$\bar{E} = f'(y)\frac{\bar{y}}{\bar{x}} \Rightarrow \bar{E} \cdot \bar{x} = f'(y) \cdot \bar{y} \quad (7)$$

f' – characterizes the relationship between the growth of the result and the factor for the corresponding form of communication.

The information base of the study is regulatory and statistical materials, reports, presentations, information materials, analytical reviews and expert assessments of international organizations: OECD, UN commissions, etc.

4. Results

Today, the issues of functioning and extension of global value chains are becoming increasingly important. The advantages due to the country participation in global value chains (GVCs) are improving the quality of products, expanding sales markets as a result of gaining access to global markets, technology modernization, stimulating foreign direct investment, increasing employment while increasing real wages, etc.

Two main approaches have traditionally been implemented to include the country in GVCs:

concentration of production and exports on a certain range of components within the framework of GVCs using the available advantages;

implementation of an industrial growth strategy aimed at creating national production facilities at all stages of production for the development of vertically integrated industries.

To identify the specifics of the inclusion of countries in GVCs and opportunities to implement foreign experience regarding the inclusion of the national economy in GVCs, as well as to identify priority areas of business cooperation with transnational organizations, taking into account the innovation component, we analyze countries that have successfully joined GVCs using such advantages as geographic location, specialization of production, availability of highly developed NIS and competitive advantages in the global market: USA, Saudi Arabia, China, Switzerland, Japan. The above countries represent different regions of the world and have a degree of inclusion in GVCs due to their global competitive advantages, so they are representative.

With the help of building the regression equation – formulas 1-7 – we determine the form of the relationship between the phenomena under study.

The model has a theoretical specification for each country selected for analysis (USA, Poland, Saudi Arabia, Japan, China, Switzerland):

$$(Hi-TechExp)X = d \times Ind)Y_1 \times (MAN)Y_2 \times (Ser)Y_3 \times (R\&D)Y_4 \times (IT)Y_5 \times (Pat)Y_6 \times (Edu)Y_7 \quad (8)$$

where: X – the volume of high-tech exports for the country m, % of GDP; Y1 – the volume of value added in industry, % of GDP; Y2 – the volume of value added in the manufacturing industry, % of GDP; Y3 – the volume of value added in services, % of GDP; Y4 – R&D expenditures, % of GDP; Y5 – exports of IT products, % of GDP; Y6 – the volume of patents in the national economy; Y7 – education expenditures, % of GDP; d – the constant.

As a result of econometric analysis using the selected parameters, the regression model for the United States will have the indicators presented in Table 1.

Table 1. Regression statistics for the USA

Dependent Variable: D (HIGH TECHNOLOGY EXPORTS)				
Method: Least Squares				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(SERVICES VALUE ADDED)	0.523213	0.141904	0.328919	0.2239
D(RESEARCH AND DEVELOPMENT)	1.751451	0.75008	0.789544	0.0167
D(PATENT APPLICATIONS BY R)	-1.591858	2.910337	-0.546967	0.5953
DfMANUFacturing value adde)	0.122097	0.062383	0.564212	0.0001
D (Informatk) N (technology e)	0.521893	0.236512	0.254126	0.8041
D(INDUSTRY VALUE ADDED)	0.124953	0.329787	0.647645	0.1015
D(EDUCAtK)N SPENDING GD)	1.215278	0.325919	0.018749	0.0002
d	12.02035	410.3938	4.347130	0.0012
R-squared	0.856412	Durbin-Watson stat		2.17
Adjusted R-squared	0.790121			
F-statistic	1.165504			
Prob(F-Statistic)	0.000016			

The obtained results allow to provide such interpretation of the model coefficients:

- indicators that have the largest statistical significance as regards the impact on high-tech exports of the USA are the value added generated in industry, and the level of R&D and education expenditures;
- with an increase in value added in industry by 1, high-tech exports increase by 1.54 under other constant conditions. With an increase in R&D expenditures by 1, high-tech exports increase significantly by 1.38 under other constant conditions.

