JOURNAL
OF EUROPEAN ECONOMY
Vol. 20. № 4 (79). October–December 2021
Publication of West Ukrainian National University

Global and European Integration

Iryna PIDORYCHEVA

UKRAINE'S EUROPEAN INTEGRATION IN THE FIELD OF RESEARCH AND INNOVATION: STATE, CHALLENGES, ACCELERATION MEASURES

Abstract

Unprecedented complexity of the modern challenges requires the international community to strengthen cooperation in science, technology and innovation to better seize the opportunities and reap the benefits of the new reality, as well as search for new solutions to problems humanity is faced with. The paper investigates the influence of European integration on the economy and innovation ecosystem of Ukraine. It is established that the innovative component of the national economy has contracted over 2015-2020. With each year, it is becoming more primitive and de-industrialized, which necessitates a revision of the Association Agreement with the EU aimed at enhancing its positive impact on innovation processes in the national economy. Conducted analysis allows for comparisons between Ukraine's involvement in the Horizon 2020 Framework Programme, which remains low, and that of EU member states and other associated members. Ukraine's predicament is explained by, among other reasons, a weak national innovation ecosystem and a lack of close contact and professional ties

Pidorycheva Iryna, Doctor of Economic Sciences, Head of the Sector for Problems of the Innovation and Investment Development in Industry, Institute of Industrial Economics of the National Academy of Sciences of Ukraine, Kyiv, Ukraine. ORCID: 0000-0002-4622-8997 Email: pidoricheva@nas.gov.ua

between Ukrainian institutions and their European counterparts. The paper offers suggested solutions to these problems, namely a set of organizational and institutional measures that will broaden Ukraine's access to EU funding and accelerate integration into European Research Area. The author emphasizes the need for planned systemic reforms in order to overcome the structural weakness of the national economy. «Natural» development of science and technology, revitalization of the industries though introduction of latest technologies, preservation and balanced development of human capital will all ensure Ukraine's advancement through development of a competitive high-technology economy.

Key Words:

integration; European Research Area; international cooperation; science, technology and innovation; national innovation ecosystem; innovation component of the national economy; Association Agreement with the European Union; Horizon 2020 Framework Programme; competitive high-tech economy.

JEL: F55, 014, O38, O52.

1 figure, 2 tables, 51 references.

Acknowledgement

This paper was prepared as part of the research project «Strategic directions of Ukraine's integration into the scientific, educational and innovation areas of EU: scientific and institutional support» of the Institute of Industrial Economics of the National Academy of Sciences of Ukraine (2020-2021) (registration No. 0120U100988).

Introduction

In recent years, radical technological transformations have been an important topic for discussion in the scientific, political and business circles. They are occurring under the influence of the fourth industrial revolution in the world economy. They are rooted in the theory of great surges of economic activity, known as long waves of M. Kondratiev. According to this theory, Kondratiev's disruptions of the economic balance of the «third order» (long waves), lasting 40-50 years, are at the heart of crises and revolutions. Their driving force is technological discoveries that affect all factors of production, accompanied by changes in technological, organizational, resource, infrastructure and social security of economic relations, which ultimately leads to structural changes in the economy. Currently, the development of breakthrough technologies of the sixth long wave of M. Kondratiev (2010-2050), such as nano- and biotechnology, information and communication technologies, new advanced materials and nanomaterials, precision medicine and genomics, neurotechnology, cognitive technology, robotics, and space technology. They have a radical impact on the dynamics of world markets and in the near future will determine the position of countries in the world economy. Today, their development is accelerated by the COVID-19 pandemic, which has had a negative impact on many sectors of the world economy, leading to declining production and even shut downs in certain industries such as transport, tourism, hospitality, arts, sports, entertainment and leisure. However, at the same time it has opened up unique opportunities for business development in the digital environment, accelerating the formation of a new «contactless economy» (Monitor Deloitte, 2020). The global trends caused by the COVID-19 pandemic are likely to continue. Even more, experts say that the world has already moved to a «5.0 society», which will largely depend on a «contactless economy» (Isarta News, 2021). South Korea, for example, has announced a restructuring of its economy based on the concept of «contactlessness», using the metaphor of «the untact economy». «Contactlessness» has become a key element of a South Korean programme *New Deal* (62 billion USD), which envisions substantial increase in investments in development of robotics, drones, unmanned vehicles and other technologies, which will reduce the need in personal contact (Monitor Deloitte, 2020; Kim, 2020).

The unprecedented complexity of global challenges presented by technological transformations and the crisis caused by the global COVID-19 pandemic highlight the need for stronger international cooperation that would facilitate better understanding of the opportunities and benefits of the new reality and promote the search for new solutions to the challenges recently posed to humanity. Ukraine must also take into account the paramount importance of the issues outlined above, especially in relations with its strategic partner – the European Union. For its part, the EU leadership is interested in strengthening ties with

neighbouring countries and other international partners to jointly overcome the crisis and recover the economy as soon as possible. This was emphasized, in particular, by the President of the European Commission Ursula von der Leyen in her speech in Strasbourg on September 15, 2021 (European Commission, 2021a). At the 23rd Ukraine-European Union Summit held in Kyiv on October 12, 2021, President of the European Council Charles Michel stressed the importance of accelerating the rapprochement between Ukraine and the EU and expressed hope that Ukraine shares Europe's views and aspirations to pursue a green course in the digital society as an opportunity to innovate and increase the welfare of its citizens (European Union External Action Service, 2021).

Literature Review and Problem Statement

The issue of research and innovation cooperation is particularly relevant now in light of the growing influence of science, technology and innovation on the development of the global economy and its ability to recover quickly from negative external shocks. Today's global challenges are too complex for one country and require close bilateral and multilateral cooperation at the interstate and global levels. That much is evident from the research of a number of influential international and intergovernmental organizations – the United Nations (Department of Economic and Social Affairs, 2020), the Organization for Economic Cooperation and Development (OECD / ICN, 2021), the World Bank (World Bank Group, 2021), and the World Economic Forum (2021).

