DOI 10.26886/2414-634X.5(32)2019.1
UDC 339.924.

BENCHMARKING OF ATLANTIC INNOVATIONS SYSTEM MODEL IN CONTEXT OF UKRAINE'S TECHNOLOGICAL EUROCONVERGENCE

B. Butko
Taras Shevchenko National University of Kyiv, Ukraine, Kyiv

The paper analyzes the structure and functional interrelations between elements of national innovation systems based on an Euroatlantic model. The types of national innovation systems of Germany and the USA have been considered. The positive and negative aspects of each of the proposed models have been outlined. It has been proved that effective international cooperation for the creation of high-tech products is possible only on the basis of existing models and progressive networks. The necessity of using the experience of introducing benchmarking in the context of the formation of the national innovation system in the context of the formation of the national innovation system has been determined.

Keywords: benchmarking; R&D; public-private partnerships; triple helix model; triangle model; high- tech; collaboration; horizontal coordination.

Бутко Б. О., Бенчмаркінг моделі системи атлантичних інновацій в контексті технологічної євроінтеграції України / Київський національний університет імені Тараса Шевченка, Україна, Київ

У статті проаналізовано структуру та функціональні взаємозв'язки між елементами національних інноваційних систем на основі євроатлантичної інноваційної моделі. Розглянуто види національних інноваційних систем на прикладах Німеччини та США підтипи їх, що базуються на європейських та американських моделях. Окреслено позитивні та негативні аспекти кожної із запропонованих моделей. Доведено, що ефективна міжнародна *співпраця для створення високотехнологічної продукції можлива лише на основі існуючих моделей і прогресивних мереж. Визначена необхідність використання у контексті формування національної інноваційної системи досвіду запровадження бенчмаркінгу, що сприятиме технологічній євроінтеграції України.*

Ключові слова: бенчмаркінг; R&D; державно-приватне партнерство; модель потрійної спіралі; модель трикутника; високі технології; співпраця; горизонтальна координація.

Revelance. Rapid development of knowledge - based economy, growing relationship between capital markets and high-tech, social orientation strengthening of new technologies, large-scale nature of creation and use of knowledge, technologies, as well as products and services produced on their base led to emergence of national innovation systems (NIS) as the institutional framework of innovative development . Those NIS are the fundamental basis on which further various models of international cooperation for the creation of high-tech products are based. At the same time, the transatlantic, or, Atlantic, model of NIS empirically proved it's success on such examples as US and Germany NIS diversification which are, in their turn, the most acceptable examples for Ukraine in the context of NIS construction and integration to Euro-Atlantic high-tech platform.

Recent articles on the research analysis. Institutional framework of formation and functioning of transatlantic NIS model was provided by the works of K. Rihler, K. Mettyu, Allen T.Dablin, F. Linn, K. Freeman and others.

Unexplored chapters of the overall problem. The success and circumstantiality of EU and US leading countries NIS as a whole is undoubtedly due to implementation of Euro-Atlantic NIS model, with some specific sectors in the US and European technological and business spaces. Ukraine demands a quick reconfiguration of national resource base components with the needs of global market; the domestic expert circles are scheduled, according to governmental "Ukraine-2020" program, in quick terms to identify the strengths of individual elements of Euro-Atlantic NIS model and develop appropriate recommendations on the formation of national NIS project roadmap.

Aim of study is to present preconditions for the formation and operation principles and basic forms of intersectional Euro-Atlantic cooperation on the examples of one American – US, and European – specifically, German, NIS.

The article body. Let's examine the key features of high-tech market leaders Euro-Atlantic NIS, ranging from the US so-called "triple helix"model.

The most powerful and diversified NIS operates in the US. It includes at least 10,000 scientific organizations that produce scientific production and technologies. They include research centers and laboratories of large corporations, governmental centers and laboratories, university research centers, thousands of small high-tech companies.

The US has the world's most innovative cluster, the so-called Silicon Valley. According to subjective list of revolutionary innovative companies in the world by MIT Technology Review in 2013, 37 out of the 50 most revolutionary companies are based in the US. [1] Also American origin adopt 39 of 100 companies that were included in the 2014 ranking of innovative companies by Forbes. This rating was based on the Innovation Award, which is calculated as the difference between market capitalization and net present value of cash flows from its existing business [1].

The most important element of American NIS throughout its evolution were private companies, as well as their research laboratories. But we should not underestimate the role of state and public-private partnership, without which the success of private US companies and their research laboratories would be impossible. Also, we should be aware that historically the US's particularly important source of scientific knowledge and innovative ideas were research universities.

