

*B. Butko,
PhD in Economics, Assistant of the Department of International economics,
Taras Shevchenko National University of Kyiv
ORCID ID: <https://orcid.org/0000-0002-9769-7523>*

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HIGH-TECH CLUSTER NETWORKING MODELS WITHIN THE CONCEPT OF THE NATIONAL INNOVATION SYSTEM FORMATION

Б. О. Бутко,
к. е. н., асистент кафедри міжнародної економіки, Київський національний університет імені Тараса Шевченка

МЕРЕЖЕВІ МОДЕЛІ ВИСОКОТЕХНОЛОГІЧНИХ КЛАСТЕРІВ У КОНЦЕПЦІЇ ФОРМУВАННЯ
НАЦІОНАЛЬНОЇ ІННОВАЦІЙНОЇ СИСТЕМИ

Paper highlights high-tech industrial cooperation forms and models; economic growth modeling within the context of national innovation system formation and investigated; perspective research in the R&D field and its directions taken to consideration.

The change in the place and role of international cooperation in the modern world economy is due to the following objective advantages: a synergistic effect; a sharp reduction of a one-time and current production costs of the implementation of cooperation projects by each of the participants; terms of mastering production and updating products; joint or coordinated solution of a complex of interrelated problems of the entire innovation cycle of reproduction (production, technologies, management, marketing, sales and after-sales service of products, R&D, improvement and creation of products). Despite the fact that current approaches to the organization of innovative activities in companies have changed significantly in favor of market-oriented methods, this model remains relevant and is used in: scientific organizations, education institutions, technological startups, spinoffs, in the organization of large projects, focused on creating breakthrough products.

Five main models of international scientific and industrial cooperation, which characterize the predominant specificity of the relations between the cooperators, the licensor and the licensee. were being distinguished: the licensor transfers technologies, licenses for the use of industrial and (or) intellectual property rights, certain types of technological equipment to the licensee; an additional obligation of the licensor to supply the licensee with a part of components of its own production; Transfer of complete technological lines (not individual types of equipment) together with the relevant technologies under the terms of financial leasing; Contracting cooperation, under which the contractor fulfills the licensor's order for the production of intermediate products. At the same time, the necessary technical documentation is transferred to the licensee, and in some cases, separate equipment and part of the components produced by the licensor; Joint production of an agreed range of products, accompanied by the exchange of some types of equipment and mutual supplies of finished and intermediate cooperated products.

Clusters generalized as objects that encompassed a large number of diverse participants, unencumbered by geographic location, time zones, and other stationary constraints. Virtualization of cooperation makes it possible to create large-scale high-tech, radically innovative projects.

Technological clusters are differentiated and classified: cross-border cluster — association of economic agents with different centers of economic interest in relation to each other from the supply and demand side, territorially concentrated in neighboring regions; transnational cluster — an international formation of clusters consisting of interacting agents effectively connected by joint technical projects, which also have cooperation with border economic entities, sovereign national and cross-border institutions, global financial and specialized economic non-profit organizations and mechanisms with the aim of intensifying the development of constituent units of the cluster and the cluster as a whole, as well as the national economy.

У статті висвітлено форми та моделі високотехнологічної промислової кооперації; досліджено моделювання економічного зростання в контексті формування та розвитку національної інноваційної системи; розглянуто перспективні дослідження в галузі НДДКР та враховані напрямки їх розвитку.

Визначено обумовленість зміни місця та ролі міжнародної кооперації в сучасній світовій економіці наявністю об'єктивних переваг: синергетичний ефект; різке скорочення змінних одиничних та поточних виробничих витрат на реалізацію проектів з кооперації кожним з учасників; термін освоєння виробництва та оновлення продукції; спільне або узгоджене вирішення комплексу взаємопов'язаних проблем усього інноваційного циклу відтворення (виробництво, технології, управління, маркетинг, продаж та післяпродажне обслуговування продукції, НДДКР, удосконалення та масштабування продукції). Незважаючи на те, що сучасні підходи до організації інноваційної діяльності в компаніях суттєво змінилися на користь ринково-орієнтованих методів, обґрунтована модель залишається актуальною та використовується у: наукових організаціях, навчальних закладах, технологічних стартапах, спін-офах, при організації великих проектів, орієнтованих на створення проривних продуктів.

