

## The national innovation system: the conditions of its making and factors in its development

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**Abstract.** This article examines general issues in the formation of national innovation systems amidst social-economic transformations. The author generalizes and structurizes the major elements of the national innovation system, systematizes its functions, classifies critical factors in its evolutionary development, and brings to light the role of the innovation system in forming a platform for the sustainable development of the global economy and national economies that make it up. The article demonstrates that the development of the national innovation system involves, based on the sustainable development concept, a consistent change of priorities in terms of searching for, developing, testing, and adopting all kinds of innovation.

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### Introduction

“Mankind entered a new epoch in its development. This happened unexpectedly and unnoticeably” [1]. The unexpectedness and unnoticeableness of the change of epoch, and, therefore, that of the technological mold as well, has become the primary factor behind the inability and unpreparedness of small and large social-economic systems, into which the national innovation system is incorporated as a component element, to pass on to a new stage of evolution, a new stage of development. Innovations are the key stimulus for civilized development at this stage of the World-System’s evolution [2], but, in actuality, the significance of innovations, their system-forming qualities and properties have not been brought to light to the fullest so far. The actualization of further theoretical-methodological investigations into the systemicity and multidimensionality of the effect innovations have on the formation and development of small and large social-economic systems is undoubted – as undoubted and objective as the role of innovations in forming national innovation systems, which, in turn, transform in essence the development of the national economy, leading it to sustainable growth [3].

### Methods

This article examines in a methodologically integrated manner the characteristics of constructing national innovation systems based on the theory of systems and systems analysis.

### Main part

It has already become customary in modern scientific literature to use the term “system” and terms derived from it (e.g., “systemic approach”, “systems analysis”, “systematization”). Quite often the term “system” is perceived as a philosophic term formed back in antiquity. In reality, that is not the case. In ancient philosophy, they most often used the term “the whole”, and systemic ideas were of an episodic nature in the ancient world.

The ideas of systemicity received the widest circulation during the epoch of Renaissance; attempts were made in the philosophy of New Time to impart consistency and complexity to the theory of systemicity. The theory of systemicity, in essence, has naturally scientific origins, since the making and enrichment of natural sciences with discoveries showed that the world around us has a physical systemic build. And the first works on the theory of systems were presented by A.A. Bogdanov in the early 20<sup>th</sup> century (1912). Currently, there are two major components to the general theory of systems: applied and theoretical.

In terms of theory, a system is to be construed as an articulate, mutually jointed multitude that reflects the objective existence of specific particular mutually-jointed aggregates of bodies and does not contain specific limitations characteristic of private systems. This definition associates a system with such attributes as being a self-propelled aggregate, interrelationship, interaction, and capacity for development.

Note that when it comes to theoretical-applied definitions of a national-innovation system, this term, apart from the interconnectedness of elements, is also characterized by the institutionality and hierarchicalness of elements that make up a system and their special mechanism of interaction. We can also view the national innovation system as an aggregate of all forms of ownership and mechanisms of their interaction, based on which activity on creating, storing, and spreading new knowledge and technology is effected [4].

Particular studies by world classics contain a view that national innovation systems should be considered as some kind of an institutional network that encompasses the state and private scientific and production sector. The operation of the national innovation system facilitates spreading innovation technology [2]. This definition continues the idea of B.-Å. Lundvall, who maintained that the national innovation system is represented by an aggregate of elements (economic entities and institutes), the interconnectedness and interaction of which is directed towards effecting, supporting, and promoting innovation activity [5].

In this regard, other authors, who also espouse the idea of the institutionalizedness of the national innovation system, hold that this system includes six primary sectors as its major elements [6]:

1. the business sector (micro-, small, and medium entrepreneurship, large and the largest corporate establishments);
2. the state sector (the bodies of national and regional executive authority administering activity in support of innovation),
3. the scientific-research sector (educational, academic institutions, scientific-research institutes);
4. the sector for technology transfer and mediation (technoparks, technopolises, business-incubators, clusters, technology-development and special economic zones);
5. the public sector (organizational and open-to-innovation civil society);
6. the partner sector (foreign partners in innovation activity).