One of the foreign experts who pay special attention to the development of international cooperation in various fields and sectors of science, technology and innovation is Gentoku Toyoma (George Washington University, USA), who views international cooperation between the US and its allies as a prerequisite for strengthening the resilience of US space systems and assets (Toyoma G., 2021). Yaya Li, Yuru Zhang (School of Finance and Economics, China), Chien-Chiang Lee (School of Economics and Management, China), and Jing Li (Beijing IncoPat CO., China) analyse international cooperation in the field of green technologies and argue that economic, technological, social affinity of countries and strict environmental standards are key factors contributing to international environmental and technological cooperation (Li et al., 2021). J. Jewell, D. Garcia-Cabrera (International Institute for Applied Systems Analysis, Austria), and M. Vetier (Central European University, Hungary) study the interdependence between countries in matters of nuclear cooperation and conclude that the global future of nuclear energy is largely determined by the national capabilities and motivations of nuclear powers, primarily the United States and Russia (Jewell et al., 2019). M. Jit, M. McKee (London School of Hygiene & Tropical Medicine, UK), A. Ananthakrishnan, Y. Teerawattananon (Ministry of Public Health, Thailand), O. J. Wouters (London School of Economics and Political Science, UK),

P. Beutels (Vaccine & Infectious Diseases Institute, University of Antwerp, Belgium) explore the importance of multilateral cooperation between countries in successfully responding to health emergencies related to communicable disease outbreaks (Jit et al., 2021).

In the context of European integration aspirations, the attention of Ukrainian research organizations, universities and think tanks is largely focused on the problems and prospects of cooperation with the European Union and its member states. For example, the Razumkov Center specialists consider new priorities of Ukraine's economic integration into the EU in the context of combating COVID-19, as well as the partnership in the security sector (Pashkov et al., 2020; Melnyk et al., 2021).

Specialists of the Institute of Economics and Forecasting of the National Academy of Sciences of Ukraine study the problems, conditions and mechanisms of convergence and divergence of socio-economic systems of Ukraine and the EU (Burlay, 2019; Borzenko & Burlay, 2020); they pay attention to the issues of Ukraine's industrial divergence with the EU, develop new views on the theoretical foundations of an effective model of industrial policy and conclude that the straightforward implementation of EU standards in Ukraine will not have a positive result due to differences in institutional environments and features of the domestic economy (Kindzerskyi, 2021).

The issues of cross-border cooperation are the focal point of the research of scientists from Institute of Market Problems and Economic-Ecological Research and Dolishniy Institute of Regional Research of the National Academy of Sciences of Ukraine, as well as the National Institute for Strategic Studies. For instance, several works (Khymynets et al., 2021; Tymechko, 2019) consider cross-border cooperation, in particular in the scientific field, as a tool for the development of local territories and regions of Ukraine and substantiate priorities and conceptual principles of territorial communities in cross-border dimensions. Laiko and Kovalenko (2020) in their article argue the need for cross-border cluster systems as management structures of intra- and intersectoral cooperation. They view them as one of the most effective mechanisms for the development of international economic cooperation in modern conditions.

Scholars of Ternopil National Economic University offer an interesting and promising direction for expanding Ukraine's international cooperation with the EU. In particular, they put forward the idea of transforming the model of the Visegrad Four (Poland, Czech Republic, Hungary and Slovakia – V4) into a Visegrad Five (V4 + Ukraine) as an intermediate stage of Ukraine's aspirations for European and Euro-Atlantic integration. The authors define the preconditions and strategic framework for such a transformation and suggest key areas of a roadmap for Ukraine's accession to the EU (Savelyev et al., 2019; Savelyev & Smalyuk, 2019).

Researchers of the Institute of Industrial Economics of the National Academy of Sciences of Ukraine have investigated various aspects and areas of cooperation between Ukraine and the EU, which include, in particular: tools for promoting business ideas and developments of Ukrainian inventors at the stage of finished innovative products in the innovation chain of creating added value in order to saturate the Ukrainian domestic market and enter EU markets (Liashenko et al., 2018; Liashenko & Pidorycheva, 2019); conceptual principles of establishing innovation ecosystems in Ukraine in accordance with the nomenclature of territorial units of the EU (Pidorycheva et al., 2020; Pidorycheva, 2021); deepening cross-border digital cooperation (Vyshnevskyi, 2020); strategic directions and scenarios of creating Polish-Ukrainian scientific, educational and innovation spaces (Amosha et al., 2019; Kharazishvili et al., 2021); problems and prospects of development of Ukrainian science, education and innovation in the conditions of European integration (Shevtsova & Shvets, 2021; Antoniuk, 2021); areas of development of scientific and educational cooperation between Ukraine and Bulgaria (Zaloznova et al., 2021).

However, despite the significant achievements in the development of international scientific, educational and innovative cooperation, this area of research requires further investigation in light of the new global challenges and threats posed by the COVID-19 pandemic, as well as accelerating technological transformation of economy and society. Identification of the European integration's impact on the economy and innovation ecosystem of Ukraine is of particular scientific interest in terms of updating and reviewing current priorities and areas of cooperation with the EU, including in science, technology and innovation.

In view of the above, **the aim of the article** is to analyse the state of Ukraine's European integration in the field of research and innovation and to develop proposals for fostering favourable organizational and institutional conditions for accelerating its integration into the European Research Area.

Research Methodology

The study is based on the provisions of the Neo-Schumpeter School of Economics and institutional theory, it builds upon the theoretical achievements of Ukrainian and foreign scientists on the expansion of international cooperation in economy, science, technology and innovation. The investigation was performed using methods of systematization and generalization, analysis and synthesis, comparative analysis and systems approach.

The article is structured as follows. First, the impact of European integration processes in the field of research and innovation on the economy and the national innovation ecosystem of Ukraine is analysed. Next, Ukraine's participation in the EU Framework Programme for Research and Innovation «Horizon

2020» during 2015-2020 is assessed and compared to the associated countries and EU member states. Further, a set of organizational and institutional measures is proposed, aimed at gaining wider access to EU knowledge, infrastructure and funding and at accelerating the pace of integration into the European Research Area. Finally, the last section of the article contains conclusions and prospects for further research.

