RESEARCH PAPERS
IN ECONOMICS AND FINANCE

Innovative development of countries in the context of global economic imbalances

Mariia Shkurat[1], **Alisa Temerbek**[2]

[1] Vasyl' Stus Donetsk National University, Vinnytsia, Ukraine; https://orcid.org/0000-0003-3263-2507
[2] Vasyl' Stus Donetsk National University, Vinnytsia, Ukraine; https://orcid.org/0000-0003-1230-1567

ABSTRACT

The paper emphasises the fact that innovation is a driver for development and a leading factor in economic growth and ensuring a high level of competitiveness. The impetus for further development is given to those countries that already have a sufficient innovation level of the economy. The aim of the research is to determine the role of innovative development of a country in its economic development and competitiveness of the national economy. The world's leading countries now face the challenge of building a competitive economy, so the dynamics of positioning countries in the Global Competitiveness Index (GCI) and Global Innovation Index (GII) has been provided and the view that innovation plays an important role in the country's development and the formation of its competitiveness confirmed. The authors have distinguished groups of countries by systematising the places they occupy. Furthermore, they have identified features of innovation strategies of the countries in the proposed groups. The paper also suggests integrated assessment of innovation and economic development of countries, which allows to determine their level, trace the dynamics and determine the relationship between innovation and economic development for every country. Additionally, the study has shown a relationship between the level of innovation and economic development for all countries under analysis. However, there is a difference in the degree of this relationship, which is higher for developing countries. Thus, it is expedient for these countries to pursue an active innovation policy to increase the level of economic development. Despite the fact that developed countries have more opportunities for active development of the innovative component in the national economy, their indicators in innovation and high-tech industries are declining and developing countries come to the fore. .

Keywords: innovative activity, economic development, technology, technological and innovative development.

1. Introduction

Economic development is formed due to the influence of national and global factors, which are multifaceted, diverse and sometimes contradictory. This is largely due to the peculiarities of different aspects of the development process. Defining the determinants of economic growth in modern economics should provide answers to the challenges facing society within the formation of a new technological paradigm.

2. Literature review

The question of global economic development, its determinants and asymmetries has occupied the attention of many scientists, such as Filipenko (2002), Lukyanenko (2011),

Baltserovych (2000), Stolyarchuk (2009) and others. However, the issue of asymmetries of global economic development in the context of imbalances in innovative development of countries is still insufficiently studied.

There are a large number of factors and determinants of economic growth, some of which are relevant over a period of time. The fundamental determinants of economic growth are: capital, technical and technological determinants, socio-subjective determinants and synergetic determinants. A new stage of rethinking the qualitative and quantitative impact of these factors on the economic growth of individual countries and the world economy as a whole is currently taking place, based on the prevalence of a new post-industrial stage of world economic development.

The new economic order forms a new paradigm of economic development of countries and acquires signs of globality, which also leads to the transformation of the concept of "development". This issue has been covered in a large number of studies by domestic and foreign experts. The analysis of scientific research made it possible to identify two approaches to determining the essence of development, i.e. philosophical and economic.

Systemic transformations are changing the traditional understanding of the term "development", especially in the context of globality, as the development of global economic processes no longer corresponds to the linear trend and is difficult to predict (Zapukhliak, Herman, 2014). According to A. Filipenko (2002), current approaches of economic development should be grouped as follows:

1) scientists of the first current believe that the result of economic development is to improve the welfare of the population, improve the quality of life and meet the needs of members of society;

2) the representatives of the second current consider the general laws of development and express the opinion that it has a cyclical nature and is associated with the processes of evolution and progress (Lukyanenko, 2011). At the same time, world practice shows that development is not always accompanied by progress, so it can be regressive (Zapukhliak, Herman, 2014);

3) such scientists as R. Nureyev (2018), N. Kuznetsova (1996) consider development as a complex and multidimensional process;

4) representatives of the historical and philosophical approach (B. Shavans, 1999), V. Bryansky (1999) emphasise the fact that development is a natural and multifactorial process of alternating order and chaos in the context of social synergetics.

Global economic development is a nonlinear process that unfolds in time and space, covering countries, regardless of their level of economic development and the degree of involvement in global economic processes, formed under the influence of both internal and external factors and civilisational factors. It is the latter that are beginning to have an increasing impact on global economic development. A. Filipenko (2002) identifies four groups of influencing factors: 1) the initial level of development of countries, 2) the state of human capital, 3) economic system of the state, 4) exogenous conditions of development.

It should be noted that in developed countries, the growth rate is characterised by greater stability over the long term than in the poorer ones, which are characterised by sudden unexpected changes in economic growth, mainly due to political instability or military action (Zhylinska, Chernyak, Bazhenova, 2019).

When studying the asymmetries of global economic development, it should be noted that they are objective characteristics of world processes that complement each other, because development itself is a contradictory process in terms of content and consequences. J. Stolyarchuk (2009), a Ukrainian scientist, has thoroughly studied the trends of global economic development and supports the idea of forming a global model of economic development, and at the same time points to the existence of asymmetries, which are manifested in the lack of structural equilibrium of the global economic system and existing contradictions between them.

