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TRANSFORMATION OF RESEARCH SYSTEMS IN CENTRAL AND EASTERN EUROPE: LESSONS FOR UKRAINE*

The milestones and characteristics of research system transformation in Central and Eastern Europe have been discussed. Major problems of the development and the EU role in the corresponding processes of transformation have been determined; the barriers on the path towards the reforms and the factors which contribute to positive transformations have been identified. Recommendations on reforming the research sphere in Ukraine have been proposed.

Keywords: scientific systems, Central and Eastern European countries, and reforms.

Before the beginning of large-scale social and economic transformations in the early nineties, the systems of organization of science and innovative activity in the Central and East European countries (CEEC) were similar to the Ukrainian ones in many aspects. Since then the countries of CEE have passed quite a long and difficult way of transformation which allowed integrating their national scientific systems, first of all, into all-European, and afterwards, into the international scientific system. That is why analysis of experience of these states is important for Ukraine.

INSTITUTIONAL REFORMS

In the early nineties of the last century many states of the CEE region headed for complete rollback of «the Soviet type» organizational system [1, 2, 3]. However from the early days of this process, the information on negative sides of such transformations in the former German Democratic Republic (GDR) where in no time the Academy of Sciences was liquidated and over 60% of research associates were dismissed had quite a sobering effect on the heads of some East European countries. The scientific infrastructure of the country was, in effect, liquidated. Instead of a completely demolished scientific system they started to create the structures similar to those of the western lands of Germany. In the first years after reunification of Germany indicators of the state and functioning of scientific capacity of the eastern lands decreased sharply. Only starting from 2000 the gap in the levels of intensity of scientific and technical activity began to reduce gradually. After privatization companies and enterprises of the former GDR switched to applying scientific and technical knowledge which was productive mainly in the western part of the country and other states of the EU. By the preliminary estimates of the early nineties, it would take not less than 20—30 years to bring together scientific and technological levels of the east and west of the country [4]. Eventually it happened like that.

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But East Germany is a special case. It widely used the help of the western lands of the country. The majority of other CEE countries were not so «lucky» with «the elder brother». Changes, certainly, were of the fundamental and unidirectional character — towards unification with the scientific system of western Germany. But the difference of transformation in East Germany and the CEE countries *in the first place* is that there already existed a working model which such transformation had to follow. *Secondly*, not a primitive 2-sector model of organization of science «Higher Education Institutions — laboratories of industrial companies» was developing in the Western Germany (by the way, this model has its influential adherents in Ukraine as well), but the system which by its organizational structure was somewhat formally similar to the Soviet one. A developed network of state-financed research institutes which are not connected organizationally with universities is an important component of this system. Thus institutes of Max Planck Society were occupied mainly with fundamental research, those of the Fraunhofer Society dealt with applied research, and the so called Blue List institutes were engaged in research in the field of social sciences (a bit later, institutes of this group were reorganized into other research organizations). In general, the above-mentioned structures include hundreds of think tanks, tens of thousands of employees work there. Thus, despite transformation, a variety of forms to organize scientific research in East Germany was preserved.

In this context it is not surprising that practically in all countries of Eastern Europe organizational forms of activity of scientific institutions inherited from the period of socialism were preserved after some not always successful experiments. Thus, naturally, functions and tasks of scientific organizations were adapted to new conditions. Persons who received their positions only thanks to support of the party leaders were removed from the management of the institutes (principally of the humanitarian institutes); new forms of management of scientific institutions and procedures for assessment of scientific results based on the use of the world-formed approaches [5] were actively introduced. It is already obvious that organization of science itself by the branch principle and by the principle of creation of academies of sciences does not automatically mean success or failure of scientific and technical activity. A system must be flexible and adapt to the time challenges. Organization of new institutes by the new directions of research became usual practice. At the same time the process of increase in the number of scientific institutions is not irreversible: in the Hungarian Academy of Sciences, for example, at the beginning of the 2000th there was a process of merger of already existing scientific organizations of a similar profile with preservation of considerable part of their autonomy. Simultaneously such association enabled to reduce administrative expenses and to allocate more funds directly on scientific research [6].

Different countries of Central and Eastern Europe used rather different transformation strategies. Thus all of them aimed for involvement of foreign companies to organize high-tech manufacturing facilities with their assistance on the territory of such states. However the progress was limited in this direction. The reason for it, according to the Hungarian professor B. Santo, was that from the very beginning western companies were unwilling to develop technologies in the countries of Eastern Europe which could bring to appearance of competitors in future [7]. Besides, multinational companies basically wanted not to create new production in the countries — potential competitors, — but simply to get already available assets to increase the efficiency of their use [8, 9].