Research Results

Innovative component of the national economy in the context of the Association Agreement with the EU

Ukraine must take into account current global transformations in its implementation of the European integration; this can be done by enshrining the relevant provisions in the Association Agreement with the EU. This possibility currently exists, as the process of revising this document has started since the beginning of 2021 and it is expected that work on its update will continue until the end of the year (Interfax Ukraine, 2021). The urgency of this task is exacerbated by the fact that during the five-year period of the Agreement – from 2015 to 2020 – it did not have the expected positive impact on innovation processes in the domestic economy. On the contrary, during the period of intensified European integration, the innovative segment of the national economy began to shrink. This is evidenced, in particular, by Ukraine's position as per the European Innovation Scoreboard – a tool for assessing the effectiveness of national innovation ecosystems of EU member states and some other countries, including EU-associated countries (Table 1). In the ranking of the Global Innovation Index, Ukraine rose from 64th place among 141 countries (in 2015) to 45th place among 131 countries (in 2020) (Dutta et al., 2015, 2020), however, it is hardly possible to say that in these five years the country has made progress in making its economy more innovative. As before, the weaknesses of its national innovation ecosystem include the low quality of institutions (primarily political stability, government efficiency, rule of law), underdeveloped venture capital markets, outdated technologies and unsatisfactory levels of fixed capital accumulation, as well as weak links between producers and consumers of innovation.

Table 1

Consolidated innovation index of the European Innovation Scoreboard of the EU member states and Ukraine*

	2015	2016	2017	2018	2019	2020	2021
Consolidated Innovation Index – EU 27	0,473	0,477	0,482	0,487	0,506	0,513	0,526
relative to the EU in 2014	101,1	102,1	103,2	104,2	108,2	109,8	112,5
Consolidated Innovation Index – Ukraine	0,177	0,184	0,168	0,155	0,152	0,153	0,157
relative to the EU in 2014	37,9	39,3	25,9	33,1	32,4	32,8	33,6

Source: adapted from European Commission (2021b).

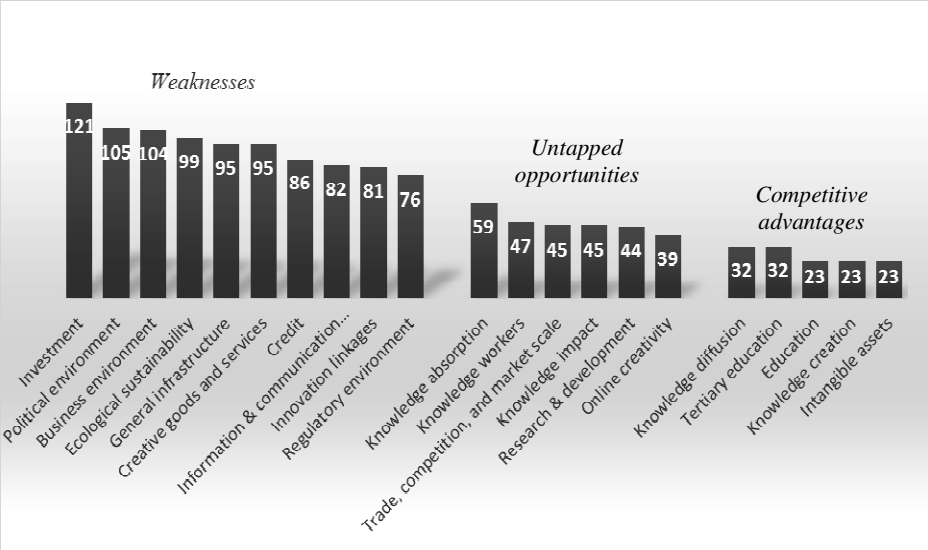
At the same time, Ukraine maintains a strong position in the quality of human capital and indicators of knowledge creation and dissemination (Fig.). In particular, it ranks 1st in the world in the registration of utility models (both in 2015 and in 2020). However, these competitive advantages are not used for innovative restructuring of the economy, which is becoming increasingly agrarianized and primitive. The most threatening manifestation of these processes is the progressive deindustrialization: over the past twenty years, the share of manufacturing in GDP decreased from 27.2% to 10.1%, while from 2015 to 2020, it fell by 1.8% (The World Bank, 2021a). The main share of GDP is used for final consumption, which in 2020 was 93.5%. That is, almost all goods and services produced in the country are aimed at meeting the final needs of consumers with low investment in production capacity. For example, the share of capital investment in GDP is only 13.0% (State Statistics Service of Ukraine, 2021), despite the fact that in 2010 it was 21% (current level of Europe and Central Asia) (The World Bank, 2021b). The structure of commodity exports is changing: the volume and share of cereals and ores are growing, while high-tech products are declining (over 2015-2018, high-tech exports decreased from 8.7% to 5.6% of total exports of industrial goods) (The World Bank, 2021c). That is, in fact, Ukraine gives other countries the opportunity to create value added, specializing in unprofitable activities that lack the capacity to accumulate knowledge and innovation.

It is obvious that the continuation of the above trends is unacceptable: it refutes the very idea of forming an effective national innovation ecosystem of Ukraine, enshrined in the 2030 Strategy for Innovation Development (Verkhovna Rada of Ukraine, 2019), Under such conditions, building Ukraine an innovatively competitive, neo-industrialized economy is impossible and so is its effective integration into the EU as an equal partner. Therefore, when adjusting the Association Agreement with the EU, key priorities should include intensification of inter-

national cooperation in science, technology and innovation, and attraction of investment and funding from the EU to increase Ukraine's integration into the European Research Area (ERA).

Figure 1

Ukraine's rank as per components of the Global Innovation Index in 2020



Source: created by the author using the data of Dutta et al. (2020).

According to Article 1 of the Law of Ukraine «On Scientific and Scientific-Technological Activity» (Verkhovna Rada of Ukraine, 2020), the ERA is a «system of programmes and policy instruments that combines the institutional environment of research and development of the Member States of the European Union and associate members to develop international scientific and technological cooperation, ensure free transfer of knowledge and mobility of researchers». According to paragraph 2 of Article 375 of the Association Agreement, cooperation between Ukraine and the EU in the field of science and technology «is aimed at promoting Ukraine's involvement in the European Research Area» (Verkhovna Rada of Ukraine, 2017).

