

Economics

Genesis of Innovation Systems and the Role of the State

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ABSTRACT. The paper touches upon theoretical issues of co-evolution of national innovation systems and the state institutions. The central problem of the discussion is the state's role in ensuring basic preconditions and the functioning of the innovation complex. Besides, major aspects of the state contribution to the innovation cooperation advancement are analyzed. © 2009 Bull. Georg. Natl. Acad. Sci.

Key words: national innovation systems (NIS), exchange of innovation, innovation interests, innovation values, innovation cooperation.

It seems reasonable to distinguish three main components of national innovation systems (NIS) development.

The first one is **the intensification of innovation activities exchange**. As an elementary "cell" of innovation exchange we consider any constructive influence exerted by an actor A on an actor B such that it enlarges the set of technologies used by the latter in his economic and social practice and thereby increases the effectiveness of his activity in this or that respect. The exchange of innovation has been permanently going on throughout the world history and, in one way or another, it concerns every individual.

Together with accumulation of knowledge in society and the development of its technology basis, the institutional structure of innovation exchange actors has been getting more and more complicated, involving individuals as well as economic communities, social formations, creative associations, various categories of citizens, and so on. The long-standing process of transformation of the state into a full-fledged actor of innovation exchange signifies a brand-new step in the evolution of innovation system inasmuch as it leads to:

- the legitimization of innovation interactions as a separate area of social organism;

- the rising responsibility of innovation exchange participants for timely implementation of innovations;
- the formation of nation-wide information space;
- the enlargement of innovation field due to bringing different types of innovation activities under state control;
- the growing opportunities for exerting cumulative innovation influence on economic and social structures, unachievable through isolated impact on their participants;
- The establishment of a system of agent support for involvement of society or its territorial units in innovation exchange.

In a market economy, innovation exchange inevitably takes the form of commercial exchange of innovation goods and services. However, it in no way can be reduced to that form. Inclusion of the state in the list of innovation exchange actors, first of all, extends the range of innovation impact outside the purely commercial sphere (for example, by ensuring free distribution and transfer of knowledge between generations, providing access to public benefits based on advanced technolo-

gies, accumulating the creative potential of society, etc.). Secondly, the state is able to sort out and support non-commercial components of innovation deals (particularly, by regulating the transfer of technologies relevant to national security or fraught with environmental risks, by accumulating innovation results for future use, etc.)

Positioning of the state as an actor of innovation processes also allows improving significantly the balance between refundable and non-refundable aspects of innovation exchange. On the one hand, the state efforts aimed at creating publicly available infrastructure for scientific innovations, restricting unfair competition and monopolistic rights of innovations owners prevent excessive monetization of the innovation sphere that may cause a slowdown and stagnation in social development. On the other hand, the authorities establish qualimetric checkpoints for price parameters of innovation interactions that cannot be evaluated by traditional indicators such as labor costs, expenditures, marginal utility, etc.

The dynamics of innovation exchange is characterized by gradual augmentation of direct innovation impulses with indirect ones, i.e. those exerted through one or more intermediaries. Being integrated into innovation relations, state structures finally take up the role of a powerful innovation mediator. This, in its turn, becomes a starting point for fine-tuning the innovation impact, as well as for expanding the innovation potential of state organizations. Moreover, co-optation of the state into innovation exchange considerably enlarges the range of innovation relations consisting of a series of interconnected innovation acts. The state can be a direct participant in such innovation chain, or act as a catalyst for coordination and synchronization of deals, for example, as a financial underwriter.

It should be also noted that state institutions are able to smooth those features of innovations that may hinder innovation exchange. Especially hampering among those features are asymmetrical, stochastic and discrete characters of innovations, which may be compensated by the state, in the following ways, respectively:

- asymmetry – by increasing the relevance and completeness of information possessed by an innovation accepting actor;
- stochasticity – by decreasing the level of uncertainty of some elements; and
- discreteness (uniqueness) – by creating a base of analogues.