All the above sectors, as the elements of the national innovation system, are dynamically dependent, while the functional and organizational interconnections between them should be regarded as both the mechanism for interaction and the generator of the search for, production, and adoption of various kinds of innovation (organizational, economic, social, technological, etc.).

On the whole, while we agree with the institutional concept of the national innovation system, we find it necessary to provide our own fine-

tuned definition of this term. The national innovation system is an institutionalized dynamic aggregate of elements represented by six major sectors which interact through a special mechanism that incorporates vertical hierarchical and horizontal network relations. The operation of the national innovation system is directed towards searching for, producing, testing, and adopting all kinds of innovation with a view to ensuring the sustainability of social-economic development at the national and global level.

There are several major functions fulfilled by the national innovation system, the most significant whereof are:

- developing and formulating national innovation policy;
- forming and regulating the statutory-regulatory, organizational, and economic space with a view to producing innovation;
- selecting and arranging scientific-innovation priorities in national social-economic development;
- aggregating, mobilizing, distributing, and redistributing the major types of resources needed for conducting innovation activity;
- stimulating innovation activity at the microeconomic and macroeconomic level;
- creating non-material assets and the national base for developing human potential and accumulating intellectual capital;
- ensuring support of new production, service, and other branches of the national economy.

The capacity of the national innovation system for evolutionizing and quality progressive development depends on many factors, which can generally be classified as stimulating and destimulating (Table 1). [The table was developed by the authors through aggregating theoretical and methodological concepts on the subject under study.]

**Table 1 – Factors in the evolutionizing of the national innovation system**

Stimulating factors	Destimulating factors
1) changes in the dynamics and quality of national and global social-economic growth; 2) changes in consumer behavior and consumer demand; 3) potential crisis-proneness of the traditional economic mold; 4) social-economic globalization and global competition based mainly on knowledge; 5) growth of the impact of the knowledge component in the economy and society (knowledge diffusion); 6) informatization of economic-technological and social-political processes	1) the detachedness of the scientific sector from the rest of the sectors of the national innovation system; 2) insufficient innovation activity in the entrepreneurial sector; 3) high costs of innovation with long times for payoff; 4) imbalance in government support of innovation activity in the sectors of the national innovation system; 5) insufficient developedness of the national innovation infrastructure; 6) insufficient dissemination of the positive experience of innovation activity (resistance to innovation)

It is apparent that the factors destimulating the development of the national innovation system lead to the latter's instability and, in essence, to the

elimination of stimuli for evolutionizing in the long run. The national innovation system, in its aspiration towards preserving its stability, is characterized by the dialectics of two processes, which can be directed differently. These are development processes and operation processes.

The operation of the national innovation system involves preserving stability over a relatively long interval of time. At the same time, development, on the contrary, means that the national innovation system has to lose in stability and equilibrium in order to acquire qualitatively new properties. These properties, at each subsequent step, on the one hand, form, as they accumulate, stimuli for the evolution of the system and forming a new order, and, on the other, ensure a base for passing on into a quality state. From this we can infer that the development of the national innovation system is possible only on condition of regular loss in stability and recovery afterwards. This means that the national innovation system ought to have capacity for self-organization.

The founder of synergetics, H. Haken, held that self-organization should be regarded as a process that involves spatial, temporal, and/or spatial-temporal ordering due to there being interaction between a multitude of elements making up said system [7].

The definition by H. Haken leads us to conclude that the national innovation system ought to have capacity for not only self-organization but self-regulation so that the processes taking place could have capacity for change under the regimens of chaos (loss in stability) and order (forming a new stable state).

Note that according to the UN concept of sustainable development, the development of the national innovation system is considered sustainable only when objectively there is "...development inclusive of the needs of today's generations, with no threat to meeting the needs of generations to come..." [8].

In relation to social-economic systems and innovation systems they incorporate, sustainable development, in our view, can be regarded as a process of actualizing the strategy of development predicated on the concept.

Sustainable development is a dynamic model for the development of society, which provides for the actualization of the primary objective based on fairness, creating ample opportunities for all, reducing inequality, improving the basic standards of living, fair social development, and conserving our ecosystems. Hence, we can say that the sustainable development of social-economic systems and innovation systems they incorporate implies a process of their operation through the effective use of resources with a view to attaining the primary

strategic objective – ensuring the sustainability of said systems and that of the World-System as a whole based on the safe and harmonious life-activity of today's and future generations.