The ERA continuously evolves and includes three interrelated aspects (Pidorycheva, 2020; Liashenko et al., 2020): 1) coordination of national and regional activities, programmes and policies in the field of science, technology and innovation in the European context; 2) creation of an «internal market» for research in which researchers, scientific knowledge and technology move freely; 3) implementation and funding of initiatives at European level. This study will focus on the third aspect of the ERA.

Ukraine's participation in the Horizon 2020 Framework Programme during 2015-2020

Despite Ukraine's participation in European programmes (*Horizon-2020* and *Horizon Europe*, *COST, EUREKA, EUROSTARS, COSME, Creative Europe, Erasmus+*), access to the resources and funds that Ukrainian enterprises and organizations have is extremely limited, as can be seen in the example of the EU Framework Programme for Research and Innovation «Horizon 2020» (hereinafter – the Framework Programme). The data in Table 2 show that Ukraine's participation in this programme is nominal rather than truly modernizing (especially if we compare the results to those of other countries). Moreover, it can be argued that countries with the status of EU associate partners receive less benefits from participating in European programmes than the EU member states and that the most powerful representatives obtain the greatest advantage. In the face of fierce competition from European programmes, associated countries will, at best, repay admission fees and, paradoxically, subsidize countries among the EU's most successful innovative economies. According to the European Innovation Scoreboard for 2021, the group of such countries includes: Sweden, Finland, Denmark, Belgium («Innovation Leaders»), the Netherlands, Germany, Luxembourg, Austria, Estonia, France, Ireland («Strong innovators») (European Commission, 2021b). Participants from these countries obtained 21,132 grants (65.36% of the total in the EU) and received € 34.79 billion, or 57.65% of the programme's total funding (Horizon Dashboard, 2021). Since these countries draw the major share of funding for research and innovation from the Framework Programme budget, it is not surprising that they demonstrate the best results in science and innovation in Europe.

The positive takeaway is that Ukraine's implementation of Horizon 2020 has returned its entrance fee (35 million euros) and attracted an additional 10 million euros (see Table 2). In addition, Ukraine ranked 7th among 16 associated countries in the overall ranking of participation in Horizon 2020 and the amount of funds obtained, which indicates a high scientific and innovative potential of the country. Other Eastern Partnership countries, such as Azerbaijan, Belarus, Georgia and Moldova, have good potential to increase their presence in the Framework Programme; only Armenia lost out without using its entrance fee.

Table 2

Participation of Ukraine and EU member states in the Horizon 2020 programme as of September 1, 2021

Indicator	Ukraine	EU member states
Grants signed	228 grants (2.90% of the total number of grants for associated countries)	32332 grants (91,84% of the total number of signed grants under Horizon 2020 in general)
Grant funding obtained	45.75 million euros (0.76% of total funding for associated countries)	60.35 billion euros (90.25% of funding under Horizon 2020)
Number of organizations that applied for grants	2838 organizations (3.42% of the total number of organizations for associated countries)	880981 organizations (87.98% of organizations under Horizon 2020)
Number of organizations that performed work on grants	318 organizations (2.38% of total organizations for associated countries)	153133 organizations (88.23% of organizations under Horizon 2020)
Success rate of submitted applications	9,22% (13,35% of success for the associated countries)	11,97% (11,95% under Horizon 2020)

Source: compiled by the author on the basis of Horizon Dashboard (2021).

It is also interesting to compare the participation rates in Horizon 2020 of the «old»[1] (EU-14) and «new»[2] (EU-13) EU member states (ЄС-13). The analysis shows that the advantage of the former is significant: participants from these countries secured 26,704 grants (82.59% of the total in the EU) and attracted 49.08 billion euros, which is 81.33% of the total funding of the programme. In comparison, EU-13 organizations raised 14 times less (€ 3.5 billion) to fund projects (Horizon Dashboard, 2021). There are several reasons for the low effectiveness of EU-13 participation in the Framework Programme. Experts note the weakness of their research and innovation ecosystems, low share of research

[1] «Old» EU members include: Belgium, Italy, Luxembourg, the Netherlands, France, Germany, Denmark, Ireland, Greece, Spain, Portugal, Austria, Finland, Sweden, since they joined the EU before 1996.

[2] «New» EU member states include: Estonia, Cyprus, Latvia, Lithuania, Malta, Poland, Slovakia, Slovenia, Hungary, the Czech Republic, Bulgaria, Romania, and Croatia, since they joined the EU in 2004-2013.

and development (R&D) expenditures in GDP (indicating low political support for science and technology), lesser inclination towards submitting project applications (compared to the EU-15) and their low quality, lack of strong international research links and professional contacts (Quaglio et al., 2020). These obstacles are also common in the EU's associated partners. It is clear that their elimination requires comprehensive sectoral and structural changes in the economy, its reindustrialization, as well as development and introduction of latest global technologies through education and training, close international cooperation, trade and foreign investment. The EU-13 can facilitate addressing these challenges due to their access to EU Structural Funds instruments, in particular the European Regional Development Fund, which finances the EU's smart specialization policy. EU associated countries do not have such a privilege. In Ukraine, in particular, the process of smart specialization is not aided by any instruments of financial support, which demotivates business, discourages dialogue with government and academia, and does not help solve the long overdue problem of improving efficiency of links between science and the real sector of the economy.

Suggestions on increasing the involvement of Ukrainian organizations and enterprises in the European Research Area

Potential participants in the Framework and other European programmes from Ukraine and other associated countries need to gain greater access to EU knowledge, infrastructure and funding to integrate into the ERA more quickly. To this end, we propose to implement several initiatives.