3. Methodology

The theoretical and methodological foundations of the study are the provisions of economic theory, theories of international economic relations, theory of economic development, scientific works of domestic and foreign scientists concerning the innovation development of countries as a factor of their economic development.

The aim of the research is to determine the role of the innovative development of a country in its economic development and competitiveness of the national economy. In order to conduct the research, several methods have been used, including: the method of system generalisation – to generalise existing theories and concepts of innovative development of countries; the induction and deduction method – to study the theoretical and methodological foundations of the unevenness of global economic development; the method of comparative analysis – to study the global economic development and countries' innovation activity; the graphic method – for visual demonstration of the results if the study; the method of analysis and synthesis – for distinguishing groups of countries by systematising the places they occupy in both GCI and GII; the economic and mathematical modelling methods – for calculation of integrated assessment of innovation and economic development of countries and finding connections between innovation activity and economic development, as well as other methods. Data from the leading international organizations – WIPO, World Bank, UNCTAD have been used for the study.

4. Results and Discussion

Global economic, socio-political and cultural development of society from the last quarter of the 20th century to this day occurs under the ever-increasing influence of globalisation. Its economic component is primarily related to the sources, factors and forms of economic progress. We are talking here about investment and technology, labour, intellectual and financial resources, management, marketing, etc.

The forms of manifestation of these processes are the following:
– increase in international trade and investment, liberalisation and deregulation of capital movements;
– unprecedented diversification of global financial and technology markets;
– a significant increase in the role of TNCs in world economic processes;
– strengthening global competition;
– emergence of global, strategic management systems;
– increase in the importance of information and communication technologies in economic development.

The modern period is characterised by profound transformations, changes in the geocivilisation space against the background of the decline of industrial world civilisation in the first quarter of the 21st century and the parallel formation of the foundations of integrated civilisation in avant-garde countries in the second quarter. Industrial civilisation is accompanied by local and global military conflicts, economic wars, redistribution of world domination and destructive reforms. These processes lead to uncertainty in world dynamics, exacerbate intercivilisational, interstate and social contradictions and create uneven global economic development (Zapukhliak, Herman, 2014).

It is well known that the determining factor of economic growth and ensuring a high level of competitiveness of a country is its scientific and technological development, which contributes to structural transformations in almost all spheres of human life. The whole history of human development is inextricably linked to the progress of technology, and each new level of socio-economic development is based on the formation of a new technological way of management. Schumpeter's Theory of Economic Development (Schumpeter, 1934) considered technological innovations as the main driving force of economic growth. Such logic has led to the recognising of the crucial role of structural economic policy and distinguishing the leading innovation industries and traditional ones in order to reach dynamic economic growth (Bazhal, 2019).

During the development of scientific and technological revolutions, the nature of human life changes dramatically. The consequences of their impact on the socio-ecological and economic development of the entire civilisation were noticeable in the second half of the 20th century. A new stage of the scientific and technological revolution. The so-called information revolution unfolded in the world, at the epicentre of which were the United States, the Soviet Union, Japan, France, Italy and some other Western European countries, as well as Canada. And much as the first scientific and technological revolution, the scientific base of which was created in the early twentieth century as a result of scientific breakthroughs in science and theoretical physics by countries such as Germany, France, the UK and the United States, led to qualitatively new transformations in industry, the modern information revolution revolutionised almost all areas (not only material production and services, but also intellectual labour). The period of scientific and technological revolution of the second half of the twentieth century was characterised by the formation of nuclear energy, gradual automation of production and constant growth of its energy consumption, creation and rapid improvement of computer technology, beginning of the development of outer space, as well as the emergence of genetic engineering (Lukianenko, Poruchnyk, Kolot, 2011).

Thus, if in the 1950s in most capitalist countries there appeared quite favourable conditions for economic growth, which was carried out mainly through the extensive use of natural and intellectual resources, then since the early 1960s, economic growth has slowed down significantly, and there emerged a need to intensify production. This need was satisfied by the introduction of the latest achievements of STP in all areas of the economy, in particular, new resource, labour and energy-saving, environmentally friendly and waste-free technologies (Fig. 1).

The equalisation of economic growth in the regions of the world among developed and developing countries indicates economic globalisation, spread of industrial production to all countries, reduced industrial capacity of developed countries and accelerating economic growth in developing countries.

According to OECD experts in the mid-20th century, the rate of economic growth of the world's leading countries was determined by the progress of new technologies by 38%, and at the end of the century – by 65% (Shiryaev, 1990). So today it is becoming increasingly clear that the economic power and progress of

each country is due primarily to the intensity of the introduction of new technologies and achievements of scientific and technological progress.

