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Scientific Innovative Factors of International Competitiveness of the State

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Abstract: The article reviews the reasons for the expansion at a certain stage of the concept of an «innovation pause». It further makes the case for the relevance and possibility of a significant intensification of scientific innovation factors in the current environment, influenced by the 2008-2009 global financial-economic crisis and the forthcoming transition to a new technological paradigm. The article argues that, for a country as big as Russia, a targeted state policy in support of the high R&D potential can play a decisive role in securing a steadily high level of the country's global competitiveness.

Nowadays in the context of progressive complication for Russia of external conditions of implementation of the scientific-innovative policy the task of exact correspondence of the strategic and operative issues of the economic policy becomes actual. Posing the question about the priorities in the sphere of the sicentific technological development should be specified and toughened. Today the most important events in the global competition among countries and at the level of corporations occur at the stage of priority determination.

The intensification of scientific and innovation activities in the country should be closely linked to the task of increasing the level of global competitiveness, especially in regard to a number of vitally important spheres of economy. Today in Russia it is necessary to give new breath to the re-creation and development of many industries that form the branches of civil aircraft construction and shipbuilding, machine-tool construction, robotics, etc. Overcoming the dependence of strategic domestic manufacturing on external sources for the elemental base of technological progress requires very serious efforts on the part of authorities responsible for the country's scientific, technical and industrial policy.

Keywords: scientific innovation policy, R&D, technological revolution, economic competitiveness, scientific technological priorities, programmatic approach, innovation gap

НАУЧНО-ИННОВАЦИОННЫЕ ФАКТОРЫ МЕЖДУНАРОДНОЙ КОНКУРЕНТОСПОСОБНОСТИ ГОСУДАРСТВА

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Аннотация: В статье рассмотрены причины распространения на определенном этапе в литературе концепции об «инновационной паузе» и показана актуальность и возможность существенной активизации в современных условиях (под влиянием глобального финансово-экономического кризиса 2008–2009 гг. и грядущего перехода мировой экономики к новому технологическому укладу) научно-инновационных факторов. Доказывается, что для страны – масштабов России – решающее значение для обеспечения устойчиво высокого уровня конкурентоспособности страны на мировой арене имеет целенаправленная правительственная политика по поддержке высокого потенциала НИОКР в стране.

В сильно осложнившихся для России в самое последнее время внешних условиях осуществления научно-инновационной политики актуализируется задача четкого соотнесения стратегических и оперативных проблем экономической политики и требуется конкретизировать и ужесточить постановку вопроса о приоритетах в сфере научно-технологического развития. На этапе определения приоритетов сегодня во многом происходят самые главные события в глобальной конкуренции между странами и на уровне корпораций.

Интенсификация научно-инновационной деятельности в стране должна быть теснее увязана с задачами повышения уровня глобальной конкурентоспособности и в особенности в отношении ряда жизненно важных сфер экономики. Сегодня в России необходимо придать новое дыхание воссозданию и развитию заново многих производств, формирующих отрасли гражданского самолетостроения и судостроения, станкостроения, роботостроения и др. Преодоление зависимости стратегических отечественных производств от внешних источников элементной базы технологического прогресса требует очень серьезных усилий со стороны органов, отвечающих в стране за научно-техническую и промышленную политику.

Ключевые слова: научно-инновационная политика, НИОКР, научно-техническая революция, конкурентоспособность экономики, научно-технологические приоритеты, программный подход, инновационная пауза

Innovation Gap Economic Prerequisites

The scientific and technological revolution after the Second World War (in the 1950s) has convincingly demonstrated to the world what real changes in the economy and well-being of peoples can be achieved if the scientific and technological development is implemented fast and consistently in more efficient means of labor and new types of products that are in demand. It was largely under the influence of this scientific and technological revolution that the concept of *welfare society* has taken its shape and progressed in highly developed countries. As secondary consequences, these results of the scientific and technological revolution has affected the economic and social development of many previously backward countries, which on this basis have switched to the category of *developing countries*. The world has become convinced that scientific and technological factors can be a powerful means of achieving high competitiveness in the world arena, in which leaders of the capitalist world, led by the United States, and subsequently some dynamic driving countries of the developing world succeeded.

