EVOLUTION OF NATIONAL INNOVATIVE SYSTEMS IN THE INFORMATION SOCIETY OF ADVANCED EAST ASIAN COUNTRIES

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Abstract: *The main purpose of this article is to publish the results of studying the experience of the advanced East Asian countries in achieving the competitive advantages of the national innovation system in the process of improving the information society (IS).Achieving this goal predetermined the need of articulating the author's interpretation of the evolution of the National Innovation System (NIS) into the National Innovation Ecosystem (NIES). In the course of the research, general scientific principles of cognition of economic phenomena were used - methods of systemic, logical, structural, factorial and comparative analysis. Result of the research is that on the basis of generalization of foreign and domestic experience, practical implementation of the mechanism of achieving competitive advantages as a partnership of scientists, the state and business has been identified at the present stage of the IS. The main conclusion from the study: the greatest competitive reserve is created, according to the author, by the evolution of NIS in the NIES. The essence of this evolution is the achievement of economic development based on the creation and implementation of such innovations that provide economic growth with respect for the environment, and through the nationwide unification of interactive networks created on the basis of innovative clusters and encompassing all leading actors (scientists, representatives of business and state structures).*

Key words: *National Innovation System, National Innovation Ecosystem, innovations, NBIC-convergence*

JEL codes: *F55, F63, O33, O43, O53*

1. Introduction

In the postindustrial era, economic and social development entered a phase of a qualitatively new state, called the Information Society.

The Information Society (IS) is a society based on the ubiquitous introduction of information and communication technologies (ICTs), with a dynamic economy and high per capita income, education and health indicators aimed at innovative development, increasing international competitiveness and the welfare of the country. Formation and development of IS influences the formation of competitive advantages in two ways: strengthening traditional competitive advantages and developing fundamentally new competitive advantages of the information era. Realization of these competitive advantages, economic effects of three types (scale effects, coverage effects, agglomeration economies based on spatial agglomeration of knowledge), obtained during the construction of the IS, and the succession of development factor bring the advanced countries of the information stage competitive advantages in comparison with the countries of the industrial paradigm.

The construction and development of a national information system is accompanied by the formation of a global information space. This process as a whole contributes to the innovative development and competitiveness of the national economy, but it also has negative consequences. That is why the process of

building IS requires regulation by the state to stimulate positive and reduce negative effects, and a multidisciplinary approach to studying the theory of IS and to the construction of strategies for its development is relevant. The identification of "best practices", strategies, tools for economic growth and the enhancement of the international competitiveness on the basis of IS development presupposes the definition of a circle of countries whose experience has theoretical and practical significance for the fatherland. Among the countries in which the construction of IS was favorable to the development of competitive advantages, and their implementation – turning into the richest countries of the world include the advanced countries of the Asia-Pacific region. We focus our research on the subsystem "East Asia and Oceania" in order to highlight the specifics of the formation of competitive advantages of IS in the East Asian countries, which demonstrate stable growth rates even in the conditions of worsening of the global conjuncture. Development priorities have now been shifted from the task of increasing the global competitiveness of key industries to meet the challenges of sustainable development, and therefore the experience of these countries in achieving sustainable development seems highly topical.

The world experience of innovative development testifies to the key role of a person. Formation of innovations and national innovation systems of each country is the result of the synthesis of material (financial, production), human (peculiar to individuals) and social (characterizing the relationship between people) capital. The main purpose of this article is to publish the results of studying the theoretical approaches and strategies of the advanced East Asian countries on the development of national innovation systems in the process of improving the information society.

Achieving this goal predetermined the need to formulate an author's interpretation of the evolution of the National Innovation System (NIS) into the National Innovation Ecosystem (NIES) as the national and the global Information Society (IS) improved. The scientific novelty of the research is that on the basis of generalization of foreign and domestic experience, practical implementation of the mechanism of achieving competitive advantages as a partnership of scientists, the state and business has been identified at the present stage of the IS.

2. Methodology and Data

The author's research methodology includes an approach to analyzing the competitive advantages of the IS in three perspectives: building the IS's infrastructure, the intensity of the use of ICT products and services, and the impact of the IS on the creation of social and economic effects, and in three contexts: informatization of the society and the formation of the ICT sector, dynamics of the international competitiveness and improve the National Innovation System.

The research used general scientific principles of cognition of economic phenomena – dialectical, concrete historical, systemic and other approaches, and general scientific methods of systemic, logical, structural, factorial and comparative analysis. The information-theoretical basis of the research was the fundamental concepts of domestic and foreign scientists, materials of international organizations, information and analytical materials of national research institutions.

