









“Financial instruments and innovations in business environment: European countries and Ukraine”

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ARTICLE INFO	Svitlana Khalatur, Zenon Stachowiak, Kateryna Zhylenko, Oksana Honcharenko and Oleksandr Khalatur (2019). Financial instruments and innovations in business environment: European countries and Ukraine. <i>Investment Management and Financial Innovations</i> , 16(3), 275-291. doi: <a href="https://doi.org/10.21511/imfi.16(3).2019.25">10.21511/imfi.16(3).2019.25</a>
DOI	<a href="http://dx.doi.org/10.21511/imfi.16(3).2019.25">http://dx.doi.org/10.21511/imfi.16(3).2019.25</a>
RELEASED ON	Friday, 04 October 2019
RECEIVED ON	Sunday, 08 September 2019
ACCEPTED ON	Friday, 27 September 2019
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JOURNAL	"Investment Management and Financial Innovations"
ISSN PRINT	1810-4967
ISSN ONLINE	1812-9358
PUBLISHER	LLC "Consulting Publishing Company "Business Perspectives"
FOUNDER	LLC "Consulting Publishing Company "Business Perspectives"



NUMBER OF REFERENCES

49



NUMBER OF FIGURES

6



NUMBER OF TABLES

3

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BUSINESS PERSPECTIVES



LLC "CPC "Business Perspectives"  
Hryhorii Skovoroda lane, 10,  
Sumy, 40022, Ukraine

[www.businessperspectives.org](http://www.businessperspectives.org)

**Received on:** 8<sup>th</sup> of September, 2019

**Accepted on:** 27<sup>th</sup> of September, 2019

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# FINANCIAL INSTRUMENTS AND INNOVATIONS IN BUSINESS ENVIRONMENT: EUROPEAN COUNTRIES AND UKRAINE

## Abstract

One of the most crucial tasks for the national economies development both in European countries and Ukraine is stimulating and ensuring sustainable economic growth. For this purpose, all states develop an innovative sphere and use financial different instruments. The aim of the article is determining the impact of financial instruments and innovations on business environment development of the national economy of Ukraine in comparison with European countries in order to create successful and effective business environment in Ukraine for foreign investments. The paper examines the impact of foreign direct investments and domestic loans on the Global Innovation Index 2018 using two-factor analysis of variance. The null hypothesis of an interaction effect (factor A (foreign direct investments, net inflows) and factor B (domestic loans of financial sector) doesn't exert an interaction effect on result Y (Global Innovation Index)) was rejected. Also the combination of foreign indicators, direct investments and domestic loans has a significant impact on the Global Innovation Index. Practical recommendations should provide a comprehensive approach to assessing the use of financial instruments in order to encourage the investments. Thus, overcoming the uneven distribution of innovations and investments should provide using the global financial resources.

## Keywords

investments, indicators, influence, loans, development, European countries, Ukraine

## JEL Classification

G18, G28, E44, O38

## INTRODUCTION

One of the most vital tasks for the development of national economies of Europe and Ukraine is stimulating and ensuring sustainable economic growth, entering of traditional business into foreign markets, as well as business environment developing for innovative projects implementation. The success of development of innovative business environment and financial instruments depends on the systemic work of the government, public-private partnerships, entrepreneurial initiatives and scientific activity. Entrepreneurship support should be accompanied by effective use of financial instruments and innovations. Innovative development of enterprises in global conditions is an important factor in the competition both on micro- and macro-levels. Different social and economic development of countries provokes uneven innovation development of enterprises in the global dimension. However, all states develop, to a greater or lesser extent, the innovative sphere and financial instruments.

The relevance of study can be proved by the significant role of financial services markets both in European countries and Ukraine. The formation of the efficient market capable to effectively mobilize domestic financial resources and able to maintain competitive positions in the global capital market is extremely important for the effective develop-

ment of any country. The problem of the Ukrainian financial services market is that it has no financial resources to provide investment demand from the real sector of the economy. The mobilization of financial resources mostly takes place through banks. However, there are a lot of banks in Ukraine, so the financial resources are rather scattered.

## Purpose of article

The aim of article is to determine the impact of financial instruments and innovations usage on business environment development of national economy of Ukraine in comparison with European countries, the development of theoretical and practical recommendations for creating the most successful and effective operating innovative business environment for the implementation of financial and economic activity in Ukraine.

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## 1. LITERATURE REVIEW

For many years, considerable attention is paid to the development of theory, methodology, informational and analytical support of financial instruments and innovations management, business environment development of national economies of the countries in the scientific papers.

Thus, Panas and Tkach (2017) argue that most indicators of national economies in Germany and the EU countries can serve Ukraine and Poland only as exemplary strategic characteristics, rather than as a comparative basis for formulating short- or medium-term plans for innovation development. It is possible to dramatically change the resource capabilities of innovation activity in Ukrainian business entities with the help of state management levers. These measures do not require significant financial investments from the state, but they require the study, adaptation and application of European management experience in Ukrainian business practice.

Lomachynska and Podgorna (2018) write that in the context of technological change and globalization, it is important to use the innovative potential to ensure the development of the national economy. Germany and Austria have sufficient information resources as developed countries. The analysis of influence of innovation potential elements on GDP and export in Germany and Austria showed that the greatest impact on competitiveness of the EU developed countries provides scientific, financial and human resources.

Dmytryshyn and Zvarych (2018), based on innovation evaluation analysis, offer a methodologi-

cal approach for determining the degree of innovation efficiency in hierarchical regional section based on the use of multidimensional statistical analysis tools.

Dzhedzhula and Yepifanova (2018), based on the systematization of modern approaches to the innovation strategy essence, have determined that it has a certain interrelated sequence of actions.

Zavadzka (2018) writes that monetarists have substantiated the role of monetary policy as the main instrument that determines the level of economic activity and possibility of financing innovations. According to the Keynesians, economic stability is provided through state-sponsored regulatory relations between the state and banks by encouraging low interest rate investment and innovative bank loans. The works of scientists representing neoclassical theories of mediation consider defining effective areas of interaction between the banks and clients, developing fundamentally new banking tools for investing in innovative business, the use of which will contribute to increasing the banks role in Ukraine.

Rusnak and Prokhorchuk (2018) argue that Ukraine needs to participate in major initiatives that are being implemented in the EU. Implementation of financial incentives for innovations development should be cautious.

Sosnovska and Zhytar (2018) found a methodological relationship between financial architecture and financial security of the enterprise, based on the dependence of appropriate level of financial security and flexible financial architecture of the enterprise through management of its financial

risks. Also, scientists have written that compliance with normative values is an important condition for ensuring the financial stability and sustainable operation of the enterprise in an unstable economic environment.

Shuba and Sotskyi (2019) write that financial support for innovative small businesses is based on its orientation and has different sources of funding. Moreover, the capitalization of intangible assets of small business in the form of intellectual capital provides financial instruments usage in a market economy. The policy of the economic world communities is focused on the initial financial encouragement of innovative small enterprises.