Saudi Arabia is another country for modeling being one of the world leaders in oil production and refining: the country occupies a leading position in the ranking of oil exports (Ali, A. (2020)), (Alkhathlan, K.A., Alkhateeb, T.T.Y., Mahmood, H., Bindabel, W.A. (2020)).

When carrying out the analysis the parameter "innovation index" turned out to be unrepresentative. The results of regression modeling are presented in Table 2. The model for Saudi Arabia proved to be a working one with a high degree of statistical significance.

Table 2. Regression statistics for Saudi Arabia

Dependent Variable: D (HIGH TECHNOLOGY EXPORTS)				
Method: Least Squares				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(SERVICES VALUE ADDED)	8.290458	14.12064	0.587866	0.5667
D(RESEARCH AND DEVELOPMENT)	-0.219799	0.304906	-0.720876	0.4837
D(PATENT APPLICATIONS BY R)	0.89182	0.02451	0.769312	0.1003
DfMANUFacturing value adde)	0.26025	5.644559	2.526371	0.0253
D(Informatk)N technology e)	-0.766796	0.329251	-2.328908	0.0366
D(INDUSTRY VALUE ADDED)	551.0625	1561.499	0.352906	0.7298
d	-68.84599	95.73827	-0.719106	0.4848
R-squared	0.621231	Durbin-Watson stat		2.956141
Adjusted R-squared	0.591234			
F-statistic	0.301695			
Prob(F-Statistic)	0.097891			

The economic interpretation of the results is as follows:

- the model indicators point to extremely low level of positive statistical impact of GVC factors on high-tech exports in Saudi Arabia;
- the value added in the structure of high-tech exports of Saudi Arabia is formed in industry.

The next country selected for modeling is Switzerland. This country is not only a world financial center, but also a country-innovator in the pharmaceutical and medical fields. Switzerland holds a leading position among European countries in the field of innovative banking services and IT technologies. The results of regression modeling are presented in Table 3.

Table 3. Regression statistics for Switzerland

Dependent Variable: D (HIGH TECHNOLOGY EXPORTS)				
Method: Least Squares				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(SERVICES VALUE ADDED)	0.523213	0.141904	0.328919	0.2239
D(RESEARCH AND DEVELOPMENT)	1.751451	0.75008	0.789544	0.0167
D(PATENT APPLICATIONS BY R)	-1.591858	2.910337	-0.546967	0.5953
DfMANUFacturing value adde)	0.122097	0.062383	0.564212	0.0001

D(Informatk)N technology e)	0.521893	0.236512	0.254126	0.8041
D(INDUSTRY VALUE ADDED)	0.124953	0.329787	0.647645	0.1015
D(EDUCAtK)N SPENDING GD)	1.215278	0.325919	0.018749	0.0002
d	12.02035	410.3938	4.347130	0.0012
R-squared	0.856412	Durbin-Watson stat		1.998260
Adjusted R-squared	0.790121			
F-statistic	1.165504			
Prob(F-Statistic)	0.000016			

The results of regression modeling allow to make the following conclusions:

- Switzerland is a country that is highly integrated in GVCs and creates the significant value added;
- with the growth of R&D funding by 1, the volume of high-tech exports increases by 1.75 under other constant conditions;
- Switzerland has the largest increase in high-tech exports (by 1.21) due to an increase by 1 of education funding under other constant conditions;
- the positive statistical impact of such factors as value added in the manufacturing industry and the level of innovation was also revealed.

Currently, the experience of a rapid increase in scientific and technological potential of China, which only in the last five years has increased its position in the corresponding world rankings by several positions, is the most relevant in the system of global innovation development. Therefore, it is logical to analyze the inclusion of this country in the GVCs for the selected parameters, which represent the following indicators in the results of modeling presented in Table 4.

