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Nano-economics in a National System of Innovation

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Abstract

This article is devoted to nano-economics represented as a theory of the economic behavior of an innovative man in the context of a national innovation system. The authors describe a number of conditions required for the effective development of nano-economics and attempt to deduce a model of an innovative person.

Keywords: ***innovative person, nano-economics, national innovation system, a process approach;***

1. Introduction

At the present stage of development of a national innovation system in Russia nano-economics is an important factor in economic growth of higher quality. It is also one of the top priorities of the national social and economic policy, which makes this topic so significant.

The emergence of the theory of nano-economics reflected changes in the direction of development of economic science from problems of use and especially employment of populations towards creation of a new employee of type that will be able to learn innovative technologies over a short period of time, adjust to scientific and technological innovations, and have a high level of innovative culture. Such a change is related to the recognition of the role and contribution of nano-economics to the pace and quality of economic development, at a time when it became clear that classical growth factors could not explain the real growth of the economies of the developed world. The formation and development of nano-economics provides for re-orientation of Russia's national innovation system from simulation-like behavior towards creation of radical

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innovations and advanced technology. Innovative economy can only be built on the high level of value added by innovators. Therefore, the importance of development of the theory of nano-economics is increasing.

1.1. State of knowledge on the topic.

In recent years, the theory of nano-economics has been gaining exposure in the science of economics. Unfortunately, the common fundamental concepts of the theory have not yet become well established. This inevitably gives rise to many problems, misunderstandings and disagreements among researchers, making it difficult to further develop key questions of the theory of nano-economics. In this regard, we propose to further the scientific discussion with a number of concepts and critical comments on a number of theoretical positions.

The first phenomenon that draws our attention is an overly broad interpretation of the concept of nano-economics. It includes a theoretical description of a sector of economic activity that changes nanotechnology. G. Kleiner considers the term nano-economics as "an area of economics, the object of study of which are internal processes in enterprises and organizations". Such all-encompassing approach is the product of a descriptive rather than analytical perception of nano-economics . This reveals shortcomings of the methodological approach to such complex phenomenon. We believe that, first of all, nano-economics should be considered a theory of the economic behavior of innovative people. From a processes perspective, nano-economics is viewed as a special type of relationship that occurs at a certain stage of historical development, at the time of transition to a national innovation system.

As we analyze evolution of the theories of innovative people, let us classify existing approaches to it. The concept of "innovative personality" was first introduced in 1962 by Everett Hagen who regarded it as a prerequisite for economic growth, and the development of entrepreneurship and capital accumulation. In his research, he pointed to a variety of personality syndromes that were typical for the traditional pre-informational and modern societies.

The author shows that authoritarian personality is most clearly manifested in traditional societies, where preservation of old foundations to all social, economic and political events is the priority.

The modern world, on the contrary, is a market economy with a developed system of views on social and political events, where an innovative person with an active lifestyle searching for new solutions in order to achieve effective results of creative activity becomes a leader.

E. Hagen, 1962 notes that the most important characteristics of an authoritarian personality are imperiousness, hardness, and rigidity. And, at the same time, they are accompanied by humility, obedience, conformity, and the desire to avoid any liability. An innovative person, on the contrary, demonstrates openness, tolerance, approval of original thoughts and ideas, creativity, stimulation of originality and desire for everything new, creativity and positive change.

G. Simon, D. Smitburg and B. Thompson, 1995, while describing agents making innovative solutions, draw our attention to such qualities as: confidence (having comprehensive information about the consequences of decision), the risk-taking (having information about the likely distribution of the consequences of choosing of an alternative), uncertainty (understanding that it is impossible to determine the likelihood of consequences of a decision or the complexity of determining its estimated probability).

Some typological features of an innovative person can also be found in the works of a French sociologist M. Crozier, who notes that in the present conditions the ability of people to take initiative is a more significant factor of growth than the ability to operate physical resources. That is why competition does not focus on a problem of possession of physical resources, but on the ability to rapidly renovate and innovate.

A concept offered by Schumpeter, 1934 is quite similar and also quite interesting. A Schumpeterian entrepreneur doesn't have any profession: he is an enthusiastic innovator for whom income is of no significance. He is driven by three motives: the dream and the will, the joy of creativity; struggle and victory.

