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The Triple Helix Model as a Mechanism for Partnership between the State, Business, and the Scientific-Educational Community in the Area of Organizing National Innovation Development

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Abstract

Setting the objective: this article is aimed at examining theoretical topical issues related to modeling innovation development within the setting of the "knowledge economy". Our new understanding of the role of three crucial institutional entities (the state, business, and science) leads us to reconsider and look for new model solutions on the formation of national innovation systems as environments that ensure sustainable national social-economic development. A goal-oriented and consistent partnership between the state, business, and science within the frame of the nascent information society and the knowledge economy helps resolve issues in ensuring sustainability not only at the level of national social-economic systems but that of the World System as a whole. The approach taken in this article lies in the following: the author is using as the article's main methodological tool the institutional evolution approach complemented by a methodology for the formation of national innovation systems through interaction between the state, business, and science. Results: the shift to new social-economic relations requires reforming the links between social entities and redistributing their roles in ensuring national social-economic development. Realizing the Triple Helix model in practice as a basis for the self-organization and evolving of national innovation systems, with the inclusion of global social responsibility in it as an element that helps ensure proper interrelationship of the components, helps neutralize the negative consequences of the action of the market mechanism for the creation of innovations and maximize the positive effects of the systemic globalization of the innovation sphere. Conclusion / recommendation: materials provided in this article not only illustrate the new special role of the Triple Helix model in shaping the national innovation economy but demonstrate the major changes taking place within the national and global social-economic system. The materials provided can be recommended for the use in working out methodologies for constructing self-organizing and self-developing national innovation systems.

Keywords: national innovation systems, innovation, evolution, self-organization, Triple Helix model, social responsibility

1. Introduction

The changes in the world economy is due to the change of global trends. Tfor the first, it is the stage of the formation of a large upward phase of the economic cycle (according to N. Kondratiev), along with this there is a change of the technological order, now the world-system is at the moment of transition from the fifth to the sixth technological order. Changing in the the phase of the economic cycle and the big transition to a new technological order determine the need for translation of national economies to innovative development.

When a nation embarks on the innovation path of development, there arises a need for working out efficient organizational, economic, and financial mechanisms for developing and commercializing innovations (Hochberg, 2003; Florida, 2007). A fundamental factor in the evolutionary development of innovation systems is the formation of a modern, creative infrastructure whose main purpose is to ensure effective entrepreneurial activity

and create favorable conditions for the self-organization and operation of modern enterprises. Any innovation is, in essence, a result of work on deriving new knowledge, a new innovation idea (Abell & Oxbrow, 2002) on upgrading existing technology (production, information, and financial). And then follows the process of implementing them, which results in deriving additional value in a fixed fashion: profit, being proactive, leadership, increasing capacity, accelerating the pace of output, creativity, and progress (Kuznets, 2005; Von Hippel, 2005).

Thus, the process of evolving of national innovation systems involves the following chain: "investment – development – the implementation process – achieving major improvement" (Figure 1).

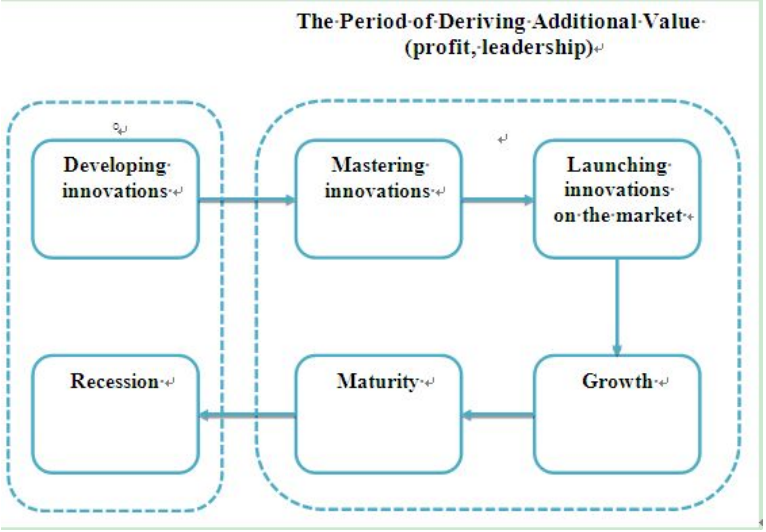

Figure 1. A cyclical flowchart for the evolving of a national innovation system (Freeman, 2005)

