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The Regional Innovation System as the Basis for Elevating the International Competitive Status of National Regions*

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ANNOTATION. In this article the authors analyze the essential operating principles of regional innovation systems (RIS), identify the types of RIS, explore the mechanisms of regional and national innovation systems, and determine the innovation capabilities of Ukrainian regions according to European Commission techniques.

KEYWORDS: regional innovation system (RIS), regional innovation capability, regional national summary innovation index (RNSII).

Introduction

The current stage in the evolution of the world economy is characterized by an invigorated localization of innovation activity, namely its concentration in individual national regions, cities and local entities. The Scandinavian economist B. Lundvall contends that regions today are performing a key generating function at the meso level today by creating hi-tech products through regional innovation networks and local clusters and using the effect of mutually enriching information from cooperating research institutes. American researchers B. Carlsson and R. Stankiewicz stress that technological density and heterogeneity are more likely the features of

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individual national regions rather than countries[1]. Such a premise is also confirmed by statistical data: judging from the evaluations of European experts, in 2001 54 % of all patents registered in OECD countries represented 10 % of the countries' regions[2]. On the one hand they believe that this is the effect of the general law of unevenness of economic development and, on the other hand, by the following three factors:

1) Transition from a linear to an interactive innovation model of social development where knowledge is a key resource and learning a key process[3]. B. Asheim[4] and A. Isaksen[5] claim that specific regions are concentration points for new knowledge given their sufficient infrastructure for the accumulation of such knowledge and its continued dissemination through spillover mechanisms. These result especially from the availability of «noncommercial interrelationships» (traditions, customs and rules of behavior based on a common historical past) among the local economic entities. The transfer of knowledge is most effective in face-to-face communication rather than through long communication channels, since some types of new knowledge are confined to the boundaries of a local social environment (such as when research results had no expected effect and were rarely published or not published at all). Such a local circulation of knowledge was termed as the «buzz effect» and is analyzed in the work of the American economist, A. J. Venables[6].

2) A high concentration of a high-tech and skilled labor force in individual centers of economic activity that offer the best employment conditions, namely in capital cities and large megapolises. According to the OECD, 80 % of Belgium's

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[1] Carlsson, B. and R. Stankiewicz (1991), «On the nature, function and composition of technological systems,» *Journal of Evolutionary Economics* No. 1, p. 115.

[2] *OECD Regions at a Glance*, OECD 2005, p. 44.

[3] Asheim, B. and A. Isaksen (1996), «Location, Agglomeration and Innovation: Towards a Regional Innovation System in Norway?» *STEP GROUP Report* No. 13-96, Oslo, p. 8.

[4] Asheim, B., A. Isaksen, C. Nauwelaers and F. Tötdling (2003), *Regional Innovation Policy For Small-Medium Enterprises*, Cheltenham, UK and Lyme, US : Edward Elgar.

[5] Ibid.

[6] Venables, A. J. (2003), «Buzz: The Economic Force of the City,» paper presented at the DRUID Summer Conference 2003, *Creating, Sharing and Transferring Knowledge: The Role of Geography, Institutions and Organizations*,' Elsinore, Denmark.

population are college educated, 77 % in the UK, 68 % in Germany and 66 % in Australia.[7] The American sociologist and economist R. Florida[8] believes that only a limited number of cities and regions offer wide and diverse prospects of career growth and satisfaction for representatives of the innovation class (individuals capable of generating new ideas and knowledge) as well as the opportunity to communicate with a substantial number of people engaged in similar activities.

If a region is attractive for highly skilled and talented personnel, its innovation activity becomes more vigorous and its economic growth and competitiveness increase, promoting in turn a stronger and larger highly skilled labor force. In this way, a circle is created comprising favorable employment conditions, highly skilled employees, a region's higher competitiveness and favorable employment conditions, and so on.

3) A specific sociocultural environment in individual cities attracts highly skilled employees not only because of good career prospects, but also because of higher standards of living. R. Florida[9] believes that such cities have a broad spectrum of different types of creative activity and, accordingly, talented employees: demographic heterogeneity (manifested among the local population by representatives of different ethnic and national groups); tolerance (confirmed by the presence of a substantial number of sexual minorities) and a diverse cultural life. Moreover, in cities with these characteristics the representatives of the innovation class usually have low barriers of entry into the labor market and the local social environment. As a rule, within a country there exist one or two, rarely three, such centers that attract highly skilled employees. According to OECD data, the large megapolises in Ireland, Greece, Finland, The Netherlands, Japan, South Korea and Canada are leaders in national innovation activity, where the level of

[7] *OECD Regions at a Glance* (2005), Paris: OECD, p. 50

[8] Florida, R. (2002), ''The Economic Geography of Talent,'' *Annals of the Association of American Geographers* 92, pp. 743–55.

[9] Florida, R. (2002), *The Rise of the Creative Class*, New York: Basic Books.

patent activity is approximately 50 % (in Dublin — 57.8 %, Attica — 52.2 %, Uusima — 49.8 %, Nord-Brabant — 49.1 %, Tokyo — 47.2 %, Seoul — 44.2 % and Ontario — 44 %)[10].

Therefore, it can be argued that innovation activity is characterized by a high level of geographic concentration that fundamentally changes the status of individual national regions, cities and localities on the international market of high-tech products, converting them into focal points of a global innovation network. Within this context, the concept of a regional innovation system (RIS) as a theoretical foundation for fashioning and efficiently implementing the strategy of raising the international competitiveness of a region gains special importance.

The theoretical foundations of the operation of regional innovation systems mostly within the context of analyzing the essence, structure and mechanisms for operating these systems in the cases of specific countries have been studied in the works of such foreign and national scientists, as B. Asheim[11], A. Isaksen, F. Tötdling[12], M. Gertler[13], C. Freeman[14], J. Howells[15], H. Bracyk, and M. Heidenreich[16], L. Antoniuk[17], V. Chuzhikov[18], and

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[10] *OECD Regions at a Glance*, OECD 2005, p. 49 [11] Asheim, B. and A. Isaksen (1996), «Location, Agglomeration and Innovation: Towards A Regional Innovation System in Norway?» *STEP GROUP Report* No. 13-96, Oslo, pp. 64.

[12] Asheim, B., A. Isaksen, C. Nauwelaers and F. Tötdling (2003), *Regional Innovation Policy for Small-Medium Enterprises*, Cheltenham, UK and Lyme, US: Edward Elgar.

[13] Gertler, M. and B. Asheim (2005), «The Geography of Innovation: Regional Innovation Systems,» *The Oxford Handbook of Innovation,* Oxford: Oxford University Press.

[14] Freeman, C. (2002), «Continental, National and Sub-National Innovation Systems—Complementarity and Economic Growth», *Research Policy* 31, pp. 191–211.

[15] Howells, J. (1999), «Regional Systems of Innovation?» in D. Archibudzi, J. Howells and J. Michie, eds., *Innovation Policy in a Global Economy,* Cambridge: Cambridge University Press, pp. 67-93.

[16] Braczyk, H. J., P. Cooke, and M. Heidenreich (1998), *Regional Innovation Systems*, London, UCL Press.

[17] Antoniuk, L. L., *Mizhnarodna konkurentospromozhnist krain: teoria ta mekhanizm realizatsii.* [The International Competitiveness of Countries: Theories and Mechanisms of Implementation], Kyiv: Kyiv National Economics University, 2004, p. 276.

[18] Chuzhikov, V. I., *Rehionalni intehratsiyni strategii postsotsialistychnych krain Yevropy*. [Regional Integration Strategies of the Post-Socialist Countries of Europe], Kyiv: Kyiv National Economics University, p. 296.

Z. Varnalia[19]. But it should be noted that detailed studies and analyses call for the successful practical application by the leading world countries of the RIS concept as the theoretical foundation for framing local innovation strategies as a component of a national strategy of innovation development. Moreover, the creation of a comprehensive technique for evaluating the level of the innovation capability of national regions as an element of the integral indicator of international regional competitiveness gains importance.

Therefore, the authors of this article set as their goal to illuminate the foundations and operating principles of a regional innovation systems, identify different types of RICs, explore the interrelations and interaction of the regional and national innovation systems, and determine the level of the innovation capability of Ukrainian regions according to the European Commission techniques.

Theoretical Foundations of the Concept of Regional Innovation Systems

The concept of the regional innovation system appeared in the early 1990s as a separate area of innovation systems theory. It integrates two main ideas: the systematic nature of innovation activity and the regional dimension of the innovation process. The first idea — the systematic and interrelated nature of innovation activity — is presented in the works by a group of economists — C. Freeman[20], B. Lundvall[21], and R. Nelson[22] — who studied the operating principles of national innovation systems (NIS). For instance, Freeman[23] iden-

[19] Varnaliy, Z. S., *Rehiony Ukrainy: problemy ta prioritety sotsialno-eknomichnoho rozvytku.* [Ukraine's regions: Problems and Priorities of Socioeconomic Development]. www.niss.gov.ua.