Виділено п'ять основних моделей міжнародної науково-промислової кооперації, які характеризують переважну специфіку відносин між кооператорами, ліцензіаром та ліцензіатом: передача ліцензіаром технологій, ліцензій на використання промислових та (або) прав інтелектуальної власності, певних видів технологічного обладнання ліцензіату; додаткове зобов'язання ліцензіара постачати ліцензіату частину компонентів власного виробництва; передача комплектних технологічних ліній (не окремих видів обладнання) разом з відповідними технологіями на умовах фінансового лізингу; договірна кооперація, за якою підрядник виконує замовлення ліцензіара на виробництво проміжної продукції — при цьому ліцензіату передається необхідна технічна документація, а в деяких випадках окреме обладнання та частина компонентів, що виробляються ліцензіаром; спільне виробництво узгодженого асортименту продукції, що супроводжується обміном деякими видами обладнання та взаємними поставками готової та проміжної кооперованої продукції.

Кластери узагальнено як об'єкти, що охоплюють велику кількість різноманітних учасників, не обтяжених географічним розташуванням, часовими поясами та іншими стаціонарними обмеженнями. Віртуалізація кооперації дає змогу створювати масштабні високотехнологічні, радикально інноваційні проекти.

Технологічні кластери диференційовано та класифіковано: транскордонний кластер — об'єднання економічних агентів з різними центрами економічного інтересу відносно один одного з боку пропозиції та попиту, територіально зосереджених у сусідніх регіонах; транснаціональний кластер — міжнародне утворення кластерів, що складається з взаємодіючих агентів, ефективно пов'язаних спільними технічними проектами, які також мають співпрацю з прикордонними економічними суб'єктами, суверенними національними та транскордонними інституціями, глобальними фінансовими та спеціалізованими економічними некомерційними організаціями та механізмами з метою інтенсифікації розвитку складових одиниць кластера та кластера в цілому, а також національної економіки.

Key words: economic growth; innovations; high-tech; national innovation system; technological clusters; industrial cooperation; R&D commercialization.

Ключові слова: економічне зростання; інновації; високі технології; національна інноваційна система; технологічні кластери; промислова кооперація; комерціалізація НДДКР.

STATEMENT OF THE PROBLEM IN A GENERAL FORM AND ITS CONNECTION WITH IMPORTANT SCIENTIFIC OR PRACTICAL TASKS

In connection with the shortening of natural resources, the process of high-tech development takes

the leading place in overcoming crisis phenomena and further economic growth, also the reformation of the social method of production is taking place. Despite the above, intensive development is only an element of the constructive evolutionary process, which also involves the refragmentation of the technological method and

culture of consumption, modification of the entire palette of the set of social relations and the economic mechanism.

ANALYSIS OF THE LATEST STUDIES AND PUBLICATIONS

A critical understanding of various aspects of the international experience of intensification of the commercialization of a high-tech product was reflected in the works of A. Asaul, V. Voynarenko, V. Geets, V. Zakharchenko, A. Yermishina, R. Kuzmenko, S. Sokolenko, V. Tretyak, H. Khasaev and others

FORMULATION OF THE GOALS OF THE ARTICLE (STATEMENT OF THE TASK)

The anticipated acceleration of innovative progress will continue in the future. The relevance of this trend can be seen in the modification of the relationship between science and production, which depends on the strengthening of the latter's dependence on science in contrast to the prevalence of empirical experience in the past.

OUTLINE OF THE MAIN MATERIAL OF THE STUDY

The unorthodox absorption of scientific experience depends on the totality of the diagnosis of technical and economic formats, immanent to the post-industrial process, which are unflexible in relation to the traditional academic method. Classical political economic indicators of volumes, efficiency and production factors are now unable to fully reflect the economic processes. Innovations have an unstable and unpredictable nature that is not subject to classical econometric formalization with basic cyclic patterns in abstraction. Depreciation of the means of production was a fairly long process for decades, today the picture has changed in the direction of a radical acceleration of its renewal. Radical innovations today have an ultra-short, virtually instantaneous value chain from R&D to its further commercialization. According to research, the usual period of absorption of innovations during 1885—1919 was 37 years, 1920—1944 — 24 years, 1945—1964 — 14 years, over time it began to reach from 3 to 5 years for the most modern advanced inventions [1].