Innovation competition through the mechanisms of integrative competitive behavior and diffusion of innovations stimulates global economic integration, filling it with systemic content. An increase in output in response to demand for a new product is accompanied by the creation of integrated entrepreneurial establishments, stimulates license acquisition, as well as the imitation of the original product. Manufacturers enter international markets with a new product, activate external trade, direct investing, and joint entrepreneurship (Walliser, 2008). The diffusion of innovations as a continuous process constantly stimulates internationalization and transnationalization. Global integration, in turn, feeds innovation competition between market actors (Freeman, 2005).

Consequently, what is ensured is, on the one hand, the sustainability of the general direction of changes, and, on the other, the shift to the next "turn" of the spiral and a higher level of systemic links in the global economy.

The driving force of innovation competition as the basis of the mechanism for the positive feedback of innovation and globalization processes is realized through the aspiration of economic entities, actors in the global economy, for innovation competitiveness (Walliser, 2008). Countries that successfully realize effective strategies for national innovation development are capable of ensuring their competitiveness through innovation factors. Furthermore, countries that realize effective strategies for national innovation development can gain additional innovation competitive advantages take an active part in the distribution of world revenue and thereby obtain resources they need for expanded reproduction and boosting of the population's quality of life and welfare in present-day conditions over the long run.

2. Results

An analysis of the results of computing the Global Competitiveness Index for 79 countries has revealed a positive correlation between the global competitiveness index inclusive of the sustainable development of national economies and such a sub-index as innovation and experience (Table 1).

Researchers have provided a rationale for the fact that the main factor for competitiveness inclusive of sustainable development is the state's corresponding policy. Only political will, effective state regulation and governance, alongside quality innovation management and social responsibility at the level of companies, can

ensure sustainable development (Baranenko et al., 2013; Dudin et al., 2014a). Consequently, transforming the model for the development of national economies requires developing and coordinating the innovation strategy and policy of states and companies, which are aimed at meeting the requirements of innovation sustainable development based on the principles of social responsibility in the broad sense of the term.

Table 1. The Global Competitiveness Index inclusive of measuring sustainable development (the Top 10) (Schwab, 2013)

Country	Global Competitiveness Index, 2013-2014		Main requirements (score)	Effectiveness factors (score)	Innovation and experience factors (score)
	Rank	Score			
Switzerland	1	5.67	6.15	5.44	5.72
Singapore	2	5.61	6.30	5.63	5.14
Finland	3	5.54	5.97	5.30	5.65
Germany	4	5.51	5.90	5.31	5.59
USA	5	5.48	5.12	5.66	5.43
Sweden	6	5.48	5.95	5.31	5.46
Hong Kong SAR	7	5.47	6.15	5.57	4.83
Netherlands	8	5.42	5.89	5.27	5.36
Japan	9	5.40	5.37	5.27	5.61
Great Britain	10	5.37	5.48	5.45	5.15

In this context, it is apropos to mention the various types of innovation models, which differ depending on the level of innovation achievements: the innovation leadership model, the innovation convergence model, and the emerging innovators model (Table 2).

It should be noted that the world's leading nations now have the opportunity to realize post-industrial development models whose competitive advantages enable the leading nations to increase their own economic potential much faster than the runner-up nations can.

Table 2. A typology of models for innovation development (Assessing the Sustainable Competitiveness of Nations, 2012; Porter & Opstal, 2001)

Model	American macro-region	European macro-region	Asia-Pacific macro-region
innovation leadership model	USA	Switzerland, Sweden, Germany, Finland, Denmark	Japan
innovation convergence model	Canada	France, Austria, Norway, Italy, Spain, Netherlands, Great Britain	Australia, New Zealand
emerging innovators model		Ireland, Israel	Singapore, Taiwan, South Korea

The world's leading nations successful in the development of the knowledge economy consider as key components in national development the availability of highly qualified and educated workforce, a developed information-communication infrastructure, an effective innovation system, and a favorable institutional climate. Amid the formation of the knowledge economy, the innovation potential of global economy entities acts as a key factor for boosting their competitiveness in global markets. That said, the objectives, scale, and pace of modern R&D activities within the leading high-tech spheres of production (nanotechnology, genetic engineering, biotechnology, the pharmaceutical industry, the aerospace industry, the information-communication sphere) require from organizers the accumulation of tremendous financial, technical, and human resources, which is possible only through the concerted effort of the state, business, and intellectual elite. Besides, dynamic processes drastically modify the character of innovation activity, turning it from a walled-off autonomous process into an integrated collective one, which requires the use of complementary knowledge, know-how, and ideas from highly qualified specialists.