The works of Western and Russian scientists are widely known in Russian scientific circles. The works of East Asian researchers are much less known. Among the works of South Korean authors on the given problems can be identified the works of Dong-Sung Cho, Hwy-Chang Moon, Min-Young Kim, I.D. Koh, J.H. Lee, B.K. Cho, I.K. Cheong. Among the works of Japanese scientists are the works of Shiro Hioki, N. Okamoto. Among the works of Singaporean scientists – the works of Pallab Saha.

3. Results and Discussion

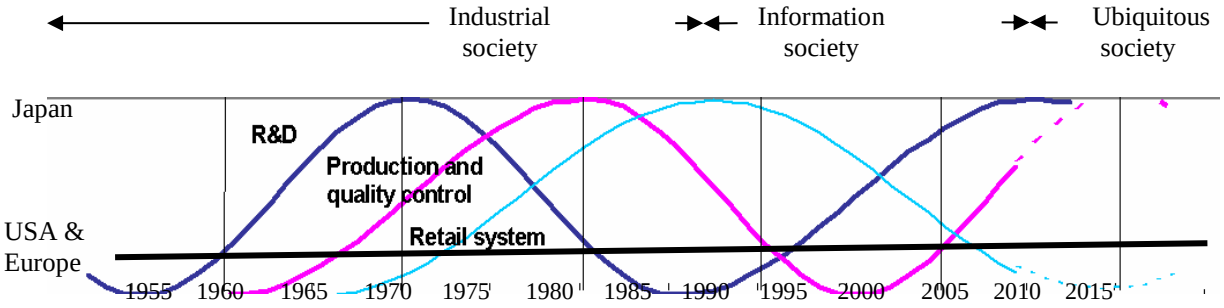
Modern society, created in the most developed countries, is called a "post-informational society", an "ubiquitous society". In accordance with the concept of the ubiquitous society, the development paradigms of Japan, for example, were replaced as follows: industrial society (1980-1990); the information society (1991-2000); transition to the post-informational society (2001-2004). Paradigms for the development of information technology in South Korea are as follows: Information Society (1993-2003); transition to building an ubiquitous network society (2004-2005); the phase of the formation of the foundations of the ubiquitous network society (2006-2010); the phase of stabilization of the ubiquitous network society (2011-2015) (Republic of Korea, 2007). The concepts of the ubiquitous society, the intellectual ("smart") society and the now-replaced "Giga-society" formed the basis for modern state programs in South Korea.

Finding ways to solve the problems of the innovation economy presupposes their consideration in three dimensions: science, state participation and innovative business. Theoretical aspects of the need for innovation and problems on the way to their implementation are related to the effectiveness of the functioning of development institutions, the role of the state in the formation of an innovative economy, the development of innovative business, beginning with the earliest stage of its emergence (Shilov, 2011). Modern economic theory

identifies several sources of economic growth: capital accumulation, new technologies, property rights, contract enforcement, rent-preventing institutional system. Another source is new social technologies (Eggertsson, 2011).

The development of the IS on the platform of intellectual ICT facilitated the transition of the considered countries from the concept of the National Innovation System (NIS) to the concept of the National Innovation Ecosystem (NIES). Among the Asian Pacific Region (APR) countries under consideration, Japan has made the most progress towards transforming its innovation system into NIES. A feature of this process is the so-called mutually inspiring co-evolutionary development cycle with the United States (and European countries, which together with the United States form a single subject of competition for Japan, see figure 1).

Fig. 1 Cycles of "mutually inspiring coevolutionary development"



Source: Fukuda and Watanabe (2005)

Figure 1 illustrates how, within the cycles of such development (in the field of scientific research since the 1950s, production and quality control since the 1960s and retail trade after 1965 and in the transition from industrial to information, and from information to the "omnipresent" society), competitive superiority passes from Japan to the US and from the US to Japan. Judging by the picture, in the conditions of the "ubiquitous" society and in the process of NIES formation, it is expected to achieve Japan's competitive superiority over the USA (and Europe).

In order to arrive at an opinion on the return of competitive superiority on the basis of "coevolutionary development," it is necessary to confirm this conclusion with data on the growth of the ICFTU and establishing the degree of tightness of communication to which independence and national security of the less powerful partner remain in the "coevolutionary" bundle. In the author's opinion, at the moment, in the "bundle" of "co-evolutionary development", Japan is a less powerful partner than the United States, and such "co-evolution" undermines Japan's ability to develop independently and consolidates the competitive advantage of a stronger partner, such as the United States. Contrary to Japan's optimistic expectations of an early return of the competitive advantage over the US, there are problems in the country's NIEC that can prevent these expectations. The weakest "links" are: disunity between the participants in the innovation process (research, educational, government agencies, private companies); a major lag in the sphere of venture business; the aspiration of the most highly profitable and advanced Japanese firms to the world markets and the prevalence among the relatively low-cost firms remaining on the domestic market, clinging to traditional technologies and business models.