[20] Freeman, C. (1987), *Technology Policy and Economic Performance — Lessons from Japan*, London: Pinter.

[21] Lundvall, B. (1992), *National System of Innovation: Towards a Theory of Innovation and Interactive Learning*, London: Pinter.

[22] Nelson, R. (1993), *National Systems of Innovation: A Comparative Analysis*, Oxford: Oxford University Press.

[23] Freeman, C. (1987), *Technology Policy and Economic Performance — Lessons from Japan*, London: Pinter, p. 58.

tifies the NIS as a network of interrelated institutions from the private and state sectors whose activity and interaction ensures the generation, adoption, modification and diffusion of new technologies. Its systematic approach is based on the specific nature of innovation activity, which results from cooperation among business entities that is based on mutual trust in creating, disseminating and applying new knowledge. Back in the early 20th century A. Marshall[24] stressed the active role of individual business entities in the economic development of national regions and countries. He argued that the model of local development is bipolar and based on the efficient interaction of two principal market players: local firms and state institutions. By introducing to the bipolar model a third component — research institutes — H. Etzkowitz and L. Leydesdorff[25] designed a «triple helix» model of territorial development. This model illustrates the interaction and interrelations that arise between companies, research institutes and state agencies in the process of creating and developing innovation systems. It is precisely the efficiency of the work of research structures that determines the innovation capability of a local innovation system.

The second essential idea of the RIS — the regional nature of the innovation process — is based on the argument that the meso (regional) level of economic development is key for ensuring stability in a country's long term competitive advantage in innovation on the global market. In the early 1990s a new trend of regional science appeared whose advocates stressed the need to cooperate locally in order to compete globally (P. Cook[26], C. Sabel[27], A. Scott[28], B. Lundvall and S. Borras[29]). The main

[24] Marshall, A. (1919), *Industry and Trade*, London: MacMillan.

[25] Etzkowitz, H. and L. Leydesdorff (1998), «A Triple Helix of University-Industry-Government Relations: Introduction,» *Industry & Higher Education* 12:4, pp. 197-258.

[26] Cooke, P. (1992), «Regional Innovation Systems: Competitive Regulation in the New Europe,» *Geoforum* 23, pp. 365-382.

[27] Sabel, C. (1995), *Experimental Regionalism and the Dilemmas of Regional Economic Policy in Europe*, Paris, OECD.

[28] Scott, A. (1996), «Regional Motors of the Global Economy,» *Futures* 28, pp. 391-411.

[29] Lundvall, B. and S. Borras (1997), «The Globalizing Learning Economy: Implication for Innovation Policy,» *Targeted Socio-Economic Studies*, DG XII, Commission of the European Union, Luxembourg.

element of interaction among business entities is the establishment of «noncommercial interrelationships»[30] based on the mutual trust of relations among partners. In the opinion of P. Cooke, noncommercial interrelationships promote the development of innovation networks and stimulate innovation activity precisely at the subnational (regional) level, but not on the macro level.

It should be noted that to date there does not exist a single, general definition of an RIS. This is evident in the existence of three interpretations of an RIS: «top-bottom,» «bottom-top,» and integral (systemic).

1. Advocates of the «top-bottom» approach (J. Howells, B. Carlsson, R. Stankewicz) claim that the regional innovation system concept was formed on the principles of a national innovation system and, on the whole, RIS was viewed as a primarily territorial level of the NIS. J. Howells pointed out that the RIS is a localized network of companies, private and state organizations whose interaction and cooperation ensures the generation, adoption, modification and diffusion of new technologies[31]. Moreover, the authors of this approach stress that the dimensions of the main component elements of the NIS with its inherent features are duplicated locally in the RIS. The following RIS characteristics are recognized as essential:

— an organizational structure comprising companies and leading participants in the innovation process;

— inter-corporate interrelationships, namely an intense interaction among the business sector and other organizations;

— a role for the state and state innovation policy;

— an institutionalised financial structure;

— activity and funding of R&D (according to a ratio involving private and state sectors);

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[30] Dosi, G. (1988), «Sources, Procedures and Microeconomic Effects of Innovation,» *Journal of Economic Literature* 26, pp. 1120-71.

[31] Howells, J. (1999), «Regional Systems of Innovation?» in D. Archibudzi, J. Howells and J. Michie, eds., *Innovation Policy in a Global Economy,* Cambridge: Cambridge University Press, pp. 67-93.

— an industrial structure (comprising average sized companies, an efficient competitive environment, primary industrial sectors, etc.);

— a territorial organizational structure (urbanization, availability of regional production networks) and a scale of inter-regional agglomerations (innovation clusters, spinoff enterprises[32] and spillover[33] effects);

— a level of openness and integration into the global production system, an ability to attract external resources of development;

— historical specificities, cultural rules and traditions affecting economic activity.

While not exhaustive, this list accounts for the generally required features for an innovation system at any level and singles out the main institutional links that promote the innovation development of a certain territory. At the same time this approach can be used for a comparative analysis of regional innovation systems (both inside and outside the boundaries of national borders) to determine the stages of development and the level of completeness of the studied RIS. The authors of the «top-bottom» approach do not determine the specific mechanisms and forms of cooperation between local economic agents which cause the geographic concentration of innovation activity.

2. Advocates of the «bottom-top» approach (F. Cooke, H. Braczyck, O. Memedovic) concentrate on the social factor of local innovation dynamics. They claim that the level of innovation activity of a region depends on its ability to perform three main functions, namely:

— absorption of new knowledge, technologies, and innovations and their modification in accordance with their own needs;

— diffusion of innovation to all levels of a regional production system and strengthening of its scientific and technological foundation;

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[32] Spinoff enterprises are defined as associated firms promoting the process of exchange of information and transfer of technologies through different channels of interactive learning.

[33] Spillover effect is defined as the dissemination and exchange of information between enterprises/partners in the process of production activity.

— generating new knowledge, technologies and innovation.

Performance of the above-mentioned functions is ensured by way of collective learning[34], which promotes the attraction, modification, dissemination, creation and use of new knowledge. Based on noncommercial interrelations of mutual benefit, this process is an exchange of expertise, knowledge and skills between business entities. Therefore, it can be argued that regional innovation advantages depend on such characteristics of a region's social environment as noncommercial interrelations, informal channels of knowledge transfer, and interactive learning. Moreover, developed sociocommunicative links are a key channel for the diffusion of technologies, learning, modification and integration of old and new knowledge at the local level. S. Breschi and F. Lissoni[35] claim that the geographic proximity of business entities does not promote the emergence of the technological spillover effect (i.e. establishment of new enterprises), while social proximity is a required precondition. The main specific characteristics of RIS according to the «bottom-top» approach at the local level are as follows:

— communication traditions and customs;

— distribution and exchange of knowledge (individual, intra- and inter-corporate, intra- and inter-regional);

— processes of interactive learning;

— R&D;

— generation of innovations (individual, organizational, institutional and social).

Notably, this list also does not completely reflect the main characteristics of RIS, focusing attention only on a region's capability to create and disseminate new knowledge and its potential to create a highly competitive local innovation system.

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[34] Cooke, P. and O. Memedovic (2003), «Strategies for Regional Innovation Systems: Learning Transfer and Applications,» *Policy Papers*, Vienna: UNIDO.

[35] Breschi, S. and F. Lissoni (2001), «Knowledge Spillovers and Local Innovation Systems: A Critical Survey,» *Industrial and Corporate Change* 10:4, pp. 975-1005.

3. American economists J. Lambooy and R. Boschma[36] brought together the main ideas of the «top-bottom» and «bottom-top» approaches and created an integral (systemic) approach relative to the definition of the essence of RIS. They argue that the evolution of RIS depends on such factors as territorial institutional structure, technological development, selectivity of the business environment, diversity and heterogeneity of innovation activity, and behavioral dependence. In the opinion of the authors of the integral approach, the regional business environment operates like a selective mechanism that can create favorable conditions for the adaptation of local business entities to new technological changes. It means that the potential of regional innovation and economic growth is caused by behavioral dependence, specifically by the establishment of RIS on the basis of previously accumulated knowledge and experience. For this reason the interdependence between structural characteristics and the RIS players is a distinctive type of feedback: not only does the business environment impact on the participants in the innovation process, but they also modify as a result of their activity.