Important role in development of the US NIS in the initial stage was also due to the fact that US was former British colony in between XVII-XVIII centuries. In addition, at the end of the XVIII century Industrial Revolution began in the US, which was largely based on borrowed British technologies. For example, spinning machine "Jenny", the circle spinning machine and spinning machine batch were borrowed from Britain, which made the creation of the then modern textile industry in the United States possible. The exports British flow to the United States after the American Revolution stimulated attempts to simulate British goods which had a big advantage in the US market [2].

It is believed that the foundations of modern US national innovation system were laid in the 1945-1950. Except of World War II the crucial matter in establishing NIS was played by the American Cold War, the arms race and space race that accompanied it. These events triggered major changes in scientific and technological policy of the country and, in particular, led to major advances in civil areas - for example, computers, jet planes, Internet, etc..

In 1980s, especially after the Cold War, the of innovation policy priorities in the US began to support technology transfer and academic research in small innovative firms.

In 1980, the 96-517 Law, better known as Bayh-Dole Act, was adopted. This law consolidated the ownership of inventions created by federal funding, contractors - universities and other academic institutions. Before adoption invention patents developed by universities including public funds was received by federal government, which then had a right to give companies non-exclusive license. In such circumstances, many companies were not profitable to develop new products based on state patents as competitors could also get that same license. Also in 1980, the 96-480 Law, or the Wydler-Stevenson Technology Innovation Act was adopted. The law ordered the Trade Department to form industrial technologies control and create industrial technology centers at universities and non-profit organizations to help individuals and small businesses in generation, evaluation, and development of technological ideas and technical support for companies, especially small ones. In 1986, Stevenson-Wydler Law was amended by the 99-502 Federal Technology Transfer Act. This law allows each federal agency to conclude agreements on joint research and development (Cooperative Research and Development Agreement - CRADA) with other federal agencies, industry organizations (including corporations, partnerships), non-profit organizations (including universities) and so on. These agreements provide that partners have access, property, labor force of each other. In 1982 the program was created to support research of small business (SBIR). Through it's federal government agencies allocated the funds to finance the projects of small companies many of which were small innovative enterprises established by immigrants from universities or federal laboratories. This initiative has become the largest public venture capital program in the US. Also an important role in small innovative companies support was performed by Advanced Technology Program (ATP) of the National Institute of Standards and Technology (NIST), which was active in 1991- 2007, and technological innovation program which replaced ATP in 2007 (now completed). These programs funded innovative technologies in the early stages of development through grants. In 1986 National Canter for Manufacturing and Sciences (NCMS) was created; it is a non-profit consortium, which is partly funded by Pentagon. This organization led to collaboration with private sector, academic institutions and government to accelerate the commercialization of industrial innovation. In 1987 a non-profit consortium – SEMATECH was created, which was tasked to carry out research in field of integrated circuits and diffusion of new technologies. The consortium is funded by membership fees, and in the early part of its existence it has received funding from DARPA government subsidies program.

In the US federal support for R&D covers a wide range of tasks, such as national defense, health, space, energy, natural resources and environment, science in general and other categories. Funding for research and development aimed at national defense purposes are provided first. Expenditures for national defense totaled in 2016 fiscal year at about 57.6% (83.2 billion US dollars) of the total R&D budget expenditure. Non-military measures respectively took 42.4% of the budget. Dynamics of federal R&D spending in key areas is given in Table 1.

It is important to emphasize that the high role of state in the US economy is not expressed in capacity to replace the business in the economic process, the government in the US is a reliable business partner in the organization of business processes, it promotes progressive change in the regulation of the rules and norms of business. In fact, the US authorities have developed systematic of collaboration between private business, which is the driving force of development, and the state, which acts as a regulator and allows development to be organized.

Table 1.