Technological basis of the current stage of development of the world economy is information technology (IT), which is a product of innovation, developed through innovation and, in turn, provides the necessary technical capabilities for the implementation of inventions and the introduction of innovations. Contrary to the seemingly inexhaustible potential, IT is approaching the limit of its capabilities. Going to a qualitatively new stage of development allows their convergence with biotechnology, nanotechnology and cognitive science, called NBIC-convergence.

The term was introduced in 2002 by American authors of the so-called "tetrahedral" concept of the interconnection of convergent technologies by Roco and Bainbridge (2003). The concept was called "tetrahedral", because it is structurally related to four basic ideal elementary nanoobjects: atoms, genes, neurons and bits, symbolically located at the tops of a tetrahedron, and nanoobjects are the focus of synergetic integration. By the authors' definition, convergence is realized as a synergetic combination of four rapidly developing areas of science and technology: 1) nanotechnology and nano-sciences; 2) biotechnology and biomedicine, including genetic engineering; 3) information technology, including advanced computing and new means of communication; 4) cognitive sciences, including cognitive neurosciences.

The modern concept of technology convergence differs from the approach of Castells, and from the concept of "improving human functionality." First, at present, thanks to the achievements of nanotechnology, a person

has for the first time found adequate tools for the radical transformation of not only technologies, but also himself as a species. Secondly, the acute statement of the problem of the social significance of the processes of convergent evolution and the methods of their management gave grounds to speak no longer of the NBIC system, but of the NBICS-convergence system, which includes the fifth component of "S", social technologies.

NBIC-convergence leads to the emergence of new competitive advantages, including the development of relationships related to creative and cognitive activities and the "new revival" (www1), based on new, transformed tools and a comprehensive understanding of the laws of the physical world, i.e. a qualitatively new stage of human development. Another important consequence of the NBIC convergence is a powerful impetus for development and increasing the competitiveness of the National Innovation System (NIS).

The initial interpretation of the NIS involved concentrating on science and technology as the main factors determining the environment in which firms operate, and the approach was dominated by a focus on high-tech industries and science, primarily focused on the Russian Academy of Sciences. One of the key fundamental problems of the modern world faced by the state when trying to influence innovative development is that there is no common model for all countries of a successful National Innovation System (NIS) that could be considered universal (Ivanova, 2016). In the Russian economic literature, attempts have been made to identify problems that the concepts of the NIS should solve, describe the main characteristics of the approaches to the analysis of NIS that have arisen on its basis, their merits and demerits. On the basis of the system structural-objective and functional approaches to the analysis of the national innovation system, a variant of the development of the NIS theory is proposed (Golichenko, 2014). Representatives of Russian scientific schools use their experience in analyzing foreign economic relations, studying foreign economic policies and forecasting world development in Russian consulting (Kuznetsov, 2015). So, for example, the necessity of carrying out a differentiated regional innovation policy based on the principles of "smart specialization" is substantiated. Based on a review of foreign experience and analysis of publications, the basic directions of the new policy are proposed, related to the preservation of human capital, the formation of innovative entrepreneurship and the intensification of horizontal links (Zemtsov and Barinova, 2016).

By the end of the 1990s the NIS concept has developed into a broader context, including the entire set of interrelated organizations (structures engaged in the production and commercialization of scientific knowledge and technology within national borders, including small and large companies, universities, laboratories, technology parks and incubators) and a set of institutions of legal, financial and social character, providing innovative processes and having strong national roots, traditions, political and cultural characteristics (Dynkin and Ivanova, 2004), as well as thesis about the determining influence of national features of the country's historical development on the level of development of technology and innovation. The concept of NIS has become the main theoretical direction in the study of technological progress and the development of policy in the field of science and technology.

As the national and global information society (IS) develops, the transition from the concept of NIS to the concept of the National Innovation Ecosystem (NIES) as an institution of a higher paradigm of IS and sustainable economic development is carried out.