Another advocate of the systemic approach, F. Cooke[37], supports the idea that RIS consists of two subsystems that are united by the process of interactive learning, namely:

— a regional subsystem that applies knowledge (firms/producers that are part of regional industrial clusters as well as supporting and related sectors);

— a regional subsystem that generates the knowledge that determines the pace of innovation development of the first subsystem (private and state research laboratories of universities, agencies of technology transfer, regional bodies of state authority, financial institutions.

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[36] Lambooy, J.G. and R. A. Boschma (2001), «Evolutionary Economics and Regional Policy,» *The Annals of Regional Science* 35, pp. 113-131.

[37] Cooke, P. (1992), «Regional Innovation Systems: Competitive Regulation in the New Europe,» *Geoforum* 23, pp. 365-382.

In other words, an RIS should develop within the context of a framed regional strategy of promoting local learning in order to ensure a region's stable innovation competitive advantages.

Notably, the advocates of the integral approach view the RIS concept not only as an instrument for analyzing the factors and dynamics of local innovation development, but also as a concrete practical mechanism for raising regional competitiveness.

In our opinion, RIS is an aggregate of private firms, state companies, NGOs, bodies of state authority and centers for the creation of new knowledge and their subsequent diffusion (such as universities, research institutes, experimental laboratories, innovation development agencies, and the like) united by specific partnership interrelations, which promote the intensification of innovation activity and, accordingly, raise the level of a region's competitiveness. It should also be emphasized that to this end an efficient mechanism for funding subsequent commercialization of research and developments, e.g. through a system of regional venture funds, should be created.

Classification of Regional Innovation Systems

Within the context of applying the RIS concept, as the basis for framing regional competition strategies, it is advisable to typologize the RIS. The criteria for classifying RIS may be the types of innovation networks on the basis of which they develop. B. Asheim and P. Cooke[38] contend that there exist two main types of innovation networks:

— endogenous networks that appear on the basis of local industrial clusters of small- and medium-sized enterprises with traditions and expertise of mutually beneficial exchange of information as well as interactive learning in the process of joint innova-

[38] Asheim, B.T. and P. Cooke (1999), «Local Learning and Interactive Innovation Networks in a Global Economy,» in E. Malecki and P. Oinas, eds., *Making Connections: Technological Learning and Regional Economic Change*, Aldershot: Ashgate.

tion activity (e.g., Baden-Würtemberg in Southern Germany, and Tuscany and Emilia-Romagna in Italy);

— exogenous innovation networks existing mainly as technoparks in technopolises. They appear under the following circumstances: when large companies single out R&D into a separate functional unit and place it in a territory that is best for the emergence of noncommercial interdependencies (e.g., Sofia-Antipolis in Greece and Ile-de-France in France); or when an innovation network is set up administratively as a planned action to establish and deepen cooperation between research institutes and enterprises (e.g. the technoparks in the United States and the United Kingdom).

Leading specialists of our time single out three types of innovation networks that appear near or direct within the boundaries of large megapolises and represent the interaction of large and medium-sized firms with universities, research institutes as well as other companies and state institutions.

A RIS is classified according to the determined main types of innovation networks. This is important both in the theoretical and practical aspects, especially within the context of interrelations along the RIS-NIS vertical. Relying on the studies of B. Asheim[39] and P. Cooke[40], we single out three types of RIS: territorially embedded innovation systems, regional online-operated innovation systems, and regional national innovation systems.

Concerning territorially embedded or *impromptu* innovation systems[41], as P. Cooke classifies them, within the boundaries of such a RIS, the activity of local companies is based on the process of local learning because of their geographical, social and cultural relationship. At the same time the level of cooperation of manufacturing firms with organizations/producers of new knowledge is minimal. A good example is the network of small- and medium-sized

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[39] Asheim, B.T. (2002), «Temporary Organisations and Spatial Embeddedness of Learning and Knowledge Creation,» *Geografiska Annaler: Series B, Human Geography* 84B:2, pp. 111-124.

[40] Cooke, P. (1998), «Introduction: Origins of the Concept, « in H. Braczyk, P. Cooke and M. Heidenreich, eds., *Regional Innovation Systems*, London: UCL Press.

[41] Ibid.

enterprises that emerge on the basis of regional clusters and industrial districts. It can be said that the innovation system of Emilia-Romagna (Italy) is embedded in the territorial structure of the socioeconomic relations of this region. In framing the competition strategy for regions of this type, the main purpose is to shape an efficient system of state support of the process of local organizational training by setting up a network of technology transfer agencies, specialized training courses, and the like.

Territorially embedded RIS can gradually turn into regional online innovation systems[42]. Retaining the main features of the previous type, this RIS is characterized by a more regular and systematized interaction of the economic players and a higher level of international openness. Regions with online innovation systems are more competitive on the global market owing to the highly developed local institutional infrastructure. In particular, they invigorate and deepen interrelationships with local research institutes, universities, technology transfer agencies, and other organizations involved in the process of generating and distributing knowledge. According to the definition of F. Cooke, an ideal type of RIS is exactly a regional online innovation system[43]: one or several interrelated clusters surrounded by a locally supporting institutional infrastructure.

Regional online innovation systems are one of the models of endogenous development, i.e. a model for raising the innovation capabilities and promoting deeper interaction of local economic agents through the use of the instruments of administrative influence. For radical innovations small- and medium-sized enterprises, in particular, will have to use not only the available local databases of knowledge, but also have access to the results of large-scale national and even international research. The establishment of a regional online in-

[42] Ibid.

[43] Cooke, P. (1998), «Introduction: Origins of the Concept, « in H. Braczyk, P. Cooke and M. Heidenreich, eds., *Regional Innovation Systems*, London: UCL Press, p.39.

novation system by way of deepening cooperation of local research institutes and universities both on the local and inter-regional and international levels, as well as the creation of technology transfer agencies, centers of innovation services, and databases of R&D results will promote the efficient integration of local companies into the global innovation system. The establishment of online RIS will not only promote higher innovation capabilities of local companies, but also prevent the use of «short-circuited» technologies (traditional but obsolete technologies).

The establishment of an online RIS is an example of the systematic implementation of government programs for innovational development of enterprises through the promotion of cooperation between research institutes and manufacturing enterprises. Such online RIS are typical of Germany, Austria, and the Scandinavian countries.

The third type of RIS — regionalized national innovation system[44] or «dirigible» system[45] — is fundamentally different from the two previous ones. First, a significant part of the enterprises and the institutional infrastructure are functionally more integrated — compared to the two previous types of RIS — into the national and international innovation systems, i.e. innovation activity is carried out mostly among economic actors from different regions. This RIS is based on the exogenous model of development.

Second, within this type of RIS, interaction among business entities is based on a linear model, since the implementation of large-scale projects requires the application of formal knowledge and the engagement of representatives of the analytical centers of manufacturing (primarily engineers). Within the regionalized national innovation systems interaction and cooperation develops more actively among

[44] Asheim, B. T. (2002), «Temporary Organisations and Spatial Embeddedness of Learning and Knowledge Creation,» *Geografiska Annaler: Series B, Human Geography* 84B:2, pp. 111-124.

[45] Cooke, P. (1998), «Introduction: Origins of the Concept, « in H. Braczyk, P. Cooke and M. Heidenreich , eds., *Regional Innovation Systems*, London: UCL Press.

representatives of similar areas of activity who have a similar knowledge. Such functional homogeneity promotes the circulation and exchange of knowledge within the «unions of practice»[46] (group of workers informally linked by joint experience in innovation activity; usually, they appear spontaneously to deal with concrete practical problems or in the process of implementing joint projects), the dimensions of their activity being inter-regional and even national.

A cluster of research institutions of a large company and/or state research institute within an existing technopark can serve as an example of a regionalized national innovation system. As a rule, such organizations are located not far from technological colleges and laboratories or maintain limited links with local manufacturing companies. On the whole, technoparks are characterized by a low level of innovation interaction of enterprises-participants, which explains the negligible scale of local learning and engagement of external enterprises in the implementation of individual projects of the basis of a subcontractual system. But at the same time, owing to the establishment of informal partnership relations among economic subjects, the interrelationship in the research institute-enterprise-state agency triangle is more stable in the regionalized national innovation system than in the NIS.

[46] Etzkowitz, H. and L. Leydesdorff (1998), «A Triple Helix of University-Industry-Government Relations: Introduction,» *Industry & Higher Education* 12:4.