However, at a certain point in this evolution, the relevance of the priority attitude towards science and new technologies has faded considerably, which has been in much affected by the general complication of the conditions of world development that has reached its particularly harsh outlines in 2008-2009 due to the unfolding of the global financial and economic crisis. This crisis has prompted all countries of the world to mobilize the main forces and funds for urgent measures to stabilize the situation in the economy and, accordingly, diverted attention from the strategic long-term issues, such as the development of science and new technologies. Purely stabilizing anti-crisis measures absorbed significant amounts of resources. For example, according to some experts (Katasonov V.Yu.), only the US Federal Reserve System has issued loans to a total of over $ 16 trillion for various banking structures (and not just the US) in the first years of the crisis.

At the same time, enormous additional complexities and contradictions produced by the crisis have themselves inspired the international expert and scientific community to search for the ways to overcome the crisis and to promote the further development of the economy based on possible new technological paradigms. The lively argument has thrived in regards to the specific options for a possible upcoming reversal of a new (*fourth*) scientific and technological revolution.

On the scientific and theoretical level, the detraction of scientific and technical progress is conditioned by the concept of 'innovation gap' or, in another version, the concept of 'technological plateau' that has appeared in the scientific literature at the turn of the 20th-21st centuries and that emanates from: (a) the idea of a cyclical effects of macro innovations; (b) the assumption that the beginning of the twenty-first century marks the exhaustion of the innovative potential of the previous wave of scientific and technological development in the absence of a new fundamental achievements. The idea of the objectivity of the 'innovation gap' has been in much conditioned by the so-called 'dotcom' crisis erupted at the turn of the twentieth and twenty-first centuries, as well as the very fact that in the past 15-20 years there have been no noticeable scientific and technological innovations radically raising the productivity of social labor [Innovative Content …, 2016].

In addition, obvious manifestations of a tendency to inhibit innovation activity within transnational corporations (TNCs), that instead of implementing technical innovations intensively use cheap labor and natural resources on foreign sites, increase the skepticism about the expectations of scientific and technological progress under the influence of globalization.

In Russia, the concept of 'innovation gap' in a number of cases is interpreted in a very literal way, justifying the suspension of scientific and technical programs. In the political documents and publications verbal statements on the need for innovative modernization of the economy are retained (albeit with less persistence), but real progress is hardly visible.

The current moment is a *decisive point*. Following the methodology of N.D. Kondratieff and J. Schumpeter in assessing the role of 'large cycles of economic conjuncture' in the long-term economic development, there is a lot of data to fix the coincidence of the turn (since 2007-2008) of the global economic crisis with the 'falling branch' of the so-called 'Fifth' Technological Wave, the dominance of which in developed countries dates back to the 1970-1980s. In this regard, the impending transition to a new 'Sixth' Technological Wave is predicted, which is associated with opportunities for the development of nano- and biotechnology, robotics, artificial intelligence systems, etc. However, these statements remain to be too general and speculative. No one has yet convincingly described when, where and how the transition to the 'Sixth' Technological Wave will occur. This is in much due to the uncertainty itself, which is objectively inherent in the logic of the development of fundamentally new technologies, and to real competition between specific participants of the technological race, which leads to the secrecy of a significant part of the obtained intermediate results.

Innovative projects to create elements of the new technical specifications, as a rule, are expensive in current conditions. Therefore, the price of an error in selecting large scientific and innovative programs can be fatally high if it does not provide for the necessary diversification of projects and do not form a mechanism for flexible management of priorities in the country, based on scrupulous monitoring of the development of scientific and innovative programs in the world.

In this context, the idea of operating with the category of 'innovation gap' seems to be justified. Besides, it should be understood that the idea of an 'innovation gap' here is simply a kind of 'verbal image' of the period of humanity's entry into the twenty-first century, when major scientific and technological developments are expected, which require for their successful implementation prudence and dynamism in specific scientific and innovation policy. As studies show, the global crisis of 2008-2009 has not become a signal for slowing down work in the sphere of science and technology for any of the self-sufficient countries. Thus, the concept of 'innovation gap' has become just a kind of *'space of concentration' in research and development of new the approaches to scientific, technological and innovation policies that meet the complex challenges of our time.*