Bondarenko, Kichuk, and Antonov (2019) consider the position of cryptocurrency in the world. Many large countries recognize it, if not a means of payment, then electronic money. At the same time, cryptocurrency is located in the “gray” zone in most countries of the world, and regulators, if not forbidden, at least do not recommend citizens to invest in such assets. Thus, the state of scientific and technological development of blockchain technology, which is the basis of cryptocurrency, and the state of demand for cryptocurrency in the Ukrainian market are ready for cryptocurrency usage. There is not only a normative base for productive implementation of cryptocurrency in Ukraine. Despite the different attitude to cryptocurrency, the volume of transactions with cryptocurrency and its capitalization is constantly increasing.

Zhylinska, Sitnicki, and Vikulova (2019) identified the main principles on which the research potential of the research university should be based. The authors’ review of the innovation evaluation system will allow experts to comprehensively assess the major reserves that the world class university has to solve, addressing the scientific problems that it faces.

Zachosova (2019) argues that financial system and financial markets are the source of a large number of threats to the normal functioning of both financial institutions, manufacturing and trading enterprises. Thus, the stable, continuous and productive activity of professional financial intermediaries is a prerequisite for improving the financial situation at the macro level in the future.

Kachuriner and Hrushko (2019) wrote that in the framework of integration processes for Ukraine, there was a need to formulate its own model of innovative development of the domestic economy.

Lazarenko (2019) writes that modern companies cannot survive on the market in the long run without dynamic innovation opportunities that relate to the organization’s ability to develop new competencies to adapt to changing business environments. The factors help to transit from “closed” innovation model, which focuses mainly on internal research and development, to open innovation practice, based on the principle of structured interaction of several partners involved in the business ecosystem for the joint development of an innovative product.

A study by Lazarenko (2019) showed that modern companies can conduct their own innovative processes to provide the access to external ideas and to better utilize their hidden innovation potential. To ensure the successful implementation of open innovation, companies need to develop specific dynamic knowledge management capabilities.

Latkovskyi and Marushchak (2019) argue that countries need to find the right balance between an efficient state and strong democratic institutions capable of ensuring the true responsibility of their rulers.

It should be noted that the issue of determining the influence of financial instruments and innovations usage on business environment development of the national economy of Ukraine in comparison with the European countries remains and needs to be further elaborated. Scientific substantiation also requires organizational and managerial aspects of financial instruments usage in globalizing environment.

## 2. RESULTS

As part of a study, the terms are used in the following sense. Financial innovation is a new financial instrument and(or) financial technology. Financial instruments are: conceptual means – concepts underlying finance; physical means – tools and processes that can be used to achieve any particular

purpose (tools – ordinary shares, fixed income securities, etc., processes – electronic trading system of securities, etc.). Financial technology is an economic and financial theory, mathematical and statistical methods.

Technological innovations have accelerated and intensified the globalization process. Experts say that recent innovations create an atmosphere of ambiguity, uncertainty, nervousness in the financial markets, which increases instability and the possibility of sharp fluctuations, especially in the markets of developing countries and countries with transition economies.

A characteristic feature of the developed countries of the world is the relatively high costs of innovation development and research. So, in 2018, the innovation cost of development in the UK was 2% GDP, in France – 1.4 % GDP, in Germany – 1.9% GDP. In the countries of the world, state interference in the innovation development is different. States of the world are divided into three groups depending on the country's innovation policy. The first group is the countries of the world focused on innovation development, the introduction and place of the world leader in innovative developments, as well as in support of scientific potential. These countries include the United States, France, and the United Kingdom. The second group is the creation of favorable conditions for the development of innovation activity, innovation potential and personnel policy. It can include countries such as Switzerland, Sweden, Germany. The third group is the world countries that promote stimulation of innovation development, coordinate innovations. This group includes Japan and North Korea.

Thus, one can distinguish two main causes of uneven innovation development of the world countries: different social and economic level of the world countries; features of the national innovation system of the world countries.

According to the EIS, the regions are divided into 4 groups:

- very high level – innovative leaders;
- high level – innovative successors;
- middle level – moderate innovators;
- low level – countries that are lagging behind.

This enables to overcome the uneven distribution of innovations through the activities and openness of national innovation systems that allow the use of world economy resources, use of foreign scientific, technical and human resources. The top five with high innovation rates include Switzerland, Sweden, the Netherlands, the United States, and the United Kingdom, and the innovation performance of these countries is higher than the average in the regions of the world. According to the Global Innovation Index (GII), which takes into account about 80 criteria and allows annual monitoring of the innovative activity of the countries, the rating of Ukraine's innovative activity in the world is also gradually increasing (Figure 1).

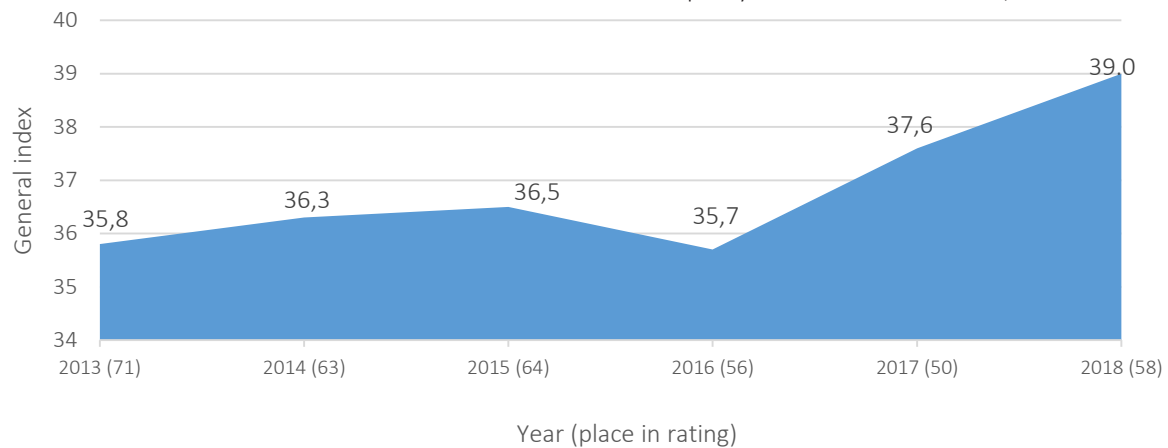
Indicators of the “Innovation capability” element of the Global Competitiveness Index of Ukraine in 2018 are shown in Figure 2.

From the above indicators, one can see that the general place of the country is particularly influenced by the relatively low ranking of indicators: state of cluster development, buyer sophistication, patent applications (applications/million pop.) The highest scores (ranked) are in the following indexes: scientific publications H Index, quality of research institutions index, international co-invention (applications/million pop.), multi-stakeholder cooperation, R&D expenditures (% of GDP).

In a more detailed study of the components of the “Innovation capability” group and the relevant indicators (Figures 2, 3), it can be seen that the quality of regulation is rather weak and requires appropriate action by the authorities to take measures to improve them by improving regulatory and legal framework.