Table 1

Comparative Characteristics of Types of Regional Innovation Systems

Types of RIS	Location of innovation enterprises	Basic innovation model	Main stimuli of interaction	Examples
Territorially embedded RIS	Locally, with an insignificant degree of innovation interaction	Interactive	Geographical, social and cultural relationship	Industrial districts
Regional online innovation system	Locally, with a considerable degree of innovation interaction	Interactive	Systematic and systematized establishment of innovation networks	Innovation clusters
Regionalized national innovation system	Primarily outside the boundaries of a defined region	Linear	Separate individuals with similar level of education and common interests	Technopolises, technoparks

Source: Compiled by the authors in accordance with Asheim, B.T., Isaksen, A. (2002) «Regional innovation systems: The integration of local 'sticky' and global 'ubiquitous' knowledge». *Journal of Technology Transfer*, 27: 77-86.

The classification of RIS presented above is based on the nature of a local innovation model and type of relations among the subjects engaged in the innovation activity. Regrettably, it does not reflect the level of institutionalization of the analyzed RIS. This problem is studied in detail by the American economist P. Cooke[47] who confirms interrelations among the institutional structure of the NIS, the national business system and the nature of RIC. He argues that support for specific forms of economic activity is typical of different types of national institutional structures. Market economies with a considerable degree of state regulation (Germany, Switzerland, the Scandinavian countries) have marked competitive advantages in traditional sectors

[47] Cooke, P. (2001), «Regional Innovation Systems, Clusters, and the Knowledge Economy», *Industrial and Corporate Change* 10:4, pp. 945–74.

of industry, while liberal market economies (US, UK) are more competitive in high-tech sectors. The main factor in the development of state regulated economies is coordination and cooperation that arise among representatives of the private and state sectors; in liberal economies it is the degree of market freedom and the availability of stable funding sources for modernizing and modifying the production system according to changes in the external environment. Also typical of coordinated economies is the establishment of formal, long-term and stable socio-economic relations between the private and state sectors, while for liberal economies it is the formation of flexible and rapidly changing interrelations depending on the specific features of the business activity. The above-mentioned specific institutional features of two types of market economies occasion the formation of qualitatively different types of innovation activity, mechanisms of knowledge generation and transfer, systems of collective learning and, accordingly, regional innovation systems.

P. Cooke sets apart traditional innovation systems, identified by him as institutional regional innovation system — IRIS, and new innovation systems, identified as entrepreneurial regional innovation system — ERIS[48].

IRIS is typical, for example, for some regions of Germany (e.g., Baden-Würtemberg) and the Scandinavian countries whose economies are based on traditional industrial sectors (mechanical engineering, shipbuilding, etc.). The effectiveness of IRIS depends on the availability of a synergic effect of interaction among the production system, the innovation infrastructure, a supporting institutional network of a region, and state bodies of local administration. According to P. Cooke, IRIS operates where technologies and innovations are more interdependent and mutually stimulating than destructive (which is more typical of EPIS during the process of emerging

[48] Cooke, P. (2003), «Integrating Global Knowledge Flows for Generative Growth in Scotland: Life Sciences as a Knowledge Economy Exemplar», in *Inward Investment, Entrepreneurship and Knowledge Flows in Scotland—International Comparisons*, Paris: OECD.

startup enterprises[49]), provided that a local institutional structure gradually develops and an adequate sectoral innovation system evolves[50].

Unlike IRIS, EPIS (which evolves mostly in Anglo-Saxon countries) is characterized by unstable systemic links among its component elements. The dynamics of ERIS is ensured by local venture funds, the vigor of entrepreneurial and innovation activity, and a constantly growing internal demand. P. Cooke calls ERIS a system whose moving force of development is venture capital. ERIS is more flexible than IRIS, adapts more quickly to changes in the external environment, and evades more frequently dangers stemming from the emergence of «short-circuited» technologies. At the same time ERIS lacks long-term stability that negatively impacts on local technological and historically occasioned development.

It should be pointed out that different types of RIS co-exist within the boundaries of a NIS. The American researcher A. Saxenian[51], comparing the electrical engineering and information technological sectors in two dominant American regions — Silicon Valley in California and Route 128 in Massachusetts, confirmed the simultaneous operation of IRIS and ERIS in one national institutional space. She claims that Silicon Valley exceeded Route 128 in employment rates and dynamics of establishment of new firms, since it is more open, flexible and mobile as compared to the more closed, conservative, and hierarchical structure of Route 128. Although both regions are recognized world leaders in information technology, Silicon Valley responds more quickly (introducing radical innovation products into the market) to changes in the global competitive environment.

In our opinion, given the turbulent global economic environment, ERIS is an optimal institutional foundation for local innovation development, which

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[49] Startup companies are defined as companies involved in innovation and are newly established.

[50] Cooke, P. (2003), «Integrating Global Knowledge Flows for Generative Growth in Scotland: Life Sciences as a Knowledge Economy Exemplar», in *Inward Investment, Entrepreneurship and Knowledge Flows in Scotland—International Comparisons*, Paris: OECD, p. 63.

[51] Saxenian, A. (1994), *Regional Advantage: Culture and Competition in Silicon Valley and Route 128*, Cambridge, Mass.: Harvard University Press.

is confirmed by the experience of the most competitive regions of the world. This fact is explained by its mobility and capability to respond quickly and adequately to changes in external conditions. At the same time IRIS, due to the use of the synergic effect stemming from close interaction of its main component elements, can serve as a foundation for establishing dynamic highly competitive ERIS.

Instruments for Studying the Innovation Capability of National Regions

A remaining challenging problem in the study of local innovation development is the evaluation of the operational efficiency of RIS in order to make recommendations for its improvement. Among the most widespread techniques to date is the evaluation of regional innovation performances (RIP) designed by experts of the European Commission as a component of the general European Innovation Scoreboard (RISc)[52].

Under this technique RISc is compiled on the basis of 13 indices united into four groups and the GRP per capita index. Let us consider the RISc indices in greater detail (see Table 2)

On the basis of the indices presented in Table 2 the revealed regional summary innovation index (RRSII) is calculated, which makes it possible to determine the regions that lead in the innovation development not only in a defined participating country, but also within the EU. RRSII is calculated as an average arithmetical meansof two indices: regional national summary innovation index (RNSII) and regional summary innovation index (RSII).

[52] *European Innovation Scoreboard: Technical Paper No.3, Regional Innovation Performances*, Brussels, 2003.

Table 2

Indices of Regional Innovation

Groups	Human resources	Knowledge generation	Transfer and application of knowledge	Funding of innovation activity and commercialization of innovations
Indices	1) proportion of population with higher education (% of population 25 to 64 years of age) 2) proportion of population with lifelong education (% of population 25 to 64 years of age) 3) number employed in medium high-tech and high-tech sectors (% of total number employed); 4) number employed in high-tech services (% of total number employed)	5) state expenditures for R&D (% of GRP) 6) private expenditures for R&D (% of GRP) 7) number of patents used in high-tech sectors (per 1 million of the population) 8) total number of used patents (per 1 million of the population)	9) share of industrial enterprises engaged in innovation activity (% of all industrial enterprises) 10) share of enterprises engaged in innovation activity in the area of services (% of all enterprises) 11) expenditures for innovation activity in manufacturing (% of total sale volumes) 12) expenditures for innovation activity in the area of services (% of total sale volumes)	13) proceeds from the sale of innovation products by enterprises (% of total sale volumes).

Source: Adapted by the authors from *European Innovation Scoreboard: Technical Paper No.3. Regional Innovation Performances.* Brussels 2003, p.21.

The regional national summary innovation index (RNSII) makes it possible to single out leading regions within an individual country calculated on the basis of the national statistical data as an average

weighted arithmetical mean (indices 1-8 having a weight of 1; indices 9-13 with a weight of 0.5):

$$RNSII_{jk} = \sum_{j=1}^{m} x_{ijk}^{n}, \text{ where } x_{ijk}^{n} = \frac{x_{ijk} - \min(x_{ijk})}{\max(x_{ijk}) - \min(x_{ijk})} \quad (1)$$

Since RNSII determines the leading regions among the EU member countries, it is calculated on the basis of the European Commission's statistical data. RNSII is also calculated as an average weighted arithmetical mean (indices 1-8 having a weight of 1; indices 9-13, 0.5):

$$RSII_{jk} = \sum_{j=1}^{m} x_{ijk}^{eu}, \text{ where } x_{ijk}^{eu} = \frac{x_{ijk} - \min(x_{ij})}{\max(x_{ij}) - \min(x_{ij})} \quad (2)$$

In formulas 1 and 2 x_{ijk} — value of index i for region j in country *k*; *m* is the number of indicators for which statistical data by regions is available.

In the present study we propose — by using the regional innovation scoreboard indices and the technique of calculating the regional national summary innovation index — to determine the level of innovation capability of Ukraine's regions and identify the leading regions by the level of their innovation development. Calculating RNSII and RRSII indices for Ukraine's regions is inadvisable, since Ukraine is not a member of the European Union.