The situation in the scientific and innovative area started to change from the late 90-ies when it became obvious that the leading countries of the region will become members of the EU in the near future. Some big western companies started opening separate scientific laboratories in the CEE countries, but the process has not become large-scale yet [10, 11].

DYNAMICS OF QUANTITATIVE INDICES

Let us consider some quantitative characteristics of transformations in the CEE countries. Since 1991, expenses on research and development as part of GDP have decreased more than twice in the majority of countries of Eastern Europe. In the overwhelming majority of these countries this indicator did not exceed 1% for a long time. Czech Republic and Slovenia were the exception, as they managed to pass the initial stage of transformations without serious consequences. Today most of the CEE countries have become members of the EU and accepted the strategy of increasing the costs for research and development to 3%. However it is obvious that for the majority of them it will be impossible to reach this aim within the EU set terms, till 2020. Therefore even such quite developed states as Poland and Hungary are setting much more modest aims for this period. In 2012, expenses on research and development in these countries reached only 0.9% and 1.3% of GDP respectively. Much better situation is in Slovenia (2.63%) and Estonia (2.19%). However, it must be recognized that such results have their reasons. Thus, some big scientific centers founded in the former Yugoslavia were left on the territory of Slovenia, in particular the «allied» center on nuclear research, and that caused the high level of research concentration. And in Estonia the essential part of work is funded by scientifically-developed countries of Northern Europe. In general it should be noted that economic growth has been observed in many Eastern European states for the last two decades. It was followed, at least, by proportional increase of the costs on research and development. Thus, corresponding total expenses in the CEE countries for these years have shown a considerable increase. In Poland, for example, they made USD 7.9 billion, in 2012, against USD 2.6 billion, in 2000 (in the current prices).

Another important resource index is the number of employees occupied in the researches and development. In the first half of 90-ies, practically all countries, the leaders of transformation processes, lost more than 50% of their staff in the area of science. But starting from the middle of 90-ies some stabilization and even growth in the number of employees occupied in researches and development has been observed, in 2000—2012 quite considerable growth was noted in the Czech Republic (2.4 times), Hungary (1.6 times), Slovenia (2 times), Estonia (1.8 times). The considerable part of this growth fell on higher education, but the essential contribution to this growth was also made by the private sector.

However in general the majority of countries on which more or less full information is available, have not reached relative values by the main resource indices of scientific and technical potential which existed in 1980-ies, but they had important structural changes, witnessed the growth of material base for research, the increase of salaries, intensity of work [12]. At the same time the phenomenon which so much scared many experts in the early nineties — outflow of scientists abroad — was not observed. The majority of scientists of the CEE countries find where to apply their knowledge in their own states.

Important institutional changes in the area of science have taken place as well. Such indices as the level of privatization of research organizations, the extent of integration of academic institutes and educational institutions, the extent of influence of the state on development of applied science (reduction is considered as the positive phenomenon), etc. are used as indicators for such transformations. In the financial area first of all the attention is paid to attraction of multiple sources of funding and organization of work around separate projects, but not the institutes. Thus it is supposed that any scientific institution must have four main sources of funding of research and development:

- *basic funding* provided depending on assessment of activity of a scientific institution in the previous periods;
- *program funding* provided on the basis of assessment of work to be executed;
- *project funding* received by certain researchers or research groups;

- *joint funding* of infrastructure or research projects.

Research institutions practically in all countries of the Central and Eastern Europe have been transferred on such system of funding to a greater or a lesser extent. Possibly, it is also essential for scientific organizations of Ukraine to try to diversify their sources of funding of scientific research and development as much as possible. Among other things, it will promote increase of stability of financial security of scientific organizations.

It is necessary to emphasize that during transformations in the CEE countries, as well as in Ukraine, the scientific organizations of the industry-specific profile suffered most of all, though this process was not the same in all countries. Thus, in Poland and Slovenia the economy growth enabled to support the industry-specific sector of science, having provided its gradual reforming. However it was impossible to carry out transformation and make big industry-specific scientific centers demanded by the national and foreign companies in their full capacity [13, 14]. The considerable part of scientific centers simply stopped existing. Alongside with it, according to the authors of the cited paper [15], the following changes in scientific systems of the CEE countries took place: reduction of the centralized control over the activity of research institutes; loss of exclusive positions by some academies in the area of science in their countries; minimization of influence of the centralized control on the choice of a topic and appointment of heads of institutes.

