MODELS OF INNOVATION PROCESS IN KNOWLEDGE ECONOMY: IMPLICATIONS FOR INNOVATION POLICY IN UKRAINE

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1. Introduction

Ukraine announced transition to innovative model of economic development on the basis of creation of knowledge economy. This model provides for the implementation of national economic development strategy aimed at significant improvement of economic performance, GDP growth through wide focus on the creation, development in production, market promotion of technological as well as organizational and management innovation. However, the lack of a clear strategy, blurring objectives and priorities of the state innovation policy and the main factor, in our opinion – the lack of serious methodological framework that would meet the latest modern understanding of the innovative process, resulted in low rates of innovation development of Ukrainian economy.

The task is to study the modern approaches to innovation process, which will meet the requirements of knowledge economy formation, and to outline main implications of these methodological issues to the innovation policy in Ukraine.

2. Theoretical background

The problems of innovative development of national economy attract attention of many native and foreign researchers. Significant contribution to the study of these processes was made by such Ukrainian scientists as V. Heyets, V. Semynozhenko, Yu. Bazhal, B. Malitskiy, L. Fedulova, H. Androshchuk and others. Mainly Ukrainian authors associate low level of innovation development with the low level of S&T spending, or consider innovation success of the country to be dependent on the degree of activity in the commercialization of results of scientific research.

We can agree with the P. Bubenko and V. Gusev, who state that one of the distinguishing features of Ukraine's scientific discussion on innovation and innovation policy is false identification of innovation and Science and Technology (S&T) activities [1, p.30] and statements on their tough cause-and-effect connection. In one form or another, Ukrainian authors underline that effectiveness of innovation processes in economy depends on the state of science, and that the support and development of the last is the prerequisite of the intensification of innovation processes.

The mentioned identification of innovation and S&T activities is largely connected with the domination of engineering approach to the processes of development which states that "science can do everything" if it is well-financed [1, p.31]. The engineering approach is based on the so-called "linear" model of innovation activities, according to which "innovation is a process of discovery which proceeds via a fixed and linear sequence of phases. In this view, innovation begins with new scientific research, progresses sequentially through stages of product development, production and marketing, and terminates with the successful sale of new products, processes and services" [2, p.14]. This approach to innovation was dominating in the domestic scientific thought and underlied massive investments in science, which had place after World War II. The same conclusion is made by T. Gareev, who points that in domestic literature still prevails linear model of innovation, which, in his opinion, is wrong in the economy, in which knowledge is considered to be the main resource. Innovation process is presented mainly in the narrow sense, through the provision of its separate stages, as the linear model, while in the foreign literature this model of the

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innovation process refers to the 1950–1960-th years [3].

The vice chairman of Federation Council of Ukrainian Employers, A. Grishfeld, considers that Ukraine has a "linear model" of innovative policy, which is supported by obsolete approaches to scientific and technical development. These approaches require large-scale government programs of budgetary funds involvement [4].

Bellow we will analyze the main characteristics and distinguishing features of innovation and models of innovation process in knowledge economy and their implications to innovation policy.

3. Results

a) Evolution of knowledge economy concept

The concept of a knowledge economy comes from Fritz Machlup [5, p.3]. In 1962, he published an influential study that measured the production and distribution of all kinds of knowledge in the United States [6]. The author estimated that, in 1958, the knowledge economy accounted for $136,4 million or 29% of GNP. Machlup was the first to measure knowledge as a broad concept, while other measurements were concerned with the production of scientific knowledge, namely research and development (R&D), not its distribution.

Machlup's calculations gave rise to a whole literature on the knowledge economy, its policies and its measurement. The first wave, starting in the 1970s, was concerned with the so-called information economy. Using Machlup's insights and the System of National Accounts as source for data, M. U. Porat calculated that the information economy amounted to 46% of GNP and 53% of labour income in the United States in 1967 [7].

The second wave of studies on the knowledge economy started in the 1990s arising from limitations in National Systems of Innovation, the then-current conceptual framework guiding science and technology policies [8, p.5]. For several decades, economists have been criticized for their failure to integrate institutions into theories and economic models. Partly as a response to this situation, scholars in the field of science and technology studies invented the concept of national systems of innovation (NIS). According to R. R. Nelson, NIS "is a set of institutions whose interactions determine the innovative performance of national firms" [9, p.4]. For B.-A. Lundvall, it "is constituted by elements and relationships which interact in the production, diffusion and use of new and economically useful knowledge" [10, p.2]. These elements of institutions are firms, public laboratories and universities, but also financial institutions, the educational system, government regulatory bodies and others that interact with the former.

