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STATISTICAL MEASURE OF NANOECONOMICS

In article expediency of formation of system of the indicators characterizing development of nanoeconomy locates in article, and also the concrete indicators entering into this system and in various aspects of displaying process of creation of a modern nanoindustry are considered.
Key words: nanoeconomy development, system of indicators, nanoindustry, nanolevel.

Formulation of the problem and the analysis of the recent publications. The modern socio-economic development of advanced countries is largely determined by the effective use of resources and factors of STP. The percentage of technological innovation in GDP of developed countries is between 70 to 90 %. Lately the development of nanotechnology has played a great importance - scientific and technological direction is formed at the interface between physics, chemistry, biology, medicine and materials science. It is estimated that in the foreseeable future, nanotechnology will be able to make a revolution in society, on a scale exceeding even bigger than the revolution of personal computers.

Nanoindustry engaged in the production of super small size materials and products by examining the properties of various substances at the molecular and atomic levels. In the metric system nanometer (nm) - from this word occurred prefix "nano" in the term "nanotechnology" - corresponds nanometers (which are the unit of length equal to one billionth of a meter, or 10-9). For comparison, the thickness of a human hair is on average 50 000 nm.

And although an exhaustive definition of "nanotechnology" doesn't exist yet, we can say that nanotechnology operates quantities of the order of one billionth of a meter. In general, we usually understand under the nanotechnology a set of methods and techniques, which enable to create and modify objects, including components smaller than 100 nm in at least one dimension and as a result received a fundamentally new quality, allowing to carry out their integration into a fully functioning system. Nanotechnology in a broader sense also includes diagnostics and study methods of such objects.

Except nanotechnology when we consider the development of the nanotechnology industry we should also take into account the development of nanomaterials and nanosystem technology that are the constituent elements of the nanotechnology industry. Nanomaterials are materials that contain the structural elements, the geometrical size of which at least in one dimension are less than 100 nm and thus have new features, including specified functional and operational characteristics.

Under nanosystem technology commonly understand the functionally complete system and device fully or partially based on nanomaterials and nanotechnology, and its characteristics are radically different from those of

systems and devices of similar purpose, created by traditional technologies. Thus, nanotech is an activity to create products based on nanotechnology, nanomaterials and nanosystem technology.

Speaking about the development of the nanotechnology industry, it should be understood that in this case expected to consider the widest range of diverse and not always directly linked problems in different areas of science and technology, which have already used the appropriate technologies and methods. Although nanotechnology is therefore not appropriate to consider as a whole thing, and more than just as a generic term, it should be recognized that the nano industry as a whole has a revolutionary impact on the development of information and communication technologies, biotechnology, safety equipment and many others. As a result, in recent years, dozens of countries have adopted national development programs in the nanotechnology industry as a top national priority. Among them are such developed countries as the USA, Japan, Germany, France, China and others.

In China about 800 companies recently, for example, have involved in the introduction of nanotechnology, and more than 100 specialized research institutions, the vast majority of which are focused on meeting the needs of the military-industrial complex in this country. Other developed countries also allocate huge funds for defense developments in nanotechnology. Russia is among the leaders by the volume of the total costs for nanotechnology development, and major centers of nanotechnology development are in more than 20 regions of the Russian Federation (for example, in cities such as Belgrade, Izhevsk, Cheboksary, etc.). However, one of the major problems in this area in the domestic economy is the problem of the massive introduction of inventions and patents obtained by the creation of nanomaterials and nanotechnology. These sorts of problems are known, one of the key R & D in Russia since the Soviet era (kinda Achilles heel of this sphere). Another serious problem of the effective development of the nanotechnology industry is undeveloped statistical systems of the development of nanotechnologies.

