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FEATURES OF THE DIFFUSION OF SCIENTIFIC INNOVATIONS IN THE DIGITAL ECONOMY

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Abstract: *The paper analyzes the process of scientific innovations diffusion in the digital economy, develops approaches to this process mathematical modeling and describes some examples of its application*.
Key words: *digital economy, science, innovation, diffusion, modelling.*

The digital economy is rapidly developing in several directions. First, digitizing the economy and transferring it to the virtual space of the Internet creates a new information space in which market reaction time is sharply reduced. Second, digitizing the economy creates a powerful demand for information technologies to ensure its functioning. Third, digitizing the market significantly reduces information asymmetry, thereby reducing market failures.

The last factor, which leads to the digitization of the economy, is an important guarantee for the development of both the market and society. Society develops as an innovation mechanism. The market acts as a powerful amplifier of the introduction of innovations. This is done mainly due to the so-called diffusion of innovations, when an innovation that was initially localized to a very small number of users begins to increase its number.

The report analyzes the process of diffusion of scientific innovations in the digital economy, develops approaches to mathematical modeling of this process and describes some examples of its application.

The main element of innovation is new knowledge (know-how). We will use the following definition (see [1] and references therein): knowledge (information) is norms of behavior, methods, results of activity, algorithms, and programs of activity of individuals, as well as ways of communicating with people in their joint behavior and joint activities. Thus, databases, algorithms, and information technologies for their application are also elements of knowledge. The novelty of the knowledge that sets the innovation may be previously unknown either for the local market of a given region or country or previously unknown on the entire planet. In the latter case, the innovation based on it will be called scientific.

Scientific innovations are fundamentally different from other innovations. To produce a scientific innovation, new scientific knowledge must be used. Similarly, users and consumers must master new knowledge to use scientific innovation. This is necessary because previously, users and buyers did not know how exactly they could use this new product based on scientific innovation.

Thus, scientific innovations should always be accompanied by some kind of organized training programs, focused on an untrained user. These training programs should include methods, technologies, and algorithms for using the product of scientific innovation both by an individual and by a group of users. They should also include a description of both the areas of application and the benefits that this product of scientific innovation provides to the user.

In the general case, a tuple of knowledge K that corresponds to a given scientific innovation should be distributed in society, i.e. $K_s=(k^s_1,k^s_2,\ldots,k^s_i,\ldots)$. Here k^s_i is a separate method, technology, or way of doing an activity (either for a person or in collaboration with other people). Such a tuple can be viewed as a knowledge piece that is localized on an individual. In the space of possible tuples K, ordering and metrics can be introduced [1]. This allows us to introduce functions in this space and apply differentiation and integration operations to them [1].

Consider the function $n(K,t)$ for the number of people who at time t possess the tuple K. In this case, we can describe the process of dissemination of scientific innovations as a diffusion process. The intensity of dissemination of innovations j (the number of people who receive a given knowledge per unit of time) in this case is determined by the first Fick's law, which is written as follows:

$$J = -D\frac{dn}{dK} \tag{1}$$

The dimension of the diffusion coefficient of innovations is then the square of the amount of knowledge divided by a unit of time.

The process of dissemination of scientific knowledge is described in detail in [1].

In the case when a scientific innovation is ΔK, the process of its diffusion into society can be represented in a simple mathematical model [1] as shown in Fig. 1.

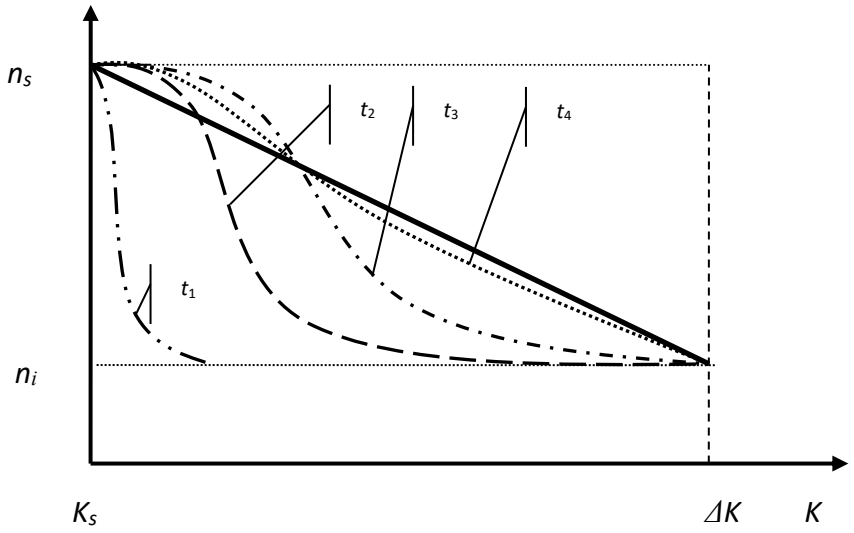

Fig. 1. Qualitative representation of the scientific innovation dynamics. $t_1<t_2<t_3<t_4$

The time required to achieve societal adoption of a scientific innovation can be estimated within the model as

$$t \sim \frac{(\Delta K)^2}{D}. \qquad (2)$$

Thus, the general direction for increasing the efficiency of economic development through the innovation mechanism should be the fulfillment of the following conditions.

Firstly, this is an increase in the diffusion coefficient of innovations by increasing the level of digitalization of the economy and increasing the level of openness and accessibility of knowledge about innovations for society.

Secondly, this is the development of a system of free (conditionally paid) training courses to create conditions for the population to master scientific innovations.

Thirdly, this is the creation of conditions for the formation and development of public opinion aimed at supporting scientific innovations. This may lead to the fact that the diffusion coefficient of innovations will depend on time and on the number of people supporting this innovation $D(n(K),t)$. This will lead to the formation of nonlinear effects, while $\partial D/\partial n>0$ will be achieved. That is, it will be possible to achieve an “explosive"\” spread of innovations. We emphasize that such effects are often found in the digital economy. It is enough to mention cryptocurrency or artificial intelligence.

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