In modern conditions of development of the global market environment the possibility of introduction of the newest technologies and access to other resources, is not uniform. For example, more than 60% of the world's population cannot integrate into the digital economy because they still do not have access to the Internet (World Development Report, 2016).
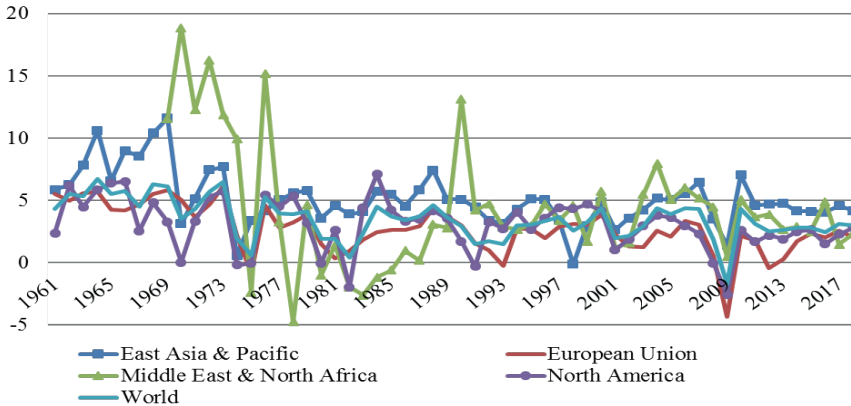

Figure 1: GDP growth (annual %) by regions of the world, 1961-2018
Source: World development indicators (2020)

Unlike innovations in the past, the current benefits of technological change are not equally distributed in all regions of the world. Real income lags behind the growth rate of productivity, and regional socio-economic inequality is deepening (Frey, Osborne, 2016, p. 7). Socio-economic and historical preconditions for the development of economically developed societies create more opportunities for the introduction and use of new technologies. However, with the development of mechanisms for coordination and control over geographically dispersed production chains, the process of automation is slowing down even in socially developed countries (Mulyavka, 2016). After all, it is possible to hire cheap labour on the periphery with a higher level of exploitation and lower standards of labour protection. This decision is explained by the simple logic of capitalist relations: minimising costs to maximise profits. It is cheaper for owners of industrial enterprises in the USA or Germany to transfer production facilities to poor societies in Africa and Asia than to technologically re-equip production at home (Dyer-Witheford, Nick, 2015, p. 135). These processes lead to redirection of trade flows of industrial goods and establishment of new industrial supply chains, formation of new industrial centres (Fig. 2).
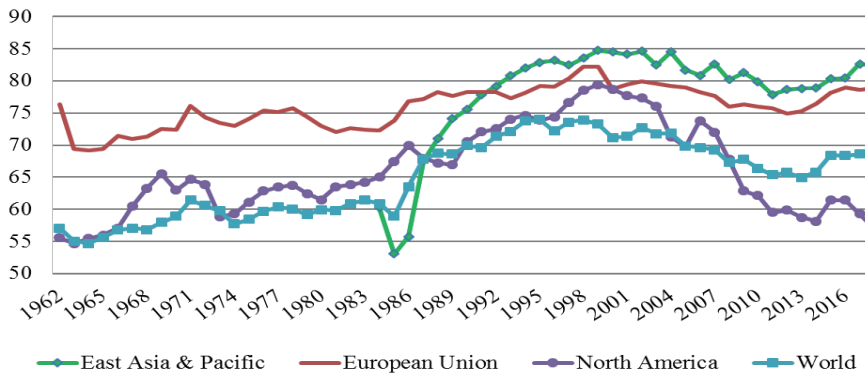

Figure 2: Manufactures exports (% of merchandise exports), 1962-2018
Source: World development indicators (2020)

Despite the fact that a number of non-Western societies are successfully coping with the process of industrialisation, income inequality between countries has deepened markedly since the Industrial Revolution (second half of the 18th century). In 1820, income in Western societies was 1.9 times higher than in non-Western countries. Over the next 180 years, the West significantly distanced itself from the rest of the world: in 2000, per capita income in Western societies was 7.2 times higher than in non-Western ones (Fig. 3).

This, in turn, leads to the re-equipment of industrial facilities in developing countries and indirectly affects the overall level of economic development of a country and its socio-economic status. This is especially true in the countries of the Asia-Pacific region.

Despite the fact that developing countries have the opportunity to implement modern technologies, the rate of technology spread is still lower than in developed economies, which leads to uneven distribution of resources and imbalances in regional development (Frey, Osborne, 2016, p. 16). To overcome existing imbalances in both economic and innovative development, developing countries need to make qualitative changes in their national development strategies, providing more attention and resources to the development of the innovation sector of the national economy.

Innovation is considered a guarantee of sustainable and long-term economic development for a country. However, innovative development involves not only technological restructuring of industry, but also requires additional investment in human resource development, i.e. knowledge, skills and creativity. Countries that invest in industrial innovations, education and human development, spend significant resources on R&D and have a national strategy for the innovation potential development, could increase their competitiveness and gain an advantage on the world stage.
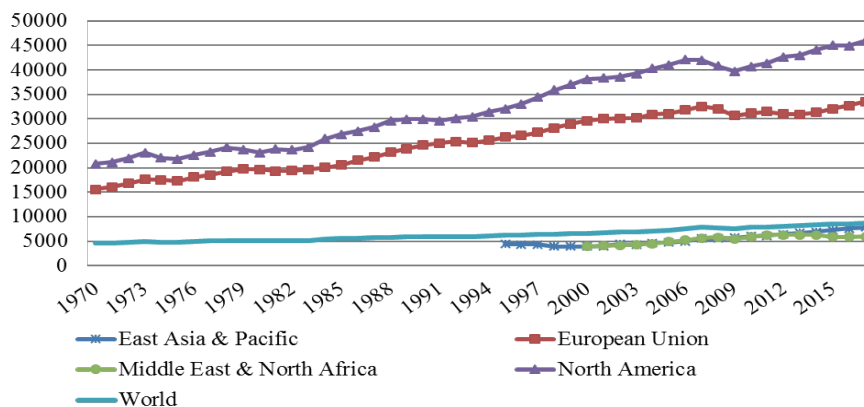

Figure 3: Adjusted net national income per capita (constant 2010 US dollars) 1970-2018
Source: World development indicators (2020)

The positioning of countries in the global economic and innovation space confirms the statement that there is a direct relationship between the key indicators of these sectors.