There are two families of authors in the NIS literature [8, p.6] – centering on the analysis of institutions and describing the ways countries have organized their NIS; and focusing on knowledge and the process of learning. From the latter group, the concept of the knowledge economy reemerged.

Lundvall launched the concept of a learning society or a learning economy in his book on NIS. According to him, "the most fundamental resource in the modern economy is knowledge and, accordingly, the most important process is learning" [10, p.1]. For Lundvall, however, learning is not located in R&D departments only, as suggested until recently, but comes also from what he calls routine activities in production, distribution and consumption. And "the most important forms of learning may fundamentally be regarded as interactive learning" [10, p.2], that is learning from interactions between the different institutions of NIS [11, p.26].

The learning economy involves the capability to learn and to expand the knowledge base. It refers not only to the importance of the science and technology systems – universities, research organizations, in-house R&D departments and so on – but also to the learning implications of the economic structure, the organizational forms and the institutional set-up.

D. Foray, who is the one behind the current concept of the knowledge-based economy, in his article written with P. David, criticized the concept of NIS for placing too much emphasis on national

institutions and economic growth, and not enough on the distribution of knowledge itself [12, p.4]. However, Foray and David concluded similarly to Lundvall on a number of points, among them: "an efficient system of distribution and asses to knowledge is a sine qua non condition for increasing the amount of innovative opportunities. Knowledge distribution is a crucial issue" [12, p.40].

Thus, a central characteristic of a NIS is the way the knowledge is distributed and used. As K. Smith, author of the OECD (Oslo) methodological manual on measuring innovation put it: "The overall innovation performance of an economy depends not so much on how specific formal institutions (firms, research institutes, universities, etc.) perform, but on how they interact with each other" [13, p.72]. Indeed, "knowledge is abundant but the ability to use it is scarce" [11, p.31].

b) Models of innovation in knowledge economy

Analyzing innovative process, B.-A. Lundvall distinguishes two approaches to innovations [14, p.8]:

– linear model (supply approach), starting within basic research and ending in economic growth. The results from basic research are regarded as inputs to applied research. Inventions taking place within science are supposed to give rise to innovations. As innovations become diffused they affect productivity and growth in the sphere of production. Such a perspective corresponds to a technology policy supporting science and R&D activities;

– demand approach, which emphasizes the importance of demand as a factor stimulating and directing innovations. When demand grows, it will pull R&D inventions and innovations forward, and result in productivity growth. Innovative activities are assumed to adjust automatically to the market forces.

Both approaches can be accused of regarding the system of production as a black box. The supply school concentrates upon the bottom of the black box where R&D is introduced and expects beneficial effects to come out at the top of the box. The demand school assumes that changes at the top of the box – changes in demand – will have beneficial effects at the bottom. A user-producer approach might be regarded as one revealing the content of the black box. The network of user-producer relationships transmits signals from the top to the bottom and vice versa.

Lundvall also criticizes traditional definition of innovations by Schumpeter, who saw them as "new combinations", which can be separated from invention that becomes an innovation only when the entrepreneur brings it to the market. He follow Schumpeter in these respects, but adds to the event of the first market introduction of new combination the process of its diffusion and use [15, p.10].

The British sociologist, Roy Rothwell distinguishes 5 generations of innovation process models [16]:

1. "Technology push" model (from 1950 to the mid-1960's).
2. "Market pull" model (from the mid 1960's to early 1970).
3. "Coupling of R&D and marketing" model (from the mid 1970's to the mid-1980's).
4. "Integrated business processes" model (from the early 1980's to the mid-90's).
5. "System integration & networking" model (from the 1990's).

T. Gareev adds to this classification the 6th model of innovation process "based on knowledge and training", which is grounded by a "Knowledge-based theory of the firm" by R. Grant. The main asset of a company is considered to be tacit knowledge. Innovative process continues to be an integrated network process, bus start to focus more on mechanisms of creation, distribution and use of all types of knowledge. The faster the company is able to learn, the more innovative it is, and the faster it is able to respond to market changes with innovative products and services [3].

OECD, defining models of innovation process in knowledge-based economy, points at the processes of knowledge distribution and at the network characteristic of the modern economy, and considers that "in knowledge-based economy ideas for innovation can stem from many sources,

innovation can assume many forms, including incremental improvements to existing products, applications of technology to new markets and uses of new technology to serve an existing market. And the process is not completely linear" [2, p.15]. This is systemic or interactive model of innovation.