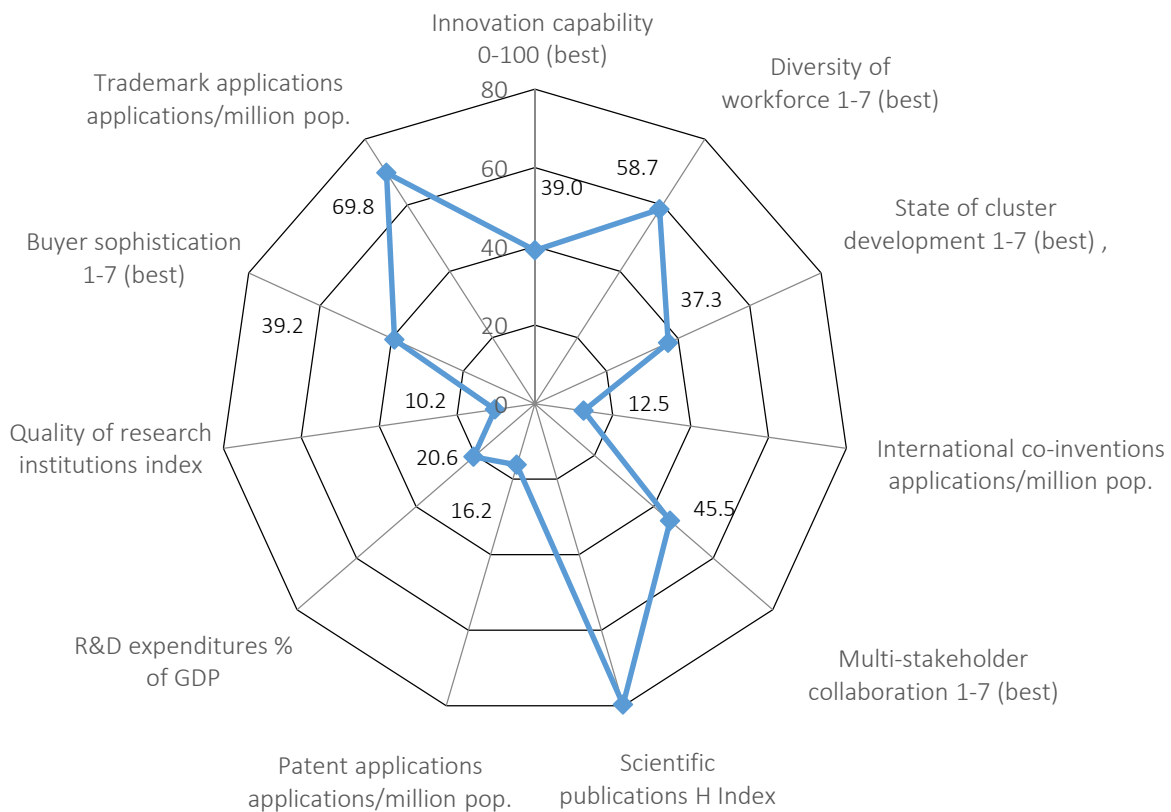
The innovation and investment legislation of Ukraine includes more than a thousand normative legal acts that regulate one or another sphere of innovation and investment activity. However, the Ukrainian legislation is complicated and includes normative legal acts of Ukraine, international legal acts, which Ukraine is party to. The analysis of innovation and investment legislation of Ukraine shows the absence of a coherent and mutually agreed system of innovation and investment legislation. Despite a significant number of

Source: Compiled by the authors based on World Bank, World Economic Forum.



**Figure 1.** Dynamics of the Global Innovation Index and place of Ukraine in the world rating for 2013–2018 period

Source: Compiled by the authors based on World Bank, World Economic Forum.



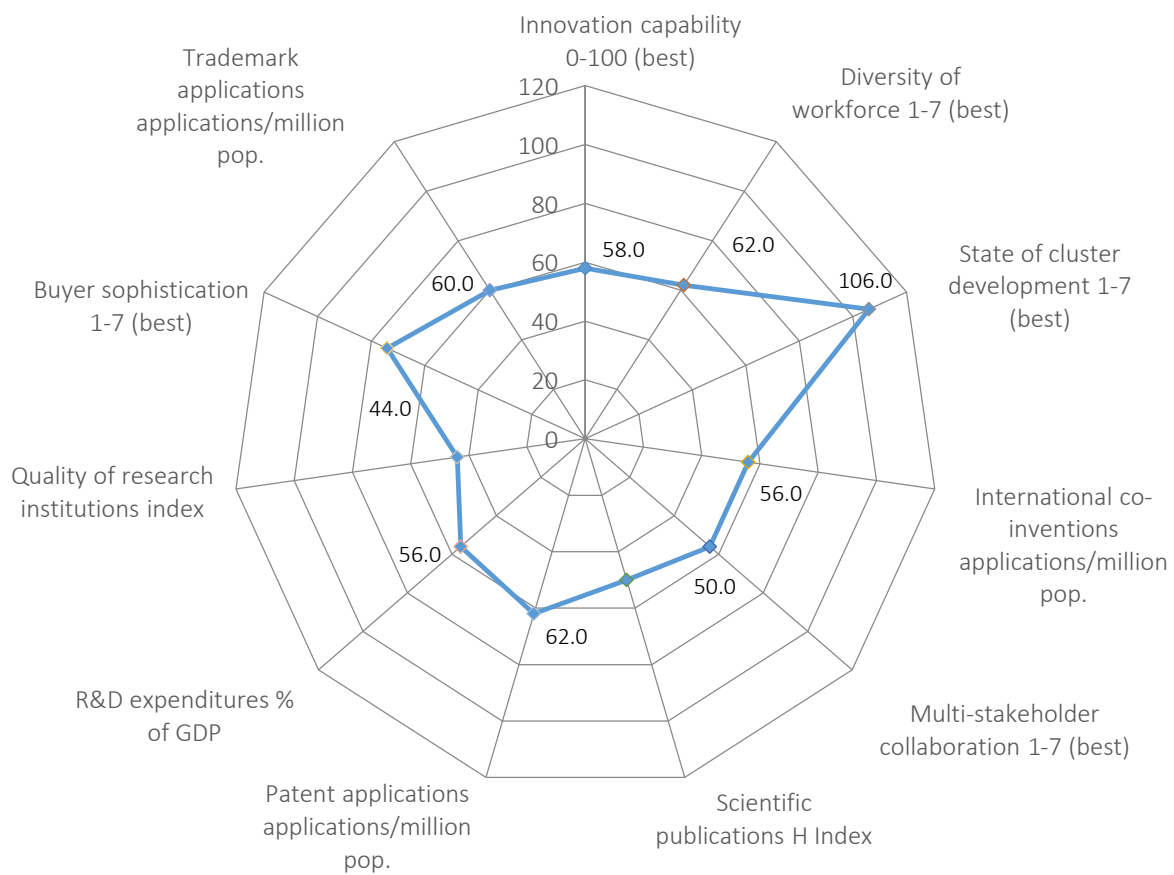
**Figure 2.** "Innovation capability" element estimation of Global Competitiveness Index of Ukraine in 2018

improvement initiatives, Ukraine's innovation and investment legislation still remains far from perfect and needs to be systematized in the light of increased investor guarantees and support for innovators.