The global distribution of innovation remains significant and quite diversified, as high-income economies lead in shaping the innovation landscape, while there are large gaps in all innovation performance between these leaders and other less developed countries, and this gap is gradually widening. In this case, developing countries can achieve better results in the development of national economies only if effective implementation of innovation policies takes place.

The innovative dimension of development of countries is provided by numerous ratings and indices, which are developed and published by recognised international institutions. These are, first of all, the Global Innovation Index (GII), the Global Competitiveness Index (GCI), the Bloomberg Index of Innovative Economies, the European Innovation Scoreboard, the OECD Scoreboard on Science, Technology and Industry, and others.

According to the methodology of the World Economic Forum to assess the level of competitiveness, one of the elements of the GCI is the technological potential for innovation. Innovation is especially important for emerging economies. And although less developed countries can still increase productivity by adopting existing technologies or gradually improving other areas, this approach is no longer enough

to increase productivity in those countries that have reached the innovative stage of development (Schwab, 2019)

The degree of economic development and the economy's competitiveness are inextricably linked with the process of increasing the innovation component in the structure of the economy and the corresponding innovation strategy. Thus, effective innovation strategies in a country lead to increased competitiveness of the economy, which is why the authors have decided to analyse the positioning of countries

on the GCI on the one hand, and the leading indices that characterise the degree of innovation in the country – on the other.

The criterion for the selection of countries was the place they occupied in the Global Competitiveness Index in 2019. It should be noted that over the past three years, the list of countries in the top 10 has not changed; there are only changes in the ranking for this period. Additionally, in 2018 the methodology for assessing the level of global competitiveness changed.

Table 1: Top 10 countries according to the Global Competitiveness Index in 2019 and the positions of these countries in 1999, 2009, 2017

Country	2019		2017		2009		1999
	Place [141]	Mark [100]	Place [137]	Mark [7]	Place [137]	Mark [7]	Place [58]
Singapore	1	84.8	3	5.71	5	5.53	12
USA	2	83.7	2	5.85	1	5.74	1
Hong Kong	3	83.1	6	5.53	11	5.33	21
Netherlands	4	82.4	4	5.66	8	5.41	3
Switzerland	5	82.3	1	5.86	2	5.61	5
Japan	6	82.3	9	5.49	9	5.38	14
Germany	7	81.8	5	5.65	7	5.46	3
Sweden	8	81.2	7	5.52	4	5.53	4
United Kingdom	9	81.2	8	5.51	12	5.30	10
Denmark	10	81.2	12	5.39	3	5.58	7

Source: based on the Global Competitiveness Report (Porter, Cornelius, 2000; Porter, Schwab, 2009; Schwab, 2019).

The dynamics presented in Table 1 show that most of the leading countries in the Global Competitiveness Index have held leading positions for the last 20 years. However, the general trend indicates a gradual increase in the position of countries in the Asia-Pacific region, in particular, Singapore, Japan and Hong Kong, while some developed Western countries are losing their positions (Denmark, Sweden), or even fall out of the top 10 (Canada, Finland).

The leading countries now face the challenge of building a competitive economy. The fact that among the leaders of innovative development are developed countries with high income confirms the view that innovation plays an important role in the development of a country and the formation of its competitiveness. That is why the Global Competitiveness Index is also used for assessing the innovative dimension of the development of countries.

High productivity of the economy is the most important factor determining long-term growth and income. The Global Competitiveness Index 4.0 report (Schwab, 2019) outlines a new set of factors important to the productivity and competitiveness of the country's economy in the Fourth Industrial Revolution (4IR) (Fedak, 2018, Syhyda, 2018). The inextricable link between

the innovative development of a country and the formation of its competitiveness is obvious – the countries that occupy the first positions in the Global Competitiveness Index are also leaders in the Global Innovation Index.

The Global Centre for Innovation can be considered the most objective means of assessing the country's innovation activity. It is well known that the list of leaders in the global innovation environment usually includes developed countries. However, since 2016, the top 25 Global Innovation Index (in 2020 – 14th place) inc-

Table 2: Ranking of countries by GII, 2020, 2018 and 2007

Country	2020	2018	2007
Switzerland	1	1	6
Sweden	2	3	12
USA	3	6	1
United Kingdom	4	4	3
Netherlands	5	2	9
Denmark	6	8	11
Finland	7	7	13
Singapore	8	5	7
Germany	9	9	2
Rep. of Korea	10	12	19

Source: based on Dutta, 2007; Dutta, Lanvin, 2020; Dutta, Lanvin, 2018.

ludes China – a country with a middle income (upper-middle). Apart from China, the only country with an above-average income level that is close to the top 25 is Malaysia (33rd place in 2020). Following the results of 2020, Vietnam, India and the Philippines are the economies with the most significant progress in their rankings. These countries are now in the top 50. Switzerland, Sweden and the United States top the innovation rankings, followed by the United Kingdom and the Netherlands. This year, for the first time, the second Asian economy – the Republic of Korea – entered the top 10 along with Singapore.