Table 4. Regression statistics for PRC

Dependent Variable: D (HIGH TECHNOLOGY EXPORTS)				
Method: Least Squares				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(SERVICES VALUE ADDED)	1.02129	2.215110	0.009170	0.0611
D(RESEARCH AND DEVELOPMENT)	0.21828	0.326560	-0.772410	0.4561
D(PATENT APPLICATIONS BY R)	0.093416	0.142018	0.657773	0.5242
D(MANUFACTURING VALUE ADDE)	1.29557	0.128286	1.578750	0.1027
D(InfORMATK)N TECHNOLOGY E)	3.12676	1.322109	0.812156	0.4339
D(INDUSTRY VALUE ADDED)	4.77948	3.10356	-0.10565	0.0090
D(EDUCAtK)N SPENDING GD)	-25581.42	26274.43	-0.65481	0.3512
d	14384.77	18061.80	0.796420	0.4426
R-squared	0.585451	Durbin-Watson stat		2.575438
Adjusted R-squared	0.512322			
F-statistic	1.259966			
Prob(F-statistic)	0.052266			

The economic interpretation of the model for PRC is somewhat contradictory. On the one hand, the significant level of integration of China in GVCs is understandable, but on the other hand, the results of the model show the statistical significance for China of the factor of the creation of value added only in industry. No statistical impact on the integration of China in GVCs was found for either education or R&D. In our opinion, this can be explained by the fact that the economy of China has significant potential, and the technological stage in China – when it is the “assembly shop” of the world economy – is not yet over.

The next country selected for modeling is Japan as a leading country in the field of high-tech production. The results of regression modeling for Japan are presented in Table 5.

Table 5. Regression statistics for Japan

Dependent Variable: D (HIGH TECHNOLOGY EXPORTS)				
Method: Least Squares				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
DfSERVICES VALUE ADDED)	9.080314	16.50093	-0.550291	0.0931
DfRESEARCH AND DEVELOPMENT)	1.789865	0.321057	0.261391	0.0086
D(PATENT APPLICATIONS BY R)	0.206372	0.180795	1.141472	0.2779
d(manufActuring value adde)	1.210743	0.225467	2.644952	0.0228
DfINFORMATION TECHNOLOGY E)	9.123396	1.453582	1.010243	0.0115
DfINDUSTRY VALUE ADDED)	-0.012341	0.12337	-0.123673	0.4142
DfEDUCATION SPENDING GD)	-0.213753	3.156407	-0.273158	0.7898
d	2.121276	2.23545	0.875612	0.4000
R-squared	0.814654	Durbin-Watson stat		2.9875
Adjusted R-squared	0.715456			
F-statistic	0.474233			
Prob(F-statistic)	0.001675			

The economic interpretation of the results is as follows:
- the integration of the economy of Japan in GVCs is taking place through the services and the manufacturing industry;
- R&D and innovation are of particular importance for the development of the high-tech sector of the economy of Japan. The has been found the statistical influence of R&D volume. As it increases by 1, the volume of high-tech exports increases by 1,789.

As for increasing export opportunities of Poland, one of the most pressing issues today is focusing its economy on the export of high-tech goods, goods with high value added and a high degree of processing.

After studying foreign experience in the integration of countries in GVCs, it is important to identify those areas that would allow Poland to be integrated in GVCs. As in the case of the above countries, for Poland we will carry out the analysis by the selected parameters and estimate the model using the method of least squares. The results of regression modeling estimation are presented in Table 6.

Table 6. Regression statistics for Poland

Dependent Variable: D (HIGH TECHNOLOGY EXPORTS)				
Method: Least Squares				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
DfSERVICES VALUE ADDED)	3.116263	13.64034	0.228459	0.8235
DfRESEARCH AND DEVELOPMENT)	-1.032507	1.123616	-0.434048	0.6726
DfPATENT APPLICATIONS BY R)	-0.086732	0.053163	-1.631435	0.1311
DfMANUFACTURING VALUE ADDE)	0.35312	0.035341	0.679358	0.5120
INFORMATION TECHNOLOGY E	1.10208	3.2314256	0.251598	0.0017
DfINDUSTRY VALUE ADDED)	-9.588577	47.03605	-0.203856	0.8422
DfEDUCATION SPENDING GD)	-24.12134	27.01384	-0.231900	0.8209
d	-1079.898	364.9125	-2.959333	0.0130
R-squared	0.620617	Durbin-Watson stat		2.214634
Adjusted R-squared	0.522315			
F-statistic	1.031513			
Prob(F-statistic)	0.002318			