At the present stage of world economic relations, the interdependence of economies of the world is growing. Ukraine took 66th place with a share in the world gross domestic product (GDP) – 0.11% in terms of economy size in 2018. At the same time,



Source: Compiled by the authors based on World Bank, World Economic Forum.



**Figure 3.** “Innovation capability” element estimation of Global Competitiveness Index of Ukraine in 2018, rank/140

half of the gross domestic product of Ukraine is formed at the expense of exports (49.3% as of 2018). The country's involvement in world trade, namely its net exports, is one of the factors of economic development. Purposeful integration into the global economic system is realized by Ukraine through the mechanism of joining the World Trade Organization in 2008, which created the basis for the development of external relations, deepening of trade and economic cooperation with the member states.

For a more detailed disclosure of the research, the European countries were selected, where Ukraine is also included. In Table 1, Global Innovation Index 2018 and the financial instruments in Europe are compared.

Of the 39 countries selected for research, 2 countries are with below average incomes (Ukraine and Moldova), the Global Innovation Index is high, indicating the ability and desire to evolve.

Innovation leaders by income group in Global Innovation Index 2018. Lower-middle income countries (USD 1,006-3,955) are Ukraine (38.52); Vietnam (37.94); Moldova (37.63). Ukraine and Moldova are European countries.

To explore the innovative business environment, we chose the European countries. Table 1 compares the Global Innovation Index with indicators that affect the quality and quantity of innovative developments in the countries under study, namely researchers in R&D (per million people); net investment in nonfinancial assets (% of GDP); foreign direct investment, net inflows (% of GDP); grants and other income (% of revenue); research and development expenditures (% of GDP).

The largest number of researchers in R&D per million people among the studied countries is in Denmark and Sweden (7,514.70 and 7153.41 researchers in R&D per million people, respectively). Both countries are high income countries. Net

**Table 1.** Comparison of Global Innovation Index 2018 and financial instruments indicators in European countries

Source: Compiled by the authors based on World Bank data.

Economy Country	Score (0-100)	Rank	Income	Researchers in R&D (per million people)	Net investment in nonfinancial assets (% of GDP)	Foreign direct investment net inflows (% of GDP)	Grants and other revenue (% of revenue)	Research and development expenditure (% of GDP)
Switzerland	68.40	1	HI	5,257.29	0.94	5.57	7.32	3.37
Netherlands	63.32	2	HI	4,842.66	1.48	38.11	5.28	2.03
Sweden	63.08	3	HI	7,153.41	2.11	5.88	7.31	3.25
United Kingdom	60.13	4	HI	4,429.58	1.61	2.45	6.39	1.68
Finland	59.63	7	HI	6,525.01	1.53	5.62	11.69	2.74
Denmark	58.39	8	HI	7,514.70	2.17	0.71	—	2.87
Germany	58.03	9	HI	4,893.15	0.65	2.11	4.33	2.93
Ireland	57.19	10	HI	5,563.38	1.53	−1.03	—	1.17
Luxembourg	54.53	15	HI	4,350.86	2.56	10.62	—	1.24
France	54.36	16	HI	4,307.22	1.55	1.83	—	2.24
Norway	52.63	19	HI	6,073.23	2.98	0.41	27.91	2.03
Austria	51.32	21	HI	5,157.51	1.75	3.74	8.48	3.08
Iceland	51.24	23	HI	6,635.10	1.74	−28.65	14.68	2.07
Estonia	50.51	24	HI	3,305.28	3.36	5.84	10.61	1.28
Belgium	50.50	25	HI	4,734.03	0.23	−7.98	3.36	2.48
Czech Republic	48.75	27	HI	3,518.81	1.83	4.26	7.89	1.67
Spain	48.68	28	HI	2,732.24	0.62	0.47	11.86	1.18
Slovenia	46.87	30	HI	3,899.20	1.82	2.21	—	2.00
Italy	46.32	31	HI	2,131.48	0.97	0.47	6.46	1.28
Portugal	45.71	32	HI	3,928.60	0.65	4.57	11.11	1.26
Hungary	44.94	33	HI	2,645.67	2.00	−9.64	12.82	1.20
Latvia	43.18	34	HI	1,599.56	3.62	3.73	16.34	0.44
Slovakia	42.88	36	HI	2,598.90	2.77	6.19	—	0.78
Bulgaria	42.65	37	UM	2,243.70	1.51	3.74	—	0.78
Poland	41.67	39	HI	2,158.46	2.06	2.02	—	0.96
Lithuania	41.19	40	HI	2,931.66	1.97	2.50	9.25	0.84
Croatia	40.73	41	UM	1,793.14	0.96	3.69	4.90	0.84
Greece	38.93	42	HI	2,629.09	2.92	1.75	—	1.00
Ukraine	38.52	43	LM	1,119.47	0.62	2.52	19.98	0.44
Russian Federation	37.90	46	UM	2,979.09	2.52	1.80	43.49	1.09
Moldova	37.63	48	LM	723.88	2.22	1.97	5.60	0.30
Romania	37.59	49	UM	912.42	1.79	2.80	14.16	0.48
Montenegro	36.49	52	UM	832.99	—	11.56	—	0.37
Serbia	35.46	55	UM	2,079.19	1.85	6.94	8.08	0.93
Bosnia and Herzegovina	31.09	77	UM	463.89	1.81	2.56	8.93	0.19
Albania	29.98	83	UM	156.10	3.87	7.83	7.90	0.15
Belarus	29.35	86	UM	—	0.80	2.34	28.92	0.58

Notes: World Bank Income Group Classification: LM = lower-middle income; UM = upper-middle income; and HI = high income. Regions are based on the United Nations Classification: EUR = Europe.

investment in nonfinancial assets is the highest in Albania (3.87% of GDP) and Latvia (3.62% of GDP). Net inflows of foreign direct investment are the highest in the Netherlands (38.11% of GDP) and Montenegro (11.56% of GDP). This indicator is disparate in the following countries: Ireland (−1.03), Iceland (−28.65), Belgium (−7.98), Hungary (−9.64).

Grants and other revenues include grants from other foreign governments, international organizations and other government departments; percentages; dividends; rent. This indicator is highest in Norway (27.91% of revenue), Russian Federation (43.49% of revenue), Belarus (28.92% of revenue). In Ukraine, the grants and other income indicators are at 19.98% of the revenue, which is also



quite high in comparison with other European countries.