The state's appearance as a player in the innovation field strongly enriches the palette of innovation exchange

forms. Suffice it to say that no turnover of intellectual property is possible without state support. The current intensification of innovation exchange gives rise to its forms with state participation, for instance, employee turnover between state and private institutions.

Another important premise for the formation of NIS is **the presence of innovation interests**. Historically, they happen to result from two main intentions: to improve one's social status (especially one's economic position) through innovation activity, and to acquire knowledge and enjoy diversity and novelty. Innovation interests of various actors of innovation activity may be concurrent, different or conflicting. The state's positioning as an innovation actor contributes to functional fine-tuning of different elements of the innovation sphere, as well as to translating concerted innovation interests into actual novelties and bringing latent innovation interests to surface. At the same time, by performing its inherent stabilizing functions the state prevents the collision of innovation interests by ordering of priorities, search for compromise decisions, and administrative preclusion of conflicts.

The state participation in the innovation sphere makes it possible to speak about the formation of public innovation interests. They take shape through interaction of personal and collective aspirations that reflect interests of most innovation actors in the development of the innovation resource base, in the provision of favorable conditions for innovation exchange, in the firm protection of rights for obtaining the results of innovation activity, in the availability of a solid "umbrella" for international innovation interactions, in enjoying a sense of belonging to a strong innovation community, etc. However, one should bear in mind that national and state interests in the innovation sphere are not identical. As state agencies get "immersed" in the innovation space they obtain relatively autonomous innovation desires such as, e.g., providing the state machinery with advanced technologies and equipment, improving the image of the state as a leading reformatory force, increase in government employees' incomes with the advent of new spheres of regulatory activities, etc [1].

In practice, innovation interests of individuals or social groups are rarely manifested in a distilled form; they are usually interwoven with other spheres of life. The same is true of specific interests of the state that are often "dissolved" in different spheres of state regulation – geopolitical, economic, social, military, ecological, socio-cultural, and others. Characteristic of the NIS formation is, on the one hand, reaching that stage

Table

Development of scientific innovation cooperation and state participation in innovation processes

Forms of cooperation in innovation sphere	Main features	Main directions of state structures interference
<i>Simple knowledge transfer</i>	Transfer of useful information in the context of other forms of interaction	<i>Virtually no interference</i>
<i>Specialized knowledge transfer</i>	Selective obtaining and spreading of knowledge	<i>Inclusion of knowledge necessary for exercise of power into knowledge transfer</i>
<i>Extended knowledge transfer</i>	Institutionalization of knowledge and education transfer due to division of labor	<i>Training of administration elite</i>
<i>Accumulation-oriented knowledge transfer</i>	Accumulation of knowledge in diversified depositories	<i>Emergence of institutions acting as knowledge collectors (libraries, etc.)</i>
<i>Change of knowledge</i>	Emergence of science as a specific kind of activity	<i>Birth of institutional support for research activities executed in the interests of the state</i>
<i>Joint generation of knowledge</i>	Division of intellectual labor	<i>Formation of a research front</i>
<i>Transfer of knowledge as a commodity</i>	Emergence of intellectual property institution	<i>Providing state guarantees of intellectual property rights</i>
<i>Targeted knowledge transfer</i>	Formation of the so-called practical (action-oriented) science	<i>The state becomes an active knowledge user</i>
<i>Knowledge turnover</i>	Regular use of knowledge for economic environment improvement	<i>Establishment of institutions for mass knowledge circulation</i>
<i>Industrial knowledge transfer</i>	Differentiation between basic and applied science	<i>Differentiation of support for basic and applied research</i>
<i>Institutionalization of innovation activity</i>	Establishment of subdivisions of industrial structures aimed at adaptation of new knowledge for practical needs	<i>Development of partnership in applied use of knowledge</i>
<i>Intrasectoral innovation cooperation</i>	Formation of documentary funds of sectoral production technologies	<i>State involvement in generation and distribution of crucial technologies in sectors of national importance</i>
<i>Science-industry cooperation</i>	Partial separation of research activity from university complexes, formation of knowledge production units in large industrial structures	<i>Formation of large science sector intended for nationwide practical needs</i>
<i>Intersectoral innovation cooperation</i>	Formation of cross-sectoral technological information base	<i>Elaboration of nationwide intersectoral policy of technological development, in particular for double-purpose technologies</i>
<i>Mediatory innovation cooperation</i>	Appearance of links between knowledge generators and potential customers	<i>Innovations are evaluated from the viewpoint of their impact on national economy and social life</i>
<i>Regional innovation cooperation</i>	Consolidation of territorial innovation clusters	<i>Division of powers between federal and local governments in innovation sphere regulation</i>
<i>Consumer-oriented innovation cooperation</i>	Adaptation of innovation products to demands of individual consumers	<i>Elaboration of measures targeted to consumers' involvement in innovation process</i>
<i>Formation of innovation cooperation structure</i>	Division of basic and service functions in innovation sphere	<i>Formation of innovation activity servicing systems</i>
<i>Innovation management</i>	Innovation cooperation principles become an object of study and practical application	<i>Establishment of a system of innovation managers training; transformation of basic knowledge of innovation mechanisms into an integral part of state administration competence</i>
<i>National innovation system</i>	Mechanisms of self-regulation and self-reproduction of national innovation complex come into play	<i>State regulation of scientific innovation sphere becomes a key area of state duties</i>