In general, it is still impossible to speak about effective use of national scientific capacity in the interests of development and creation of complex national innovative systems in the countries of Eastern and Central Europe first of all because some companies and enterprises of the countries of this region are joining the production chains of international corporations and their activity is hardly controlled on the national level [16]. In the majority of the CEE countries this process received a powerful impulse with the beginning of deeper integration of the country into the world (and, first of all, European) economic space. The main advantage of the CEE countries — rather cheap and educated labor — started to unite with needs of the companies for creation and development of research base directly on the places of product manufacturing. Besides, some countries have implemented some special instruments for stimulation of innovative and scientific and technical activity. For example, in Hungary 200% credit against tax was introduced for carrying out research and development using the nation's own resources. This norm also extends on subcontracted works if they are carried out by a university or a state research institute. The country has 400% credit against tax for research and development if the company carries it out using its own resources, and the scientific laboratory is located at the university or the state research institute. The students working in research laboratories at the universities or the state research institutes do not pay taxes on the received salary if it does not exceed the minimum level established in the country. The accelerated depreciation of the equipment used for research and development (depreciation term is 2 years) is applied; it is allowed to form nontaxable «reserve» of about USD 3 million on carrying out research; 70% reduction of tax on donations for research and development is introduced if such research is performed in public interests (that is, there is no direct commercial benefit) [17]. The fact that such strategy was integrated into the long-term plan of the national development (so-called *Széchenyi plan*) in Hungary and in such a way included into the system of national priorities [18] is important for realization of the strategy of scientific and technical and innovative development in this country.

As for productivity of scientific research, the most important index is the number of works published by scientists from the CEE countries. Main tendencies are quite obvious: despite reduction in the number of researchers in comparison with the period of socialism, the total number of published works in the CEE countries constantly increases, both according to Thomson-Reu-

ters system, and according to Scopus system. Thus, in 1996—2012, the total number of articles of scientists from Poland according to Scopus increased almost three times (from 11.5 thousand articles to 33.9 thousand) and in the Czech Republic, for the same period, it grew more than three times (from 4.8 thousand to 16.4 thousand). A bit smaller growth is observed in Hungary and Slovakia; however these countries have also essentially increased the level of their publishing activity. At the same time one interesting fact attracts our attention: the number of articles written in a co-authorship with foreign colleagues for the same period was growing quicker than total number of publications. For the majority of the CEE countries the number of articles written in a co-authorship with colleagues from the EEC countries makes 35—40% of the total number of publications. For Estonia this index even exceeds 50%. This phenomenon has both positive and negative sides. On one hand, a large number of joint publications is the evidence to internationalization of science of this or that country, on the other hand — it is an indicator of a certain weakness of the national scientific system, its prevailing orientation on external, but not on internal problems. For the developed countries the index of 20—30% is considered to be the norm. Perhaps, for the CEE countries such number of joint publications is a temporary phenomenon connected with the need of the fastest expansion to the international level, but meanwhile there is no evidence to the change of the tendency formed [19]. It must be also recognized that the number of publications per one scientist in the CEE countries still lags behind the indices of the developed countries.

We are not going to dwell upon the dynamics of patent activity because it is not as closely connected with carrying out research and development as publications, but it would be interesting to note that in the last two decades the number of patents in the CEE countries has remained on the lower level in comparison with a similar index for the developed and fast-growing countries. It is hardly worth expecting that the CEE states which actually destroyed high-tech sectors of their economies (electronics, precision mechanics, etc.) during transformation will be able to reach indices of at least Taiwan by the level of patent activity.

In general, one might agree with the assessment of *Meske* and *Weber* [20] made at the beginning of the XXI that it will take not less than 15—30 years for the CEE countries to reach the Central European level by the main economic indices, including the level of development of scientific and technical potential. Saying that, the German experts emphasized that the change of content of educational processes and transition to the life-long training together with the institutional changes in the scientific system are the major factors which will ensure the success of transformations.

CONCLUSIONS

Despite a large number of publications on transformation of scientific systems of the CEE countries, two problems connected with transformations in these states have not still been adequately discussed in the research.

First of all, sources of innovations as well as many key links of the innovation process more and more often happen to come from outside the East European countries. There is a transition to so-called «push-button» technology when new equipment and technologies are transferred in the form of «a black box» and are not subject to modifications or use without active participation of the party which transfers such technologies. Among other things, it leads to obtaining of the main part of the added value by the western companies controlling technological component of the production process. Scientific organizations and scientific workers of the CEE countries appeared to be «debarred» from receiving the main financial results of the innovation process. The second problem (and it is connected with the previous one) is the extremely irrational use of intellectual resources of the countries of the region. The countries of the Central and Eastern Europe continue to be among leaders of the modern world by the number of persons who have engineering

or natural scientific education in total number of able-bodied population. However now most of these people work not by the specialties received in higher education institutions. A lot of scientists and engineers who left the sphere of research and development found work which is not connected with their previous activity. «Erosion» in the area of education, when teaching technical and natural scientific disciplines comes to an end, can lead to even more considerable lagging from the western countries in the technological sphere in the nearest decades.