Research and development expenditures (% of GDP) – gross domestic research and development costs (R&D) include both capital and current costs in four key sectors: the business environment, government, higher education and private non-profit organizations. The R&D indicator covers fundamental research, applied research and experimental development. This indicator is the highest in Switzerland (3.37% of GDP), which is fair, as Switzerland leads the country's Global Innovation Index 2018. Less than 0.5 percent of research and development spending is in the following countries: Latvia, Ukraine, Moldova, Romania, Montenegro, Bosnia and Herzegovina and Albania. In order to develop an innovative business environment, investment attraction needs to increase research and development expenses.

Three European countries will be analyzed in more detail: the country ranked the 1st in the Global Innovation Index ranking 2018 in HI classification – Switzerland, the 1st in UM – Bulgaria and the 1st in LM – Ukraine. In Table 2, there were considered the general indicators of national economies of the countries under study, that is, the initial available business environment conditions for the possibility of innovation.

After analyzing the general indicators of business environment of the national economies of the countries under study, it can be concluded that countries with a smaller land area and smaller population are

more successful in economic growth than Ukraine. Education duration is a valuable indicator when considering the innovative potential of countries. In Switzerland, preprimary education duration is only two years, while primary education duration is six years. Secondary education duration is the greatest in Bulgaria (8 years). Annual GDP growth per capita is also the largest in Bulgaria (4.57%), and the smallest in Switzerland (0.68%). Expenditure on primary education and expenditure on secondary education is the smallest in Ukraine. However, the total government expenditure on education in Ukraine is the largest – 5.89% of GDP. At the same time, the total government expenditures on education in % of government expenditure in Ukraine are less than in Switzerland and Bulgaria. The largest number of researchers in R&D per million people is in Switzerland. There are 5,257.29 Researchers per million people, while in Ukraine, there are only 1,119.48 researchers per million people, which is almost five times smaller. Consequently, the country's innovative business environment is significantly influenced by expenditure on education and the number of researchers in R&D.

Further on the aim of study, there will be considered in more detail the influence of financial instruments on the innovative business environment formation of the countries under study. Thus, the market of financial services is a market for the exchange of financial resources, provision of loan and mobilization of capital, while it is a mechanism for ensuring the country's economy competitiveness, which allows to direct investment flows into the most attractive segments of the national economy.

**Table 2.** General indicators of business environment of the national economies of the studied countries on average for 2014–2018

Source: Compiled by the authors based on World Bank data.

Indicator	Switzerland HI country	Bulgaria UM country	Ukraine LM country
Population. total	8,450,851	7,075,947	44,831,135
Land area (sq. km)	39,516	108,560	579,290
Preprimary education (years)	2	4	3
Primary education (years)	6	4	4
Secondary education (years)	7	8	7
GDP per capita growth (annual %)	0.68	4.57	2.98
Expenditure on primary education (% of government expenditure on education)	28.94	19.69	19.63
Expenditure on secondary education (% of government expenditure on education)	38.80	38.91	27.89
Government expenditure on education, total (% of GDP)	5.02	4.09	5.89
Government expenditure on education, total (% of government expenditure)	15.64	12.78	12.51
Researchers in R&D (per million people)	5,257.29	2,243.71	1,119.48

**Table 3.** Indicators of financial instruments usage effectiveness in the innovative business environment, on average in 2001–2018

Source: Compiled by the authors based on World Bank data.

Indicator	Switzerland HI country	Bulgaria UM country	Ukraine LM country
Foreign direct investment, net inflows (% of GDP)	5.58	3.75	2.52
Research and development expenditure (% of GDP)	3.37	0.78	0.45
Domestic loan provided by financial sector (% of GDP)	179.32	53.98	65.57
Insurance and financial services (% of commercial service imports)	5.75	5.58	4.10
Net acquisition of financial assets (% of GDP)	–	–	2.88
Government expenditure on education, total (% of GDP)	5.02	4.09	5.01
Government expenditure on education, total (% of government expenditure)	15.64	11.78	12.35
ICT goods exports (% of total goods exports)	1.05	2.75	0.93
ICT goods imports (% total goods imports)	3.91	4.94	5.12
Individuals using the Internet (% of population)	93.71	63.41	57.11
Interest payments (% of expense)	1.24	2.65	11.12
Interest payments (% of revenue)	1.16	2.49	11.39
Interest rate spread (lending rate minus deposit rate, %)	2.89	6.22	7.25
Lending interest rate (%)	2.63	6.39	16.38
Listed domestic companies, total	236	381	78
Net lending (+) / net borrowing (–) (% of GDP)	0.97	–0.74	–1.39

Table 3 summarizes the performance indicators of financial instruments usage in the innovative business environment of three European countries under study. Data are taken on average for eighteen years (2001–2018).

FDI indicator shows a net inflow into the economy from foreign investors. Of course, in Switzerland (HI country), this indicator is the highest (5.58% of GDP), while in Ukraine (LM country), it is the lowest (2.25% of GDP). Domestic loan provided by the financial sector is also the highest in Switzerland, and the lowest in Bulgaria. The indicator insurance and financial services is divided as follows: Switzerland – 5.75% of commercial service imports; Bulgaria – 5.58% of commercial service import; Ukraine – 4.10% of commercial service imports. Net acquisition of government financial assets is known only in Ukraine and it is 2.88% of GDP.

The state budget expenditures for education (current, capital and transfer) include expenditures that are financed through transfers from international sources to the government. In Ukraine and Switzerland, general education expenditures are almost equal.

Figure 5 shows the analysis foreign direct investment, net inflows in % of GDP.

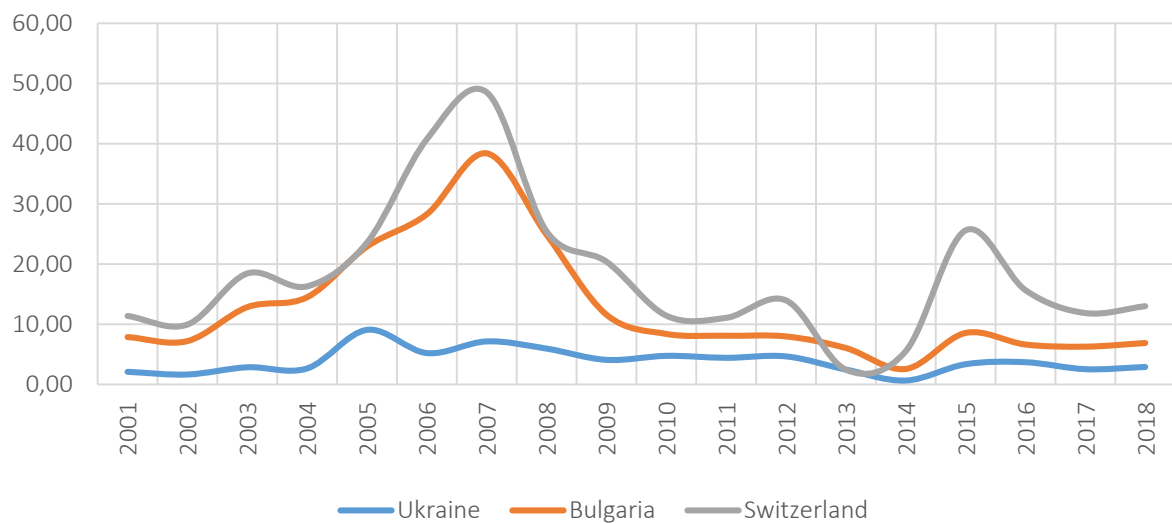
Analyzing Figure 5, it can be concluded that the fluctuation of foreign direct investment (net inflows) in Switzerland is in such limits (from – 3.62% of GDP to 17.05% of GDP), in Bulgaria it is ranged from 1.92% to 31.24% of GDP, in Ukraine – from 0.63% to 9.02% of GDP.

