

## Ensuring economic security of the innovative development of nanotechnology in the Russian Federation and foreign countries

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**Abstract.** In modern conditions nanotechnologies and nanotechnological activity are decisive factor of sustainable innovative development of economy. Formation of efficient system of economic security oriented to developing and using nanotechnologies is a key task of national strategy of nanoindustry development in conditions of globalization of its markets. The article generalizes the particularities of state regulation of nanotechnology development in foreign countries in the aspect of ensuring economic security. Russian problems of ensuring economic security of nanoindustry development have been analyzed. Conceptual solutions in formation of economic security while developing and using nanotechnologies are proposed.

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### Introduction

Innovative development of economy is strategically important trend in state policy in current conditions which forms the basis for dynamic qualitative growth of national economy, change of its structural characteristics, determines its international competitiveness and surviving capacity [1].

But decisive turn of the country to innovative model of development by means of intensive use of the potential of “breakthrough” techniques and technologies, pioneer and large-scale inventions creates preconditions for de-stabilization of economy and formation of the source of specific threats to economic security.

Nanotechnologies positioned as new basis innovation [2], and nanoindustry is considered as a system of interrelated innovative processes in the framework of transition to 6th technology revolution. Nanotechnologies are also considered as future of such spheres as energy production, electronics, medicine, biology and pharmacology, chemical production, space and defense. Even today obtained with the use of nanotechnologies products stand for 0,01% of world GDP (2010), it is expected that it will increase to 2% by 2015 [3].

Potentialities of nanotechnologies in terms of competitiveness of the country, its technological leadership and national security interests demand active approach to their development and commercialization. The results of nanotechnology rivalry determine the place of the country in world division of labour and its role in world financial system which assigns “technological” rent to the countries-leaders in innovative development.

Nanotechnologies are characterized as highly expensive innovations, potential of which is not defined and risks are very high. Structures and sums of costs of endogenous factors of production in single product of specific type on nano-level have not been defined and measured yet [4]. Confidence in the future of nanoindustry is based on market forecasts which differ greatly. Estimates of modern market of nano-products vary in intervals from 12 billion to 254 billion dollars [5]. Numerous popular forecasts (Lux Research) can contain a mistake of double calculation. Such non-reality of economic expectations from nanotechnologies can result in financial bubbles, a-priori negatively influencing their further progressive development [6].

So, secure development of nanoindustry is up-to-date task; its solution will guarantee positive dynamics of innovative development in long term. It is necessary to carefully balance potential risks and the benefits obtained from nanotechnologies, legalizing basic caution principles in law system.

### Main part

In economic literature economic security is defined as “sufficiency in ensuring of needed level of national security by means of necessary resources, formation of favourable conditions for development of competitive economy, protected state of personal, social and state economic interests from internal and external threats” [7]. Economic security can be understood, on the one hand, as complex system consisting of different sub-systems (scientific-technological, energy, financial securities etc.) [8]. In formation of innovative economy scientific-technological and resource securities play prioritized

role. On the other hand - as special steady state of national economy which is characterized by constantly improved set of its parameters and abilities allowing to function efficiently in constantly changing medium. The algorithm of formation of economic security suggests stage-by-stage finding out of economic interests and economic challenges. Analysis of economic security state suggests identification of indicators systems and study of its threshold values.

Nanotechnologies and nanotechnological activity are considered as one of the key factors influencing national economic security in conditions of globalization. Development of nanoindustry in pro-active mode demands scientifically grounded optimization of strategic regulation.

In developed countries (leading countries which claim for nanotechnologies superiority - the USA, Japan, EU countries – Germany, Finland, Sweden, South Korea - strategic conceptual approaches have been developed to ensure economic security while developing and use of nanotechnologies with due regard to national particularities and priorities of economy.

Elements of strategic management of nanoindustry development

1. Ensuring safe development of nanotechnologies necessitates evaluation of: potential risks for human health, environment and labour safety; ethic, legislative and social effects of nanotechnologies' development [9]. While developing nanoindustry the following factors must be taken into account: 1) productivity of nanotechnologies; 2) long-term scenarios of economic development; 3) scenarios of social development and convergent technologies; 4) threats to national security; 5) ethics, risks and uncertainty; 6) legal and international aspects; 7) interaction with public, development of human resources. [10].

2. The concept of safe development of nanoindustry is based on 2 interrelated and mutually contributing subsystems: 1) subsystem of objects of nanotechnological security: scientific and high-qualification workforce, techniques and technologies, goods and services, development and commercial use; 2) servicing sub-system: investments, management, marketing. The aim of secure development of nanoindustry is maximizing of benefits and prevention of potential harm from nanotechnologies, it must be grounded on reasoned estimates of social and economic benefits and technical characteristics.

3. Key principles of management of nanotechnologies' safe development.

System character of developed solutions. Compliance with the requirements of system

approach to management of safe development including purposefulness of managerial decisions, feedback loop.

Scientific reasoning. In preparation and making decisions modern scientifically grounded methods, models and approaches to management must be used.

Coordination. Issues of formation of nanoindustry demand coordination on international, regional, national and municipal levels. Development of national, regional and international policy in nanotechnological sphere will not be efficient without coordination with world practices of realization of international and interregional projects and programs.

Dynamics. Flexibility and adaptive capacity of management system to the trends and dynamics of socio-economic development of the country and global economy. Concept approach to development of nanotechnologies must be flexible. The foundation of adaptive regulation system is regional (local) nanotechnological initiatives which contain both industrial inventions/production plans and academic studies, planned results, incentives for participants.