The essence of the NIES concept is as follows. Sustainable development requires such innovations that will contribute to the achievement of the threefold goal of economic, environmental and social well-being: innovation should increase productivity and generate new value to meet higher standards of living while reducing resource use and environmental impact. Such innovations will be implemented through interactive networks covering all closely interacting stakeholders in the public and private sectors. The complex multidimensional complex of these conditions (careful interaction with the environment and networks of interacting stakeholders) forms an innovative ecosystem in which the three stages of interaction are distinguished: coexistence, co-evolution, co-adaptation (Fukuda and Watanabe, 2012). Thus, the concept of "national innovation ecosystem" is postulated in the perspective of the role of innovation for careful interaction with the environment, sustainable development and the formation of networks of interaction.

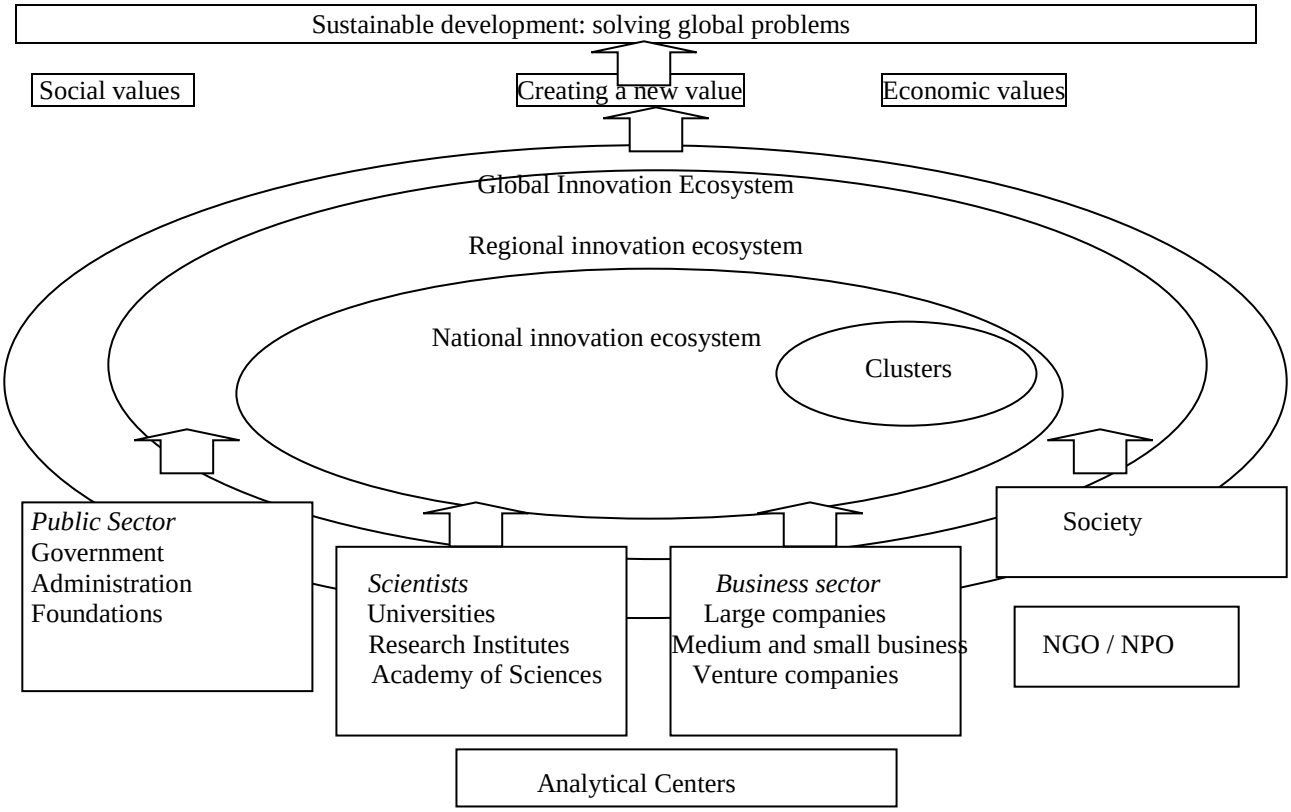
Many of the problems that threaten social stability affect not only individual countries, but the world as a whole, so an innovative ecosystem that addresses the problems of safe and sustainable development will develop not only at the national, but also at the regional and global levels. This system covers scientists, the public sector, industry, universities, research institutes, analytical organizations, non-governmental organizations (NGOs), and non-profit organizations (NPOs).

