EMPIRICAL RESEARCH ON KNOWLEDGE REPRODUCTION AND QUALIFIED PERSONNEL: GEOECONOMIC ASPECT

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Abstract

The aim of the research is to reveal knowledge reproduction structure and outline a country's behavior strategy that shall be determined in a context of increasing geo-economic competition. The study comprehends both theoretical and empirical factors and trends in recent economic dimension transformation, possibilities of state influence on situations associated with knowledge transformation (including export of education) into synergy dimension.

The research novelty is linked with economic dimension transformations and a country's strategy within geo-economic dimension. A structural change in the world system of knowledge reproduction has been outlined as well as states were clustered in accordance with selected strategies.

In the leading countries education export is given great attention as a national goal. It was concluded that at each stage of innovation-based development, progress is achieved through effective management of knowledge reproduction. Basic element is qualified personnel training by universities. At the same time universities are turning into international institutions.

The research is based on methodological basis of economic theory, new trends in institutional and spatial economy. In order to denote such scientific complex definition "geospatial paradigm" was introduced. The main source for statistical data is the UNESCO Science Report: towards 2030.

It was concluded that it is a great challenge to change global innovation dimension landscape since it requires a systematic work on knowledge administration (to strengthen intellectual potential), national schools and basic universities supporting, students and academic degree holders migration flows regulation(in order to achieve a positive migration "balance") and knowledge economy development as an integral part of country's innovative system. Intellect devaluation entails a serious systemic risk of falling behind the leading states.

Keywords: geo-economics, knowledge economy, export of education, migration, intellectual potential, science internationalization, human capital.

1 INTRODUCTION

Fundamental global changes are taking place all over the world resulting in a qualitatively new type of technological order formation as well as new economic reality development known as knowledge economy. Both productive forces allocation as well as labor division shift towards increasingly higher mental activity. 25% of labour force is engaged in science and high-tech in developed countries [2]. Science becomes locomotives for serious changes in the world.

Nowadays there is a rapid knowledge economy update going on. This is mainly due to the fact that geo-economic space in modern globalizing world has become more transparent, mobility flows has increased, economic activities spectrum has expanded promoted by telecommunications and networks development [7]. Service sector expansion (through the development of intellectual, financial, information and communication technologies, Internet) contributed to a new economic reality resulting in strategic networks or global business networks competition alongside with traditional competition [6]. All this changes global labor division fundamentally [6] since "innovations diffusion" [25] is being accelerated.

Research goal is to show up knowledge dimension structure reproduction around the world, economic space transformation vector as well as states' strategy aimed at states' competitiveness increase in terms of geo-economic competition strengthening.

2 METHODOLOGY

The research is based on economic theory's general methodological basis, new institutional and dimensional economy specifics. In order to denote such scientific complex, the so called definition of "geospatial paradigm" [1, p.104]) was introduced. It does not however reject Schumpeterian evolutionary paradigm showing a new type of technological order as a fundamental basis for the global changes around world. However, within its framework, it focuses on global economy phenomena where attention is mainly focused on dimensional effects. Within such paradigm both economic spatial theoretical and empirical knowledge, factors and trends of its transformation, states' possible influence associated with knowledge transformation are widely comprehended. As a source of information, the UN documents are applied, in particular, the UNESCO Science Report: towards 2030 "[39].

3 RESULTS

Intellectual potential concentration (including academic degree holders' skills and innovations spatial dislocation) results in "knowledge externalities" development. The definition of "external effects" by P.Samuelson was widely used by A.Marshall, P.Romer and C. Arrow. Papers of T. Hagerstrand, P. Krugman, M. Fujita, E. Venablez also deal with the study of spatial knowledge externalities. Thanks to these studies much attention is paid to spatial development as a manifestation of space synergy. At the same time, attention is also focused on intellect concentration effects studying and focuses mainly on the following factors:

- traditional migration factors (including living standards, institutional and social roots that affect living and working conditions in both donor and recipient states);
- intellectual potential concentration (including developed scientific and production bases, knowledge reproduction system, scientific schools), which determines economic space synergy;
- science internationalization (minds circulation), affecting cross-border knowledge flows (researchers migration, scientific co-authorship, joint copyrights ownership);
- human capital quality (including quality and skills of ADH), trust in scientific activity;
- country's geo-economic strategy aimed at new technological development stimulating and economy structure changing.

3.1 Traditional factors for migration

Since the beginning of the century migration flows increase has been fixed. The UN press release notes that currently there are 232 million migrants in the world [8]. A.Krasteva argues that highly qualified migration constitutes to one-third of all migration flows in the world and exerts greater influence on all spheres of life rather than labor migration [27].

Figure 1 shows a significant increase in both researchers' number and their concentration mainly in a high-income cluster of countries. This is due to the right incentives introduction for the development of national schools and intelligence import. For example, this was noted by R. Appleyard [15]: changes are associated not only with geographical, professional and temporal characteristics related to "brain drain", but mainly with the state policy.