Evaluation of the Innovation Capability of Ukraine's Regions

The main problem in calculation was to correlate and determine corresponding indices in accordance with the European Commission technique and the data of the State Statistics Committee of Ukraine. In this process some considerable difficulties arose because of the existing difference in the classification of types of economic activity in Ukraine (CVEA) and in the EU (NACE). As a result, not all the indicators used by the EU experts are calculated

by Ukraine's statistical agencies (especially at the meso level). Therefore, we suggest using in the present study the following indices, which, we believe, are more adequate to the technique of the regional innovation scoreboard. The indices we chose and the technique of their calculation are presented in Table 3.

The calculated 13 indices reflecting the level of the innovation development of Ukraine's regions and required for determining the RNSII are presented in tables 4 and 5.

Table 3

Indices used for calculating the RNSII index under the Regional Innovation Scoreboard technique and in this study

Regional innovation scoreboard technique			In this study	
Groups of indices	Index	Calculation technique	Used analogies	Source (data for 2003-2004)
Human resources	1. proportion of population with higher education (% of population 25 to 64 years of age)	**Numerator:** Population with higher education 25 to 64 years go age **Denominator:** Total population 25 to 64 years of age inclusive	**Numerator:** Accountable number of hired workers with higher education accreditation levels 1-4 (thousand persons) **Denominator:** Accountable number of staff workers (thousand persons)	*Ukraine's Labor 2003:* Statistical Bulletin, p. p.80 *Ukraine's Labor 2004:* Statistical Bulletin, p. 80
	2. proportion of population with lifelong education (% of population 25 to 64 years of age)	**Numerator:** Population that studies throughout their life (taking part in education programs, trainings, seminars and the like related to their main trades and professions, as well as education of a general nature) **Denominator:** Total population 25 to 64 years of age inclusive	**Numerator:** Trained personnel by their place of employment and types of education and regions (thousand persons) Advanced training of hired workers by their place of employment and regions (thousand persons) **Denominator:** Accountable number of staff workers (thousand persons)	*Ukraine's Labor 2003:* Statistical Bulletin, p. p.99, p.105 *Ukraine's Labor 2004:* Statistical Bulletin, p.99, p.105
	3. number employed in medium high-tech and high-tech sectors (% of total number employed)	**Numerator:** Number employed in the chemical industry, mechanical engineering, manufacture of office equipment, electric equipment, telecommunication sector, precise instrument building, automotive sector, aircraft building and other transport equipment **Denominator:** Total number employed	**Numerator:** Number employed in the chemical industry (24), manufacturing of radio, television and communication equipment (32), control and measurement instruments (33.2) and spacecraft (35.3)*, manufacturing of machines and equipment (DK), office equipment and computers (D), transportation equipment (DM)** (thousand persons) **Denominator:** Total number employed in a region (thousand persons)	Reference data of the state enterprise «Information and Analytical Agency» *Ukraine's Labor 2003:* Statistical Bulletin, p. p.35 *Ukraine's Labor 2004:* Statistical Bulletin, p.34

Table 3 (cont.)

Regional innovation scoreboard technique			In this study	
Groups of indices	Index	Calculation technique	Used analogies	Source (data for 2003-2004)
Human resources	4. number employed in high-tech services (% of total number employed);	**Numerator:** Number employed in the telecommunication, postal and information sector (including software development) and R&D services (R&D in natural science and engineering; R&D in social sciences and the humanities) **Denominator:** Total number employed	**Numerator:** Number employed in: postal and communication services (64), information (72), research and development (73) (all in thousand persons) **Denominator:** Total number employed in a region (thousand persons)	Reference data of the state enterprise «Information and Analytical Agency» *Ukraine's Labor 2003:* Statistical Bulletin, p. p.35 *Ukraine's Labor 2004:* Statistical Bulletin, p.34
Knowledge generation	5. state expenditures for R&D (% of GRP)	**Numerator:** Difference between total and private expenditures for R&D in current prices in national currency **Denominator:** Gross regional product (GRP)	**Numerator:** Distribution of total volume of innovation funding by sources and regions (in actual prices, UAH thousand) **Denominator:** GRP (in actual prices, UAH million)	*Scientific and Innovation Activity in Ukraine 2005*, p.211 *Ukraine in Figures 2005*, p.44
	6. private expenditures for R&D (% of GRP)	**Numerator:** Expenditures of the business sector for R&D **Denominator:** Gross regional product (GRP)	**Numerator:** Distribution of total volume of innovation funding by sources and regions (in actual prices, UAH thousand) **Denominator:** GRP (in actual prices, UAH million)	*Scientific and Innovation Activity in Ukraine 2005*, p.211 *Ukraine in Figures 2005*, p.44
	7. number of patents registered in high-tech sectors (per 1 million of the population)	**Numerator:** number of patents in high-tech sectors registered with the European Patent Office: computer and automatic equipment; microorganisms and genetic engineering; aircraft building; communication facilities, semiconductors, lasers; **Denominator: T**otal population size	**Numerator:** number of acquired new technologies (technical achievements) by enterprises in the high-tech sectors: manufacture of radio, TV and communication equipment (32); construction of aircraft and spacecraft (35.3)** (units) **Denominator:** distribution of available population by place of residence and regions (persons)	Reference data of the state enterprise «Information and Analytical Agency» www.ukrstat.gov.ua/operativ/operativ2003/ds/kn/kn u/122003.html

Table 3 (cont.)

Regional innovation scoreboard technique			In this study	
Groups of indices	Index	Calculation technique	Used analogies	Source (data for 2003-2004)
Knowledge generation	8. total number of registered patents (per 1 million of the population)	**Numerator:** total number of patents registered with the European Patent Office **Denominator:** Total population size	**Numerator**: received protection documents from the State Department for Intellectual Property of Ukraine by regions (units) **Denominator**: Distribution of available population by place of residence and regions (persons)	Reference data of the state enterprise «Information and Analytical Agency,» p.279 www.ukrstat.gov.ua/operativ/operativ2003/ds/kn/kn u/122003.html
Knowledge transfer and application	9.share of industrial enterprises engaged in innovation activity (% of total number of industrial enterprises)	**Numerator:** number of industrial enterprises engaged in innovation activity in industry **Denominator:** Total number of industrial enterprises	**Numerator:** number of industrial enterprises which introduced innovations, by regions (units) **Denominator:** number of industrial enterprises/legal entities (units)	*Scientific and Innovation Activity in Ukraine* 2005, p.220 Statistical bulletin *Regions of Ukraine* part II, 2005, p.123
	10. share of enterprises engaged in innovation activity in the area of services (% of total number of enterprises)	**Numerator:** number of enterprises engaged in innovation activity in the area of services (trade, transport, warehousing, communication; financial intermediation; transactions in real estate, leasing, business consulting) **Denominator:** total number of enterprises in the area of services	**Numerator:** number of enterprises engaged in innovation activity in the following areas: wholesale trade and trade mediation (51), retail trade in domestic products and their repair (52), land transport (60), water transport (61), aviation transport (62), warehousing (63.12), communication (64.2), financial intermediation (65), transactions in real estate (70), hiring without attending personnel (71), activity in law, accounting and consultations on management (74.1)**(units) **Denominator:** number of entities in the Unified State Register of Enterprises and Organizations of Ukraine (USREOU) by regions (units)	Reference data of the state enterprise «Information and Analytical Agency» *Ukraine in Figures* 2005, p.58

Table 3 (cont.)

Regional innovation scoreboard technique			In this study	
Groups of indices	Index	Calculation technique	Used analogies	Source (data for 2003-2004)
Knowledge transfer and application	11.expenditures for innovation activity in industry (% of total sale volumes)	**Numerator:** total amount of expenditures for innovation activity in production **Denominator:** sale volumes in industry	**Numerator:** total amount of expenditures and informatization in mining (C), manufacturing (D), and output of electricity, gas and water (E)** (UAH thousand) **Denominator:** volume of marketed industrial products in actual prices (UAH million)***	Reference data of the state enterprise «Information and Analytical Agency» Statistical bulletin *Regions of Ukraine* part II, 2005, p.126
	12. expenditures for innovation activity in the area of services (% of total sale volumes)	**Numerator:** total amount of expenditures for innovation activity in the area of services **Denominator:** Sale volumes in services	**Numerator:** total amount of expenditures for innovation and informatization in construction (F), wholesale and retail trade; trade in vehicles; repair services (G), hotels and restaurants (H), transport (I), financial activity (J), transactions in real estate, hiring and services to legal entities (K), state governance (L), education (M), health care and social assistance (N), collective, civic and personal services (O), services of domestics**** (P)** (UAH thousand) **Denominator:** volume of traded services at market prices (UAH thousand)	Reference data of the state enterprise «Information and Analytical Agency» Statistical bulletin *Regions of Ukraine* part II, 2005, p.799
Commercialization of innovations	13. proceeds from the sale of innovation products for enterprises (% of total sale volumes in industry)	**Numerator:** proceeds from the sale of innovation products **Denominator:** Sale volumes in industry	Sale volumes of innovation products by regions (UAH thousand)	*Scientific and Innovation Activity in Ukraine 2005*, p.241

* The construction of aircraft and spacecraft is not calculated for the following regions: Volyn, Donetsk, Zhytomyr, Ivano-Frankivsk, Kirovograd, Poltava, Rivne, Ternopil, Khmelnytsky, Cherkassy, Chernivtsi, Chernihiv, and the city of Sevastopol

** In brackets are the codes of types of economic activity according to the Classifier of Types of Economic Activity in Ukraine (CSEA)

*** Available data for 2004 **** Available 2004 data for Luhansk oblast

Source: Adapted by the authors according to the European Innovation Scoreboard: Technical Paper No.1. Indicators and Definitions. Brussels 2003.