of significance of innovation goals when their transcending the traditional segments of state policy cannot be ignored any more, and, on the other hand, the emergence of a separate innovation aspect within the particular interests of state structures.

Thus, it is to a considerable degree owing to the state that its citizens can realize their natural desire to increase their material well-being through the prism of improving their intellectual and innovative potential, as well as their active involvement in the upgrading of the technological basis of society.

At the same time, the nation's progressive movement along the innovative path is accompanied by two interrelated processes at the state level, namely: the development of the institution of innovation policy as a substrate of national interests in this sphere, and the process of adding an innovative "filling" to the interests traditionally controlled by the state. Consequently, economic policy becomes accompanied by a lot of issues concerning innovative technological restructuring of economy; social policy – with workforce capacity increase; military policy – with brand-new approaches to army build-up; environmental policy – with a search for innovative mechanisms of human-environment co-evolution; foreign policy – with efforts aimed at the nation's integration into the world innovation complex, etc.

The third integral part of NIS emergence is **the establishment of innovation values** shared by whole society or, at least, by some parts of it. Innovative aspirations and traditions take their place among the norms of social life and the internal regulators of the social organism. The state not only raises the customary opinion about innovation activity to the national level, but also forms the innovation climate by fixing innovative feelings and attitudes in particular documents, statements and actions of statesmen, as well as in a system of state incentives and so on.

It is evident that innovation values cannot be perceived simultaneously and equally by all members of society. That is why an important element of NIS build-up is the launch of state-induced actions aimed at spreading innovation values throughout all strata of the national socioeconomic system, and also stimulating an innovation-oriented style of life (naturally, with proper regard to the peculiar conditions of life and consciousness of different social strata). Training and promotion of bright individuals who personify innovation values and act as consolidators of innovation systems is also of great importance.

It should be underlined that the formation and effective functioning of NIS presupposes the fulfillment of all three above-mentioned conditions. Their simultaneous realization is, to a great extent, determined by the peculiarities of the particular state system and consistency of state policy. Thus, any measures aimed at stimulating innovation activities are doomed to failure unless innovation checkpoints become an integral part of everyday life. Moreover, in a case like this there emerge favorable conditions for the innovation exchange to become a pure formality, and for innovations themselves to become a crude substitute for personal interests. Providing favorable conditions for the synthesis of the factors of NIS formation, and in particular, supporting high enough living standards for most citizens and democratization of state administration, also strongly depend on state institutions.