First, countries should develop professional state consulting entities that will expand the practice of informing Ukrainian organizations about open and forthcoming calls of European programmes, advise on the conditions and peculiarities of participation in them, conduct preliminary evaluation of project applications. Such initiatives are usually implemented by National Contact Points (NCPs), which hold information days and webinars from time to time. For example, the Horizon 2020 national contact point in Ukraine launched a series of webinars in February 2021, hosted by Lviv Polytechnic National University and the «European Innovation Agency» NGO (latest webinars – «How to find a relevant Horizon Europe call and to form a project idea», «How to get a grant under cascading funding»). Therefore, it is necessary to intensify the activities of other NCPs, use state financial support to introduce master classes from experienced participants of European programmes on submitting project applications and successful project implementation, and encourage research institutions and higher education institutions (HEIs) to participate in European programmes.

Second, the conditions of many Horizon Europe calls ensure that funding is provided to groups of actors working not only in different countries but also in various sectors and areas of the economy. Therefore, the state should stimulate cooperation between scientific institutions and HEIs on one side, and large companies, small and medium enterprises, public organizations on the other side, both nationally and internationally. Such cooperation can be encouraged using different tools, for example, it is possible to arrange meetings to establish contacts and partnerships between the parties and to form multidisciplinary, intersectoral teams in related areas of activity, to further participate in EU brokerage to find foreign partners primarily from developed EU member states, and to create consortia. Already, in the second cluster (thematic area) of «Horizon Europe» *Culture, Creativity and Inclusive Society* a relevant brokerage meeting was held on September 30, 2021. Participants from 39 countries, a total of 296 organizations (including 2 from Ukraine), including 160 universities, 28 research institutes, 25 SMEs, 19 non-governmental organizations, 8 large companies, and 6 startups took part (A sustainable future for Europe, 2021).

Third, organizations and enterprises from Ukraine and other associate members of the EU are likely to be more actively involved in the Horizon Europe if joint topical calls for such countries are launched within its framework. The idea of associated countries creating international funds independently and with the involvement of donor countries to finance joint R&D and innovations such as the International Visegrad Fund is also promising. Such international funds can be established, for example, by the Associated Trio countries (Georgia, Moldova, Ukraine), the Lublin Triangle (Lithuania, Poland and Ukraine), Ukraine and the Baltic States.

Fourth, the Ministry of Education and Science of Ukraine and the National Research Foundation of Ukraine should launch grants for the acquisition of competencies in the field of project management by employees of scientific institutions and universities, expansion of their knowledge, skills and abilities to prepare and manage EU-funded projects. Training can be carried out by private Ukrainian institutions with the involvement of domestic and foreign experts who have experience in implementing and evaluating European projects, as well as by foreign higher education institutions through their structural units in Ukraine. Foreign HEIs have received permission to create remote divisions on the territory of Ukraine after the adoption of the Resolution of the Cabinet of Ministers of Ukraine No. 304 on March 24, 2021. Such units can provide specialists in the field of «Project Management» with key modern competencies in the field of European project management.

Fifth, creation of joint Ukrainian-European master's and doctoral programmes together with EU member states, implementation of joint postgraduate programmes that will expand the European education opportunities for the Ukrainian youth and allow experienced professionals to improve their skills or retrain according to market needs and new technological trends (in particular, MBA

programmes). The introduction of such an initiative will help bridge the gaps in the knowledge and skills of Ukrainian specialists, establish stable international professional contacts, increase awareness and self-confidence in submitting project applications, which will increase the number and quality of the latter.

Both sides will benefit from the implementation of such initiatives: scientists from developed EU member states will have the opportunity to work more closely with foreign counterparts working in the associated countries, thus involving them in solving complex scientific problems. Thus, Ukrainian scientists are participating in experiments on the Large Hadron Collider and are involved in a number of discoveries of the European Organization for Nuclear Research. European colleagues are also interested in Ukrainian scientific equipment, which includes, in particular, the world's largest radio telescope UTR-2 and the nuclear installation «Source of Neutrons» (Onyshchenko, 2021). EU-associated countries, for their part, will have access to European funds and research infrastructure. This will enable research at a high scientific level, bring it to the level of readiness of developments and technologies IRL8 / TRL8 and IRL9 / TRL9, ensure faster mastery of modern technological advances (than would be possible for researchers and enterprises alone) and develop national inventive activity.

Observations by World Bank experts show that patents obtained by organizations from Eastern Europe and Central Asia as a result of cooperation with inventors working in leading innovation centres are of higher quality than exclusively «regional» patents, and are more closely related to global technological advances. This is obviously due to the fact that the latter are better informed and integrated into modern technological developments. Since 1997, more than half of the patents were registered for teams of inventors from more than one country, which demonstrates the importance of developing joint innovation for Eastern Europe and Central Asia (Goldberg et al., 2011). The experience of participation in Horizon 2020 shows that Ukraine's main partners are France (712 collaborations in projects involving Ukrainian organizations), Spain (521 collaboration projects), Germany (520) and Italy (459 collaboration projects) (Horizon Dashboard, 2021). In this regard, Ukrainian inventors need both advisory and financial support from the state in patenting their developments at the international level. In addition, international cooperation benefits EU-associated countries by deterring researchers from «internal» and «external» migration through decent pay and opportunities to participate in state-of-the-art research.

At the same time, these initiatives cannot replace systematic and planned measures to overcome the structural weakness of the economies of EU-associated countries and the low (usually) quality of their institutions, which restrains investment inflows, technological modernization and, consequently, their socio-economic development. A vicious circle emerges: weak economies, which are prevented from participating in European programme calls on an equal footing, from formulating noteworthy project applications and gaining access to advanced knowledge and technologies by imperfect national research and innova-

tion ecosystems, which, in turn, upholds technological lags and low competitiveness.