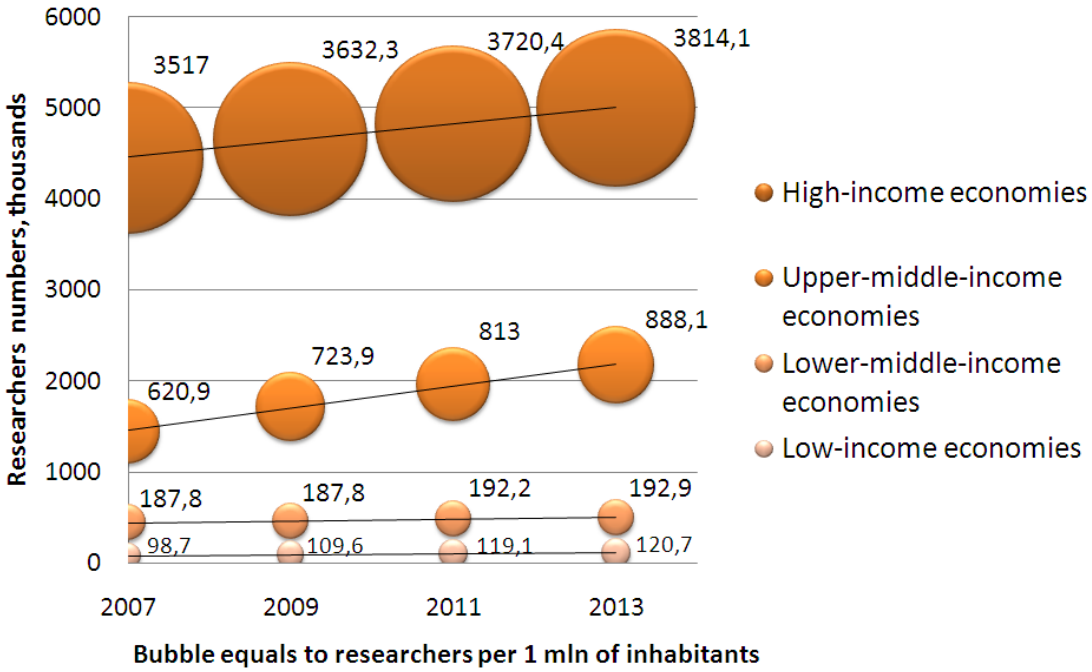

Figure 1. Trends in researchers concentration in a context of states clusters for the period 2007-2013

Further, low-income and lower-middle-income countries will be further referred to as peripherals, while high-income countries and higher-middle-income countries will be referred to as leaders later. The leaders are the United States and China. Since the beginning of this century, more than 50% of all foreign PhD graduates in the US are coming from China, India and South Korea. This is precisely due to state policy dealing with academic degree holders migration [21]. For the crisis period 2007-2013 countries showed rather different approach to stimulating policy for academic degree holders. So the countries of South-Eastern Europe, possessing initially weak intellectual potential, nevertheless, rapidly increased it - the increase in 2013 to 2007 amounted to 31.5%. The biggest increase was shown only by the Republic of Korea (45%). Negative trend was demonstrated by Russia - the drop was 6.1%.

Knowledge reproduction basic element is linked with academic degree holders training in university education system. Universities are becoming international institutions. According to the UNESCO report, a number of foreign students in 2013 reached 4.2 million (in 2025 there will be 8 million people) [30]. Growth in a number of foreign students results in a future growth of academic degree holders migration. The most successful foreign students selection for the resident companies accompanies educational process.

Let us compare R&D costs in different countries per researcher. As it is shown in the Fig. 2 changes indicate the appropriate quality of a working place as well as intellectual work conditions. For example, China and the United States not only increase researchers' numbers but also support considerable cost of a working place, which is necessary for high efficiency. Other countries try only to retain the required jobs quality.

The Russian Federation and peripheral European countries are seriously lagging behind. At the same time Russia is witnessing a concentration reducing in researchers' number. Simultaneously, there is no improvement in a working place quality for intellectual personnel that affects the quality. In the Strategy of Scientific and Technological Development of the Russian Federation [11], there is a lower efficiency of Russian research organizations comparing to the leading countries (the USA, Japan, China, and Republic of Korea).