Table 4

Values of indices used for calculating the RNSII index for Ukraine's regions, 2003

Indices / Regions	1	2	3	4	5	6	7	8	9	10	11	12	13
Autonomous Republic of Crimea	52.73	9.0	4.00	0.63	0.0000	0.3072	—	79.79544	1.86	1.20	—	0.8	9.5
Vinnytsia	45.09	6.7	2.85	0.33	0.0005	0.4663	—	130.1666	5.59	1.47	—	0.9	2.5
Volyn	47.74	6.6	2.89	0.21	0.0002	0.2490	—	32.41837	5.18	1.33	—	1.1	7.3
Dnipropetrovsk	52.79	16.6	7.13	1.21	0.3310	1.1486	—	193.8421	1.14	2.16	—	3.0	5
Donetsk	51.43	14.5	5.79	0.74	0.0026	2.6615	—	146.1581	1.64	1.67	—	1.8	7.2
Zhytomyr	43.17	6.7	3.54	0.15	0.0094	0.5785	—	24.26749	1.89	1.20	—	0.9	2
Transcarpathia	49.79	9.3	2.24	0.14	0.0000	0.2354	—	49.55572	1.69	1.19	—	1.0	24.2
Zaporizhia	48.90	13.6	16.50	0.76	0.0190	1.4751	—	154.2853	1.36	1.91	—	1.9	5.5
Ivano-Frankivsk	55.63	9.3	3.74	0.31	0.0057	0.4640	—	150.2337	1.75	1.10	—	0.9	2
Kyiv	46.03	8.9	2.77	0.34	0.0035	0.9930	—	64.66438	1.38	1.23	—	1.0	4.2
Kirovograd	49.27	11.2	4.52	0.41	0.0001	1.0468	—	59.99869	4.60	1.21	—	0.6	7.2
Luhansk	48.98	11.3	7.35	0.65	0.0863	1.1519	—	114.4536	1.93	1.58	—	1.2	3.1
Lviv	53.30	6.4	4.76	0.79	0.0036	0.6571	—	112.3807	1.92	1.56	—	1.5	5.9
Mykolaiv	49.41	10.5	6.77	0.49	0.0249	5.3694	—	94.32396	2.69	1.25	—	1.1	5.1
Odessa	47.69	7.4	3.32	0.63	0.0118	0.2311	—	119.3399	1.62	1.11	—	1.0	7.8
Poltava	48.64	10.4	7.29	0.42	0.0019	0.8241	—	96.82386	1.70	1.64	—	1.4	1.4
Rivne	49.14	8.1	2.49	0.19	0.0036	0.2872	—	66.14279	1.71	2.39	—	1.7	1.3
Sumy	47.59	10.3	9.20	0.38	0.0000	1.7135	—	76.08679	2.65	1.77	—	1.3	12.7
Ternopil	52.21	5.9	2.29	0.38	0.0631	0.3828	—	173.0869	3.46	0.72	—	0.8	2.3
Kharkiv	54.94	10.2	11.50	1.55	0.0151	2.7267	—	402.903	2.19	2.04	—	2.5	5.3
Kherson	52.46	8.5	4.69	0.29	0.0052	0.4464	—	6.261898	2.33	0.97	—	0.9	7.5
Khmelnytsky	42.61	8.1	3.36	0.16	0.0000	0.3594	—	32.1167	1.27	1.09	—	1.3	3
Cherkassy	47.24	7.4	6.11	0.23	0.0082	0.2657	—	55.37534	0.92	1.37	—	0.8	0.6
Chernivtsi	48.89	7.3	1.19	0.17	0.0124	0.8817	—	51.38926	2.70	1.19	—	0.6	10.5
Chernihiv	44.77	7.2	5.10	0.52	0.0000	2.1109	—	19.88703	4.18	1.40	—	1.0	1.8
City of Kyiv	58.48	9.0	7.45	21.36	0.0116	0.6335	—	678.2795	2.29	2.09	—	8.0	9
City of Sevastopol	59.33	9.8	3.79	1.11	0.0000	0.0651	—	81.93407	1.25	2.31	—	1.9	0.6

Sources: Calculated by the authors according to *Ukraine in Figures 2005.* Statistical Bulletin. State Statistics Committee of Ukraine. Kyiv, 2006, p.247

Scientific and Innovation Activity in Ukraine: Statistical Bulletin. State Statistics Committee of Ukraine. Kyiv, 2005, p.360

Ukraine's Labor 2003: Statistical Bulletin. State Statistics Committee of Ukraine. Kyiv, 2004, p.387

Ukraine's Labor 2003: Statistical Bulletin. State Statistics Committee of Ukraine. Kyiv, 2005, p.369

Regions of Ukraine. Statistical Bulletin: part I. State Statistics Committee of Ukraine. Kyiv, 2005

Regions of Ukraine. Statistical Bulletin: part II. State Statistics Committee of Ukraine. Kyiv, 2005

Table 5

Values of indices used for calculating the RNSII index for Ukraine's regions, 2004

Indices / Regions	1	2	3	4	5	6	7	8	9	10	11	12	13
Autonomous Republic of Crimea	51.17	9.6	3.48	0.50	0.0175	0.79	0	196.93	1.81	1.39	0.73	0.7	12.3
Vinnytsia	46.62	7.7	3.05	0.47	0.0023	0.19	0	127.84	1.71	1.61	0.50	0.9	1.2
Volyn	47.69	7.4	2.88	0.21	0.0000	2.35	0	27.83	0.97	1.37	2.90	0.9	14.7
Dnipropetrovsk	51.90	16.2	7.57	1.26	0.0773	0.40	0	206.17	1.35	2.17	0.45	3.7	4.4
Donetsk	50.14	15.1	5.60	0.73	0.0052	2.18	0	153.25	1.56	1.75	1.30	2.0	3.8
Zhytomyr	43.37	8	2.99	0.12	0.0000	0.28	0	26.00	1.74	1.27	0.67	0.8	3.5
Transcarpathia	49.64	9.9	2.83	0.15	0.0000	0.16	0	42.55	1.33	1.34	0.69	1.0	28.7
Zaporizhia	48.61	15.9	18.02	1.21	0.0551	1.30	0	194.52	1.25	2.00	0.93	1.5	9.9
Ivano-Frankivsk	55.44	10.6	3.06	0.29	0.0090	0.68	0	92.75	1.77	1.17	1.08	1.5	3.3
Kyiv	45.57	9.4	2.73	0.38	0.0027	1.03	0	51.32	1.86	1.30	1.45	1.3	3.5
Kirovograd	49.25	10.7	4.52	0.36	0.0000	0.63	0	44.55	4.55	1.43	1.16	0.9	9.3
Luhansk	47.73	14.8	6.92	0.56	0.0580	0.60	0	128.09	1.53	1.67	0.55	2.0	4.8
Lviv	52.77	7	5.15	0.80	0.0001	0.46	0	107.41	0.86	1.30	1.09	0.9	4.3
Mykolaiv	49.52	11.2	7.31	0.49	0.0319	3.35	0	69.99	1.31	1.21	3.66	1.2	5.9
Odessa	47.77	7.5	3.41	0.66	0.0000	1.02	0.831724	130.58	1.16	1.30	2.21	1.1	7.5
Poltava	48.92	11.7	8.76	0.45	0.0021	0.57	0	97.15	2.35	1.83	0.58	1.8	1.3
Rivne	50.50	10.9	2.61	0.25	0.0059	1.00	0	49.15	1.63	2.55	1.55	1.3	2.1
Sumy	48.08	11	11.15	0.49	0.0028	1.15	0	68.45	1.52	1.84	1.49	1.6	11
Ternopil	52.72	6	2.06	0.31	0.0117	0.07	0	134.37	2.27	0.78	0.33	0.9	2.3
Kharkiv	54.42	10.7	11.48	1.60	0.0095	3.77	0	401.74	2.22	2.33	3.60	3.8	9.7
Kherson	50.45	9.7	4.79	0.27	0.0000	0.59	0	116.12	1.70	0.94	0.94	0.8	6.4
Khmelnytsky	43.31	8.7	3.70	0.16	0.0000	0.17	0	31.77	1.09	1.15	0.52	1.1	3.9
Cherkassy	48.36	8.4	5.90	0.16	0.0000	1.63	0	56.89	1.82	1.40	2.02	1.1	1.2
Chernivtsi	49.03	6.6	1.33	0.20	0.0516	0.70	0	96.87	2.10	1.14	2.13	0.7	26.5
Chernihiv	44.48	8.2	5.51	0.54	0.0000	2.04	0	18.66	2.63	1.32	2.88	1.2	4.3
City of Kyiv	58.14	9.8	7.67	23.00	0.0207	1.36	0.380939	698.26	2.64	2.08	2.55	7.4	14
City of Sevas-topol	57.96	9.6	3.79	1.25	0.0000	0.01	0	188.51	0.41	2.17	0.37	1.8	0.4