It should also be noted that under the term "nanotechnology industry system" we understand the term "nanoeconomics", and under nanoeconomics we understand the reproductive system of relations connected with the production and use of nanotechnology, nanomaterials and nanosystem's technology. However, there is another option of using the term "nanoeconomics". Thus, G. Kleiner allocates 5 hierarchical levels: mega-, macro -, meso-, micro-and nanosensing level, and also the relevant economic disciplines: international economics, macroeconomics, mezoekonomics, microeconomics and nanoeconomics [3, p . 81]. At the nanoscale relations unit labor division and cooperation of individual employees, competition and monopoly on individuals knowledge and skills within professional groups, the formation and realization of the value and usefulness of their work are the objects of study of the economic theory. Thus, the subject of nanoeconomics in this sense is a single individual, a person. In our view, both approaches have their place, but in the future we'll stick with the first option. Such well-known scientists from Russia and Ukraine, as academicians NAS NG Chumatchenko and AI Amosha, Professor

V. And Lyashenko, M. Shishkin, A . S. Flerov and others also studied the problems of the nanoindustry development.

Definition of the problem. The development and establishment of a system of indicators for the effective development of nanoeconomics plays the great role in the various aspects, characterizing the current state and dynamic parameters of the development of nanotechnologies. And we are talking about the creating a scorecard that uses an integrated approach and accounted for at least all the main aspects and elements of the formation and development of nanoeconomics. Of course, this system must have a section that contains the indicators characterizing the nanoeconomics development in general, and at different levels of the management hierarchy: the global and international level, at the national, sectoral and regional levels, as well as at the level of the individual enterprise (organization) and its individual business units.

Here, above all, we are talking about indicators such as the total volume of the development and use of nanoproducts, expressed in monetary and physical units, as well as the total costs of the creation and implementation of such products at the different levels of the management hierarchy. In addition, this group of indicators must also include parameters describing specific gravity fraction of the cost of nanoproducts in the total output value, which produces the active entity. It should also include indicators that characterize the socio-economic efficiency of nano- and nanotechnology industry as a whole - as common performance indicators and private indicators (productivity, return on assets, material consumption, capital intensity, etc.).

The main material of studying. The most important factor is a measure of research intensity which characterizes the technology and shows the extent of its connection with research and development. In this case, under the technology we should understand the set of methods and techniques used in all stages of the development and manufacturing of a certain type of products [4, p. 29]. Under the same knowledge-based technology we understand a technology that includes amounts of experimental work , exceeding the average values of this parameter in a particular field of technology and economics research intensity is often seen in the manufacturing sector [5, p . 12]. It's important for nanoproducts to assess their knowledge intensity.

High-tech industries is usually measured as the ratio of total costs to the costs of sale, as well as the ratio of the volume of sales to the number of scientists, engineers and technicians who work in the industry. High-tech products are products in which the cost of R & D spending is higher than the average of the spheres of industry.

Such indicators as growth and growth of nano, the growth rate and the growth rate of it characterize the dynamic of nanoeconomics. Structural changes are characterized by indicators such as changes in the share value of the total cost of nanoproduct data business entity (enterprise, industry, region, national economic complex as a whole).

Any industrial product is characterized by a certain level of quality, which is currently one of the most important characteristics of the degree of competitiveness of the production. Improving quality is especially true for domestic goods in the present time when the Russian economy is trying to make

the transformation from commodity -type economy to a developed modern innovative economy. The formation and development of the nanotechnology industry is one of the key areas of implementation of such transformation, and therefore the issue of assessing the level of quality of nanoproducts is particularly acute. The most important aspect of product quality is its reliability, i.e. the property of products to save time within certain limits the values of all parameters which characterize the ability to carry out the certain functions in specific modes and conditions of use, maintenance, repair, storage and transport.

Reliability is an important property of nanoproducts, that's why the reliability indicators are the main indicators of the quality of products. They reflect the ability of nanoproduct over time to implement the required functions in a given system. These indicators characterize the features of reliability, durability, maintainability and persistence. Reliability is the ability of nanoproduct constantly keep working for a certain period of time or specific developments, which manifests itself in the possibility of trouble-free performance. Maintainability - the property of nano, which is its adaptability to prevent and detect the causes of failure, damage and mitigation of their consequences as a result of repairs and maintenance.