Among the attempts to propose mechanisms for boosting innovation culture, of particular interest is the open innovation model, which was introduced by H. Chesbrough in 2003 (Chesbrough, 2003). According to this

concept, a company does not necessarily have to be a pioneer in the market to be able to make gains from innovation, when active integration into the external environment helps form an optimum model with the engagement of both internal and external resources.

World practice proves that one of the most effective schemes for the self-organization and evolving of national innovation systems through university and academic science, economics and industry is the successful use of the Triple Helix model, which was proposed by H. Etzkowitz and L. Leydesdorff (Etzkowitz & Leydesdorff, 1995) (Figure 2).

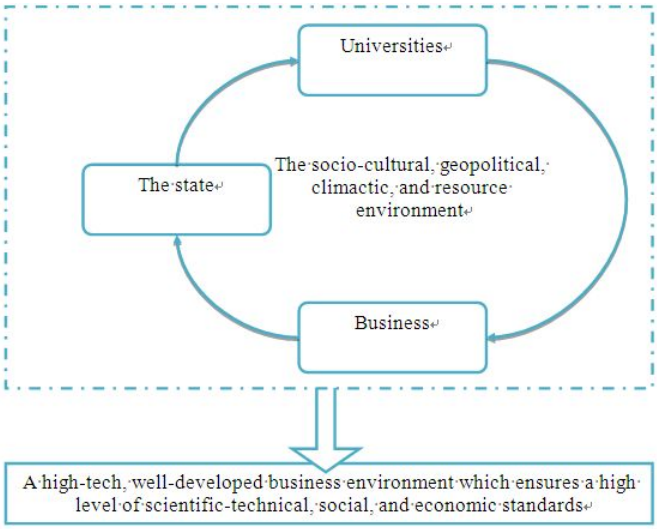

Figure 2. The Triple Helix model and effects of implementing it; the mechanism for partnership between the state, business, and the scientific-educational community

An up-and-running partnership based on the "universities – industry – the government" scheme produces a tangible economic, scientific-technical, and social effect in those countries and regions where the Triple Helix model is employed. Among such countries are regions within North and South America, Japan, Southeast Asia, Western Europe, Australia, as well as Russia.

3. Discussion

In correspondence with modern inter-disciplinary approaches towards presenting general trends and drivers of the innovation and globalization development of the economic system through spiral cyclical-wave models, which found reflection in O. Giarini's "The Double Helix of Learning and Labor" report to the Club of Rome, H. Etzkowitz's "Triple Helix" concept, etc., the modern innovation model for economic development can be pictured as a double or triple helix. This dimension of research is of considerable interest in the context of the innovation development of entrepreneurial establishments and formation of their effective interaction with the state and the science sector with a view to ensuring the sustainable development of the national social-economic system.

The modern economy is developing in such a way that the production of added value is increasingly getting concentrated in the links of the global "chain" which are the carriers of special knowledge. There are evolving conditions which are external in relation to science and innovation, the major of which are the shift to post-industrial economics (the knowledge economy), globalization, and the emergence of new forms of organizing economic and scientific activity. In a number of countries, institutes involved in the process of production of new knowledge, are set up and operate in the person of universities, while in other countries they form a system of academic organizations. As a result of such changes in the structure of the economy and society, the state can no longer play a dominant role in innovation development, since it is unable to independently create knowledge, although it is responsible for organizing the production of knowledge to the extent to which knowledge is a public good. There is formed a new model for the innovation system, which is different from both the model for the national innovation system wherein the main driver of innovation were entrepreneurial establishments and the J. Sőbato's Triangle model which is based on the state's dominant role in the process of innovation development.

In the late 20th century, the innovation policy of developed countries began to be prevailed by a new approach which relied on reforming interrelationships and forming horizontal links between universities, entrepreneurial establishments, and the state. It is these elements that determined in large part the nature of formation of the Triple Helix model. Using this model, universities come up with ideas, the government forms the regulatory framework, and entrepreneurial establishments provide them with resources (material, labor, and financial).