Following Joseph Schumpeter, Peter Drucker, 1985 developed a concept of a new knowledge society, where creative destruction is an essential part of humanity. Drucker explains that a man of the new era will be forced to adapt to frequent transformations, and notes that in periods of radical structural changes, only those leading the change and those who sense upcoming changes and adapt to them quickly, using opportunities that open up before them will survive.

2. Methodology of the economic theory of nano-economics.

The theory of nano-economics is a holistic, evolving system of true knowledge, which includes a set of components (elements) and performs certain functions in a national innovation system. Structurally the theory of nano-economics includes functions, principles and laws that reflect the essence of the object of study, original ideas, value factors, and the logic of the theory.

From a functional point of view, the theory of nano-economics is a set of inter-related provisions, describing, explaining and predicting a variety of events in a national innovation system. Therefore, the theory of nano-economics performs a deductive, explanatory, and predictive function. Furthermore, the theory of nano-economics performs a methodological function, because it serves as a basis for innovation. It becomes clear why I. Lakatos related advancement of scientific knowledge with methodology. The works on the subject refer to such scientific methods as the subject-informative (object-informative), operational, and axiological (praxiological). Regardless of the methodology used, the theory of nano-economics should include such criteria as the degree of novelty and usefulness. German economist and philosopher Hans Albert believed that any methodology should include the following:

- Knowledge should be perceived as an achieved result when it is considered credible for a problem (cognitive) situation;
- Knowledge should be perceived as a process of continuous movement towards the truth, which involves continuous criticism of knowledge achieved as a result that has to be discredited.

These different approaches to a cognitive process are found in diverse paths to the theory of nano-economics. According to the theory of cumulativism, the development of knowledge occurs via continuous addition of new knowledge to that already accumulated. The model of an innovative person takes into account the quality aspect: a new theory of nano-economics has a greater explanatory power, so the old theory of human capital is considered as a special case of the new one. Thus a statement made by Thomas Kuhn, 2012 starts to make more sense: the dynamics of a science represents a paradigm shift in the scientific revolution. The theory of nano-economics focuses on increasing knowledge about the object and focuses on problem solving and regulation of innovation activities. Therefore, such assessment criteria as "progressive problem shift" are applicable to it. The theory of nano-economics has the most sophisticated methodological basis. It includes discovery, problem solving, and creating innovative designs. The main evaluation assessment criterion is their usefulness and practical significance.

2.1. The theory of nano-economics

The methodology of economic theory determines the relationship between two theories: the theory of nano-economics and the theory of national innovation system. The theory of national innovation system cannot be separated from the theory of nano-economics. A scientific theory must predict the behavior of the subject in space and time.

To ensure continuous development it is necessary to pay close attention to nano-economics which can transmit external objectives of an innovation system. Nano-economics plays the role of the DNA of an innovation system. While forming a comprehensive image of an intellectual life of a human world and expressing the value priorities of a relevant innovation system, nano-economics determines which parts of a continuously developing scientific knowledge should get into the flow of an innovation broadcast, and what should stay out of it. Thus, nano-economics determines what knowledge, values, goals, and examples of creative activity and behavior will form an innovative kind of life and will become the main regulators of human behavior, communication, and daily activities. In this respect, the functioning of nano-economics is quite similar to the role of DNA as a special matrix of an innovation system, which defines the basic structure of innovative activity.

Important place of nano-economics among other domains of economics is defined by a natural position of its object: individual innovation in a national innovation system. The goal of nano-economics is to explain and predict the economic behavior of an innovative man in an innovative environment, to identify internal and external determinants and factors affecting his/her behavior in different economic situations with respect to rationality and irrationality. Thanks to nano-economics it is possible to reveal the influence of innovative human activities on the innovation process. The world is moving to the sixth technological order and requires a nano-economic strategy in line with the basic directions of the sixth order, primarily nanotechnology, biotechnology, information and communications technology, and new materials sciences. An innovative economy can only be built on the high added value of human intelligence. Therefore, we can reasonably assume that the sixth technological order and qualitative changes of nano-economics are correlated.

Analysis of the possible motivations and other factors influencing the behavior of companies' employees and managers (for example, in the spirit of H. Leibenstein's X-factor theories) naturally complements microeconomics and minieconomics. Innovative human activity successfully manifests itself only when people are able to learn new technologies, and support and commit to improvement. That's why today nano-economics has become a key component of many strategies.