As a result, the task of forming effective mechanisms and models for the commercialization of high-tech products has been updated. Thus, with the rapid development of high technologies, the process of cognition can no longer remain on the evolutionary basis of development. The enormous speed of the emergence of fundamentally new information, its scope and modification determines, in order to maintain high competitiveness, the need to create a new format and principles of response to the results of scientific and experimental activities.

That is why in the "Report on Global Competitiveness 2024" special attention was paid to the development of the innovative potential of national economies as a prerequisite for the formation of competitive economic systems [2].

Today, the concept of the "knowledge economy" is inextricably linked with the constant cycle of innovative development, the ability to create new knowledge, technologies, processes, the ability to access information and the ability to effectively use it commercially. It should be noted that international cooperation in the process of commercialization of a high-tech product, cooperation in the field of research and development are becoming a powerful driving force for the development of the industry in the world economy, the main form of international industrial cooperation, the core of the transnationalization of production, the material base of the processes of international economic integration and globalization of the world economy.

The change in the place and role of international cooperation in the modern world economy is due to its objective advantages. Among them: a synergistic effect, a sharp reduction of investment (one-time) and current production costs of the implementation of cooperation projects by each of the participants, as well as terms of mastering production and updating products, joint or coordinated solution of a complex of interrelated problems of the entire innovation cycle of reproduction (production, technologies, management, marketing, sales and after-sales service of products, R&D, improvement and creation of products). Today, such international interaction has actually transformed into international scientific and industrial cooperation. This is evidenced by the analysis of many international cooperation projects and relevant agreements conducted by the United Nations Economic Commission for Europe.

On its basis, the following five main models of international scientific and industrial cooperation can be distinguished, which characterize the predominant specificity of the relations between the cooperators, the licensor and the licensee.

Model 1. Under the cooperation agreement, the licensor transfers technologies, licenses for the use of industrial and (or) intellectual property rights, certain types of technological equipment to the licensee. The received is paid by the licensee with the products produced by him, as well as, at the request of the former, with services and own licenses.

Model 2. Contains an additional obligation of the licensor to supply the licensee with a part of components of its own production.

Model 3. Unlike the first model, it involves the transfer of complete technological lines (and not individual types of equipment) together with the relevant technologies under the terms of financial leasing.

Model 4. Contracting cooperation, under which the contractor fulfills the licensor's order for the production of intermediate products. At the same time, the necessary technical documentation is transferred to the licensee, and in some cases, separate equipment and part of the components produced by the licensor.

Model 5. Joint production of an agreed range of products, accompanied by the exchange of some types