Every actor plays a role in creating innovations:

- society signals to scientists about their needs and requests;
- scientists generate scientific knowledge;
- the government and administrative bodies financially and organizationally support the creation of scientific knowledge and innovative goods and services by creating the necessary institutions and funds to ensure a public environment that favors innovation;
- large corporations, small and medium-sized enterprises (SMEs), venture companies produce innovative goods and services;

- think tanks (research institutes, political institutes, etc., that carry out research in the field of science and technology, social policy, political strategy, economy, military industry, culture, most political institutions are non-profit organizations, other think tanks are funded by governments, support groups, businesses or receive income from consulting or research related to their projects) provide consultations;
- NGOs and NPOs contribute to interaction between subjects of innovation and civil societies (figure 2).

Fig. 2 The structure of an innovative ecosystem aimed at addressing global problems of sustainable development



Source: Center for Research and Development Strategy of the Japan Science and Technology Agency (www3)

Scheme of the partnership scientists-business-state:

1. Statement of the problem:
   - scientists of universities, research institutes, academies of sciences, in collaboration with experts from think tanks, identify medium and long-term perspectives of society and potential threats, analyze the social consequences of threats from various points of view, formulate a specific problem that needs to be addressed;
   - based on the recommendations of scientists, the government and administrative agencies are building the necessary changes mechanisms to solve the problem.
2. Basic design of the solution to the problem:
   - through the efforts of scientists, in partnership with the government and administrative agencies, a new integrated science and technology is created and an organic link is established between the creation of knowledge and the development of technologies to solve a particular problem;
   - scientists, business and public sector representatives, with the support of think tanks and NGOs / NPOs, contribute to strengthening the scientific-business-state partnership, joint international open research, the formation of consortia and research centers in order to find the optimal ratio between the results of scientific and technological progress and the safety / comfort of society.
3. Implementation of the solution in society:
   - based on the basic design of the problem solution, leading actors (scientists, business, public sector, NGOs / NGOs, analyst center specialists) create the necessary environment and systems by creating institutions in specially organized zones (clusters);

- on the basis of a close partnership between scientists and the business state and the formation of regional consortia and an innovative network, actors expand international links between the creation of knowledge and the development of technologies to solve the problem.

4. Development of a unified system for joint promotion of the solution of the problem:
   - scientists, representatives of business and public sector jointly build a network of research and development work aimed at solving the problem;
   - the public sector focuses on creating a mechanism in which the relevant government bodies (administrative agencies) would coordinate their administrative activities for conducting research in full;
   - in order to support the career aspirations of people engaged in full research to solve the problem, the public sector assesses the degree of contribution to the solution of the problem and provides work in administrative institutions or NGOs / NGOs through a partnership of business scientists-NGOs/NPOs;
   - on the basis of the partnership between scientists and the business state, a system is built in which the countries of the region (and then the world as a whole) cooperate in a full cycle of studies aimed at solving the problem and support the necessary exchange of talents, knowledge and resources.

4. Conclusions

The study revealed the transition of the advanced East Asian countries of the APR to the paradigm of a higher level of IE, characterized by the stability of economic development – to the paradigm of the "post-informational", "omnipresent", "intellectual" society.

The greatest competitive reserve is created with the improvement of the IS and the transition to the post-IO paradigm by the evolution of the NIS in the NIES. This is due to the essence of NIES, which is to achieve sustainable economic development based on the creation and implementation of innovations that ensure sustainable economic growth while respecting the environment. This competitive reserve is realized through the nationwide unification of all interactive networks created on the basis of innovative clusters into a single system and encompassing all leading actors (scientists, business representatives and government agencies).

In order to formulate an innovation policy (including IT policy), it is useful for researchers and industry experts to come together and discuss how to shape the future: a new wave of technology driven by the ongoing fourth industrial revolution (Industry 4.0) and its associated policies the creation of new ideas, relationships, networks, not on a "top-down" basis, but in partnership and in strengthening the impact of social, ethical and legal aspects – and inspiration.

On the construction of the partnership system, scientists-business-state should focus new interdisciplinary research (new integrated science and technology) as a new tool for the development of innovation and the evolution of the National Innovation System in NIES.

Research methods of promoting this evolution is expedient to carry out based on the concept of the Triple Helix of Knowledge (www2). The model of innovation development in the "Triple Spiral" includes three main elements: (1) strengthening the role of universities in interaction with industry and government in a society based on scientific knowledge; (2) three institutes (University, Business, Power) aspire to cooperation, while the innovative component derives from this interaction, rather than at the initiative of the state; (3) each of their three institutions in addition to traditional functions "partly assumes the role of another" (The concept of the Triple Helix model). Institutes that are able to perform unconventional functions are considered to be the most important source of innovation.

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