At first, the roles of each of the model's elements were strictly and clearly defined: the role of industry within the Triple Helix model was production, the government was the source of contractual relations guaranteeing stable interaction, while the university was seen as the source of knowledge and technology, which thereby shaped the economy predicated on knowledge. The rising significance of knowledge and the role of creative innovations in the incubation of science-driven companies helped universities gain a larger per-unit share in the process of interaction with business and the government.

In a climate of creative economics, the main element of global competition is not the struggle for the expansion of sales markets and attraction of investment but the rivalry of key actors in the international economic arena for the capacity to employ the talent and know-how of highly educated and competent employees. The local population's education and professional qualification level not only determines the region's capacity for creating innovation products and boosting labor productivity but determines its role within the hierarchical global production system. It should also be noted that a clearly crucial factor for the region's competitiveness is its ability to engage and retain talented employees (Saxenian, 2006).

The general trends of changes in the nature of knowledge are observed throughout the world, and innovation development has become synonymous with the success of particular nations. The Triple Helix model unites the innovation efforts of the state's colleges, production (business), and authorities. In the view of Henry Etzkowitz, the founding father of the concept of the Triple Helix model, a professor at Stanford University and the Centre for Entrepreneurship Research at the University of Edinburgh Business School, this triad is the most rational form of innovation system, as it fits both the market and non-market arrangement of relations within society (Etzkowitz, 2010; Etzkowitz & Loe, 2000). In his works, Etzkowitz investigates into the following evolution of the Triple Helix model: from administrative-command control of science and industry (China, the former USSR, and countries within the socialist bloc) to a market type (laissez-faire), wherein science, business, and the state are independent of each other and engage in moderate interaction beyond their clearly demarcated boundaries. It is interaction between the institutional spheres of universities, enterprises, and authorities amid the performance of both their standard functions and a wider range of functions that serves as a precondition for a creative approach towards the formation of the organizational process, which, in turn, becomes the reason behind the emergence of various innovative solutions.

According to Triple Helix theory, the helix consists of an internal pivot and external space. The state, universities, and business have different knowledge capitalization sources. When knowledge is transformed into capital, any members of the institutional sphere can be potential entrepreneurs or founders of firms. In the Triple Helix model, each strand relates to the other two by developing an "overlay of communications, networks, and organizations" (Etzkowitz & Loe, 2000). It is a spiral-type development: a synthesis of evolution in the vertical axis and circulation in the horizontal. The principal existence of the Triple Helix model is predicated on the following (Dudin et al., 2014b):

Firstly, innovation processes are characterized by internal uncertainty (which, really, is the case with any other social or economic processes), and the effects of the impact of the three components of the spiraled model may vary depending on the quality and type of interaction between institutes of the same name (the state, business, and science);

Secondly, the innovation process allows of a certain set of solutions, but the choice and realization of a specific solution will depend on the effects of interaction between the helices, their relative dependence on or independence from each other;

Thirdly, the existence of the national innovation system, as well as the specificity of the progress of processes of the same name within it, is associated with the existence and impact of initial conditions which not only shape innovation trends in the economy and society but determine the boundaries (frame) of the intensity of innovation processes.

H. Etzkowitz particularly stresses that each iterative step in the interaction of the three key institutes (business, the state, and science) within the frame of processes that take place within the national innovation systems are characterized by two-ness. This means that the interaction of two institutes shapes the boundary and frame

conditions of a specific situation in innovation development (creation of science-intensive products), with the third institute being an environment formation within the interaction of the first two institutes.

Innovations act in this model not only as a means of ensuring the strategic sustainability and competitiveness of entrepreneurial establishments but as drivers of national social-economic development.

An innovation process that takes place within the model of the same name can be pictured as a consecutive change of three stages: the creation of knowledge to form new technology; the transfer of new technology; the market mastering of products created based on new technology. Within each stage, there interact two institutional actors, with the third actor not being left out of the process but, on the contrary, constituting the environment needed to realize the stage.