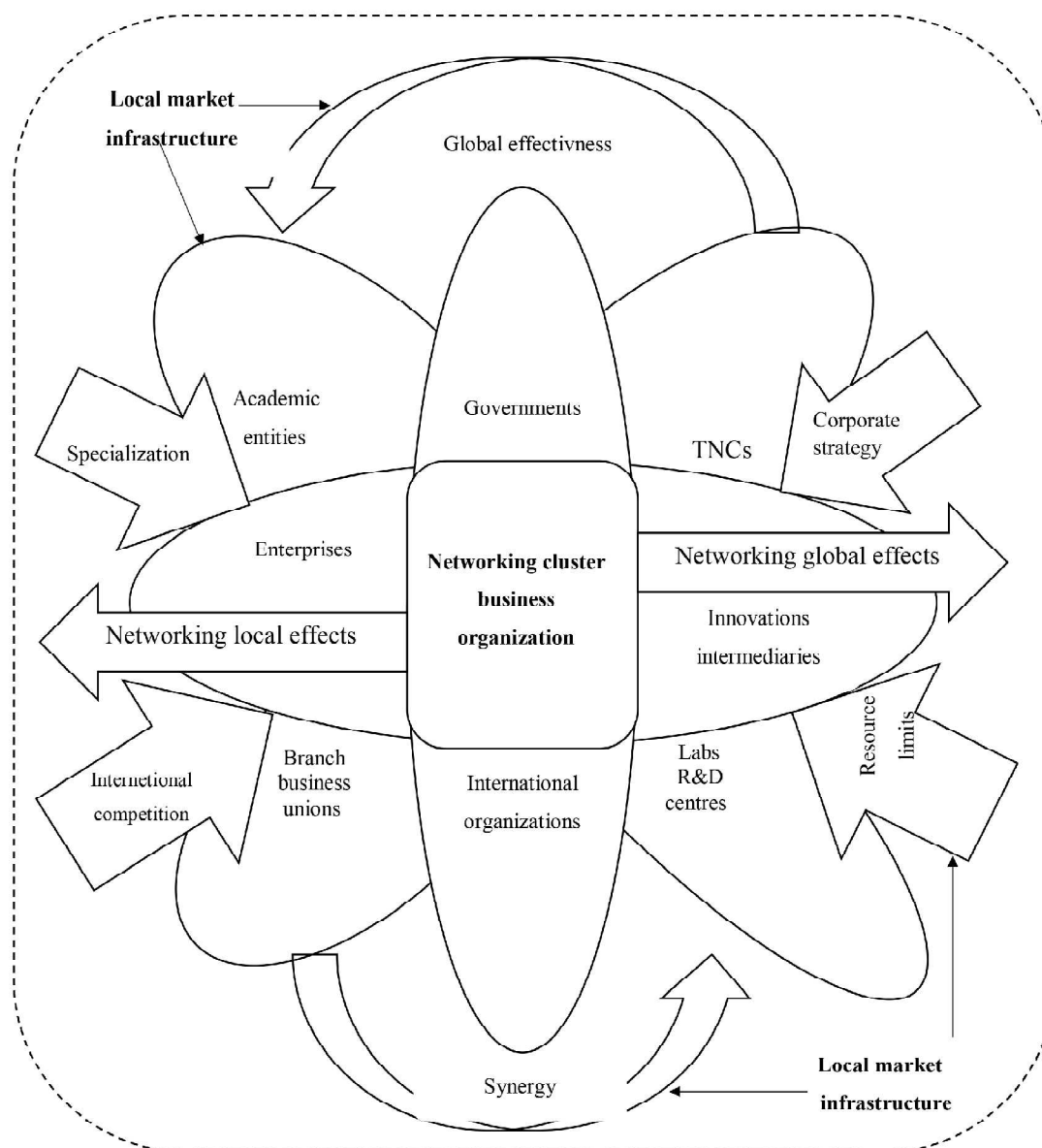


Fig. 1. High-tech product production network cluster formation (formed after [6])

of equipment and mutual supplies of finished and intermediate cooperated products. Joint R&D projects are often envisaged at the same time.

However, the mentioned variants of forms of cooperation are only part of a complex and diversified pool of possible tools for the commercialization of high-tech products. The intensification of the transnationalization of global economic processes, the invigoration of competitive requirements, and the progress of innovation have significantly strengthened the expansion of existing varieties of forms of cooperation between enterprises that are residents of different economic territories and agents of sovereign national innovation systems. The following can be considered relevant modern forms of cooperation today: consortium (alliances), technological clusters, technoparks, innovation funds.

R. Wallace sees a set of the following components: reducing moral risks, postulating common

missions, goals and tools; segmentation of the product group for the consumer, critical reflection, establishment of communication and partner contact, specification of restrictions on cooperation, clear delineation of project start-up boundaries, consolidation of good neighborly relations, guarantee of the right to independence, legal support, business exit plan [4].

Cooperation between partner entities of the formed consortium (alliance) may consist in the essence of the following forms:

- a complex consortium, where agents interact in all areas of business activity, from fundamental research of prospective development to the stage of its commercialization, inclusive;

- limited consortium, which is functionally simplified in terms of interaction: in this case, attention is focused on a limited number of areas of responsibility. The intensity and prospects of cooperation

between partners are determined by the goals of each of them.

In the case of technological clusters, differentiation is possible according to the international or interstate nature of the clustering. The classification of variants of the form of cooperation depends on the definition of the cluster itself:

1) cross-border cluster — association of economic agents with different centers of economic interest in relation to each other from the supply and demand side, territorially concentrated in neighboring regions;

2) transnational cluster — an international formation of clusters consisting of interacting agents effectively connected by joint technical projects, which also have fruitful cooperation with border economic entities (including the entire available complex of economic infrastructure), sovereign national and cross-border institutions, global financial and specialized economic non-profit organizations and mechanisms with the aim of intensifying the development of constituent units of the cluster and the cluster as a whole, as well as the national economy [5] (Fig. 1).