As a result of the countries' comparative description on the GII and GCI, the following conclusions can be drawn.

It is possible to distinguish groups of countries by systematising the places they occupy. Thus, there are countries whose places in the GCI are higher than in the GII: Singapore, Hong Kong and Japan – the countries of the Asia-Pacific region. This may indicate that the innovation system in these countries is not a key factor determining the level of competitiveness of the country's economy. The positioning of the countries on the world stage is actively influenced by other factors, such as human potential, industrial production or imported innovations. This assumption is logical because of Japan's experience in building its own innovation system. In the period after World War II, Japan actively involved foreign technologies and that became the base for developing their own technologies and industries, which led to the fact that in the 1980s Japan became one of the most technologically advanced countries in the world. Thus, these countries can be called importers of innovation.

Another group of countries are those whose places in the GCI are lower than in the GII: Sweden, Denmark and Finland. In this group, the country's innovation potential is a more decisive factor in positioning the country on the world stage, but significant innovation potential is not fully used for achieving a significant level of competitiveness. Perhaps, in this case, the results of the country's innovation activities are more exported, so the country acts as a producer and exporter of innovations.

China should be added to this group (14th place in GII and 28th place in GCI). China is not in the top 10 of the indexes we observe, but its role at the global arena is huge and the features of its innovation strategy should be noted.

The next group of countries are those who cannot be unanimously assigned to the first or second group of countries: their places on the proposed indices are almost the same (Netherlands, Germany, USA, UK). The level of innovation and competitiveness of these countries is about the same, so they are effective innovators because their innovation systems are able to produce the amount of innovation that is necessary for economic development and increasing the country's competitiveness.

Table 3: Grouping of countries by positioning according to the GCI and GII, 2019-2020

Importers of innovation, GCI>GII	Producers of innovations, GCI<GII	Effective innovators, GCI~GII
Singapore, Hong Kong, Japan	Sweden, Denmark, Finland, China	Netherlands, Germany, USA, UK

Source: the authors' own analysis.

It should be noted that the countries suggested for grouping have common features in the implementation of innovation policy measures. In order to develop and provide innovations, most countries successfully create and use networks of technology parks and science cities (USA, Germany, UK, Sweden, Denmark, China), free trade and investment zones (China), venture funds and public-private partnerships (China, USA, UK), as well as business incubators (Japan, Denmark, USA, Germany).

The group of countries that we suggested as Producers of innovations has common features of the innovation strategy. The existing over-concentration of innovative developments around large multinational companies leads to an increase in the export potential of the knowledge and technology transfer. Significant state financial support for research and projects borders on delegating the innovation management process to the regional and municipal levels. The countries in this group are innovators in implementing e-government. Universities and research institutions are independent agents with significant government and external funding and have the ability to commercialise projects.

A group of Effective innovators demonstrate common goals of innovation strategy – to achieve leadership in science and technology (USA), to seize world leadership in high-tech development, production and export of high-tech goods and services and to become an innovative state (Germany), which will increase the national level of welfare of the nation. The countries of this group are characterised by the active participation of the public sector in stimulating research and their implementation in production processes, availability of a significant number of high-tech industries and services, the significant role of higher education and its close relationship with industry.

According to provided research, the authors see that the leading countries in the GCI are also leaders in the GII, which confirms the strong connection between the innovative development level and the overall level of economic development. These countries conduct certain measures to stimulate innovative development and occupy leading positions in the indicators of innovation performance.

To obtain mathematical confirmation of the analytical conclusions, the authors propose to conduct economic and mathematical modelling of the interaction of innovation activity and economic development of countries. As none of the existing indicators of economic development or indicators of the innovation sphere can fully characterise the effectiveness and efficiency of the policy implemented by a country, we propose to calculate the integrated indicators of innovative development and economic development.

To perform this task, a mathematical apparatus has been used, namely – calculating the multidimensional average for each of the indicators.

The multidimensional average is an integral estimate of an object in a multidimensional feature space; such an estimate is geometrically interpreted as a point in multidimensional space, the coordinates of which indicate the scale or position of the j-th unit or j-th object. The algebraic value of the feature of the j-th unit of the population is represented by a vector

$$X_i = \{x_1, x_2, ...x_m\}$$

and their aggregation means the translation of vectors into a scalar.

The aggregation of features is based on the so-called theory of "additive value", according to which the value of the whole is equal to the sum of the values of its constituent elements.