Technological Development after the Global Crisis of 2008-2009

The US government, in spite of the crisis collisions, has allocated over $ 100 billion for long-term programs to develop priority high-tech areas and in 2009 as a counteraction to the crisis has adopted the American Recovery and Reinvestment Act (ARRA). An unprecedented package of measures for investment stimulation of the economy relies on 800 billion dollars government investments. In 2011, the White House has approved the Strategy for American Innovation: Securing our Economic Growth and Prosperity. Accordingly, in order to strengthen the scientific and technological potential of the US, it was planned to act in three directions: (1) creating the necessary infrastructure and institutional base, (2) stimulating the activity of private sector, and (3) provision of state support for priority directions of scientific and technological development. Many other countries – China, Britain, Germany, France, Japan, India, et al. – have undertaken similar measures.

The question of real priorities for scientific and innovation policy is extremely difficult in practical solutions for governments. In principle, publicly declared priorities in all countries are almost the same. However, this does not mean at all that in each of them there is an independent and full-scale development of all priority areas. None of the counties including the US can afford such a policy. Typically, it is highlighted a narrower range of priorities that concentrate the main resources of the country, and in other areas, the development progress is carefully monitored for further redistribution of priorities if needed. The other solution consists in the development of cooperation with those who moved forward.

The situation of global instability in the world encourages the most powerful players in the R&D space in modern conditions to resort in many cases to the classification of their breakthrough developments, as well as to use the methods of misinformation of competitors of the forwarded directions in science and technology. Providing surprise to competitors, suddenness in mastering a major technological innovation becomes an important factor in securing the country's leading position and competitive advantages in a new round of scientific and technological development. I.e., the level of the country's competitiveness is decisively determined in practice by the reliability of government policy to support the high potential of R&D in the country in the broad sense of this term.

For example, according to the projections of the US federal budget for the fiscal year 2016, $146 billion was to be allocated for research and new technological expenditures from the total US state budget expenditure ($4 trillion), which is about 6% higher than the previous year. The special character of strategically oriented R&D in this country in the current time is evidenced by the fact that the notorious US Defense Advanced Research Projects Agency (DARPA) has recently developed a superprogram under the motto "Driving *Technological Surprise*: An Enduring Mission *in a Changing World*".

A prominent researcher of the regularities of the long-term dynamics of scientific and technological development Carlota Perez, honorary professor at the Science Policy Research Unit (SPRU) of the University of Sussex (GB), says that at the moment we (the whole world) are at an intermediate point between the initial phase and the phase of deployment of a new technological wave. I.e., at the stage of *transition from aggression to synergy*. She believes, Russia should not limit itself to a narrow specialization in science and technology and calls on the country to be ready to move in many areas of science and technology, setting working priorities here depending on specific needs and on real technological advances.

This conclusion seems to me justified, since it corresponds to the logic of events characteristic of the tipping time in the world as a whole as described above, as well as the specifics of the situation in the sphere of science and technology specifically in Russia. Today, our country, which is much behind the most developed countries in mastering the technologies of the Fifth Technological Wave (leaving in the past) at the stage of the initial formation of a fundamentally new (Sixth) Technological Wave, has the possibility to boost the scientific and innovation policy on the basis of the old principle: 'Overtake, not follow'.

However, this can be achieved with the indispensable condition if the top priority in the country will again be the development of the sphere of *science* and *education*.

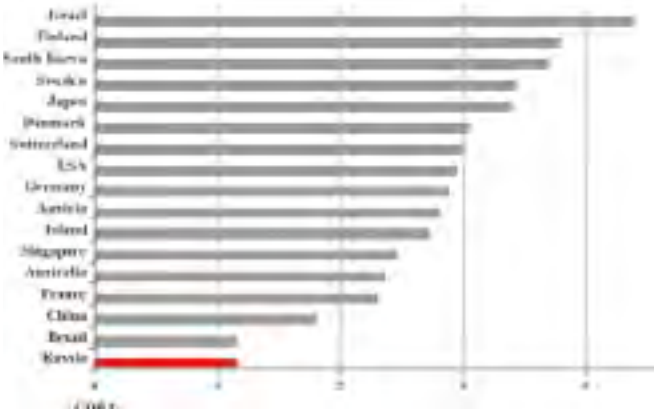
R&D Financing in Russia and Foreign Counties