The economic interpretation of the results of the estimation of regression model for Poland is as follows:

- none of the factors that indicate the importance of the economy for GVCs turned out to be statistically significant;
- the export of information technologies is the only statistically significant factor that has a positive impact on the growth of high-tech exports, which confirms the position of Poland as one of the world's centers for IT outsourcing. However, it should be noted that in Poland outsourcing projects are placed mainly by US companies, which thus save money due to cheap labor, and therefore, the value added value in GVCs is received just by the USA.

So, it can be argued that the NIS of Poland has the features of a scientific and technological platform aimed at the creation of new promising technologies, innovative products and services, attraction of additional resources for joint R&D, facilitation of the transfer of technology and information through international transfer networks.

Considering that the volume of funding for scientific and scientific-technical activities in Poland (from all sources of funding) remains insignificant (12.2 billion hryvnias in 2016, including 4.25 billion hryvnias from the state budget), you should mention the need for a differentiated approach to the choice of sectoral development priorities.

The results of modeling for the above countries can be presented in the aggregate (Table 7).

Table 7. The results of modeling the integration of the innovation systems of countries in global value chains

Indicator	USA	Poland	Saudi Arabia	Switzerland	PRC	Japan
Y1 - volume of value added in industry, % of GDP	1.5958	X	0.2602	0.1220	4.7794	X
Y2 - volume of value added in the manufacturing industry, % of GDP	X	X	X	0.1249	1.2955	1.2107
Y3 - volume of value added in the service sector, % of GDP	X	X	X	X	1.0212	9.0803
Y4 - R&D expenditures, % of GDP	1.3864	X	X	1.7514	X	1.7898
Y5 - exports of IT products, % of GDP	X	1.1028	0.8918	0.521	X	9.1233
Y6 - volume of patents in the national economy	X	X	-0.766	X	X	X
Y7 - education expenditures, % of GDP	1.546	X	X	1.215	X	X
R-squared	0.80	0.62	0.62	0.85	0.58	0.81
Prob (F-statistic)	0.0020	0.00023	0.097	0.00006	0.0522	0.001
DW	2.17	2.21	2.95	1.99	2.57	2.98

The data in Table 7 show that in the USA a fairly high level of value added is created in industry, as the US industry has a high level of production and territorial concentration and includes all branches that manufacture both mass and serial products. The USA is the undisputed world leader in the chemical, light, mining industries, and in military-industrial complex, which causes a fairly high level of R&D spending in this country, and the service sector in the USA generates 74.9% of GDP.

Saudi Arabia is distinguished by a high level of exports of IT services, which is explained by the intensification of the development of this sector in the country over the past 7 years, and the development of the manufacturing industry, as the economy of Saudi Arabia is based on the oil industry, which accounts for 45% of GDP and 75% of budget revenues; oil products account for 90% of the country exports.
Switzerland is characterized by a high level of innovation, which is confirmed by high expenditures for education and R&D, and high innovation index.

Switzerland has a high level of value added in industry (until 1981 it became one of the most industrialized countries in the world): the main branches of industry are machine-building, textile, chemical, food and pharmaceutical industries. Switzerland is also a world leader in gold refining processing two-thirds of its world production.

China is included in GVCs through manufacturing industry and service sector. The industrial potential of China provides about 46.6% of GDP (Attia, A. M. (2015)). China ranks first in the world by the number of industrial enterprises. Currently, the industry of China is presented by 360 branches. Along with the traditionally developed industries (textile, coal industries and ferrous metallurgy), there are new industries – such as oil extraction, oil refining, chemical, pharmaceutical, automotive, aviation, space, electronic industries. In 2013, the percentage of service sector in GDP of China for the first time exceeded the percentage of industrial production and has been growing recently. Such economic sectors as real estate, retail and finance account for 41% of GDP.