Some Ukrainian experts believe that one possible solution to this problem would be a quota for associated countries when it comes to accessing the funds of European programmes (Pashkov et al., 2020). These views were expressed to EU partners, but did not find support as they would violate the conditions of calls. According to the latter, EU-associated countries need to expand contacts with more experienced partners from developed EU member states, learn from their experience in preparing project applications, be more active in submitting international publications, and participate in conferences and seminars to disseminate the results of their own R&D. Admittedly, the position of the European Commission is clear and justified, because if some countries are granted privileges to participate in calls, it will distort competition between project applicants and may eventually lead to corruption in this field. The only possible way to solve this problem, in particular for Ukraine, is the «natural» development of science and technology, revival of industry using advanced modern technologies, preservation and balanced development of human capital. Hence, there is a need for public and private investment in long-term and priority areas of science and technology to increase the level of technological complexity of the national economy and ensure compliance with global trends. In this regard, international cooperation is important because it will contribute to the activation and increase of scientific, technological and innovative potential of Ukraine, bring scientific and technological developments to higher levels of technological capacity. It will also facilitate the development of specialization and strengthen the country's position in certain technological areas, encourage creation of innovative products on this basis, which will saturate the domestic market and compete on the European and world markets. All of this will accelerate the country's progress towards building a competitive high-income economy.

Conclusions and Prospects for Future Research

Ukraine's integration into the European Research Area leads to stabilization and effective development of the national economy, growth of its scientific and innovative potential. However, the conducted analysis shows that during the five years since the implementation of the Association Agreement with the EU, from 2015 to 2020, the innovative component of the national economy began to shrink. Ukraine's position in the European Innovation Scoreboard has worsened and the country has not come significantly closer to solving the persistent problems that have plagued the national innovation almost the entire time since the pronouncement of independence, like low quality of institutions, outdated tech-

nology, weak links between producers and consumers of innovation, poor development of venture capital market. On the positive side, Ukraine maintains a strong position in terms of knowledge creation and dissemination and quality of human capital. However, it does not use these benefits to structurally transform the economy, which is becoming more and more primitive and deindustrialized every year. Therefore, one of the urgent tasks on the policy agenda includes the revision of the Association Agreement with the EU, comprehensive adjustment of its provisions to take into account the challenges and threats of the present, improve the structure of the national economy, and increase its competitiveness. Key priorities in this concern deepening cooperation in science, technology and innovation with EU member states, and attracting European investment and funding to increase Ukraine's integration into the ERA.

It is determined that over the five years of associated participation in the Horizon 2020 Framework Programme, Ukraine has achieved good results, ranking 7th among 16 associated countries in terms of overall participation and the amount of funds attracted. At the same time, the pace of integration remains slow, and some indicators demonstrate a low level of involvement of Ukrainian organizations and enterprises in the European Research Area. In particular, Ukraine has obtained 228 grants, which is only 2.90% of the total number of grants for associated countries and 0.71% of the total number of grants obtained by EU member states. The success rate of the submitted applications is lower than the average for the EU-associated countries – 9.22% vs. 13.35%.

A study of the experience of the «new» EU member states shows that they have long faced similar problems of low productivity in the Framework Programme and still lag behind the «old» EU member states in terms of involvement in Horizon 2020. The reasons for this situation are generally common for the associated countries and Ukraine, in particular, the weakness of their innovation ecosystems, low knowledge-intensity of GDP, lack of strong international research contacts and professional ties, low rate of organizations submitting project applications.

A set of organizational and institutional measures and initiatives has been proposed to solve existing problems and grant Ukrainian organizations wider access to knowledge, infrastructure and EU funding. We also substantiated the need to implement systemic reforms to overcome the structural weaknesses of Ukraine's economy which prevent it from participating in European programme calls on an equal footing and preserve its technological lag and low competitiveness. Such reforms should be aimed at «natural» development of science and technology, revival of industry using advanced modern technologies, preservation and balanced development of human capital, which will allow Ukraine to accelerate progress in building a competitive high-end economy.

Moving towards European integration, Ukraine needs to align national strategic goals, policies and decisions on national science, technology and innovation development with European ones, strive to ensure their compatibility in order

to synergize joint efforts with European partners and minimize policy fragmentation. Ukraine must take into account and adapt the new agenda of the European Research Area to national conditions, as well as meet the objectives set out in the 2015-2020 ERA Roadmap approved by the Order No. 167 of the Ministry of Education and Science of Ukraine from February 10, 2021.

Considering everything afore-mentioned, we face a pressing question: what should the strategic priorities of Ukraine's European integration in science, technology and innovation be. In determining them, we must take into account the achievements and potential of domestic science, national interests of Ukraine, and strategic interests of international cooperation arising from global challenges that require the world to pool resources, efforts and experience. We are talking primarily about the global COVID-19 pandemic and the crisis generated by it, as well as the radical technological transformations taking place in the world economy under the influence of the Fourth Industrial Revolution. However, some priorities are clear even now. Cooperation in health care and pharmacology should be developed further, joint research in biotechnologies and genomics should be encouraged. Similarly, digital technologies should be developed through collaborative efforts. We should increase the attention towards research and innovation ties in various branches of agriculture and the food industry, especially in organic farming, precision farming to ensure healthy soil, food and food safety. Further research of the author will be devoted to a more detailed analysis and substantiation of opportunities and institutional framework of scientific, technological and innovation cooperation between Ukraine and EU member states in various areas.

References

Amosha, A., Liashenko, V., & Pidorycheva, I. (2019). Inter-regional and cross-border spaces in the context of smart specialization. *Scientific Papers of Silesian University of Technology. Organization and Management Series*, *140*, 7-16. https://www-arch.polsl.pl/wydzialy/ROZ/ZN/Documents/Zeszyt%20140/01.%20Amosha_Lyashenko_Pidorycheva.pdf

Antoniuk, V. (2021). Higher education of Ukraine on the way of integration into the European educational space: Achievements and tasks of further development. *Economic Herald of the Donbass*, *2*, 169-182. https://doi.org/10.12958/1817-3772-2021-2(64)-169-182

Borzenko, O., & Burlay, T. (2020). Socio-economic divergence of Ukraine and the EU: New challenges. *Journal of European Economy*, *19*(4), 660-676. https://doi.org/10.35774/jee2020.04.660

Burlay, T. V. (2019). *Socio-economic convergence: Theory and practice: Monograph* [in Ukrainian]. Institute for Economics and Forecasting of the National Academy of Sciences of Ukraine.