The authors [17] argue that definition of innovation models is based on changes in the process of knowledge creation itself, i.e. at difference between tacit and codified knowledge. Codification of knowledge implies that knowledge is transformed into "information" which can be easily transmitted through information infrastructures. It is a process of reduction and conversion which renders the transmission, verification, storage and reproduction of knowledge especially easy. In contrast to codified knowledge, tacit knowledge is the knowledge which cannot be easily transferred because it has not been stated in an explicit form. The fast development of ICT gives a strong impetus to the process of codification by increasing the economic value of codified knowledge. Most knowledge, which can be codified and reduced to information, now can be transmitted over long distances at very limited cost. Codification is important for economic activity for four main reasons:

– codification reduces costs of the process of knowledge acquisition and technology dissemination;
– through codification, knowledge is acquiring more and more the properties of a commodity;
– codification facilitates knowledge externalization and allows firms to acquire more knowledge than previously at a given (but not necessarily lower) cost;
– codification helps directly to speed up knowledge creation, innovation and economic change.

But there are two important limits to the codification process:

– the fact that codified and tacit knowledge are complementary and co-existing means that there are natural limits to codified knowledge. The main point here is that codification is never complete, and some forms of tacit knowledge will always continue to play an important role;
– increased codification does not necessarily reduce the relative importance of tacit knowledge. Actually, easier and less expensive access to information makes skills and capabilities relating to the selection and efficient use of information even more crucial than before.

This means that tacit knowledge is still a key element in the appropriation and effective use of knowledge, especially when the whole innovation process is accelerating.

The significance of tacit knowledge highlights the role of learning, which has become the key to successful economic and market operations. This means that the most important factor for individual firms is no longer having a given set of skills, but rather being able to acquire new ones effectively. A firm's capacity to learn and transform in this new context is a crucial competitiveness factor. There is a definite need to constantly rebuild the skills of the individual and the technological and organizational competencies of the firm.

Based on two types of knowledge in the knowledge economy M.B. Jensen, B. Johnson, E. Lorens and B.-A. Lundvall distinguish two modes of innovation [18]:

– the Science, Technology and Innovation (STI) mode – based on the production and use of codified scientific and technical knowledge;
– Doing, Using and Interacting (DUI) mode – an experienced-based mode of learning based on tacit knowledge.

c) Implications to innovation policy

The terms "national system of innovation" and "knowledge-based economy" have been around for more than 20 years and today they have become widely spread among policy makers as well as among scholars all over the world [19].

The wider implications of an innovation and learning perspective on general economic policy have not been seriously considered and worked out. Innovation policy has been added to an economic policy based upon static economic theory. Policy implications have been worked out on the basis of a narrow definition of innovation system where the focus is on science based innovation.

Despite the broad acceptance of the literature on knowledge economy, on national innovation systems, on the interactive nature of innovation process, there remains a bias among scholars and policy makers to consider innovation processes largely as aspects connected to formal processes of R&D, especially in the science-based industries [18].

B.-A. Lundvall, one of the authors of NIS concept, argues that during the process of diffusion there has been a distortion of the concept as compared to the original versions. Often policy makers and scholars have applied a narrow understanding of the concept and this has gives rise to so-called "innovation paradoxes" which leave significant elements of innovation-based economic performance unexplained. Such a bias is reflected in studies of innovation that focus on science-based innovation and on the formal technological infrastructure and in policies aiming almost exclusively at stimulating R&D efforts in high-technology sectors [19].

At the policy level this can be seen in the emphasis on benchmarking variables related to STI and in their focus on such instruments as tax subsidies to R&D, the training of scientists in high-tech fields such as ICT, bio-, nano-technology and strengthening the linkages between firms and universities.

As it was shown models of innovation in knowledge economy emphasize that innovation is a systemic and interactive process in which firms interact both with customers and suppliers and with knowledge institutions. Innovations can't be reduced to scientific innovations. Yet, when one turns to policy analysis and prescription, as well as to the quantitative survey-based studies, there is a clear bias to consider innovation processes largely as aspects connected to formal scientific and technical knowledge and to formal processes of R&D. At the European level, this kind of bias can be seen by examining the empirical measures used and the supporting research undertaken for EU bench-marking exercises, such as Trendchart's [20] annual ranking of the innovative performance of EU member nations, which is based largely on conventional S&T measures such as R&D expenditures, patenting, the share of the population with tertiary education, the weight of S&E graduates in the workforce, ICT expenditures and the importance of venture capital. None of the 22 individual measures which are used to construct the 'summary innovation index' for EU member countries are designed to capture organizational aspects linked to informal processes of learning.