The Ukrainian scientific system has some common features with the countries of the Central and Eastern Europe. First of all, the outdated research base, outflow of personnel and weak innovative activity of business sector is the general challenge for their existence and effective development. It is partially attributable to insufficient development of science at the level of companies, and also to the general inheritance of the transition period connected with low demand for enterprise (commercial) science. In addition to these common problems there are some differences between Ukraine and the CEE countries.

The countries of the Central and Eastern Europe, unlike Ukraine, since 2006, have been receiving considerable support from the EU Structural funds. Substantial investments have been brought into the sphere of research, development and innovations. New members of the EU from the Central and Eastern Europe have made big steps in strengthening of their innovative policy which now includes more considerable practical component. Weak horizontal coordination in innovative policy is a considerable weakness of EU new members. It remains a considerable weakness of the Ukrainian scientific and innovative policy as well. However due to support from the EU, especially intersector programs of the EU, there has been a tendency towards gradual improvement of coordination between the main ministries and between the business sector and the sector of research and development. Increase in the emphasis on regional scientific policy is an additional feature of «the policy support» by the European Union. It opened completely new sphere of regional initiatives which still are one of the most neglected aspects of the scientific policy of Ukraine.

Financial support of science in the EU has resulted into a big variety of forms of funding (institutional funding, program, project, grant, joint funding, etc.). This is in direct contrast to quite a narrow set of instruments of funding in Ukraine. It is the combined effect from interaction with the EU in the institutional and financial sphere that leads to more considerable breakaway of scientific systems of the CEE countries with their historical starting point — the Soviet model of science. Therefore more active interaction with scientific systems of the EU countries with the following integration into the uniform European research area must become one of the most important directions of transformation in the area of science in Ukraine.

However there is no need to imitate practice of the countries of the Central and Eastern Europe in all spheres. It is important to intensify interaction between scientific organizations and the business sector within the country. Thus under a business sector we also mean the state enterprises which work in the market conditions. Without creation of powerful national companies focused at production on the basis of national advanced technologies, Ukraine will not reach the qualifying position in the system of the international division of labor. In its turn, it will increase vulnerability of the national economy in relation to crises and will not allow taking advantage of the possibilities of scientific and technical development to the full extent. As the experience of the CEE countries shows, fragmentation of the national scientific system and the actual loss of its national components focused at production caused strengthening of technological dependence on other countries and delay in processes of technological modernization. Ukraine should learn on its neighbors' mistakes. Creation of the big technologically focused companies (most likely with the assistance of the state), will become not only a guarantee of preser-

vation and development of technologically focused science in Ukraine, but also a prerequisite of the successful economic development.

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ТРАНСФОРМАЦІЯ НАУКОВИХ СИСТЕМ В КРАЇНАХ ЦЕНТРАЛЬНОЇ ТА СХІДНОЇ ЄВРОПИ: МОЖЛИВІ УРОКИ ДЛЯ УКРАЇНИ

Розглянуто основні етапи та особливості трансформації наукових систем країн Центральної та Східної Європи. Визначено найважливіші проблеми, показано роль ЄС в відповідних процесах змін, зроблено висновки щодо бар'єрів на шляху реформ та факторів, які, навпаки, сприяли позитивним перетворенням. Сформульовано деякі рекомендації для проведення реформування наукової сфери України.

Ключові слова: наукові системи, країни Центральної та Східної Європи, реформи.

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ТРАНСФОРМАЦИЯ НАУЧНЫХ СИСТЕМ В СТРАНАХ ЦЕНТРАЛЬНОЙ И ВОСТОЧНОЙ ЕВРОПЫ: ВОЗМОЖНЫЕ УРОКИ ДЛЯ УКРАИНЫ

Рассмотрены основные этапы и особенности трансформации научных систем стран Центральной и Восточной Европы. Определены важнейшие проблемы, показана роль ЕС в соответствующих процессах изменений, сделаны выводы относительно барьеров на пути реформ и факторов, которые, наоборот, способствовали позитивным преобразованиям. Сформулированы некоторые рекомендации для проведения реформирования научной сферы Украины.

Ключевые слова: научные системы, страны Центральной и Восточной Европы, реформы.

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