Main directions of US federal spending on R&D, mln USD in comparable prices of 2005 [4]

	2010	2011	2012	2013	2014	2015	2016	2017	2018
1	2	3	4	5	6	7	8	9	10
Total expences, including:	131 259	131 546	133 280	132 554	148 681	133 574	126 960	121 368	120 804
Defence	74	76 14	77 642	78 15	77 50	77 82	73 18	68 01	65 65

	641	8		0	4	4	5	8	0
Non-military measures, including:	56 617	55 397	55 639	54 403	71 176	55 751	53 775	53 350	55 154
Fundamental research	7 477	7 291	8 183	8 269	12 786	9 423	9 304	9 161	8 867
Space exploration	9 656	10 059	10 321	9 797	8 199	7 382	7 613	7 705	7 758
Energetics	1 324	1 203	1 805	1 906	3 433	2 305	1 992	2 070	2 322
Environmental protection	2 245	2 146	1 969	2 021	2 367	2 179	2 035	1 978	2 065
Agriculture	2 094	2 048	1 832	1 833	2 035	1 978	1 555	1 690	1 666
Commercial and residential loans	475	446	485	514	951	599	572	638	1 767
Transport	1 866	1 673	1 296	1 297	1 322	1 360	1 249	1 248	1 353
Regional development	45	53	46	46	56	98	73	49	88
Education and social services	495	506	542	504	500	521	559	561	557
Medicine	29 129	27 981	27 786	26 817	38 055	28 419	27 251	26 928	26 737
Benefits and services for veterans	742	744	770	813	853	927	1020	1005	990
Justice	779	975	347	326	303	285	162	98	729

Source: compiled by the author based [1].

The state's role in US NIS is not only planning and maintaining a favorable environment for innovation, but also to stimulate supply and demand, development of the necessary infrastructure and to meet needs of society.

Thus, we may note that the current US NIS formed throughout nearly 50-60 years. Today, some researchers define the so-called "triple helix" as an embodied NIS US model. Regarding the development of innovations, triple helix model describes the interaction of three institutions (science-state-business) at every stage of innovations creation.

Triple helix model is a network coordination mechanism and a forming social consensus in decision-making based on the principle of collaboration ("coordination beyond hierarchy"). Triple helix is a radically different model to public-private partnership of industrial age, not only in the nature of interactions of the three players, but their functional role in the economic process.

First, a key player in today's economy, which determines the direction of development is science (instead of the former leadership of State) as the main generator of constantly updated knowledge.

Second, the three links not just collaborate interactively, binding ties, but also adopt inherent functions of each other, becoming a hybrid network organization and providing integrated synergistic effect of continuous updates - for each player individually and for the whole economy in general.

Somewhat different NIS are employed by major Western European countries. The NIS model of the EU is called Euro-Atlantic NIS model. It is a model of a full innovation cycle - from emergence of innovative ideas to mass production onto ready product. This model is used by the country which leads the world rankings of competitiveness of national economies.

State funding is an important element of state regulation and innovation in the EU. In the EU, the often called policy triangle approach dominates - encouraging innovation, which in turn helps developing dynamic economy by increasing the competitiveness in international markets.

While R&D public investment increased in Germany and in Scandinavian countries, they decreased in other large EU countries (France, UK, Italy and Spain). Latest Eurostat data on budgetary allocations or expenditures on research and development (GBAORD) by 2011 stated, that Germany, France and the UK together accounted over 50% of total public expenditure on R&D from the EU budget (GBAORD). The total budget for R&D spending by 15 member countries reached 87.6 billion Euros, representing 96% of total appropriations for R&D (The general budget spending of EU member states - 91.5 billion Euros). The level of R&D budget expenditure for some of the EU member states are presented in Figure 2.

It should be noted that the share of government allocations for R&D in the EU is somewhat higher than in US - in 2011 it amounted up to 37.8% of total spending on R&D. In some countries the figure is even higher, for example, in Germany - 45.7%, France - 44.3% (data for 2009) [7]. As a result, these countries are leaders on economic development in the EU.