Let's construct a model of innovative man that can largely be seen as a model of personality, receptive to innovative activity in the sixth technological order. It includes:

- openness to experimentation, innovation, and changes;
- focus on the present and future;
- confidence and ability to overcome obstacles;
- high value of education;
- the need for change;
- a systematic and forward-looking approach to selection and organization of innovations;
- willingness to take risks;
- focus on innovative development as a process of constantly renewable diffusion of innovation in all aspects of their lives.

Undoubtedly, this is not an exhaustive list of features and requirements of innovative personality, which can be supplemented as the study progresses. However, in our opinion, this list allows to outline the boundaries of a model of an innovative man.

The model of personality presented here is a basic version of the innovative development of nano-economics. In this sense nano-economics is considered a special social organism, which is characterized by its interaction with the innovative system of the sixth technological order. The development of nano-economics is a subject to certain rules, on the one hand, and on the other hand, nano-economics is part of an innovation system and forms functional connections with it. Consequently, all changes in these components influence each other.

Process approach to the study of nano-economics focuses on quality of life, adaptation, learning, cognition and the corresponding change in the intensity and productivity of labour. The subject of study is rhe interaction and development of innovative individuals. It is a natural setting of nano-economics.

Innovation, in our opinion, is largely dependent on the quality of human life. However, as shown by E. Toffler, 2007 in his book "Revolutionary Wealth", the common notion of quality of life in an information society changes. The quality of life is largely determined by the possibility of access to information products, services, their availability and quality. The authors see a direct relationship between the development of innovative human and information products. In his view, mobile telephony, Internet and personal computers not only make life easier, but also allow us to obtain instant access to knowledge and information that we need.

One of the indicators of the current abundance of information is an index of development of information and communication technologies (ICT Development Index). This index is a composite measure of global achievements in terms of information and communication technologies. According to the new data provided by the study conducted in 2010 and 2011, South Korea is the most successful economy in the world as far as the development of ICT goes, followed by Sweden, Denmark, Iceland and Finland. Based on data from Table 1, we see that the first eight of ten countries are located in Europe; the remaining two countries belong to the Asia-Pacific region.

Table 1. The index of information and communication technology development in the world in 2010-2011.

Country	Rating 2011	Index 2011	Rating 2010	Index 2010
South Korea	1	8.56	1	8.45
Sweden	2	8.34	2	8.21
Denmark	3	8.29	3	8.01
Iceland	4	8.17	4	7.96
Finland	5	8.04	5	7.89
Netherlands	6	7.82	7	7.60
Luxemburg	7	7.76	6	7.64
Japan	8	7.76	8	7.57
Great Britain	9	7.75	14	7.35
Switzerland	10	7.68	9	7.48

The authors of the study point to a relation between revenues and progress in the field of ICT, as the first 30 places in the ranking belong to the countries with high level of income. We also see striking differences between developed and developing countries: the index in developing countries is on average two times lower than in the developed ones.

The subject domain of nano-economics is an intellectual product, which is seen as the result of spiritual, mental, and intellectual activity, including discoveries, inventions, patents, scientific papers, reports, reports, procedures, concepts, descriptions, technology, etc.

The main criteria of the subject domain were defined by P. Drucker, 1993:

1. Products of creative work, as opposed to the physical nature of material products, initially have no mass, or weight, or length, or volume;
2. Work required to create them (develop them) is a complex activity.
3. These objects are usually associated with knowledge gain.
4. They often have specific authors and creators.

5. Social and economic relations occur in regards to these objects.

6. These objects can have valuation, be a subject of labor contracts, they become commodities.

Creativity of a person and his/her creative and intellectual potential are the fundamental components of nano-economics that ensure a man's ability for effective self-development in an innovative environment. The novelty is counterbalanced by rationality, realism, and pragmatism. Moreover, the process of innovative thinking focuses on consequences of the practical use of innovations and is, therefore, obliged to "simulate the future" in order to predict the dynamics and behavior of an innovative product in a dynamic environment.

Transition to an innovative economy and a more sustainable development begins with creation of institutional environment and reformation of the means of coordination of communications of innovative entities, built on horizontal (non-hierarchical) relations and a principle of collaboration. Such a principle is referred to as a mechanism of interaction, where its participants are continuously exchanging knowledge, use each other's assets and coordinate their decisions.

A subject of innovation A, sharing some amount of asset X for some amount of asset Y with a subject of innovation activity B, thus expresses its innovative interest XA to YB. The subject of innovation activity B exchanging some quantity of asset X for a certain amount of asset A with the subject of innovation activity A, thus expresses its innovative XB interest to YA (Fig. 1).