For continuous improvement and development of the innovative business environment of the country, it is necessary to finance its formation and development and to create new elements of innovation infrastructure. Both commercial organizations and public authorities and non-governmental organizations can fund innovative infrastructure. Each of them has its own motives for funding. Based on the financing of innovation infrastructure, there is a group of internal and external factors aimed at achieving the maximum effect (economic, social, and political) by optimizing the country's innovative business environment.

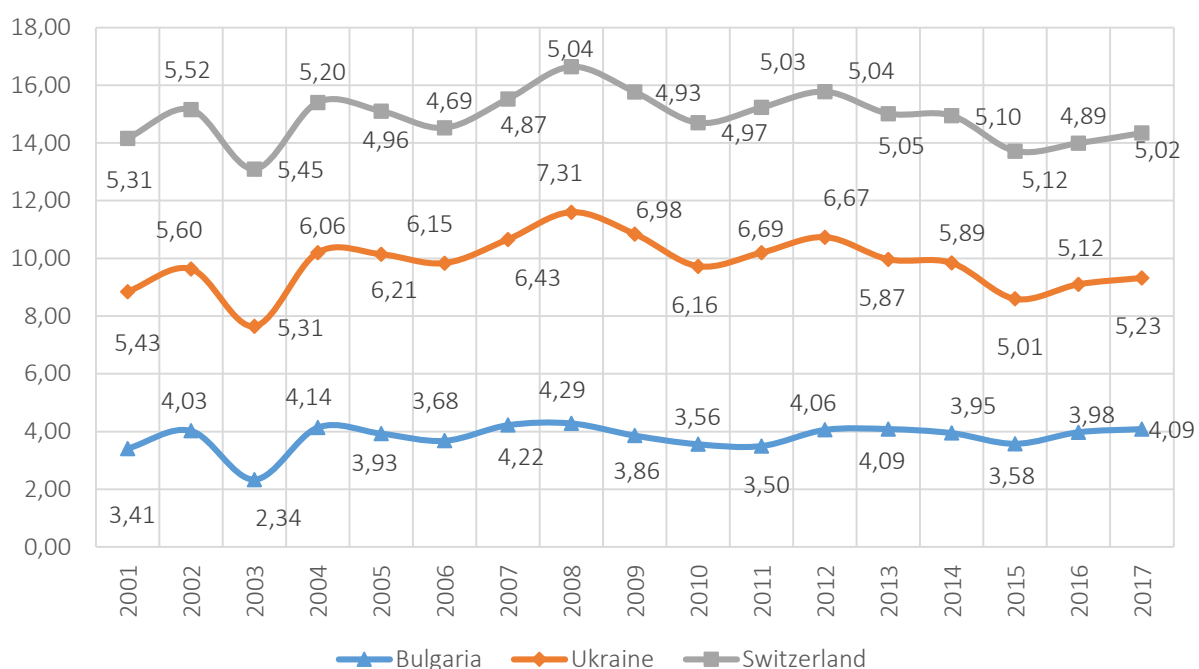
Taking into account the main economic indicators and processes in Ukraine in recent years, the formation and development of a modern innovative business environment of the country has the following disadvantages:

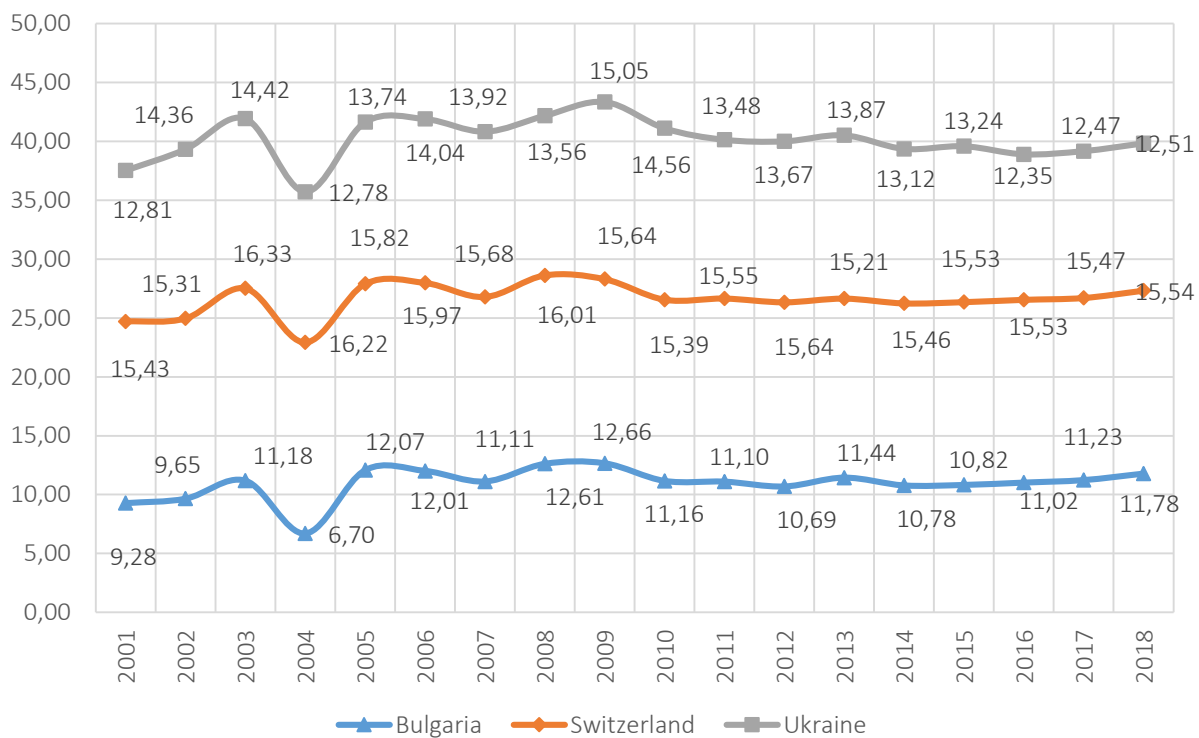
- unsystematic and inconsistent in the formation and development of innovation infrastructure;

Source: Compiled by the authors based on World Bank data.