Rationality and efficiency. Positive results of managing impact both for subjects and object of management, minimization of costs and maximizing of benefits. Benefit for economy and society from regulation of development of nanotechnologies must exceed costs for it. Risk management must be comprehensive, include all phases of life cycle of nanotechnologies, their importance, scale and terms.

Transparency, responsibility and control. Identification of all stakeholders, beneficiaries and those who are responsible for risks while development and using nanotechnologies and managing them. Responsibility for the decision, for non-fulfillment or improper fulfillment of one's duties. Necessity of performance of different kinds of works, related to control over the activity of security objects: collection, analysis and generalization of statistic information.

4. Level of investment and innovative activity in nanotechnologies sphere can be considered as one of the criteria of evaluation of economic security [11].

System of threshold indicators of economic security is intended for prevention and identification of threats. From the whole number of indicators of threat to economic security those indicators must be taken which really correspond to critical points of development of national economy. System of indicators showing the level of threats to economic security of a state in conditions of accelerated development of nanoindustry is individual for every country and is formed depending on particularities of

its economic development. Indicators are as follows: infrastructure of nanoindustry, investments into nanotechnologies (R&D costs in the sphere of nanotechnologies), the share of foreign investments into nanotechnological projects etc.), resulting indicators of nanotechnological activity (number of nanotechnological enterprises, share of nanotechnological products in export etc. (Table 1)

**Table 1. Key indicators of world nanotechnologies' development**

Period	Number of scientists	Publications	Number of registered patents	Nanoproducts market, Billion dollars	Investments into R&D, Billion dollars	Venture capital, Billion dollars
2000 (factual)	~60,000	18,085	1,197	~30	~1.2	~0.21
2008 (factual)	~400,000	65,000	12,776	~200	~15	~1.4
2000–2008 (average growth)	~25%	~23%	~35%	~25%	~35%	~30%
2013 (2000 estimate)	~2,000,000	-	-	~1,000	-	-
2020 (extrapolation)	~6,000,000	-	-	~3,000	-	-

**Source:** Rocco M.C. The long view of nanotechnology development: the National nanotechnology initiative at 10 years // Journal Nanopart Research. 2011. № 13. pp. 427-445.

The issue of assessment of investments into nanotechnologies, their social and economic effect (contribution into solution of economic and social problems of the state) is critical for study of economic aspects of security of development and use of nanotechnologies [12].

Difficulty in assessment of investments into nanotechnologies is associated with complexity of evaluation of their influence when end product does not contain nanomaterials and its functions do not change if they are used; necessity to develop appropriate economic indicators for all stages of value creation chain in order to find out the participation of nanomaterial or nanoproduct in it [13].

Organization of economic cooperation and development (OECD) proposes to use 3 basic indicators for assessment of investments:

- resources (tools and mechanisms of public financing, public-private partnership, pilot projects and programs, state purchasing, number of scientists working in nanotechnologies sphere, venture capital and other kinds of private financing, incomes and indicators of influence;
- results (publications and patents, volumes of sales (of nano-products);
- contribution into solution of economic and social problems of development of the state (purely nanotechnological companies, growth of market volumes, creation of new jobs).

## Conclusion

Fundamental studies in nanotechnologies sphere are of strategic character. In long term their results will be used as foundation of significantly transformed high-tech industries which to a great extent will determine innovative, economic and defense potential of the country. So, nanoindustry becomes one of the most important industries which set the pace of innovative development of global economy.

Category of nanotechnologies security is vague and must be considered in complex terms. But every element of it can be analyzed separately. Economic security is a state of protection of economy which would provide competitiveness of scientific researches and inventions in the sphere of nanotechnologies and nanotechnological production in internal and world markets, ability of economy for sustainable development and compare negative factors which take place in world markets.

By now the threats to national security in nanotechnologies sphere must be formulated. We can use statistics and different indicators for evaluation of the level of security in Russia and foreign countries: indicators of the situation in scientific sphere (mainly it is financing of R&D); investments into fixed assets, use of studies' results and inventions in economy. Development, realization and constant improvement of measures to provide state control over the spread of nanotechnologies including export control.

Main threats to economic security when developing and using nanotechnologies are as follows:

- high production costs, namely, process of development, implementation and commercialization demands significant financial and time costs;
- absence of information about impact of nanotechnologies on living cells (toxicity of nanomaterials and their bio-compliance) and as a result - reluctance of society to accept innovative technologies without guaranteed safety rules;
- relative shortage of venture capital;
- non-readiness of private corporations for big financial investments into nanoindustry because of high risk level in comparison with other high-tech productions;
- undevelopment of the infrastructure of nanoindustry, manifested in poor coordination and inefficiency of nanoindustry entities - from invention to use of nanoproducts;
- absence of quality control.

The tasks in regard to mentioned above problems were formulated in national programs on development of nanoindustry. This, in our opinion, is some guarantee of security.

Nanotechnologies can be considered as challenge to Russian economy, R&D and education systems, the whole methodology of predicting. Methodology must correspond to nanotechnologies' particularities as innovations; state program of nanoindustry development must be based on constructive dialogue between stakeholders.

The resources should be concentrated in those nanotechnological branches where this industry has some advantages, and it is necessary to coordinate activity between different nanoindustry entities, broaden use of mechanisms of public-private partnership and methodology of strategic management.

The following ways of ensuring economic security are proposed understanding of which can facilitate safe development of nanoindustry: analysis of market of high-tech products and identification of state technological needs in this sphere; forecasting of development of separate technological spheres and provision of targeted support for most perspective, in terms of their economic use, development of measures on support of spin-off companies and startups, interdisciplinary networks, scientific-research groups and institutions, industrial partnerships; activation of organizational-legal, financial-economic, external investment forms and ways of broadening of innovative activity in the country, creation of information data bases, support of interdisciplinary training and education.

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