If the features of the information set {X} are represented by different units of measurement, then additive aggregation requires bringing them to one basis, i.e., pre-standardisation (rationing). The vector of initial features

$$X_i = \{x_1, x_2, ...x_m\}$$

is replaced by the vector of standardised values

$$Z_i = \{z_1, z_2, ...z_m\}$$

Integral estimation is defined as a multidimensional mean, i.e., the arithmetic mean of standardised values of the features – for the j-th unit of the population:

$$\overline{\rho_j} = \frac{1}{m} \sum_{i=1}^{m} Z_{ij} \qquad (1)$$

The authors suggest calculation of integrated assessments of innovation and economic development of chosen countries. Based on a previous study of global innovation trends, the leading countries were identified as leaders in the GII and GCI, which allowed to divide countries into groups of exporters of innovations, importers of innovations or effective innovators. The countries were chosen to calculate the integrated indicators of innovation and economic development. Integrated estimates are calculated for the following countries (in the dynamics for 2010-2019): China, Denmark, Finland, Germany, Hong Kong, Japan, Singapore, Sweden, Netherlands, UK, USA.

Among the indicators of innovative development there are: Computer, communication and other services (% of exports of commercial services) (X1); Computer, communication and other services (% of imports of commercial services) (X2); High-tech exports (% of exports) (X3); R&D expenditures (% of GDP) (X4); Number of researchers in the R&D (per 1 million people) (X5); Exports of ICT goods (% of total exports of goods) (X6); Imports of ICT goods (% of total imports of goods) (X7); Patent applications, pcs. (X8) – stimulator. Integral assessments of innovative development provided in figure 4.

Analysing the dynamics of integrated assessment of innovation development, we can say that for the period of 2010-2019 the most significant development was shown by China (with an average annual growth rate of integrated indicator amounting to 12.5%), Germany (+11%) and Hong Kong (+10%). The average rate of development is observed in Singapore (+7.3%), Denmark (+6.1%), USA (+5.6%). Slight growth in innovation development in the UK (+1.7%). Netherlands, Japan, Sweden and Finland showed a negative result in innovative development for the period of 2010-2019 (-0.1%, -0.1%, -2.5%, -9.8%, respectively).

The indicators of economic development include: Adjusted net national income per capita (thousands of US dollars) (X1); GDP per capita (thousand US dollars) (X2); Employment in industry (% of total employment) (X3); Employment in services (% of total employment) (X4); Machinery and transport equipment (% of value added in production) (X5); Exports of industrial goods (% of exports of goods) (X6); Exports of commercial services (billion USD) (X7).

Regarding the integrated assessment of economic development, the leader among the represented countries in 2010-2019 was China, where the average integrated indicator grew by 29.5% annually. High economic development

is also demonstrated in Germany (+16.1% on average annually) and the UK (+14.6%). Favourable development is observed in Singapore (+8.8%), Netherlands (8.7%), USA (+8%). Slight development was shown by Denmark (+5.1%), Hong Kong (+4.7%), Sweden (+3.6%), Japan (+1.2%) and Finland (+0.6%).
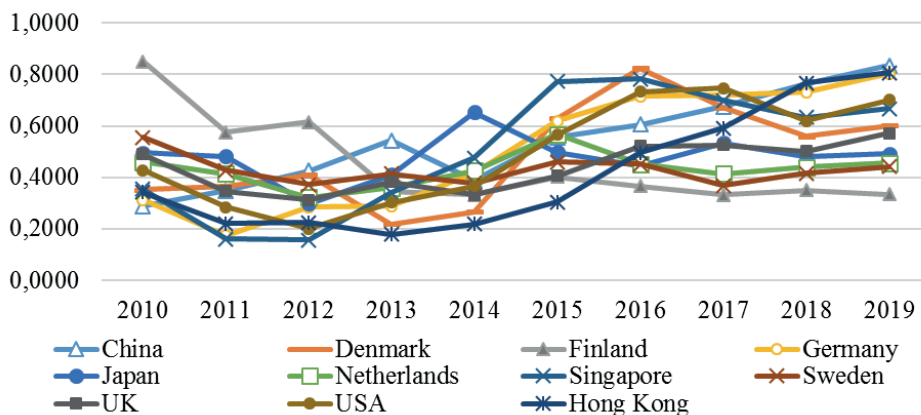

Figure 4: Integral assessments of innovative development, 2010-2019
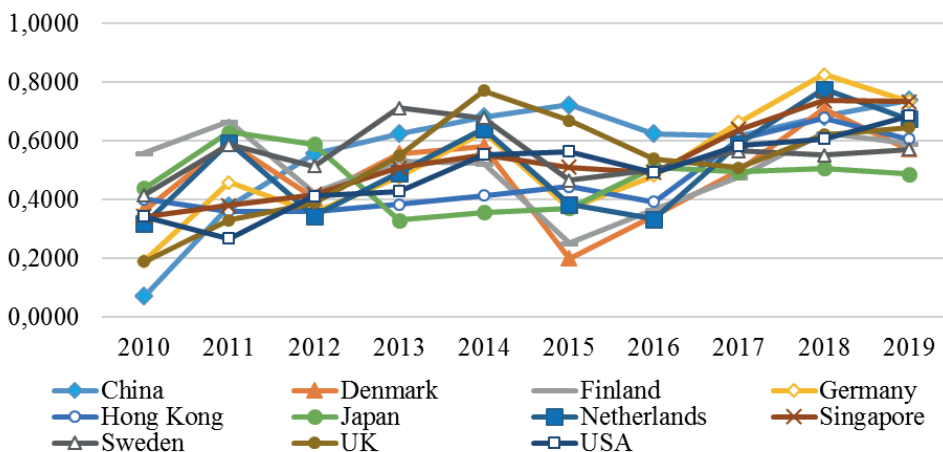Source: calculated by the authors

Figure 5: Integrated assessments of economic development, 2010-2019
Source: calculated by the authors

To assess the correlation between the integrated indicators of innovation and economic development, linear pairwise correlation coefficients were calculated using the CORREL function in MS Excel. The even correlation coefficient indicates the direction and closeness of the relationship between the indicators and varies within [-1; +1]. The sign before the coefficient indicates the direction of dependence (direct or inverse), the closeness of the relationship is determined by the Chaddock scale (Table 4).