As a result of this set-up for the national innovation system based on the Triple Helix model, there occurs a non-linear diffusion of innovations, which is a consequence of the non-linear interaction of the three institutional actors forming the above system's platform (the state, business, and science). Note that the non-linear diffusion of innovations and non-linear interaction of institutional actors within the national innovation system produces synergetic effects, which can be described as balanced economic growth and sustainable development.

Over the recent past, there have been multiple changes in social, economic, and political relations, and the development of the World System is no longer characterized by being unipolar – on the contrary, relations at the international level are characterized by the deepening of integration and globalization processes. In this light, there is taking place a change of scientific-managerial paradigms and concepts. The Triple Helix model seems a new line of sight for scientific and empirical research, which helps grasp and identify the conditions for the formation, self-organization, and evolving of national innovation systems and, as a whole, the specificity of the innovation model for the development of the national and world economy.

The innovation model for the development of the economy presupposes such a form of organization wherein the core is the scientific center which acts as an "incubator" for new ideas. From the innovation center (a technopolis, a science city, etc.) the impulse of growth is translated into the growth of a particular region (a hinterland) and onwards into the growth of the national economy as a whole. Innovative ideas are then picked up by experienced companies within the "implementation belt", which realize them in the form of ready-made products and services. Afterwards, the innovative product is handed over to entrepreneurial establishments proper. The advantages of this scheme are in the speed of the practical realization of scientific achievements (Kobayashi & Okubo, 2003).

Thus, the Triple Helix model is predicated on three major tenets:

1. Three institutions – universities, business, and the government – aspire for partnership; and the innovation component is initialized not through the state's vertical but specifically through the "university – business – government" interaction axis.

2. In addition to traditional functions, each of the system's three elements partially assumes the role of the other. Institutions capable of performing non-traditional functions are considered a significant source of innovation progress.

3. A society predicated on scientific knowledge is characterized by an increase in the role of universities in interaction with industry and the government.

Economic development produces the dynamics of the innovation process, with each of the components capable of developing at a different pace. The shift to a higher level of development can, in principle, take place through both scientific and production (technological) knowledge and an already realized product, i.e. under three scenarios:

1) science is shifting to a higher level of development and predetermines ascent to a higher level of technological knowledge based on which there is developed totally different, qualitatively speaking, technology;

2) technological knowledge is, in terms of development, ahead of scientific knowledge, as it uses and studies particular phenomena with a view to technological externalization in the absence of theoretical designs, under the influence of augmented state stimulation of this dimension of technological research. In that case, the development level of science has to "catch up" with that of technological knowledge;

3) specific implemented technology opens up new vistas for the development of science (markets), after which the first scenario is realized.

Just as important is that the level of each of the three subsystems in the innovation process can in terms of development be above that of the other two only within a rather limited period of time. That is, if technology is

not developing, then science will sooner or later cease to develop too (just like technological knowledge will), and vice versa: without the development of science, technological knowledge and technology, by using the base there is already, can develop for some time, but as the scientific base gets used up their propulsion will decelerate to a complete standstill. As we can see, the innovation process equally depends on all the three components: science, production (technological knowledge), and the market, which is partially regulated by the state.

Thus, the Triple Helix model, which determines the evolving of the national innovation system and global and national innovation processes, is characterized by that:

Business is in a larger measure a recipient of applied and fundamental knowledge, as well as concurrently a producer of innovations. Business ensures the maximization of national economic turnover through the production of goods with a high added value, as well as forms financial flows, including those redistributed into resolving socially significant objectives;

The state can be viewed as a strategic node of contractual network relations between business, science, and society as a whole, which determines the organizational and legal specificity of the development of the national innovation system, its infrastructure, and entities operating within it;

Science is in a larger measure a producer of fundamental, applied knowledge, and innovations, but at the same time the scientific sector actively interacts with business (including under the mediation of the state) and takes part in testing and commercializing innovations, which is an additional intensifying stimulus for processes taking places within the national innovation system.

The Triple Helix model is increasingly gaining in popularity as it suggests a new mechanism for achieving a consensus on national social-economic development, which is predicated on the organic interaction of three key actors (the state, business, and science). This helps ensure the reserves of self-organization and evolving of the national innovation system in a new capacity and harmonize interaction at all levels of social-economic relations.