As is known, even in the most difficult years in the past, science in our country was really one of the most priority sectors both in terms of financing and prestige in the society for people engaged in this field. Arguably, such an emphasis on priorities has provided the main contribution to the country's conquest of the authority of the world power of the first row. A prominent American sociologist Randall Collins has some time ago advanced an idea that the state in essence needs science precisely and primarily to maintain 'its prestige of power'. So, shouldn't the care for such 'prestige of power' by regarded as a strategic goal of the highest category in our country? This power should give the decent foundation to any other components of the power and authority of the state (country), and ensure a high level of competitiveness of its economy.

Regretfully, it is during the last 15-20 years, i.e. during the years identified with the period of market reforms, the prestige of science in the country has fallen and the level of funding for this sphere has drastically decreased. While in the USSR until the very last years of its existence, the total amount of R&D financing was at the level of at least 4-5% of the annual national income, in Russia it fell by no less than three times, making all the last years only 1-1,1% of annual GDP. These trends contrast sharply with financing of science in the other countries (see Figure 1). Relative to the country's GDP, the share of R&D expenditures in 2012-2014 was in Russia – 1,1-1,2%, in the US – 2,8-2,9%, in Israel – 4,4%, in Finland – 3,8%, in South Korea – 3,7%, in Japan – 3,4%, in Germany – 2,8%, and in France – 2,3-2,4%.

Even more striking are the figures of the contrast of the

Fig. 1: Expenditure on R&D in different countries, as percentage of GDP[1]



1 UNESCO Institute for Statistics, 2012

situation in Russia with highly developed countries in terms of the level of science financing, if we analyze the absolute figures of investment. For example, in the US, total R&D expenditures in 2012 were $447 billion, and in 2014 about $460 billion, while in Russia they amounted to 700 billion rubles in 2012, which, in terms of recalculation at the official exchange rate was $23 billion. Besides, the recalculation ruble amount of investments in R&D in 2014 will make no more than $15-16 billion dollars per year. To be noted, that in the period between 2009 and 2014, the growth rate of Russian investments in R&D (in rubles) continued to fall year after year.

Throughout 1994-2014, practically all the countries of the world (USA, the main EU countries, China, South Korea, etc.) consistently continued the line to increase the number of workers engaged in scientific research. And only Russia had a falling dynamics of the indicator of the number of researchers in the country during the whole period of transformations of the economic system. Their number has decreased from 600 thousand to about 440 thousand people.

The maintenance of a sustainably high level of competitiveness of a large country in the scientific and technological respect depends heavily on the ability to provide tangible results of concrete applied scientific and innovative programs and, at the same time, intensive support of targeted (fundamental) research and development.

The first part of this problem is successfully solved based on the so-called *programmatic approaches* to the budgeting of scientific and technological development, which is the case today in virtually all dynamic countries. In the US, the share of the project mechanism in the total amount of R&D funding is about 80%. In European countries, it is somewhat smaller – from 20% to 40%, but steadily increases. It is arguable that there is a similar trend in our country, which is indicated, in particular, by the formation of new scientific funds focused on financial support for the most promising scientific projects – the Russian Science Foundation, the Foundation for the Advanced Studies, etc.

Today, in Russia the state assumes the main burden in R&D financing. The share of government funding for research and development is over 60%. Accordingly, the share of business accounts in R&D financing is less than 30 %. In other highly developed countries, in terms of the share of R&D expenditures in GDP, it is the business that occupies a leading position in GDP: in Japan this share is at 77%, the USA – 65%, Germany – 68%, China – 69%. At the same time, it should be noted that Russia, as is already mentioned, lags behind all the listed countries in absolute terms of GDP, on which the scale of R&D expenditures depends. In general, Russian entrepreneurs invest in scientific activities and technology development significantly (by an order of magnitude) less money than their competitors in developed and many developing countries, which is abnormal.

The tendency of the programmatic approach, along with the obvious advantages includes contradictory moments expressed in increasing the dangers of the loss of flexibility in responding to changing conditions, when all resources are constrained by a rigid distribution for applied purposes. In this case, there is neither a basis for responding to new opportunities for technological shifts disclosed by science, nor for the actualizing new needs.