With strengthening of innovation relations in economy and society the role of the state in the formation of the three mentioned NIS cornerstones changes. Fractional participation of the state in innovation exchange transforms into a large-scale system of contracts concluded and registered in the innovation sphere. In the same way, initial urges towards separate improvements in administration technologies in the innovation sphere develop into a ramified network of state regulation of innovation aspects of national development. Similarly, the manifestations of state innovation values evolve from single acts to support innovators to all-embracing nationwide innovation strategies and policies.

Ontologically, the methodological basis of studying NIS as an object of state regulation is analysis of incorporation of state institutions into the system of innovation relations, but in the epistemological discourse the key topic is investigation of the role of the state in innovation cooperation and its development from simple to complex forms that ultimately leads to NIS consolidation. The main stages of cooperation in generation and implementation of innovations, together with respective state functions, are shown in Table below.

The enlargement and intensification of innovation cooperation is an integral part of the development of cooperative principles in economy and society as a whole. The efficient state regulation of integration processes contributes to building up a platform for innovative complexes in two ways. On the one hand, state stimulation of cooperation aimed at better use of productive resources, labor division improvement and coordinated development of economic actors, favors the transforma-

tion of traditional industrial cooperation into innovation cooperation. On the other hand, state authorities possess instruments (particularly antitrust policy tools) necessary to prevent counter-innovation trends in economic agreements. The mature phase of innovation system formation implies an amalgamation of the two just mentioned types of state activities to support the so-called cooperative competition. Of no less importance are state efforts to promote social contacts through support to social associations, movements and networks that generate collective innovation resources.

The state can significantly contribute to the creation of the national innovation system by amplifying the following effects of innovation interactions:

Effect	Amplified by:
Cumulative	Tracing of nationwide innovation dynamics
Emergent	Support and improvement of integrity and coherence of nationwide innovation area; making the structure of state machine multifunctional
Multiplying	Providing proper integrity of scientific innovation depository
Cognitive-synergetic	Pursuing a policy of simplified access to innovation information resources and knowledge dissemination channels

Like any other system, NIS is subject to a phenomenon of hysteresis when minor temporary changes in some parameters of a system result in a radical long-term transformation of its overall functioning. The state can both give an impetus for positive hysteresis (for example, through timely investment in a breakthrough macrotechnology) and neutralize negative “domino” effects in the innovation sphere (for instance, by providing continuity of crucial innovation projects in a declining market situation). That is why the role of the state in the initial “launch” of systemic innovation mechanisms deserves special analysis. Large innovation injections into economy and society can be further reimbursed a hundredfold when NIS settles into orbit of homeostasis.

It makes sense here to touch upon the issue of the limits to innovation cooperation. The main economic boundaries of innovation cooperation are predetermined by the level of competition and by the “embedding” of innovation activity into particular commercial purposes of economic actors, while social boundaries are set by the diversity of innovation paradigms for progressive national development. However, the framework for cooperation in the innovation sphere may be outlined by

state authorities as well – for example, in the following cases:

- when there is limited access to defense capacity related innovations as well as to other issues of national security;
- when a certain set of innovations can be used for antisocial purposes;
- when the hypertrophy of some forms of innovation cooperation may cause undesirable separation of some components of the innovation complex (for instance, if universities pay less attention to fundamental research because of excessive interest in contacts with industry);
- when an innovation “overheating” of the economy unable to absorb the innovations inflow is prevented, etc.

The main subject matter of innovation is transition from the linear to iterative model of the innovative research cycle embracing all stages of innovation turnover – from basic research to product consumption. The state can play very different roles in this innovation system, including those of generator of innovations, information interactions transmitter, innovation economic interface, direct innovation consumer, trigger for innovation turnover, etc. But the main difference between the iterative model and the linear scheme of innovation implementation is that the state institutions act not only as parts of the national innovation mechanism, but also as a stabilizer that can damp dramatic swings in the innovation conjuncture.