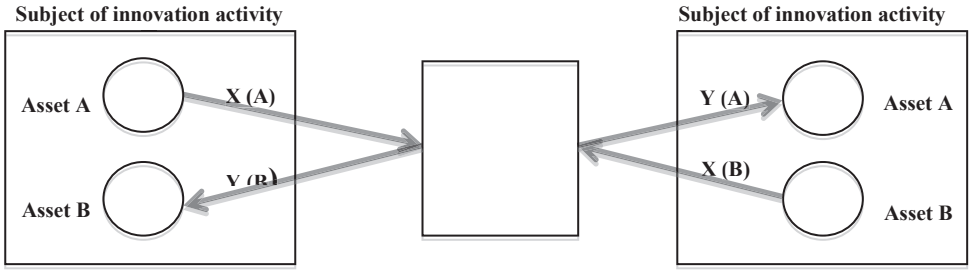

Fig. 1. Exchange of innovative assets in order to meet the interests of the subjects of innovation activity.

An exchange of innovative assets provides a powerful research, design and technological potential by combining the results of innovation developments performed by the subjects, each of whom depends on the innovative capacity of a person. For the purposes of the study we propose to calculate the integral index of efficiency of innovative development of an economic system using special indices for each innovative person. It will connect indicators of economic problems and will show how they change over a certain period of time, and reveal the mechanism of collaboration.

$$Kef_t = \sum K_f^t, \quad (1)$$

Where Kef_t is an integrated indicator of the effectiveness of innovative development of an economic system;

K_f^t – sustainability index of i-innovation in the context of human factors f in year t;

$$K_f^t = \sum K_{ij}^t, \quad (2)$$

Where K_{ij}^{t} – special index of i-th index factor f in year t.

With that, the calculation of special indices is done with the formula:

$$K_{ij}^{t} = \frac{(K_{ij} - \min_{i=1,\dots 45} K_{ij})}{(\max_{i=1,\dots 45} K_{ij} - \min_{i=1,\dots 45} K_{ij})}, (3)$$

Where K_{ij}^{t}– is an index of an i-th indicator of an innovative person ($i \in [1; M]$, where M – is the number of innovative subjects assessed in the year t);

K_{ij} – an index of the i-th indicator for a i-th innovative person

Calculation of an integral index of efficiency of innovative development shows that an innovative economy is an economy of a changing variety, and to enable the birth of innovations, at least three innovation actors - government, science, and business (triad interactions)- need to be brought together.

The need to steer an economic system towards an innovative development model actualizes the need to assess the effectiveness of a person's innovative potential where the following key aspects should be considered: education, economic freedom, and the level of innovation.

One important factor influencing the formation of an innovative man is his/her education. In a knowledge economy it is practically impossible to achieve success without education, lifelong learning and advancement of own skills. It has been proven that the higher the proportion of educated population of the country is, the higher the rate of economic growth is. An increase of budget funding for education by 1% leads to an increase in GDP by 0.35%.

According to the UNDP report from 2010 on Human Development entitled the Real Wealth of Nations: Pathways of human development, Norway has the highest level and accessibility of education. In Table 2, we can see that the list of top five countries also include Australia, New Zealand, United States and Ireland. Russian Federation ranked 65 among 146 countries.

Table 2. Quality and availability of education by country.

№	Country	Achievements in the domain of education		Availability of education				
		Adult literacy rate	Population with at least secondary education	Primary education enrollment ration (% of population of primary school age)		Secondary education enrollment ratio (% of population of secondary school age)		Higher education enrollment ratio (% of population of high school age)
		(% age 15 and older)	(% age 25 and older)	Aggregate	Net	Aggregate	Net	Aggregate
		2005- 2008	2010	2001-2009	2001-2009	2001-2009	2001-2009	2001-2009
1	Norway	-	87,3	98,4	98,4	112,5	96,6	75,9
2	Australia	-	73,4	104,9	97,0	147,9	87,5	75,0

3	New Zealand	-	67,9	101,2	99,2	120,4	90,8	79,1
4	USA	-	89,7	98,0	91,5	94,3	88,2	81,6
5	Ireland	-	64,1	105,4	96,9	113,4	88,1	61,2
6	Liechtenstein	-	-	109,6	89,3	119,5	88,6	60,1
7	Netherlands	-	67,4	106,8	98,5	119,5	88,6	60,1
8	Canada	-	79,6	107,1	99,5	101,3	-	62,3
9	Sweden	-	80,3	94,2	93,8	103,1	99,1	74,5
10	Germany	-	97,2	105,7	98,2	100,6	-	-

It is quite evident that in order to achieve a successful formation of an innovative person it is important to increase his/her level of education, and to improve the individual process of self-education. Tough professional competition requires constant replenishment of individual knowledge and skills. It also demands continuous improvement of skills related to self-education that are necessary in order to follow the lifelong learning approach that is gradually becoming an integral part of our thinking and living.