Japan has a high degree of integration in GVCs due to the intensive development of innovations. In accordance with the government program of development of the Japanese NIS, the transition was made from the import of technical achievements to the development of its own R&D system. Radical measures have been taken to improve personnel training and further develop international scientific cooperation. The main structural factor is science and education, so they are paid special attention, which is confirmed by the high level of R&D expenditures, and high innovation index. In 2017 in Japan the exports of high-tech products amounted to 17% (93 trillion dollars) of total merchandise exports, and exports of innovative services amounted to 1.74 trillion dollars.

As for Poland, today the country has no competitive advantages and preconditions for integration in GVCs, except for IT technologies. Therefore, a purposeful transition to an innovative model should be the main priority of economic development for Poland, which requires, as noted above, understanding and use of foreign experience. Successful implementation and adaptation of foreign models of innovative development significantly intensify the reform of the national economy on the path of innovative development. In our opinion, the most suitable model of innovative development for Poland today is the Chinese one, as it allows balancing the financial and scientific-personnel systems of ensuring the functioning of NIS and its integration in GVCs.

5. Discussion

In this context, the issue of improving the system of commercialization of R&D with the purpose of creating capacity for technology transfer, which is also within the competence of the government, is relevant. Transfer and commercialization are considered key activities in the active search for opportunities and maintaining relationships with third parties that bring potential benefits (Lovio, R., & Välikangas, L. (2015)). Funding for technology transfer and commercialization should be provided by government or other external resources taking into account extremely limited R&D budgets, especially in the case of academic institutions. In the long run, the transfer may also be financed from funds received from the commercialization of knowledge, including capital gains through participation in the share capital of subsidiaries, part of royalties for licensed technologies or additional funds under cooperation agreements.

The commercialization of scientific research involves costs that are not usually available in academic organizations (Casadella, V., & Uzunidis, D. (2017)). Considering the uncertainty of expected revenues from commercialization, there becomes important the issue of providing state support through:

- providing subsidies for the commercialization of scientific research activities, in the form of grants or a small share of the total research budget;
- subsidizing the cost of obtaining patents and other forms of intellectual property protection or enabling recipients to use research funds to cover the costs associated with the protection of intellectual property (IB);
- training of technology transfer agency personnel, in particular on various issues related to intellectual property, including patent applications, copyright and registration of samples, licensing negotiations with companies;
- simplification of access to legal and patent services when outsourcing them.

Public sector participation in innovation will help coordinate private initiatives and strengthen links between industry and researchers. Balancing relationships between the science and business sectors is possible under the following conditions:

- active promotion of cooperation between different innovative companies by the authorities in order to constantly change their behavior. The range of government interventions may include different resource commitments and be focused on different areas, including strategic cooperation between different organizations, which is funded through a partnership of science and industry stakeholders. This type of intervention can be focused on the creation and promotion of key technologies or centers of excellence that support the development of partnership structures in the field of research and innovation;
- support for industry clusters aimed at strengthening links between startups, companies and research organizations in a particular industry or region. Specific activities may include funding joint projects or improving framework conditions, including physical infrastructure, human capital and internationalization platforms;
- the presence of intermediary structures;
- availability of platforms for interaction between research organizations and business, which provide information services, organization of exhibitions and innovation fairs.

International cooperation in science can be encouraged by strengthening the mechanisms of coordination and distribution (Watkins, A., Papaioannou, T., Mugwagwa, J., & Kale, D. (2015)). Participation in it requires special skills that can be developed through appropriate training. Taking into account the measures already taken in this area, efforts need to be made as regards:

- the development of Internet platforms for improving the skills of scientists and engineers in the field of international scientific and technological cooperation, including its management and administrative aspects related to the submission of applications for research grants and commercialization of research projects;
- the improvement of access of scientists to international scientific publications, as well as provision of translation into foreign languages, and other organizational support for articles of scientists who apply for their publication in international journals.

Conclusions

According to the results of the conducted study, it has been found that, except for IT sector, today Poland has no competitive advantages and preconditions for its integration in GVCs. Considering the significance of the human development index in the country and the lack of funding for scientific and scientific-technical activities (from all sources of funding), the Chinese model of innovation development is most acceptable for it, the use of which will allow to balance the financial and scientific-personnel systems of ensuring the functioning of NIS and its integration in GVCs.