Sources: Calculated by the authors according to *Ukraine in Figures 2005.* Statistical Bulletin. State Statistics Committee of Ukraine. Kyiv, 2006, p.247

Scientific and Innovation Activity in Ukraine: Statistical Bulletin. State Statistics Committee of Ukraine. Kyiv, 2005, p.360

Ukraine's Labor 2003: Statistical Bulletin. State Statistics Committee of Ukraine. Kyiv, 2004, p.387

Ukraine's Labor 2003: Statistical Bulletin. State Statistics Committee of Ukraine. Kyiv, 2005, p.369

Regions of Ukraine. Statistical Bulletin*:* part I. State Statistics Committee of Ukraine. Kyiv, 2005

Regions of Ukraine. Statistical Bulletin*:* part II. State Statistics Committee of Ukraine. Kyiv, 2005

As a result of the calculations, we obtained the following values of the regional national summary innovation index for Ukraine's regions (Table 6)

Table 6

Values of the regional national summary innovation index (RNSII) for Ukraine's regions, 2003–2004

Regions	RNSII	
	2003	2004
Autonomous Republic of Crimea	0.0205	0.0299
Vinnytsia	0.0256	0.0208
Volyn	0.0131	0.0109
Dnipropetrovsk	0.0374	0.0319
Donetsk	0.0305	0.0256
Zhytomyr	0.0109	0.0093
Transcarpathia	0.0168	0.0134
Zaporizhia	0.0323	0.0317
Ivano-Frankivsk	0.0298	0.0184
Kyiv	0.0171	0.0127
Kirovograd	0.0179	0.0131
Luhansk	0.0252	0.0225
Lviv	0.0246	0.0196
Mykolaiv	0.0230	0.0164
Odessa	0.0247	0.0219
Poltava	0.0224	0.0189
Rivne	0.0174	0.0131
Sumy	0.0207	0.0164
Ternopil	0.0319	0.0219
Kharkiv	0.0657	0.0545
Kherson	0.0105	0.0206
Khmelnytsky	0.0121	0.0101
Cherkassy	0.0159	0.0138
Chernivtsi	0.0157	0.0188
Chernihiv	0.0112	0.0094
City of Kyiv	0.1053	0.0896
City of Sevastopol	0.0213	0.0290
Average value	**0.0259**	**0.0227**

Source: Calculated by the authors.

The dynamics of changes in the RNSII of Ukraine's regions for 2003-2004 is presented in Fig.1.

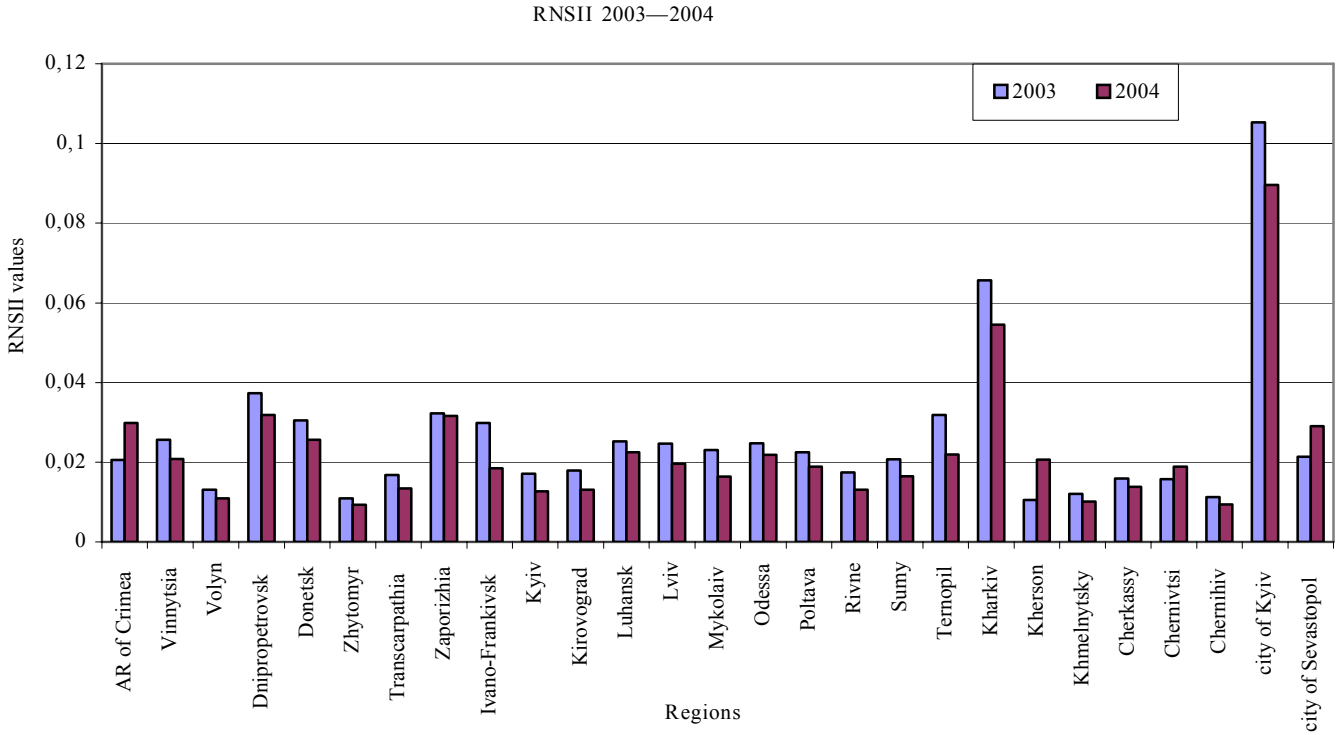

Fig. 1. Dynamics of the changes in the regional national summary innovation index (RNSII)
of Ukraine's regions for 2003—2004

Source: Compiled by the authors on the basis of Table 6.

On the basis of the analyzed innovation capability of Ukraine's regions we can single out the following trends in the development of regional innovation in 2003—2004:

1. Ukraine's regions are obviously different as regards the level of their innovation development. There are four distinct groups: regions that are undoubted leaders; regions pursuing the leaders; regions with an average level of innovation development; and regions-outsiders. The regions were thus grouped by comparing individual RNSII values with the average level of a given index for the country as a whole.

a. Among the unchallenged leaders (city of Kyiv and Kharkiv oblast) the RNSII index ranged from 0.657 (Kharkiv oblast) to 0.1053 (Kyiv) in 2003 and from 0.0545 to 0.0896 in 2004, i.e. three to four times higher than the average index for the country as a whole (0.0259 in 2003 and 0.0227 in 2004). The successes of these regions are explained by their traditional role in the political-economic and public life of the country. As the capital of Ukraine, Kyiv is somewhat of a concentration point from which are redistributed the key production resources (information, intellectual, financial) and a center of strategic decision-making. Kharkiv oblast is one of the leading industrially developed regions and at the same time a recognized leader in such high-tech sectors as mechanical engineering, instrument making, manufacture of electric and transportation equipment. The leading positions of these two regions are explained by the following factors: size of population with a higher education; number of people employed in high-tech services; total number of registered patents; expenditures for innovation activity in the area of services.