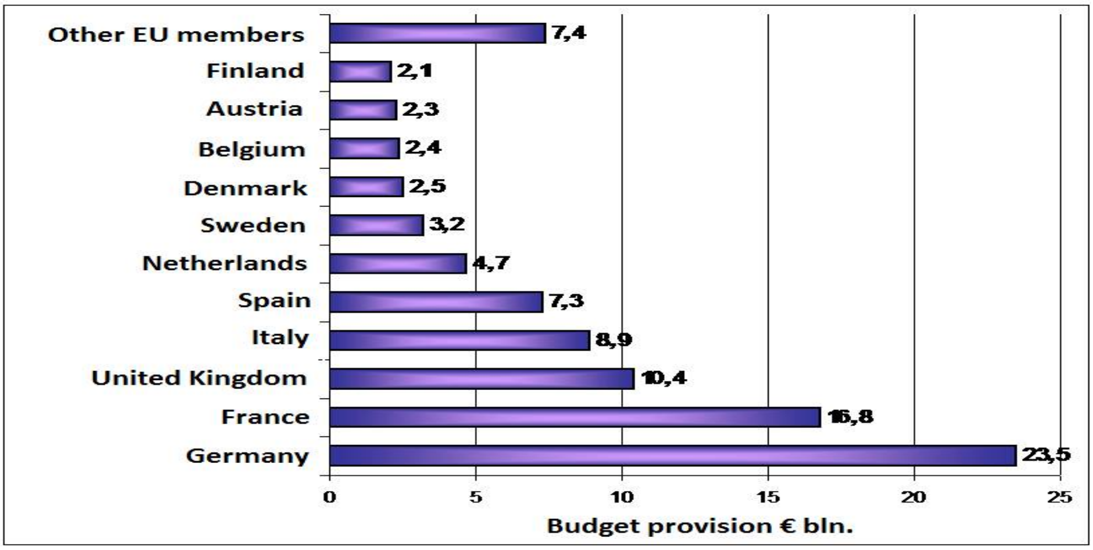

Fig. 2. Budget allocations or expenditures on R & D (GBAORD) member states of the European Union in 2018 (bn. Euros).

Source: compiled by the author on the basis of [5]

However, Germany's innovative strengths still lie in areas that have gained popularity in the XIX century. For example, Germany still has strengths in automotive, mechanical engineering, electrical and chemical industries. This aspect was taken into consideration by German government when developing new practical innovation policy.

This innovative policy includes four strategic areas:

- Public funding of innovations (IP) increase with focus on the key science and technology (health, ICT, nanotechnology, «clean» technology);

- Improving conditions for innovation in the private sector, stimulating the use of technology transfer mechanism;

-Institutional reform of scientific organizations;

- Administrative reforms implementation to improve the coordination of innovation public (IP) authorities.

In 2006, German government approved "Strategy of High Technologies" - actually a comprehensive program of national economy innovative development. One of the main goals of the strategy - to create conditions for maximum freedom of science and the removal of bureaucratic obstacles in the implementation of innovations, transition to a free and competitive knowledge society. In this context, planned measures are:

- Development of advanced high-tech domestic markets, stimulating development and implementation of innovative products and services (strategy identified 17 areas of innovation);

- Strengthening the links between science and industry through innovations state support program, implemented jointly with the private high-tech sector;

- Accelerate technology commercialization process of state ownership, disclosure talents of the nation, particularly within innovative SMEs that create most jobs in Germany.

In accordance with the objectives of the strategy interdisciplinary and interagency coordination will be strengthened, positive aspects of global competition in innovations will be taken into account, "world incubator of talents" will be built.

The organizational structure of German NIS is a very sophisticated and complex system, including public authorities, a system of scientific and educational organizations as well as knowledge-intensive business, especially SMEs. Structurally German NIS system is constituted of the following structural elements - subsystems:

- Implementation of IP in the public and private sectors;
- Vocational training and retraining;
- Innovation in industrial production and services;
- Development of new high-tech industries;
- Use of information and communication technologies.

The area of IP employs about 460,000 people, of whom about 50% are scientists and engineers, and the other half is equally divided into technical and support staff, including management. The overall IP is carried out in universities, private (industrial) sector and federal research institutions [7].

Science and Education innovation policy is developed in Germany by Federal Ministry of Education and Research (Bundesministerium für Bildung und Forschung - BMBF), functions of which includes the following areas:

- Strategy and general issues;
- European and international cooperation in education and science;
- Vocational training and lifelong learning;
- Research system;
- Key technologies and innovative research;
- Biological science and research in the field of public health;

- Ensuring future generations (research in the field of culture, and the fundamental problems of sustainable development).

According to the national policy perspective of science, technology and innovation the Government of Germany defined a general goal - formation of a "new culture of innovation", which should cover all aspects of society, and the development of innovative economy in order to become the criterion of effectiveness of public policy. Governmental authorities declared that only innovative technologies and services provide the global competitiveness of Germany. In this regard, the priority directions of the government on development and implementation are:

- High-tech strategy for Germany (High-Tech-Strategie für Deutschland);
- European research and development program (Euro-Programm für Forschung und Entwicklung);
- Strategy development and application of technologies of the future (Zukunftstechnologien) - biotechnology, nanotechnology, ICT, etc.