Considering that apart from the financial component (funding for science and scientific-technical sphere in Poland is at a critically low level, in the absence of measures to indirectly stimulate innovation), one of the main reasons for slowing down innovation in Poland is the lack of effective relationship between government, business and science (fundamental knowledge about IV-VII technological modes are still accumulated, but the preconditions for their commercialization in the economy are practically absent), there was substantiated the need to develop a government innovation policy based on combining direct and indirect methods of innovation support in these areas: support for innovation infrastructure; development of the venture capital industry; management of change processes in social capital; transformation of universities into powerful business academic centers; improving the system of commercialization of R&D with the purpose of creating capacity for technology transfer, etc.

There was underlined the importance of building a common information and scientific space with Europe, which is possible under conditions of an open NIS based on the interaction of institutions of national innovation systems through: social and communication cooperation; technological trajectories; scientific and technical policy; common R&D markets, technology integration policy; intellectual property; international investment and trade agreements.

References

Acs, Z. J., Audretsch, D. B., Lehmann, E. E., & Licht, G. (2017). National systems of innovation. The Journal of Technology Transfer, 42(5), 997-1008. Available at: https://link.springer.com/article/10.1007/s10961-016-9481-8

Ali, A. (2020). Financial Performance, Disparity, and Trend of Petrochemicals sector of Saudi Arabia. Entrepreneurship and sustainability Issues, 8(1), 809-824. http://doi.org/10.9770/jesi.2020.8.1(54)

Alkhathlan, K.A., Alkhateeb, T.T.Y., Mahmood, H., Bindabel, W.A. (2020). Concentration of oil sector or diversification in Saudi economy: consequences on growth sustainability. Entrepreneurship and Sustainability Issues, 7(4), 3369-3384. http://doi.org/10.9770/jesi.2020.7.4(52)

Attia, A. M. (2015). National innovation systems in developing countries: barriers to university–industry collaboration in Egypt. International Journal of Technology Management & Sustainable Development, 14(2), 113-124. Available at: https://www.ingentaconnect.com/content/intellect/tmsd/2015/00000014/00000002/art00004

Casadella, V., & Uzunidis, D. (2017). National innovation systems of the south, innovation and economic development policies: A multidimensional approach. Journal of Innovation Economics Management, (2), 137-157. Available at: https://www.cairn.info/revue-journal-of-innovation-economics-2017-2-page-137.htm

Drobyazko S., Barwińska-Małajowicz A., Ślusarczyk B., Zavidna L., Danylovych-Kropyvnytska M. (2019). Innovative Entrepreneurship Models in the Management System of Enterprise Competitiveness. Journal of Entrepreneurship Education, Volume 22, Issue 4, 2019. URL: https://www.abacademies.org/articles/Innovative-entrepreneurship-models-in-the-management-system-1528-2651-22-4-408.pdf

Drobyazko, S., Okulich-Kazarin, V., Rogovyi, A., & Marova, S. (2019). Factors of influence on the sustainable development in the strategy management of corporations. Academy of Strategic Management Journal. Available at: https://www.abacademies.org/articles/factors-of-influence-on-the-sustainable-development-in-the-strategy-management-of-corporations-8623.html

Fagerberg, J., Lundvall, B. Å., & Srholec, M. (2018). Global value chains, national innovation systems and economic development. The European Journal of Development Research, 30(3), 533-556. Available at: https://link.springer.com/article/10.1057/s41287-018-0147-2

Fukugawa, N. (2017). University spillover before the national innovation system reform in japan. International Journal of Technology Management, 73(4), 206-234. Available at: https://www.inderscienceonline.com/doi/abs/10.1504/IJTM.2017.083079

Gokhberg, L., & Roud, V. (2016). Structural changes in the national innovation system: longitudinal study of innovation modes in the Russian industry. Economic Change and Restructuring, 49(2-3), 269-288. Available at: https://link.springer.com/article/10.1007/s10644-015-9164-8