The synergetic effect of innovation interactions are projected onto coordinated planes of the national innovation complex – its cognitive-technological foundation, provision of resources, results of innovation process, and also affects the interaction with its socioeconomic environment. From the viewpoint of combining knowledge and technologies, the state acts as a main promoter of such undertakings as the development of interdisciplinary and multidisciplinary research, elaboration and diffusion of intersectoral systemic technologies, rational balancing of different types of innovations (fundamental and improving innovations, product and process innovations, developing and disruptive, single-stage and multiple-stage, etc.), intertwining of theoretical and empirical foundations of innovations, and so on [2].

In the resource aspect, the state maintains trends towards innovation integration through stimulating employee turnover, organizing mixed funds and other financial sources for innovation activity, granting common access to unique objects of the material and techni-

cal research base, developing national information resources and science and technical information networks.

The evolution of the resultant subsystem of the innovation complex assigns to the state a significant role in socialization of innovation outcomes, i.e. their transformation into public good, into support of different types of collective ownership of innovation products, into innovations market development and into complex assessment of NIS.

One of the main functions of the state is to provide proper balance between the innovation system and its socio-economic environment. The most important directions of state control at the innovation sphere boundaries are the following:

- maintaining reasonable relationship between traditions and innovations, in particular between innovations in newly-emerging and basic spheres;
- securing, wherever possible, equal access of all groups of population to innovation processes;
- harmonizing the level of innovation activity with anthropogenic parameters of human capabilities and environmental situation.

The NIS building and development produces brand new economic and social results observable in the first place at national and global levels. Identification, analysis and forecast of such phenomena are only possible with direct involvement of the state. It can be exemplified by changing relations between the individual and society being currently shifted from administrative resource mobilization and conservation of principal load-bearing structures toward a better and more profound self-realization of the individual. Another example is the concept of sustainable development aimed at bal-

ancing biological and social driving forces of human civilization.

* * *

Summing up what has been said above about the innovation system genesis, we can set out the following features of state involvement in innovation systems formation.

1. The formation of NIS elements within the public sector of economy.

This process started in Russia only a few years ago and has been recently gaining force.

2. The elaboration of a nationwide innovation strategy has developed into a complex of measures aimed at stimulating innovation system formation with regard to both worldwide trends and national specificity. Russian documents stipulating national innovation policy are now mostly confined to general declarations, while state efforts aimed at shunting Russia onto the path of innovation-based development remain occasional and fragmentary.

3. The launching of nationwide mechanisms of innovation turnover.

Such projects in this country are still at the stage of theoretical investigations.

4. The formation of a specific innovation culture within the state machine.

This trend is actually represented in Russia by wishful euphonic declarations at best.

Thus, the genuine involvement of the state in efficient NIS formation requires both new approaches to innovation processes regulation and significant changes in responsible decision-makers' understanding of new innovation realities.

ეკონომიკა

საინოვაციო სისტემების გენეზისი და სახელმწიფოს როლი

ლ. მინდელი

რუსეთის მეცნიერებათა აკადემიის მეცნიერების კვლევის ინსტიტუტი, მოსკოვი, რუსეთი

(წარმოდგენილია აკადემიის წევრის ვ. პაპაუას მიერ)

ნაშრომი ეხება ეროვნული საინოვაციო სისტემების და სახელმწიფო ინსტიტუტების კოველოუციის (თანაგანვითარების) თეორიულ საკითხებს. განხილულია სახელმწიფოს როლი საინოვაციო კომპლექსების ფორმირებისა და ფუნქციონირების ძირითადი წინაპირობების უზრუნველყოფაში. გაანალიზებულია საინოვაციო კოოპერაციის განვითარებაში სახელმწიფო სტრუქტურების წვლილის ძირითადი ასპექტები.

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