Recovery of nanoproduction average recovery time is due to a certain value of the quality and degree of regeneration. Under the persistence we understand the ability to maintain nanoproducts workable, usable condition and operation after a period of time of storage and transport. Average storage time and the designated shelf life are indicators of persistence. Durability is the ability of nano to save states before limit in the timing of maintenance and repair. Average resource and an average life are indicators of the durability, the term "resource" is used to characterize the product durability on running, and the "service life" is used to characterize the durability on a calendar time period. In this unit reliability index isolated, which characterizes one of the qualities of nanoproducts and comprehensive measure of the several qualities of nano reliability components.

It's also important to determine the performance of nano- technology. The most important indicators of this group are specific material nanoproducts, its specific complexity of manufacturing, energy intensity of manufacturing and operation of nanoproducts and the average duration of the operational maintenance of these nanoproducts. Overall, the manufacturability expresses generalized characteristic of rationality applied in product design and technological solutions and the best allocation of costs at all stages of the life cycle of nano.

The problem of statistical estimation is actual not only in technology of nanoproducts in general, but also in constituent nanoelements in complex design. Manufacturability of design is the feature to reflect how well the requirements are taken into account available technology and system development of the production, transportation and maintenance of the product. Cutting-edge design minimizes the duration of the production, costs of materials and activities in all phases of the product's life cycle. The main indicators of the technological design, which are nano-elements might include: the propor-

tion of nanodetails of their total amount in this product ratio inter-project of unification (i.e. borrowing) nanoelements of device, manufacturability nanoprocesses rate unification and several others.

Given that the development of the nanotechnology industry in Russia is currently one of the least efficient units is mass, mass production of nanoproducts, great importance is the development of indicators of standardization and unification of nano- , reflecting the degree of application of the standard, unified and unique component of the product. Recall that standardization - a system development and definition of requirements, rules, regulations, specifications, expressed in the standards, both mandatory and recommended for implementation in the production process. Standardization is a very significant factor in improving product quality and to accelerate STP at the different levels of the social hierarchy. Unification is one of the methods of standardization and unification under the unification we understand the cause of the objects of the same constructive purpose uniform form for determining the quality and rational reduction of these objects on the basis of information about their effective use. The smallest necessity, but sufficient types, varieties, sizes, components, parts with high quality and interchangeability are determined under unification. The uniform quality requirements of nanoproducts, health and working conditions of workers in the factories appear due to the standardization and unification.

Indicators of the standardization and harmonization are the coefficients of applicability, repeatability parts of nanoproducts, unification of the products, new and original design, mass production with economic efficiency standardization of the nanoobject. Coefficients of repeatability and unification for structural components are also calculated in addition to these indicators. Thus, the performance of standardization and unification characterizes saturation of goods of ordinary and standardized components, which are included in a design, equipment, assemblies, kits, etc. One of the major trends and methods of standardization is aggregation, which is understood as a way to create machines, installations, structures, components, devices and other products from the unified units installed in the product in varying amounts and in different combinations.

The development of indicators has the great importance and characterizes the innovative activity of socio-economic systems at the different levels of the management hierarchy. Thus, the level of innovation activity indicator reflects the proportion of enterprises and organizations (in the region, the industry in the national economy as a whole), implementing technological, organizational and marketing innovation in the field of nanotechnology in the total number of enterprises and organizations. For individual enterprise similar indicator is expressed as the proportion of shops and other structural subdivisions of the enterprise engaged nanoinnovations in the total number (as in the total number of innovatively active units and the proportion of the whole). Besides this index the level of innovation activity and market saturation of nano also is characterized by the indicator on the share of nanogoods, works and services in the total volume of innovative products and services, as well as in the total volume of shipped goods, works and services organizations.

Appropriate to calculate the intensity and the cost of the technological nanoinnovations as the ratio of expenditure on technological nanoinnovations to the volume of goods shipped and completed work. For more detailed analysis, it is important to determine the proportion of small, medium and large enterprises engaged nanoinnovatsii, respectively, of the total number of small, medium and large enterprises. Indicators should also be calculated share of exports and imports nanogoods and nanotechnology in the total volume of exports and imports, respectively.