An effort to strengthen German position of a world-class science BMBF themselves increases both investment and efficiency of their use of universities and research institutions by increasing the quality of research and teaching, as well as cooperation with business sector. As noted by Dr. Claudius H. Reyhler, the representative of the Federal Ministry of Education and Research of Germany (BMBF), - «the third phase of the Federal high-tech agenda that addresses the dominant «innovation-breakers», which creates a new, digital economy, currently operates» [8].

In general German NIS is a bit cumbersome, complex and multi-layered structure. However, this system is effective. We can define the following system advantages of innovation organizations in Germany:

- A significant federal role in the organization and financing of IP, which reduces the burden on federal budget and increases the total amount of financing;
- A relatively high level of independent IP in business sector coupled with an effective science funded by the state;
- Availability of scientific societies, associations and foundations that finance and organize basic research;
- High IP concentration (especially basic science) at universities and other institutions of higher education that combine education and research in a single system;
- A high level of education of economically active population;
- A combination of their own competences in the area of technological development of imported technologies;
- German NIS openness due to the increasing internationalization of IP, which makes the country attractive to foreign companies and foreign scientific organizations.

However, German NIS has got certain disadvantages. For instance, shortage of natural sciences researchers in the education field of IP can be observed. There is a strong bias towards scientific publications on the economy that leads to lower the competitiveness of German science and technology. A significant lack of venture capital to stimulate innovation activities of industrial firms of the private sector can also be seen.

General review on the world’s most successful NIS can conclude that effective international cooperation for the creation of high-tech products is possible only on basis of existing models and progressive NICs. Also, in process of different NIS models interaction, cooperation in high-tech industry needed to be built with the peculiarities and specifics of each of the participating NIS. In context of Ukrainian NIS Ukrainian authorities should consider both advantages and disadvantages of «both hands» of the general Atlantic NIS model in order to accelerate integration into the high-tech industries global economy.

References:

1. The World's Most Innovative Companies. Forbes - 2018. Retrieved from http://www.forbes.com/innovative-companies/list. (2018, June, 06).

2. Dublin, T. (2014). Women and the Early Industrial Revolution in the United States, The Gilden Lehrman Institute of American History. Retrieved from http://www.gilderlehrman.org/history-by-era/jackson-lincoln/essays/women-and-early-industrial-revolution-united-states (2018, June, 02).

3. The American Association for the Advancement of Science. Historical Trends in Federal R & D. U.S. R & D Funding by Source, 1953-2012. AAAS. Retrieved from http://www.aaas.org/page/historical-trends-federal-rd (2019, June, 09).

4. Science and Engineering Indicators 2014. A broad base of quantitative information on the US and international science and engineering enterprise. The National Science Foundation. NSF. Retrieved from http://www.nsf.gov/statistics/seind14/index.cfm/chapter-4/c4s6.htm (2019, June, 03).

5. Innovation Union Competitiveness report 2018. Commission Staff Working Document. European Commission. Innovation Union. A Europe 2020 Initiative. European Commission. Retrieved from http://ec.europa.eu/research/innovation-nion/pdf/competitiveness_report_2013.pdf (2019, June, 09).

6. Innovation Union Competitiveness report 2017. Commission Staff Working Document. European Commission. Innovation Union. A Europe 2020 Initiative. European Commission. Retrieved from

http://ec.europa.eu/research/innovation-union/pdf/competitiveness-report/2017/part_1.pdf#view= fit & pagemode = none (2019, June, 09).

7. Allen, M.M. (2009). Allen. The National Innovation System in Germany. University of Manchester, UK. Retrieved from https://www.escholar.manchester.ac.uk/item/?pid=uk-ac-man-scw:3g34 (2019, June, 06).

8. Claudius, H. (2014). Riegler. Workplace Innovation in Germany and its Policy Framework. Retrieved from http://portal.ukwon.eu/Workplace_Innovation_in_Germany. (2019, June, 06).

9. Transport i shliakhy spoluchen [Transport and communication paths]. Retrieved from http://ea.donntu.org:8080/jspui/bitstream/123456789/27408/2/ТиПС_Конспект_.pdf [in Ukrainian]. (2017, June, 02).

Citation: B. Butko. (2019). BENCHMARKING OF ATLANTIC INNOVATIONS SYSTEM MODEL IN CONTEXT OF UKRAINE'S TECHNOLOGICAL EUROCONVERGENCE. Innovative Solutions in Modern Science. 5(32). doi: 10.26886/2414-634X.5(32)2019.1