Such shortcomings, for example, have shown up at the initial stages after the creation in the US of the famous *Planning–Programming–Budgeting System (PPBS)*, implemented (based on the RAND Corporation development for defense purposes) for planning the US state budget in 1965. It is no coincidence that the US has virtually abandoned the PPBS system only five years after its widespread introduction. As specialists in the field of budget planning say, "the fiasco of PPBS was not due to the flaws in the development of specific target programs, but due to the transfer of this methodology to the budgetary process as a whole, that is, as a result of the complete 'programing' of the budget and the budget process" [Tambovtsev, Rozhdestvenskaya, 2016. P. 77-90].

It is known that some countries have made significant progress in scientific and innovative development based on skilful concentration of forces and resources on very clearly identified priority areas. Among such countries are South Korea, Finland, Singapore and others.

Israel acted somewhat differently in the implementation of the technological breakthrough in the 1990s: the state bodies did not give priority to any sectors of the economy, providing support to all projects that met the criteria of scientific and commercial viability. Since the beginning of the 21st century, the formulation of the issue has changed somewhat, since it was found problematic to ensure the uniform development of all branches for a small country. Three priority directions were identified, according to which Israel had the opportunity to become a leader and maintain this position for, but, which is noteworthy, the state did not refuse from the policy of supporting high technologies in the entire scientific spectrum. These three priority areas included:

1) Life sciences, which include biotechnologies (medical and agricultural), pharmaceuticals, medical devices (including diagnostic equipment), information technologies in the field of recovery;

2) The so-called clean technologies, that is, related to the

development of alternative sources of energy, purification and desalination of water, as well as technologies aimed at protecting the environment;

3) Cybersecurity technologies [Maryasis, 2016. P. 92-100].

Bringing this example from the practice of Israel, I want to draw attention to the important fact that in the understanding of priority here (along with a nomenclature of several important areas), the very principle of scientific and innovation policy is included, which consists in *maintenance of a high technological level, moving forward across the entire scientific spectrum*. It is this principled approach, in our opinion, that should be applied when building scientific and innovation policy in today's Russia.

The Prospects for R&D Recovery in Russia

For some reasons, in Russia, a significant part of the highest-quality scientific and technical potential is concentrated in the *defense sector* of the economy. Moreover, today, under the influence of the complexity of the international situation, this sector of R&D will obviously continue to be the most supported by the state. Our country is in the top five (the United States, Russia, China, Germany, France), which in total control almost three quarters of the world arms market. In recent years, the share of this market in Russia has grown. If five years ago our country controlled 22% of the world market, then recently – 27% [1]. As is known, the basic technologies in the world, giving the ground to the growth of a new technological structure often arose as consequence of military programs. A vivid example here is the Internet born in the bowels of the Pentagon.

If we (Russia) are compelled today to spend enormous resources on maintaining the country's defense capability and military potential, then perhaps we should try to derive sufficient benefits from this reality in terms of influencing the dynamics of scientific and technological progress of the country as a whole. Is concerns the organization of a reasonable transfer of research and development results obtained in research institutes, design bureaus and enterprises engaged in military subjects for use in the field of innovative economic modernization. Diffusion, transfer and all other forms of relocation of new technologies from the defense sector to other sectors of the economy is quite feasible for our state, and, moreover, it is its sacred duty.

The intensification of scientific and innovation activities in the country should be closely linked with the tasks of increasing the level of the country's global competitiveness and, in particular, with regard to a number of vitally important spheres of the economy. Today, based on the complications of the external conditions for the acquisition in the world markets of many vital technical means (aircraft, commercial vessels, machinery equipment, instruments), in Russia it is required to *give new breath to rehabilitation and development of the industries that form the branches of civil aircraft construction and shipbuilding, machine-tool building*, etc. [The Issues of Innovative … P. 47-48]. However, in order to restore the machine-building industries required by the country, it is necessary to supply components that are guaranteed by domestic enterprises – *prime items, standardized parts, and element bases* [The Issues of Innovative ... P. 47-48]. Overcoming the dependence of strategic domestic production on external sources of the element base of technological progress requires serious efforts on the part of the bodies responsible for scientific, technical and industrial policy in the country.

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