Another important group of indicators are indicators that characterize the efficiency and effectiveness of the nanotechnology industry in the industry in the region and the national economy as a whole. These include indicators of cost recovery nanoinnovations (under this indicator is the ratio of the volume nanogoods, works and services to the amount of expenditure on research, development and acquisition of nanoinnovations). Release of nano on the average per capita ratio of the number of advanced nanotechnology used to the number created nanotechnology as well as the ratio of nanogoods, works and services to the number of innovative enterprises. Some studies have shown that in the most regions of Russia, for example, the relationship between the development of innovative and efficient territorial reproduction are very weakly expressed [6, p. 94].

Aggravation of environmental issues necessitates statistical accounting degree which harmfully effects on the environment arising during production, use and operation of nanoproducts. To quantify the environmental performance of products used, which is one of the fundamental properties that determine its level of quality. The main indicators of nano- related to environmental indicators such as the content of harmful impurities in nano-products, emissions of harmful substances into the environment due nanofabrication assessment of noise, vibration, environmental contamination (scientific direction in which we investigate the influence of the development of the nanotechnology industry issues on the environment the medium can be called nanoecology).

Besides the environmental performance of the development system of indicators for the formation and development nanoeconomics should consider the feasibility of other groups of indicators, such as, for example, ergonomic, aesthetic, and other groups of indicators . Ergonomics reflects the convenience and comfort of using nano-products. So, psychological indicators used in determining compliance capabilities of nanoproducts perception and information processing, as well as psychological quality person. Another kind of ergonomics is anthropometric indices used in determining that the design of the product size, shape and weight of the human body and its individual components are coming into the contact with nanoproducts. This category also includes hygienic, physiological and physiological indicators.

So, health's indicators are used to establish compliance with hygienic applications of nanoproducts life and human performance in its reaction with the product. In other words, health's indicators define the product conforms to sanitary norms. Physiological parameters used to determine compliance with the physiological characteristics of nanoproducts' rights and the func-

tioning of his senses (for example, the device's power and speed nanoproducts human features or design meets nanoproducts visual and psycho-physiological features of human).

Aesthetic appeal of nano characterizes its aesthetic impact on a person. Indicators in this group are associated with a complex quality - aesthetics, acting on the human perception of nano in terms of its appearance. This quality is determined by such simple features as form, harmony, composition, style, etc. In accordance with aesthetic indicators compliance of nanoproducts characterizes the environment, style, information and decoration of nano, its harmony and expressiveness, originality of design and packaging, etc.

These groups represent the scorecard, in our opinion, the main aspects of the formation and evolution of nanoeconomics (in this regard, this system can be called a system of nanocoefficients). The system of nanocoefficients thus should include the following sections: a general section of nanocoefficients, dynamics section, section which describes the quality, standardization and unification of nano, section of efficiency and innovation activity of the nanotechnology industry, as well as sections which describe ecological, ergonomic and aesthetic properties of nano. However, the above does not mean that over time, the system of indicators, which characterizes the nanotechnology industry will not undergo significant changes and it will not be added new sections of indicators. In the conclusion, it should also be added that the performance of all these groups should be considered at the different levels of the management hierarchy: mega-, macro -, meso- , micro-and miniurovne. This scorecard can be an element of the emerging in national and regional innovation systems in Russia now. The proposed system of indicators can be used for analysis of the current state and the development of prospects of nanoeconomics, which should be determined not only in Russia but also in other countries, including Ukraine.

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СТАТИСТИЧЕСКОЕ ИЗМЕРЕНИЕ РАЗВИТИЯ НАНОЭКОНОМИКИ

В статье обосновывается целесообразность формирования системы показателей, характеризующих развитие наноэкономики, а также рассматриваются конкретные показатели, входящие в эту систему и в различных аспектах отображающих процесс создания современной наноиндустрии.
Ключевые слова: развитие наноэкономики, система показателей, наноиндустрия, наноуровень.

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СТАТИСТИЧНІ ВИМІРИ РОЗВИТКУ НАНОЕКОНОМІКИ

Резюме
У статті обґрунтовується доцільність формування системи показників, що характеризують розвиток наноекономіки, а також розглядаються конкретні показники, що входять в цю систему і в різних аспектах відображають процес створення сучасної наноіндустрії.
Ключові слова: розвиток наноекономіки, система показників, наноіндустрія, нанорівень.