**Figure 4.** Foreign direct investment, net inflows, % of GDP

- insufficient regulatory and legal regulation of issues of innovative business environment development;
  - low level of financing for all elements of the innovative business environment;
  - lack of constantly available systematic information on the new technologies development completion in countries with a higher level of development of innovative business environment.
- Thus, stable and full support from the state is needed for the effective development of an innovative business environment in Ukraine.
- The study will examine the impact of foreign direct investment, net inflows (% of GDP) and domestic loan provided by the financial sector (% of GDP) on Global Innovation Index 2018 by conducting a two-factor dispersion analysis. The dispersion analysis is designed to evaluate the impact of various but controlled factors on the result of the experiment. Let the result of the experiment be some

**Figure 5.** Government expenditure on education, total (% of GDP)



**Figure 6.** Government expenditure on education (total), % of government expenditure

random variable  $Y$ . The value of the random variable  $Y$  is influenced by the factor  $X$ , which consists of  $n$ -levels. A dispersion analysis is possible if the measurement results are independent random variables that are subject to the normal distribution law with the same dispersion. In a one-factor dispersion analysis, the degree of influence of one factor  $X$  on the mathematical expectation  $M(Y)$  is detected.

Then, check the homogeneity of a number of dispersions  $S_{bi}^2$  or pairwise using Fisher's criterion (if  $m_i$  different), or using the Cochren criteria (if  $m_i$  constant). To do this, formulate the null hypothesis

$$H_0: D(X_1) = D(X_2) = \dots = D(X_L).$$

On samples of one volume it is determined the observable value of the Cochren criteria:

$$G_n = S_{\max}^2 / \sum_{i=1}^L S_i^2.$$

The observable value of the criterion is compared with the critical point of the right-hand critical area  $G_{kp}(\alpha; k; L)$ , where  $k = m - 1$  and conclude that the dispersions are homogeneous or not. If the dispersions are heterogeneous, no further analysis

is performed. After confirmation of the homogeneity of dispersion hypothesis, an analysis is performed. It is believed that the result of any measurement  $Y_{i,j}$  can be represented by the model:

$$Y_{i,j} = \mu + F_i + \varepsilon_{i,j},$$

where  $Y_{i,j}$  – the value of the investigated variable obtained at the  $i$ -th level of the factor with  $j$ -th ordinal number;  $\mu$  – overall average of response  $Y$ ;  $F_i$  – the effect of the  $X_i$  factor's influence on  $Y$ ; the deviation of the mean values  $\mu_i$  at the  $i$ -th level (group average) from the general average  $\mu$  (i.e.  $F = \mu_i - \mu$ );  $\varepsilon_{i,j}$  – a random remnant that reflects the impact on the magnitude of all other uncontrollable (unrecognized) factors.

The main assumptions of the dispersion analysis are the following:

- residues  $\varepsilon_{i,j}$  are mutually independent for any  $i$  and  $j$ ;
- values  $\varepsilon_{i,j}$  are subordinated to the normal law.

The task of the dispersion analysis is to assess the effect significance of the change in the level of the

factor. The scattering of the response values caused by the controlled factor is estimated by the factor variance (the sum of the squares of group average deviations from the total average) –  $S_{fact}^2(X)$ . The influence of uncontrolled factors ( $\epsilon_{i,j}$  contribution) can be estimated by the average dispersion of reproducibility (residual variance) –  $S_v^2$ .

The general dispersion of the response values, caused by both controlled and uncontrolled factors, is estimated by the total (or complete) dispersion (total amount of squares of deviations) –  $S_t^2$ . To determine the degree of influence of factor X and its comparison with the distribution (caused by random, uncontrolled reasons), check the homogeneity of the variance of factor and reproducibility (residual) according to Fisher's criterion:  $F_n = S_{fact}^2 / S_b^2$ .

The observed value of the criterion is compared with the critical  $F_{kp}(a, k_1, k_2)$ , (which are found by the F-distribution tables for the significance level of  $\alpha$ , the number of freedom degrees  $k_2 = N - n$ . If  $F_n \leq F_{kp}(a, k_1, k_2)$ , then, the effect of factor X is not significant. Thus, all the measured results belong to one general set, normally distributed with the parameters  $\mu$  and  $S_t^2$ .

When  $F_n > F_{kp}(a, k_1, k_2)$ , the factor influence is taken significant. It is assumed that in this case, there are  $n$  normally distributed populations, each of which has the corresponding mathematical expectation  $\mu_i$  and the same dispersion  $S_b^2$ . The estimation of the effect of  $i$ -level factor is equal to the difference between total and group average ( $F = \mu_i - \mu$ ).

In the framework of the study, it will be examined the impact of foreign direct investment, net inflows (% of GDP) (factor A) and domestic loan provided by the financial sector (% of GDP) on the global innovation index 2018 by conducting a two-factor dispersion analysis. At the significance level  $\alpha = 0.05$ , the hypothesis of the influence of the factors A and B and their combination on the indicated sign is checked. The pre-checked by Cochran's criterion is the equality of variances in groups.

Let's formulate conjecture hypotheses:

*H0: Factor A (Foreign direct investment, net inflows) and factor B (Domestic loan provided*

*by the financial sector) do not have the effect of interaction on the result Y (Global Innovation Index).*

*H1: Factor A and factor B effect interaction on result Y.*

Hypotheses for factor A:

*H0: For all values of foreign direct investment, net inflows ( $A_i$ ), there is no difference between the average results of global innovation index ( $Y$ ).*

*H1: For all values of  $A_i$  there is a difference between the average results of  $Y$ .*

Hypotheses for factor B:

*H0: For all values of domestic loan provided by the financial sector  $B_j$  there is no difference between the average results of  $Y$ .*

*H1: For all values of  $B_j$  there is a difference between the average results of  $Y$ .*

Factor A takes  $m = 4$  different values.

Factor B takes  $k = 3$  different values.

At each of the level combinations there are  $n = 4$  observations of the output value.

The presence of two factors allows using another estimate of dispersion – interaction. Estimation of the variance of the error (takes into account the influence of all factors, including not taken into account).

Degrees of freedom for each factor:

Factor A:  $v_1 = m - 1 = 4 - 1 = 3$

Factor B:  $v_2 = k - 1 = 3 - 1 = 2$

Interaction (A·B):  $v_3 = (m - 1)(k - 1) = (4 - 1)(3 - 1) = 6$

Error inside the group:  $v_{om} = m \cdot k(n - 1) = 4 \cdot 3(4 - 1) = 36$

Indicator	SS	df	MS	F
Factor A	35.29	3	35.29	10.72
Factor B	5.32	2	10.65	3.23
Interaction A i B	4.93	6	9.85	2.99
Error inside the group	118.5	36	3.29	x
Total	164.04	47	x	x

Criterion table value with degrees of freedom  $\nu_1 = 3$  i  $\nu_2 = 36$ ,  $F_{table} = 2.84$   $10.722 > F_{table}$ , therefore, the data contradict the hypothesis  $H_0$ , and it should be assumed that foreign direct investment, net inflows affects the average result Global Innovation Index.