The next important feature contributing to the development of an innovative environment and an innovative person is economic freedom of a country. It should be noted that the concept of economic freedom is based on the ideas of the economist Adam Smith, as he defined them in his work The Wealth of Nations.

The authors point out that in countries with a free economy the level of well-being is much higher, and, surprisingly, economic freedom is a more effective tool than the state regulation of economy. The data show that "free" countries have on average double the per capita income of "mostly free" countries, whose per capita income, in turn, is more than three times the per capita income in "mostly not free" and "not free" countries. The researchers explain this phenomenon by noting that transferring responsibility and some of the economic functions of the state to the private sector, as a rule, leads to a significant increase in social welfare. The governments supporting a policy of economic freedom create favorable conditions for innovation, which certainly leads to growth.

According to the rating in Table 3, the leaders of the free economy are Hong Kong, Singapore, Australia, New Zealand and Switzerland.

Table 3. Economic freedom index of 2013.

Rank	Country	Index
1	Hong-Kong	89.3
2	Singapore	88
3	Australia	82.6
4	New Zealand	81.4
5	Switzerland	81
6	Canada	79.4
7	Chile	79
8	Mauritius	76.9
9	Denmark	76.1
10	United States of America	76

Besides education, level of income, economic freedom and ICT, and the level of innovative development are other key factors of innovation.

Innovative development is an area of focus of two major organizations: International business school INSEAD and the World Intellectual Property Organization (World Intellectual Property Organization, WIPO), which measures innovative development through a global innovation index. In our opinion, the authors identified it as a key measure because the resources available and practical results achieved, which are calculated as a weighted sum of the two groups of parameters, are very important for the development of the innovative personality. Note that the resulting index is a ratio of cost and effect, which allows estimation of the effectiveness of efforts towards development of innovation in a country.

According to the analytical report The Global Innovation Index of 2012 the list of the top ten world countries in innovation has not changed compared to the previous year. Switzerland holds the first place in innovation capacity in 2012. Below in Table 4, we also see that Sweden and Singapore are still among the top three countries. They are followed by Finland, Great Britain, Netherlands, Denmark, Hong Kong, Ireland and the United States. The only country that is no longer among the top ten is Canada, due to a weakening position in all major indices. The United States continues to be an innovation leader, but shows a relative decline of performance in such areas as education, training and innovative development. As a result, in 2012 the U.S. rating was downgraded.

Russia, in 2012 ranked 51st in the overall list. As the report notes, the strengths of Russia are in the quality of human capital (43th place), business development (43th place), development of knowledge (32th place). Imperfect institutions (93rd place), performance of the internal market (87th place) and the results of creative activity (84th place) hinder its innovative development.

Table 4. Ranking of countries by Innovation index in 2012

Ranking	Country	Index
1	Switzerland	68.2
2	Sweden	64.8
3	Singapore	63.5
4	Finland	61.8
5	Great Britain	61.2
6	Netherlands	60.5
7	Denmark	59.9
8	Hong-Kong	58.7
8	Ireland	58.7
10	United States of America	57.7
10	Luxembourg	57.7

Thus, based on the above factors influencing the formation of innovation, we present a model of human innovation as follows:

$$HI = f(P, ICT, E, F, I),$$

where HI – innovative person,

P – level of income,

ICT – level of ICT development,

E – education,

F – degree of economic freedom,

I – rate of innovation.

It should be noted that these variables do not have equal power, and one of them may have greater weight than others. Let's also make it clear that the weight of a variable depends on the level of economic development of a country.

To conclude, let's think of the fact that the changes occurring in the economy are mainly related to intangible, socially active, subjective and personal structures that require targeted development of all perspectives, but an objective incompleteness of research on the theory of nano-economics requires us to continue and to further review, deepen and expand the development of pertinent theoretical and methodological concepts, methods, techniques and tools of research of this phenomenon.

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