Thus, we obtain the following results: China r_{xy}= 0.708, Denmark r_{xy}= -0.341, Finland r_{xy} = 0.145, Germany r_{xy}= 0.634, Japan r_{xy}= -0.420,

Singapore r_{xy}= 0.631, Hong Kong r_{xy} = 0.898, Sweden r_{xy}= -0.627, Netherlands r_{xy}= -0.045, UK r_{xy}= 0.053, USA r_{xy}= 0.705.

The closest direct link between innovation and economic development is demonstrated in Hong Kong (0.898) and China (0.708). This means that innovation has a positive and very strong connection to the economic development of a country. There is also a strong positive relationship in Germany, Singapore and the United States. A weak link has been observed between innovation and economic development in Finland, the United Kingdom and the Netherlands. There is a moderate inverse relationship between innovation and economic de-

velopment in Denmark and Japan. Significant inverse feedback is typical of Sweden.

Using the method of proportional distribution, the calculation of integrated assessment of innovation and economic development of countries allowed to determine their level, trace the dynamics and determine the relationship between innovation and economic development for every country. Furthermore, the study showed a relationship between the level of innovation and economic development for all countries studied, but there is a difference in the degree of this relationship: for developing countries (China, Singapore, Hong Kong) it is higher. Thus, it is expedient for these countries to pursue an active innovation policy to increase the level of economic development. And as we see following the conducted research, these countries are already stepping up their innovation activities.

Table 4: Chaddock scale to characterise the closeness of the relationship between indicators

Quantitative measure of correlation (modulo)	Qualitative measure of correlation
0,0	No connection
< 0,3	Weak connection
0,3-0,5	Moderate connection
0,5-0,7	Noticeable connection
0,7-0,9	High connection
0,9-1,0	Very high connection
1,0	Functional communication

5. Conclusions

The level of innovative development of a country and technological equipment of industry creates opportunities to improve the living standards of mankind and determine the level of economic development of the country. However, these processes take place in the conditions of the formed global inequality and only deepen technological and economic gaps between the regions of the world.

Economically developed countries are more ready to adopt the latest technologies, as it is advisable to replace expensive labour with au-tomated processes. In these regions, the ICT industry is traditionally more developed, and developed social guarantees for employees provide mechanisms to reduce the negative influence of automation on unemployment.

Based on the analysis of global innovation development trends, the leading countries that are leaders in the Global Innovation Index, the Global Competitiveness Index have been identified. The authors have distinguished groups of countries by systematising the places they occupy in both GCI and GII: Importers of innovations (Singapore, Hong Kong, Japan), Producers of innovations (Sweden, Denmark, Finland, China) and Effective innovators (Netherlands, Germany, USA, UK). Furthermore, they have identified features of innovation strategies of the countries in the proposed groups.

Using the method of proportional distribution, the calculation of integrated assessment of innovation and economic development of countries has been suggested. That allowed for determining their level, tracing the dynamics and determining the relationship between innovation and economic development for every country. Also, the study showed a relationship between the level of innovation and economic development for all countries studied, but there is a difference in the degree of this relationship: for developing countries it is higher. Thus, it is expedient for these countries to pursue an active innovation policy to increase the level of economic development.

Despite the fact that developed countries have more opportunities for active development of the innovative component in the national economy, their indicators in innovation and high-tech industries are declining and developing countries come to the fore, with China deserving special attention. It is substantiated that innovation activity in China has intensified in recent decades, which leads to the improvement of both the country's innovation indicators and general economic indicators. Other countries in the Asia-Pacific region (Japan, Singapore and Hong Kong) are also improving their performance on these indicators, in contrast to European countries and the USA.

References

Baltserovych, L. (2000). *Svoboda i rozvytok. Ekonomiia vilnoho rynku* [Freedom and development. Free market economy]. Lviv : [b.v.], 332 (in Ukrainian)

Bazhal I. (2019). Innovations as a Crucial Factor of the Catch-up Economic Growth. Scientific papers NAUKMA. *Economics*. 4(1), 3-8. DOI: https://doi.org/10.18523/2519-4739.20194.1.3-8

Bransky V. (1999). Sotsialna synerhetyka yak postmodernistska filosofiia istorii [Social synergetics as a postmodern philosophy of history]. *Social sciences and modernity*. 6, 117-127. URL: http://www.ecsocman.hse.ru/ons/msg/18427220.html (In Russian).