Criterion table value with degrees of freedom  $\nu_1 = 2$  i  $\nu_2 = 36$ ,  $F_{table} = 3.23$   $3.234 > F_{table}$ , therefore, the data contradict the hypothesis  $H_0$ , and it should be assumed that domestic loan provided by financial sector affects the average result global innovation index.

Criterion table value with degrees of freedom  $\nu_1 = 6$  i  $\nu_2 = 36$ ,  $F_{table} = 2.34$   $2.994 > F_{table}$ , therefore, the data contradict the hypothesis  $H_0$ , and it should be assumed that levels of factors A and B affects the average result Y. Since the null hypothesis of the interaction effect was rejected, it can be concluded that the combination foreign direct investment, net inflows and domestic loan provided by financial sector has a significant impact on global innovation index. The Cochran criterion is used to evaluate the homogeneity of test result variances. The calculated value of Cochran criterion is based on the formula:

$$G_p = S_{\max}^2 / \sum S_i^2,$$

where  $S_{\max}$  – maximum value of the mean square deviation in one of all analyzed groups;  $S_i$  – mean-square deviation of test results in groups, determined by the formula:

$$S_i = \sqrt{1/(n_i - 1) \sum (y_{ik} - \bar{y})^2},$$

where  $n_i$  – number of measurement results  $i$ -th group at this level;  $y_{ik}$  –  $k$ -th of these measurement results;  $\bar{y}$  – arithmetic mean of measurements results of the  $i$ -th group.

Let's calculate the spread (disagreement) in the basic elements:

6	8.75	12.75
9	26	8.75
8.75	2.75	16
6	9	4.75

The maximum of them is  $S_{\max}^2 = 26$

Cochran criterion:

$$G_p = 26/118.5 = 0.22$$

Let's find the table "Critical values for Cochran criterion":  $G_{kp}(p; n-1; m \cdot k) = G(0.05; 3; 12) = 0.3264$ . Since  $0.22 \leq G_{kp}$ , it can be concluded that the variances in the groups are equal (the hypothesis of dispersions equality is taken – the experiments are considered reproducible, and the dispersion estimates are homogeneous).

### 3. DISCUSSION

In contradistinction to our research, Zhilinska, Balan, and Andrusyak (2017) developed a methodical approach for rating assessment of innovative provision level of sustainable economic development of the countries of the world and the construction of an integrated index of innovative provision of sustainable economic development in a defined sequence of stages, which enables a comparative analysis of the countries of the world.

A comparative analysis of the innovative provision level of sustainable development of the national economy and the nineteen countries of the world was conducted by Zhilinska, Balan, and Andrusyak (2017) and confirms the presence of significant problems in Ukraine in implementing the concept of sustainable development. At the same time, the need for a more detailed analysis of the innovative provision level of sustainable development of the national economy, the reasons identification for the existing deviations in the results of Ukraine in comparison with the leaders and the identification of possible ways to overcome them are necessary.

Orlovska, Kvaktun, Chala, and Vovk (2017) studied the sustainable provision of international competitiveness at different levels (goods, enterprise, sector, region and country). According to



Orlovska et al. (2017), one of mechanisms of international competitiveness stimulation can be the program of green investments in the construction sector. The research identified the main and most common areas for attracting green investments to enhance the international competitiveness of the construction sector.

The purpose of the study by Lamine and Yang (2010) was to identify the impact of FDI on the development and economic growth of the Republic of Guinea. The analysis showed that employment was an important determinant of FDI. This suggests that a large part of direct investment in developing countries and their policies aimed at raising the level of education can help to attract investment.

The purpose of the study by Tabi and Ondo (2011) was to analyze the relationship between economic growth, inflation and cash. Their results show that money in circulation contributes to economic development and inflation growth. However, money circulation increase does not necessarily lead to an increase in the general level of prices. Thus, monetary policy and especially the problems associated with information asymmetry between banks and project managers hinder the achievement of an optimal level of growth.

Dunford and Weidong (2017) argue that globalization is associated not only with the strengthening of economic interdependence, but also with increasing environmental, political and

social interdependence. Nkoro and Uko (2013) also wrote that an efficient capital market can contribute to stabilize the financial sector, to secure an important investment channel. Research by Rehman, Ali, and Nasir (2015) was conducted to study the relationship between financial development, savings and economic growth. Their results show that 3% of GDP can be explained by the effects of savings, and financial development – about 10%.

Panagopoulos, Chatzigagios, and Dokas (2018) argue that the effectiveness of market and price transparency are factors that reflect economic growth. The main task of international financial regulation is to minimize the systemic risk that arises as a result of the capital markets functioning and derivatives. The research focused on whether it is possible and to some extent to create a single regulatory framework that will regulate all financial products globally.

In our study, the development of innovation activities in European countries is considered; its main characteristics and financial instruments are outlined. The main tendencies and scales of growth, expansion of innovative business environment and financial instruments usage in Ukraine in comparison with European countries are shown. As part of our study, the impact of foreign direct investment and domestic loan provided by the financial sector on Global Innovation Index 2018 was tested by conducting a two-factor dispersion analysis.

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## CONCLUSION

The Global Innovation Index 2018 and financial instruments indicators in European countries were compared to reveal the topic of the study. From the list of 39 countries selected for the research, there are two lower-income countries (Ukraine and Moldova). However, these two countries have high Global Innovation Index, which indicates an opportunity and a desire to develop.

Three European countries have been analyzed in detail: the country that holds the 1st place in the Global Innovation Index ranking 2018 in HI classification – Switzerland, the 1st place in UM – Bulgaria and the 1st place in LM – Ukraine. The general indicators of the national economies of the studied countries are investigated, that is, the initial available conditions of the business environment for investment opportunities. Thus, taking into account the strategic priorities of Ukraine's growth directions, as well as its integration into the EU economy, a number of discrepancies specific to the system of investment development management and innovative business environment in Ukraine and European business entities have been identified. The study examined the impact of foreign direct investment and domestic

loan provided by financial sector on the Global Innovation Index 2018 by conducting two-factor analysis of variance. The null hypothesis of an interaction effect (namely, factor A (foreign direct investments, net inflows) and factor B (domestic loans provided by financial sector) doesn't exert an interaction effect on result Y (Global Innovation Index)) was rejected. And the combination of foreign indicators, direct investments and domestic loans from the financial sector has a significant impact on the Global Innovation Index.

The practical significance of the research is that the development and practical recommendations should enable: to form effective functioning organizational and economic and information and control mechanisms to stimulate the development of innovative business environment both in European countries and Ukraine; to improve the use of financial instruments, financial and economic indicators of the national economies of the studied countries; to achieve the consolidation of economic growth dynamic trends; to provide a comprehensive approach to assessing the use of financial instruments to encourage investments.

Further research can be provided in order to explore Ukrainian practice of cooperation with foreign partners in the field of investments and financial instruments usage.

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