Since the innovation environment and the innovation system operating in it are the basis for the innovation transformations of social-economic systems of various scales and levels, the innovation system, consequently, provides for operation and provides stimuli for the search for specific dimensions of sustainable development for all economic agents and society as a whole. The innovation environment fulfills a transportation function, taking innovation produced by the innovation system to the level of social-economic systems and the global environment. Note that, there being a structured innovation system and an optimum innovation environment means a priori obtaining global, national, and local effects. These effects can be expressed in the following major aspects:

- the economic-financial aspect of sustainable development indicates steady positively evaluated equivalent gains from using innovation and the results of adopting them;
- the scientific-technical aspect of sustainable development demonstrates the actual novelty, usefulness, estheticalness, and practicalness of an innovation solution and its capacity for evolutionizing as part of attaining objectives set;
- the social aspect of sustainable development is inclusive of and governs the social outcomes of innovation and the public and civil significance of fundamental and applied studies and design work conducted earlier;
- the ecological aspect of sustainable development is inclusive of and indicates the impact of innovation on the condition of the environment and governs the ecological safety of innovations actualized.

All the above effects associated with there being a structured innovation system and an optimum innovation environment define the resolution of the ultimate objective of creating and developing this system and this environment. This ultimate objective is expressed in creating a competitive national economy [9], which is a platform or basis for the balanced development of society in terms of the social and economic proper aspect.

However, there are at least two major issues that stand in the way of ensuring the competitiveness of the Russian national economy through innovation [10]:

- firstly, the innovation infrastructural component is still poorly developed in Russia (the innovation infrastructure is a complex of interconnected objects and institutes providing for the

operation base of the innovation system and the development base of the social-economic system);

- secondly, Russia has a really low degree of involvement of the population and small business with macro- and micro-level innovation processes, which is also the effect of the special Russian mentality in relation to any novelties and innovations.

Objectively, we need to resolve the above issues in totality, since they are interdependent and interconnected. In resolving these issues, it is important to take into account the impact of external-environment determinants defining the major conditions and providing for the transformation of the evolutionary path of the economy and society through the development of the national innovation system. To ensure the transition of the industrial economy to the knowledge economy (the innovation economy), we need to:

- systematically develop market relations and ensure conditions for fair competition;
- perfect the condition of the financial-credit system as the major source of resources needed for the growth of innovation activity in the business environment;
- provide for the creation of an optimum investment climate, which makes it possible to use development reserves accumulated by the individual-private sector;
- put together organic systemic measures for supporting the innovation and investment activity of both business establishments and private persons (groups of them).

#### Inferences

Thus, summing up the above, we can emphasize that the development of the national innovation system based on the concept of sustainability involves a consistent evolutionary change of priorities in terms of searching for, developing, testing, and adopting all kinds of innovation. These changes are aimed at forming such conditions for the operation of the national innovation system at which all the system's elements (the main sectors) totally lose the interrelationship between each other but, having structured themselves in new form, acquire capacity for mastering new stimuli for development. Taking into account modern concepts of exploring small and large systems, including systems of a technology-development nature, we can say with confidence that the phenomenon of the sustainability of the national innovation system is, first of all, scrutable from the scientific point of view. And, second of all, the phenomenon of the sustainability of

the national innovation system can be regarded as capacity for recovery after losing patterns of sustainability and for improving set parameters of social-economic development.

The wavelike nature of the sustainability of the national innovation system (as the change of the states of chaos and order with the preservation of the most important properties) is, on the whole, coherent with the wavelike nature of national and global development in the social, political, economic, and technological aspects. The wavelike conjoinedness of the economic and innovation aspects allows us to speak of that the factors, conditions, and stimuli dealing with national social-economic growth are in modern conditions based, above all, on producing new knowledge and its transfer. Employing this knowledge for creating innovations, both in the technical-technological dimension and the innovation dimension in the social, organizational, or economic-managerial sphere means that the national innovation system, and, therefore, small and large social-economic systems, does have the capacity for sustainable development.

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