Dutta S. (2007) *World business: The power of innovation*. INSEAD. URL: https://www.globalinnovationindex.org/userfiles/file/gii-2007-report.pdf

Dutta S., Lanvin B. (2020). The Global Innovation Index 2020: Who Will Finance Innovation. *Cornell University, INSEAD, WIPO.* URL: https://www.globalinnovationindex.org/gii-2020-report

Dutta S., Lanvin B. (2018). The Global Innovation Index 2018: Energizing the World with Innovation. *Cornell University, INSEAD, WIPO.* URL: https://www.globalinnovationindex.org/gii-2018-report

Dyer-Witheford, Nick (2015). *Cyber-Proletariat. Global Labour in the Digital Vortex*, London: Pluto Press

Fedak M. (2018). *Ohliad stratehii po 4.0 krain YeS vid Yevrokomisii* [Review of strategies for 4.0 EU countries by the European Commission] URL: https://industry4-0-ukraine.com.ua/2018/08/27/review-national-strategies-4-0-in-eu/

Filipenko, A. (2002). *Jekonomicheskoe razvitie: civilizacionnyj podhod* [Economic development: a civilizational approach]. Moscow: Jekonomika. p. 260 (in Russian).

Frey C., Osborne M. (2016) *Technology at work v 2.0 Oxford Martin School*. University of Oxford. URL: https://www.oxfordmartin.ox.ac.uk/downloads/reports/Citi_GPS_Technology_Work_2.pdf

Kuznetsova, N. P. (1996). *Economic growth in a historical context. St. Petersburg*, p. 106 (in Russian).

 Lukianenko D. H., Poruchnyk A. M., Kolot A. M., Stoliarchuk Ya. M. (2011) *Resursy ta modeli hlobalnoho ekonomichnoho rozvytku* [Resources and models of global economic development]. K.: KNEU (in Ukrainian).

Mulyavka V. (2016). *Novi tekhnolohii i hlobalna nerivnist* [New technologies and global inequality]. *Spilne* [Joint]. URL: https://commons.com.ua/uk/novi-tehnologiyi-i-globalna-nerivnist/

Nureev, R. M. (2018). Digital technologies: main directions of development. *The Business and Management Review*, 9(4), 523–533.

OECD (2020). *Research and Development Statistics*. URL: http://www.oecd.org/innovation/inno/researchanddevelopmentstatisticsrds.htm

Porter M., Cornelius P. (2000). The Global Competitiveness Report 1999. *World Economic Forum.* URL: http://web.mit.edu/15.018/attach/Global%20Competitiveness%20Report%202000,%20part%201.pdf

Porter M., Schwab K. (2009). The Global Competitiveness Report 2008-2009. *World Economic Forum.* URL: http://www3.weforum.org/docs/WEF_GlobalCompetitivenessReport_2008-09.pdf

Schumpeter, J. (1934). *Theory of economic development: An inquiry into profits, capital, credit, interest, and the business cycle*. Cambridge, MA: Harvard University Press.

Schwab K. (2019) The Global Competitiveness Report 2019. *World Economic Forum.* URL: http://www3.weforum.org/docs/GCR2018/05FullReport/TheGlobalCompetitivenessReport2019.pdf

Shavans, B. (1999). *Evolyutsionnyiy put ot sotsializma* [An evolutionary path from socialism. Voprosyi ekonomiki]. Vol. 6, URL: http://www.r-reforms.ru/shavans.htm (in Russian).

Shiryaev Yu. S. (1990). *SEV: nauka – proizvodstvo – sotrudnichestvo. Puti k tekhnologicheskomu sotrudnichestvu (tendentsii 80-kh godov)* [CMEA: science - production - cooperation. Ways to technological cooperation (trends of the 80s)]. M.: Nauka, 1990. – p. 143. (in Russian)

Stoliarchuk, Ya. M. (2009). *Asymetriia hlobalnoho rozvytku: sotsialno-ekonomichnyi vymir* [Asymmetry of global development: socio-economic dimension]. Kyiv; p. 34.

Stoliarchuk, Ya. M. (2009). *Hlobalni asymetrii ekonomichnoho rozvytku*. [Global asymmetries of economic development]. Kyiv: KNEU; p. 302 (in Ukrainian).

Syhyda L.O. (2018). Industriia 4.0 ta yii vplyv na krainy svitu [Industry 4.0 and its impact on countries around the world]. *Economy and society,* 17, 58-64 (in Ukrainian).

World Bank Group (2016). *World Development Report: Digital Dividends* URL: https://www.worldbank.org/en/publication/wdr2016

World Bank Group (2020). *World development indicators*. URL: (https://datacatalog.worldbank.org/dataset/world-development-indicators).

Zapukhliak V. Z., Herman L. T. (2014). Asymetrii hlobalnoho ekonomichnoho rozvytku [Asymmetries of global economic development]. *Ekonomichnyi analiz* [Economic analysis]. Ternopil': Vydavnycho-polihrafichnyi tsentr Ternopilskoho natsionalnoho ekonomichnoho universytetu «*Ekonomichna dumka»,* 18(3), 16-25 (in Ukrainian).

Zhylinska O., Chernyak O., Bazhenova O. (2019). The Role Of Innovations In Driving Economic Growth: Case Of Advanced Economies, *Globalization And Business*, 7, 11-15. https://doi.org/10.35945/gb.2019.07.001