Hekkert, M. P., Janssen, M. J., Wesseling, J. H., & Negro, S. O. (2020). Mission-oriented innovation systems. Environmental Innovation and Societal Transitions, 34, 76-79. Available at: https://www.sciencedirect.com/science/article/pii/S2210422420300010

Kwon, S., & Motohashi, K. (2017). How institutional arrangements in the National Innovation System affect industrial competitiveness: A study of Japan and the US with multiagent simulation. Technological Forecasting and Social Change, 115, 221-235. Available at: https://www.sciencedirect.com/science/article/abs/pii/S0040162516304139

Lovio, R., & Välikangas, L. (2015). National Innovation System of F inland. Wiley Encyclopedia of Management, 1-14. Available at: https://onlinelibrary.wiley.com/doi/abs/10.1002/9781118785317.weom130048

Lundvall, B. (2015, September). The origins of the national innovation system concept and its usefulness in the era of the globalizing economy. In 13th Globelics Conference. Havana, Cuba (pp. 23-26). Available at: http://www.globelicsacademy.org/Lundvall_NSI-origins%20and%20globalisation.pdf

Maloney, W. F. (2017). Revisiting the national innovation system in developing countries. The World Bank. Available at: https://elibrary.worldbank.org/doi/abs/10.1596/1813-9450-8219

Nesterenko S., Drobyazko S., Abramova O., Siketina N. (2019). "Optimization of Factorial Portfolio of Trade Enterprises in the Conditions of the Non-Payment Crisis", IBIMA Business Review, Vol. 2019 (2019), Article ID 278890, DOI: 10.5171/2019.278890
Resele, L. (2015). Impact of the National Innovation System on innovation. Journal of Business Management, (9).

Rudskaia, I., & Rodionov, D. (2018, April). The concept of total innovation management as a mechanism to enhance the competitiveness of the national innovation system. In Proceedings of the 2018 International Conference on Internet and e-Business (pp. 246-251). Available at: https://dl.acm.org/doi/abs/10.1145/3230348.3230349

Suzuki, J., Tsukada, N., & Goto, A. (2015). Role of public research institutes in Japan's national innovation system: Case study of AIST, RIKEN and JAXA. Science, Technology and Society, 20(2), 133-160. Available at: https://journals.sagepub.com/doi/abs/10.1177/0971721815579793

Watkins, A., Papaioannou, T., Mugwagwa, J., & Kale, D. (2015). National innovation systems and the intermediary role of industry associations in building institutional capacities for innovation in developing countries: A critical review of the literature. Research Policy, 44(8), 1407-1418. Available at: https://www.sciencedirect.com/science/article/abs/pii/S0048733315000803

Wonglimpiyarat, J. (2018). Challenges and dynamics of FinTech crowd funding: An innovation system approach. The Journal of High Technology Management Research, 29(1), 98-108. Available at: https://www.sciencedirect.com/science/article/abs/pii/S1047831018300099

Lidiia KARPENKO, Doctor in Economics, Professor, Odessa Regional Institute for Public Administration of the National Academy for Public Administration under the President of Ukraine
ORCID ID: orcid.org/0000-0002-2888-2477

Anatoliy RACHYNSKYI, Doctor of Science in Public Administration, Professor, National Academy for Public Administration under the President of Ukraine
ORCID ID: orcid.org/0000-0001-9888-6978

Hennadii DMYTRENKO, Doctor of Science in Public Administration, Professor, Institute for Personnel Training of the State Employment Service of Ukraine
ORCID ID: orcid.org/0000-0003-3368-3410

Anatolii AKHLAMOV, Doctor in Economics, Professor, Odessa Regional Institute for Public Administration of the National Academy for Public Administration under the President of Ukraine, Odessa, Ukraine
ORCID ID: orcid.org/0000-0002-9356-2103

Nataliia OLIINYK, Doctor of Science in Public Administration, Assosiate Professor National Academy for Public Administration under the President of Ukraine
ORCID ID: orcid.org/0000-0001-8489-4141

Register for an ORCID ID:
https://orcid.org/register