The basic provisions of Ukraine's legislation on innovation policy and National Innovation System show that Ukrainian policymakers use narrow understanding of the concepts of "innovation", "innovation policy" and "NIS". Such an approach focuses on science-based innovation and on the formal technological infrastructure and on policies aiming at stimulating R&D efforts in high-technology sectors. Thus, according to the article 1 of Law of Ukraine "On innovation activity" of 4 June, 2002, "innovation activity" is set up as the activity directed to use and commercialization of results of scientific research and elaborations and stipulates the issue to the market new competitive goods and services [22]. And the main "purpose of the state innovation policy" is to create socio-economic, organizational and legal conditions for the effective reproduction, development and use of scientific and technical potential, to ensure implementation of modern environmentally friendly, safe, energy – saving technologies, production and implementation of new competitive products.

In accordance with the Concept of the development of the national innovation system, approved by the Cabinet of Ministers of Ukraine [23], the "national innovation system" is defined as a complex of legislative, structural and functional components (institutions) that participate in the process of creating and using of scientific knowledge and technology and determine legislative, economical, organizational and social conditions to secure the innovation process.

However, along with the other main components of the NIS (state controlling, knowledge genera-

tion, innovation infrastructure, and production), [23] identifies the subsystem of education, which consists of the institutes of higher education, research and methodological institutes, scientific production enterprises, state and local boards of education, as well as educational organizations that provide training, retraining and advanced training.

Ukraine has to move away from a model of increasing budget spending on science regardless of the results. It is necessary to encourage interaction between knowledge sector and sector, where knowledge is transformed into concrete economic results. Special attention should be given to measures aimed at development of Doing, Using and Interacting – experienced-based skills, which are based on tacit knowledge. It is necessary to implement following measures:

- create effective national and regional innovation systems with an accent on innovation culture, stimulation of interactions of key innovation actors and institutions;
- develop communication and operative interaction of academia and business environment;
- improve academia's understanding of innovation and entrepreneurship including business skills;
- create innovative environment in research and scientific institutions and universities;
- implement entrepreneurship education of researchers.

4. Conclusions

Ukraine announced transition to innovative model of economic development on the basis of creation of knowledge economy. Unsuccessfulness of its innovation policy is conditioned, in our opinion, with the lack of serious methodological framework that meets the latest modern understanding of the innovative process, which results in low rates of innovation development of Ukrainian economy.

One of the distinguishing features of Ukraine's scientific discussion on innovation and innovation policy is false identification of innovation and S&T activities and statements on their tough cause-and-effect connection. Looking into the nature of innovation and innovation process, the authors of knowledge economy and NIS concepts highlight the importance of distribution of knowledge, while previous studies were concerned with the production of scientific knowledge, namely research and development (R&D), not its distribution. Modern models of innovations and innovation process are based at user-producer approach, networking, organizational and management innovations, learning and training of organizations, importance of skills and codified knowledge.

The wider implications of an innovation and learning perspective on general economic policy have not been seriously considered and worked out. Innovation policy has been added to an economic policy based upon static economic theory. Policy implications have been worked out on the basis of a narrow definition of innovation system where the focus is on science based innovation. The basic provisions of Ukraine's legislation on innovation policy and NIS show that Ukrainian policymakers use narrow understanding of the concepts of "innovation", "innovation policy" and "NIS". They focus on science-based innovations and on the formal technological infrastructure and on policies aiming at stimulating R&D efforts in high-technology sectors. Ukraine has to move away from a model of increasing budget spending on science regardless of the results. It is necessary to encourage interaction between knowledge sector and sector, where knowledge is transformed into economic results. Special attention should be given to measures aimed at development of DUI – experienced-based skills, which are based on tacit knowledge.

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Summary

The article analyses modern Ukrainian discussion on innovation and innovation policy and proves that that in domestic literature still prevails linear model of innovation, which is wrong in the knowledge-based economy. Evolution of knowledge economy and National Innovation System concepts are considered. The models of innovation process in knowledge economy are presented. The author argues that modern innovation policy is worked out on the basis of a narrow definition of innovation system and is focused is on science based innovation. Basic Ukrainian legislation on innovation policy and NIS is analyzed, necessary measures to build effective innovation environment are proposed.

Keywords: the knowledge economy, tacit and codified knowledge, innovation, innovation process, "linear" and "interactive" models of innovation, learning economy, national systems of innovation.

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