Changes within a number of economically developed countries in the strategy for the realization of the state's innovation policy towards cluster philosophy, the reconfiguration of innovation policy within the system of integrated actions on supporting the formation of new high-tech sectors within regions with considerable scientific potential, and the reformation of higher school education at the beginning of the new century have led to the activization and complexification of the role of universities in the partnership of government agencies, business establishments, and scientific-research institutions (Foray, Lundvall 1996). On the whole, the changes which have taken place can be characterized as follows:

the corporatization of national universities,

educational institutions' gaining the juridical status of national academic corporation and a considerable degree of autonomy,

the resolution of the issue of university academics getting employed at a second job, their conducting entrepreneurial activity, etc.

Today's interrelationship between the state, business, and universities is characterized by a number of problematic aspects, which in particular cases can be viewed as organizational-cooperation dilemmas. While what matters to business the most are experience, the priority of making profit, pragmatism, the mandatoriness of getting a positive result, and professional communications, universities prioritize the importance of knowledge, the priority of career, the usefulness of a negative result, and broad communications (Foray & Lundvall, 1996). At the same time, there are unifying universal long-term trends, both in the world and national economy, such as intellectualization, professionalization, international mobility, and humanization. These categories not only form the fundamental base of strategic partnership within the frame of the Triple Helix model but serve as a backbone factor for the innovation-oriented development of all the key institutions and a basis for the interaction of these institutions in terms of achieving the set strategic objectives of the sustainable development of national social-economic systems.

Educational and scientific institutions (universities and scientific-research institutes) are playing an increasingly significant role in the process of production and diffusion of knowledge. The fact that educational institutions, as units for creating and spreading new knowledge, are gaining in critical and quite sizable significance substantiates the need for incorporating in the Triple Helix concept the component of mutual social responsibility of the state, business, and the scientific community through the support of the educational system.

The topical dimensions of interaction between the Triple Helix components and the educational system are illustrated in Table 3; these can be viewed as parallel trajectories of interaction between the three key institutions, whose cooperation means not only receiving new rights and obligations in the process of interaction but realizing the shift to a new level of social responsibility.

Table 3. Parallel trajectories of interaction between education and the Triple Helix components through mutual social responsibility

Education and Science	Education and Business	Education and the State
1. Boosting cooperation between academic and college science, including setting up under the auspices of colleges branches of corresponding scientific-research institutions with a view to conducting work with students and arranging graduate student internships at academic institutions. 2. Coordinating lines of study and scientific research (launching new specialties related to new up-and-coming lines of research at colleges). 3. Creating a joint research material-technical base.	1. Introducing stimuli to entrepreneurial innovation activity by college graduates (creating business incubators at colleges, developing the venture industry, etc.) 2. Officially recognizing the status of trainees (interns) at an enterprise for persons simultaneously engaged in study and work related to the field and concurrently providing employers with corresponding stimuli to employing such persons. 3. Introducing and stimulating the operation of the institute of continuing education for working persons.	1. Facilitating the boosting of the financial autonomy of colleges regardless of form of ownership. 2. Facilitating the resolving of social issues in education – in particular, through building student campuses within educational cluster regions. 3. Realizing the state's strategy on training human resources to ensure the activity of innovation enterprises and enterprises within the IT sphere. 4. Forming a public consensus and applying the "bottom-up" principle on reforms undertaken within the sphere of education.

4. Conclusion

Realizing in practice the Triple Helix model as the basis for the self-organization and evolving of national innovation systems with the inclusion in it of global social responsibility as an element that ensures the interrelationship of the components helps neutralize the negative effects of the action of the market mechanism for creating innovations and maximize the positive effects of the systemic globalization of the innovation sphere, which include:

Reducing the global innovation gap;

Ensuring fundamental technical-technological and social conditions for overcoming global risks and threats and adhering to the principles of sustainable innovation development within the scale of the global economic system;

Boosting the innovation potential of national economies by virtue of the synergy effect in realizing the processes of diffusion of knowledge and innovation over educational, scientific-research, and industrial space;

The emergence of new forms of specialization and cooperation at all stages of R&D, innovation and production processes based on the globalization of inter-state and inter-firm ties of a scientific-technical and economic nature;

Establishing and developing an organizational-legal system of supra-state regulation and self-organization of scientific-technical ties;

Creating opportunities for the broad coordination of the innovation strategy and scientific-technical policy of state and companies through the creation of joint organizational establishments that would ensure integration in the sphere of innovation activity.

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