Today, the theory of network cluster formation is based on M. Porter's cluster theory. According to his definition, a network cluster combines forms and features of international competition, specific features of countries, highlighted in the theory of comparative advantages and differentiated subjects of the cluster formation of different states. V. Chernykh claims that the network international cluster is not necessarily formed in the territories connected by the geographical principle, usually the basis of the idea of the defined cluster formation is laid: indicators of the effectiveness of the activities of its agents, the influence of the synergistic effect, the expediency of cooperation, the absence of significant limitations of institutional, economic, of a production and financial nature, the depth and profile of the partners' specialization and their ability to cooperate. A feature of the international network cluster is the free transfer of technologies, diffusion of knowledge and competences within the cluster [7].

The creation of network clusters is preceded by a PEST analysis to identify the peculiarities of the development of the national economies of the cluster's partner countries, the opportunities and prospects for the development of the main, supporting and related industries, the level of competitive interaction and confrontation, the quality, diversification and mobility of the resource base are determined [8].

The concept of the national innovation system was proposed by K. Freeman in the late 1980s to explain differences in the technological development of countries. The concept was later developed by B. Lundvall and R. Nelson. The research was based on the results previously obtained by J. Schumpeter (theory of economic dynamics), F. Hayek (the concept of dispersed knowledge), D. North (institutional theory), R. Solow (the role of NTP in economic growth), P. Romer and R. Lucas (new theory of growth).

In his writings, K. Freeman defines the economic system as a joint formation of economic subjects and institutions in the legal environment of the state, which participate in the creation, storage, dissemination and transformation of new knowledge into new technologies, products and services consumed by society [9].

According to the classic definition of B. Lundvall and R. Nelson [10], innovation is a complex process that unites various participants (enterprises, educational institutions, technological and analytical centers, innovation intermediaries), which form an innovation system. The overall results depend not only on each element of the national innovation system, but also on the interaction of the components of the collective system of creation and use of knowledge, supported by public institutions, values and norms. The theoretical definition of the national innovation system is a special type of the country's economic system, developed taking into account its institutional features, based on an innovative model of interaction of economic entities, the purpose of which is to increase the role of competition between entities based on the introduction of innovations as a key factor in economic dynamics, which directly affects both the structure and content of the state's economy. In international practice, there is the following more practical definition: the national innovation system is a set of institutions belonging to the private and public sectors, which individually and in the process of cooperation with each other determine the development and spread of new technologies within the borders of a specific state. Elements of the national innovation system include:

- innovation-oriented enterprises;
- state and private institutes;
- system of higher education;
- macroeconomic environment and structure of the economy.

CONCLUSIONS AND PROSPECTS OF FURTHER INVESTIGATIONS IN THIS DIRECTION

The main measurements of the national innovation system are the number, volumes and degree of centralization of business agents, the structure of financial, human and physical resources, the innovative effect in form of patents, products, technologies and publications. The main structural feature of the national innovation system is the ratio of state and private business funding in R&D [8].

Our own vision of the category of the national innovation system consists in defining it as a set of institutions, rules, and conditions that ensure the emergence within the national economy of such intangible assets (part of the national heritage), which are called innovations in the form of intellectual property objects, ready for commercialization.

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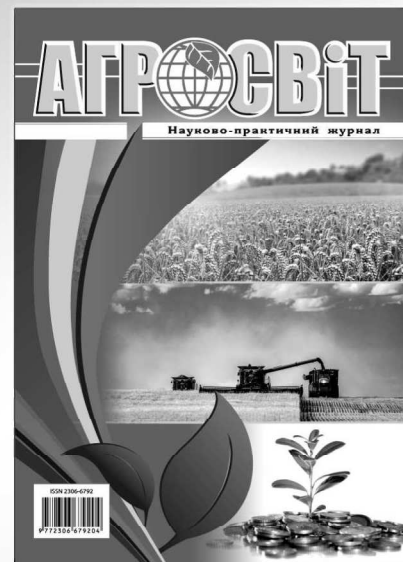
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