Department of Economic and Social Affairs. (2020). *DCF survey study 2020: Toward effective development cooperation in the COVID-19 period*. United Nations Publications. https://www.un.org/development/desa/financing/ sites/ www.un.org.development.desa.financing/files/2020-08/DCF-July8-Final3-rev %20%281%29.pdf

Dutta, S., Lanvin, B., & Wunsch-Vincent, S. (Eds.). (2015). *The Global Innovation Index 2015: Effective innovation policies for development*. Cornell University, INSEAD & WIPO. https://books.google.com.ua/books/about/The_ Global_Innovation_Index_2015.html?id=-B9zDwAAQBAJ&printsec= frontcover&source=kp_read_button&hl=en&redir_esc=y#v=onepage&q&f=false

Dutta, S., Lanvin, B., & Wunsch-Vincent, S. (Eds.). (2020). *Global Innovation Index 2020. Who will finance innovation?*. Cornell University, INSEAD & WIPO. https://books.google.com.ua/books/about/Global_Innovation_Index _2020.html?id=AEodEAAAQBAJ&printsec=frontcover&source=kp_read_b utton&hl=en&redir_esc=y#v=onepage&q&f=false

European Commission. (2021a). 2021 *State of the Union Address by President von der Leyen*. https://ec.europa.eu/commission/presscorner/detail/ov/ SPEECH_21_4701

European Commission. (2021b). *European and regional innovation scoreboards 2021* [Interactive tool]. https://ec.europa.eu/research-and-innovation/en/ statistics/performance-indicators/european-innovation-scoreboard/eis

European Union External Action Service. (2021). *Speech by the President of the European Council Charles Michel following the EU-Ukraine summit* [in Ukrainian]. shorturl.at/hwzBS

Goldberg, I., Goddard, J. G., Kuriakose, S., & Racine, J. L. (2011). *Igniting innovation: Rethinking the role of government in emerging Europe and Central Asia*. World Bank Publications.

Horizon Dashboard. (2021). H2020 Country Profile. Key Figures. European Commission. https://webgate.ec.europa.eu/dashboard/sense/app/a976d168-2023-41d8-acec-e77640154726/sheet/0c8af38b-b73c-4da2-ba41-73ea34ab 7ac4/state/analysis

Interfax Ukraine. (2021). *Shmyhal hopes that in 2021 the revision of the Ukraine-EU Association Agreement will be completed* [in Ukrainian]. https://ua.interfax.com.ua/news/general/723037.html

Isarta News. (2021). *The contactless economy is here to stay*. https://isarta.com/ news/the-contactless-economy-is-here-to-stay/

Jewell, J., Vetier, M., & Garcia-Cabrera, D. (2019). The international technological nuclear cooperation landscape: A new dataset and network analysis. *Energy Policy*, *128*, 838-852. https://doi.org/10.1016/j.enpol.2018.12.024

Jit, M., Ananthakrishnan, A., McKee, M., Wouters, O. J., Beutels, P., & Teerawattananon, Y. (2021). Multi-country collaboration in responding to global infectious disease threats: Lessons for Europe from the COVID-19 pandemic. *The Lancet Regional Health – Europe*, *9*, 100221. https://doi.org/10.1016/j.lanepe.2021.100221

Kharazishvili, Y., Kwilinski, A., Dzwigol, H., & Liashenko, V. (2021). Strategic European integration scenarios of Ukrainian and Polish research, education and innovation spaces. *Virtual Economics*, *4*(2), 7-40.

Khymynets, V. V., Holovka, A. A., & Mirus, O. I. (2021). *Cross-border cooperation as a tool for local and regional development: Analytical report* [in Ukrainian]. National Institute for Strategic Studies.

Kim, S. (2020). *South Korea bets on 'untact' for the post-pandemic economy*. Bloomberg. https://www.bloombergquint.com/businessweek/south-korea-untact-plans-for-the-post-pandemic-economy

Kindzerskyi, Yu. (2021). Ukraine's industrial divergence with the eu and problems of it overcoming [in Ukrainian]. *Ekonomika ta derzhava*, *6*, 9-18. https://doi.org/10.32702/2306-6806.2021.6.9

Laiko, O. I., & Kovalenko, S. I. (2020). The problem of mesoeconomic synthesis of clusters development and international integrating formation concepts. *Economic innovation*, *22*(1), 111-121. https://doi.org/10.31520/ei.2020.22.1(74).111-121

Li, Y., Zhang, Y., Lee, C.-C., & Li, J. (2021). Structural characteristics and determinants of an international green technological collaboration network. *Journal of Cleaner Production*, *324*, 129258. https://doi.org/10.1016/j.jclepro.2021.129258

Liashenko, V. I., & Pidorycheva, I. Yu. (2019). «Innovative elevator» of startup development: concept and Implementation algorithm. In V. I. Liashenko, O. V. Prokopenko & V. A. Omelianenko (Eds.), *Institutional model of innovative economy: Collective monograph* (pp. 131-148). Institute of Industrial Economics of the National Academy of Sciences of Ukraine. https://iie.org.ua/wp-content/uploads/2020/12/instytutsionalna-model-innovatsijnoi-ekonomiky.pdf

Liashenko, V. I., Pidorycheva, I. Yu., Kucherov, A. V., & Tesnovsky, P. V. (2018). Directions of Ukraine's integration within the European scientific-educational and innovation areas under the Association Agreement with the European Union [in Ukrainian]. *Economic Herald of the Donbass*, *3*, 147-179.

Liashenko, V., Pidorycheva, I. & Antoniuk, V. (2020). European Research Area: Comparative analysis of institutional prerequisites and integration approaches for Ukraine. *Journal of European Economy*, *19*(3), 456-481. https://doi.org/10.35774/jee2020.03.456

Melnyk, O., Pashkov, M., Poliakov, L., & Sunhurovskyi, M. (2021). *Ukraine-EU partnership in security: Current status and prospects* [in Ukrainian]. Razumkov Centre.