b. The second group of regions (Dnipropetrovsk, Donetsk, Zaporizhia, Luhansk and Ternopil oblasts) has a RNSSI value that exceeds (or approximates) the average level for the country. These regions (except for Ternopil oblast) are close behind the leaders by such indicators as size of population with a higher education; number of people employed in high-tech services; private expenditures for R&D; share of

enterprises engaged in innovation activity in the area of services; as well as (along with Ternopil oblast) by the total number of registered patents. Moreover, according to some indicators, the pursuing regions exceed the leaders. For example, Dnipropetrovsk, Donetsk, Zaporizhia and Luhansk oblasts hold first place as to their residents' lifetime education, while Dnipropetrovsk, Zaporizhia and Luhansk oblasts have the highest number of employed in medium high-tech and high-tech sectors. It means that the regions of this group have the potential to join the group of leaders.

c.In the regions with an average level of innovation development (Autonomous Republic of Crimea, Vinnytsia, Ivano-Frankivsk, Lviv, Mykolaiv, Odessa, Poltava and Sumy oblasts and the city of Sevastopol), the RNSII values are below the average index for the country. They are close to the second group of regions by such indicators as size of population with a higher education; number of people employed in average high-tech and high-tech sectors (Lviv, Mykolaiv, Poltava and Sumy oblasts); number of people in high-tech services (Autonomous Republic of Crimea, Lviv and Odessa oblasts as well as the city of Sevastopol); and total number of registered patents (all regions of this group). Moreover, in 2003 Mykolaiv oblast ranked first in the country in terms of the level of private R&D expenditures, and Vinnytsia oblast ranked first in terms of the share of industrial enterprises engaged in innovation activity. In 2004 Odessa oblast led in the number of patents registered in high-tech sectors.

d.In the region-outsiders (Volyn, Zhytomyr, Transcarpathia, Kyiv, Kirovograd, Rivne, Kherson, Khmelnytsky, Cherkassy, Chernivtsi and Chernihiv oblasts) the RNSII values are much lower than the average for the country. Yet by the size of population with a higher education they are negligibly behind the three preceding groups. Moreover, in 2003-2004 the Transcarpathian oblast was a leader in proceeds from the sale of innovation products, while in 2004 Kirovograd ranked first in the share of industrial enterprises engaged in innovation activity.

2.2004 saw a downward trend in the level of innovation capability of Ukraine's regions compared to 2003 (except for the Autonomous Republic of Crimea, Kherson and Chernivtsi oblasts, and the city of Sevastopol). The average value of RNSII in 2003 was 0.0259, while in 2004 it was 0.0227 (i.e. only 87 % of the year before). This is explained by a general political crisis in the country and, accordingly, a worsening environment for foreign business. These macroeconomic factors caused such negative trends as reduction in industrial enterprises engaged in innovative industrial activity (1,140 in 2003 and 958 in 2004[53]) and fewer people employed in average high-tech and high-tech sectors of industry (1,269,400 in 2003 and 1,242,100 in 2004[54]), which had a negative impact on the innovation capability of the regions.

3.All regions have the following common features:

— a very high proportion of population with a higher education (≈ 50 %);

— an extremely low level or complete lack of state funding of R&D (in 2003 — Autonomous Republic of Crimea, Sumy and Chernihiv oblasts, and city of Sevastopol; in 2004 — Volyn, Zhytomyr, Transcarpathia, Kirovograd, Odessa, Kherson, Khmelnytsky, Cherkassy and Chernihiv oblasts, as well as the city of Sevastopol);

— minimal patenting by enterprises in high-tech areas (according to 2004 data, only Odessa oblast and the city of Kyiv registered patents in the high-tech sectors);

— a negligible share of enterprises engaged in innovation activity both in industry and services;

— an insufficient level of employment in high-tech services (except for Kyiv), which reflects the traditionally industrial orientation of Ukraine's regions.

4. According to their level of innovation capability, Ukraine's regions are sharply divergent. For instance, in 2003 the leading region (city of Kyiv) exceeded the outsider — Kherson oblast — ten times; and in 2004 it exceeded Zhytomyr oblast 9.6 times.

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[53] *Scientific and Innovation Activity in Ukraine: Statistical Bulletin*, 2005, p.220

[54] Reference data of the state enterprise, «Information and Analytical Agency, 2005

The innovation systems of the regions are very inefficient because of the lack of funding of R&D both by private companies and, especially, the government; the venture mechanism of support programs of innovation development is underdeveloped; and the interaction of the private and state sectors in the implementation of promising scientific and technological projects is inadequate. In our opinion, it is advisable to stimulate the innovation processes at the meso level, proceeding from the principle of polarized development, as embodied in the *State Strategy of Regional Development for 2015*[55]. It provides for the establishment of «focal regions» (poles, prime movers of growth), in which are concentrated financial, administrative, managerial, human and other resources to be used for the subsequent invigoration of innovation activity in other regions. Other countries applied this principle at the outset of their socioeconomic development when the innovation wave was just taking shape and expanded due to its concentration in individual «poles of growth.» In our opinion, among the promising territories for setting up «focal regions» are the leading regions of Kyiv and Kharkiv oblast and the second group of regions (Dnipropetrovsk, Donetsk, Zaporizhia, Luhansk and Ternopil oblasts) who have enormous experience and traditions as well as a powerful resource base for the development of high-tech sectors and are in a position to set up highly efficient regional innovation systems.

Conclusions

After analyzing and systematizing a broad spectrum of theoretical and analytical sources related to the issues of setting up regional innovation systems and their role in elevating the international competitive status of national regions, we arrived at the following conclusions:

[55] *State Strategy of Regional Development to 2015,* www.nau.kiev.ua.

— Given the growing localization of innovation activity worldwide, the formation of efficient regional innovation systems is an important precondition for elevating the international competitive status of national regions in the long-term outlook. As a result, priorities in the competitiveness of national economies will shift from the macro level to the meso level, which requires further theoretical examination.

— The concept of regional innovation systems is a theoretical foundation for framing local strategies of innovation development as a component part of a national innovation strategy. Especially important in this context is further study of the theoretical operational principles of RIS under global competition as well as the interaction processes in the RIS-NIS system. Moreover, it is necessary to analyze the «resonance effect» of innovations proliferation, which consists of disseminating positive technological externalities, as well as to disseminate best practices in the design and implementation of innovation development programs from the leading regions to the regions-outsiders. Such studies, in turn, will promote the elevation of the competitive status of both individual national regions and the country as a whole.

— The implementation of an innovation strategy of regional development requires the application of a comprehensive technique of evaluating the operational efficiency of a RIS in order to offer recommendations for its improvement. Among the most widespread technique to date is the evaluation of regional innovation performances (RIP) designed by experts of the European Commission as a component part of the general European Innovation Scoreboard (RISc). In this study, the authors adapted this technique to evaluate the innovation capability level of Ukraine’s regions. The difference between the national system of statistical accounting and the general European standards complicated the calculations. We believe that the continued harmonization of the Ukrainian and European systems of statistical accounting requires the all-round support and attention of the Ukrainian government.

— After evaluating the innovation capability of Ukrainian regions for the period 2003—2004 according to the technique of the European Commission, we can state that the level of the national region's innovation competitiveness is low and, accordingly, the development of the Ukrainian RIS is rudimentary; we also revealed a number of negative trends in regional innovation development. First, there is a considerable differentiation of Ukraine's regions as regards the level of innovation development. Second, there is a downward trend in the innovation capability of the national regions. Third, we have observed a deepening divergence of the regions by their levels of innovation capability. In our opinion, the development of these destructive processes is explained, on the one hand, by the low level of interaction of the economic entities in the state-research institutes-enterprises triangle and, on the other hand, by the lack of systemic links in the generation-diffusion-commercialization of innovations chain. For these reasons invigorating local innovation activity and elevating the competitive status of national regions are the priorities of regional development. In the *State Strategy of Regional Development to 2015* it is recognized that the strategic objectives of state regional policy are, in particular, to raise the regions' competitive capability by stimulating the innovation trend of production of enterprises and venture business as well as introduce an effective mechanism of legal, financial, organizational, personnel, and educational support of promising innovation projects[56]. However, within the context of implementing the *State Strategy of Regional Development to 2015*, there is an urgent need for a theoretical foundation for the design and implementation of definite innovation development programs in order to establish efficiently operating highly competitive regional innovation systems.

The level of the innovation activity of individual national regions depends very much on the ef-

[56] Ibid.

ficiency of a regional innovation system, namely: the availability of a developed mechanism for technologies transfer, an efficient innovation infrastructure and institutional structure, as well as the establishment of informal partnership relations between economic entities to promote the diffusion of new knowledge. It is precisely the development of a regional innovation system as a powerful catalyst of local innovation activity that is a necessary precondition for raising the international competitiveness of a region under the conditions of knowledge economy creation.

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