Monitor Deloitte. (2020). *Contactless economy. Are you prepared?*. https://www2.deloitte.com/content/dam/Deloitte/sg/Documents/strategy/sea-cons-contactless-economy.pdf

OECD/ICN. (2021). *OECD/ICN report on international co-operation in competition enforcement*. http://www.oecd.org/competition/oecd-icn-report-on-international-cooperation-in-competition-enforcement-2021.htm

Onyshchenko, O. (2021). *Anatolii Zahorodnii: «We need to change the approach to understanding the role of science in the development of the state»* [in Ukrainian]. ZN.UA. https://zn.ua/ukr/science/anatolij-zahorodnij-treba-zminiti-pidkhid-do-rozuminnja-roli-nauki-v-rozvitku-derzhavi.html

Pashkov, M., Sidenko, V., Markevych, K., Stetsiuk, P., Honchar, M., & Stukalenko, I. (2020). *Ukraine's sectoral integration into the EU: Preconditions, prospects, challenges*. «Zapovit» Publishing House. https://razumkov.org.ua/ uploads/article/2021_sektor_eu_eng.pdf

Pidorycheva, I. (2020). Ukraine in the scientific-technological and innovation spaces of the European Union: Problems, positive results and integration directions [in Ukrainian]. *Economic Herald of the Donbas*, *2*, 36-52. https://doi.org/10.12958/1817-3772-2020-2(60)-36-52

Pidorycheva, I., Shevtsova, H., Antonyuk, V., Shvets, N., & Pchelynska, H. (2020). A conceptual framework for developing of regional innovation ecosystems. *European Journal of Sustainable Development*, *9*(3), 626-640. https://doi.org/10.14207/ejsd.2020.v9n3p626

Pidorycheva, I. Yu. (2021). Innovation ecosystems of Ukraine: A conceptual framework for development in the conditions of glocalization and Eurointegration [in Ukrainian]. *Economy of Industry*, *2*(94), 5-44. http://doi.org/10.15407/econindustry2021.02.005

Quaglio, G., Millar, S., Pazour, M., Albrecht, V., Vondrak, T., Kwiek, M., & Schuch, K. (2020). *Exploring the performance gap in EU Framework Programmes between EU13 and EU15 member states. In-depth analysis*. European Parliamentary Research Service. https://www.europarl.europa.eu/RegData/etudes/IDAN/2020/641542/EPRS_IDA(2020)641542_EN.pdf

Savelyev, Ye., & Smalyuk, H. (2019). Economic convergence in the European integration space in the context of relations between Ukraine and the Visegrad Four. *Journal of European Economy, 18*(4), 425-438. https://doi.org/10.35774/jee2019.04

Savelyev, Ye., Kuryliak, V., Lyzun, M., & Lishchynskyy, I. (2019). Concept «Visegrad Four + Ukraine»: the reality and prospects [in Ukrainian]. *Herald of the Economic Sciences of Ukraine, 1*(36), 115-121. http://www.venu-journal.org/download/2019/18-Savelliev.pdf

Shevtsova, H. Z., & Shvets, N. V. (2021). Development of science, education and innovation of Ukraine in the context of European integration: Diagnostic results [in Ukrainian]. *Economics, Education, Technologies in the Context of Global Challenges*. *Materials of International scientific-and-practical conference*, 372-374.

State Statistics Service of Ukraine. (2021). Gross Domestic Product for I-IV quarters of 2020 and 2020 overall [in Ukrainian]. http://www.ukrstat.gov.ua/ express/expr2021/03/31.pdf

A Sustainable Future for Europe. (2021). *Virtual Brokerage event. September 30*. https://sustainable-future-brokerage.b2match.io/

Toyoma, G. (2021). Countering threats in space through international cooperation. *Space Policy*, *55*, 101387. https://doi.org/10.1016/j.spacepol.2020.101387

Tymechko, I. R. (2019). *Territorial community in cross-border space: Factors, patterns, development priorities: Monograph* [in Ukrainian]. Dolishniy Institute of Regional Research of NAS of Ukraine.

Verkhovna Rada of Ukraine. (2017). Association Agreement between the European Union and the European Atomic Energy Community and their Member States, of the one part, and Ukraine, of the other part [in Ukrainian]. International Agreement No. 984_011 of March 21, 2014 (in effect since September 1, 2017). https://zakon.rada.gov.ua/laws/show/984_011/ed20140321

Verkhovna Rada of Ukraine. (2019). On Adoption of the 2030 Strategy for the Development of Innovation: Order of the Cabinet of Ministers of Ukraine No. 526-p of July 10, 2019. https://zakon.rada.gov.ua/laws/show/526-2019-%D1%80#Text

Verkhovna Rada of Ukraine. (2020). On Scientific and Scientific-Technological Activity: Law of Ukraine No. 848-VIII of November 26, 2015 (amended July 3, 2020). https://zakon.rada.gov.ua/laws/card/848-19

Vyshnevskyi, O. (2020). International digital platform as a tool for the formation of cross-border research, educational and innovation spaces. *Economic Her-*

ald of the Donbas, *4*, 46-51. http://doi.org/10.12958/1817-3772-2020-4(62)-46-51

The World Bank. (2021a). Manufacturing, value added (% of GDP) – Ukraine [Interactive graph]. https://data.worldbank.org/indicator/NV.IND.MANF.ZS?locations=UA

The World Bank. (2021b). World Development Indicators: Structure of demand [Interactive table]. http://wdi.worldbank.org/table/4.8#

The World Bank. (2021c). World Development Indicators. High-technology exports (% of manufactured exports) [Interactive graph]. https://data.worldbank.org/indicator/TX.VAL.TECH.MF.ZS?view=chart&locations=UA

World Bank Group. (2021). *World development report 2021: Data for better lives*. https://openknowledge.worldbank.org/bitstream/handle/10986/35218/9781464816000.pdf

World Economic Forum. (2021). *Annual Report 2020-2021*. https://www3.weforum.org/docs/WEF_Annual_Report_2020_21.pdf

Zaloznova, Yu. S., Liashenko, V. I., & Trushkina, N. V. (2021). Topical issues of scientific and educational cooperation between Ukraine and Bulgaria [in Ukrainian]. *Implementation of modern science and practice*. *Abstracts of XXV International Scientific and Practical Conference*, 122-126. International Science Group. http://doi.org/10.46299/ISG.2021.I.XXV

Received: November 1, 2021.
Reviewed: November 25, 2021.
Accepted: November 29, 2021.