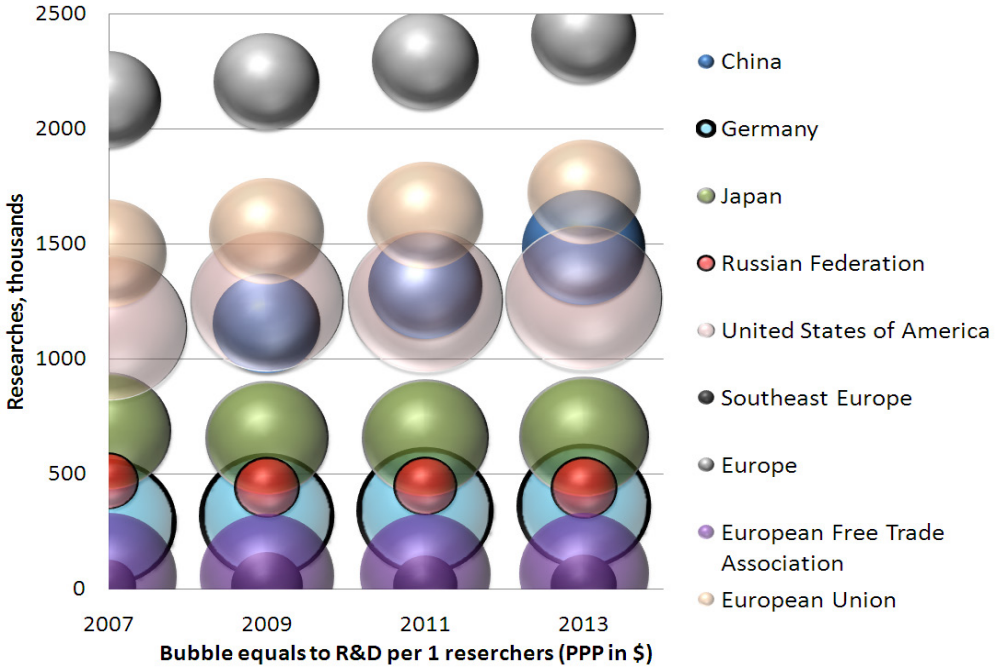

Figure 2. Changes in R&D per one researcher at certain states for the period 2007-2013

3.2 Intellectual potential concentration

Nowadays there are 7.76 million researchers in the world (in 2013 an increase of 21% compared to 2007). Most of the researchers are concentrated in the EU, China and the US. In Russia in 2013 there were 440,600 researchers. General researchers share fell from 7.3% to 5.7% globally [30]. The researchers' effectiveness shall be evaluated by both publication and patent activity. According to UNESCO [30], scientific publications share has increased by 28% globally comparing to 2008. In 2014 there were 1.27 million articles while in 2013 - 277.8 thousand patents (leaders: the United States and the EU).

Intellectual potential concentration (taking into account academic degree holders and innovations spatial distribution) causes "knowledge externalities" development. Economic effect is presented with data in Table 1. Economic "weight" (characteristic of the power of the element of the economic landscape) causes an exponential increase in intellectual potential concentration (number of researchers and patents) (Table 2) and corresponds to R&D funding increase.

Table 1. *GDP and actors' intellectual potential indicators, 2013*

	GDP, thousands $	R&D costs in % from GDP	Researchers number, thousands	Share of WoS publications from, %	Share of patents, %
USA	45,1	2,81	1265,1	25,3	50,1
China	10,1	2,08	1484	20,2	2,7
Japan	32,0	3,47	660,5	5,8	19
Europe	23,4	1,75	2408,1	39,3	17,5
South-Eastern Europe	8,3	0,51	14,9	0,4	0
European Free Trade Association	43,9	2,44	67,2	2,8	1,4
Other EU states	13,7	1,02	599,9	4,5	0,3
Germany	35,5	2,85	360,3	7,2	6,3
France	31,9	2,23	265,2	5,1	2,6
UK	35,3	1,63	259,3	6,9	2,7
Russia	15,5	1,12	440,6	2,3	0,2
Iran	13,4	0,31	54,8	2	0

According to UNESCO [30], growth of R&D was 31% (above 20% of world GDP growth). The leaders are the USA (28% growth), China (20%), EU (19%), Japan (10%). All other countries have a share equal to 23%. At the same time, Russia's share is only 1.7%.

According to UNESCO largest costs on research and development are located in Israel (4.21% of GDP), Japan, Finland and Sweden. The top three are the United States, Japan and Russia in terms of researchers' numbers, and by citation index - Denmark, Sweden, and the United States. At the same time, European countries have multidirectional vectors of innovation space development. Central and Northern Europe are trying to maintain competitive advantages in contrast to peripheral Europe. Russia has preserved its scientific schools, both quality and numbers academic degree holders.

All countries face global innovation space landscape changing challenge requiring systemic work to manage knowledge externalities in order to strengthen intellectual potential, academic degree holders migration flows regulation, and knowledge economy development as an integral part of country's industrial development.

At the same time knowledge economy externalities are institutionally inter-linked in space providing a strong advantage to enterprises located in close proximity to knowledge sources in comparison with enterprises removed from these sources [4; 12]. Despite the fact that international knowledge market represents a branched system of links between producers and consumers and a complex mechanism for interests reconciling, in the final analysis, leading countries impose their game rules on periphery with national markets openness and international labor distribution system [5].

There is a structural change in knowledge production global system. Relatively lowest growth in R&D funding was outlined by countries with high incomes, and the larges- by countries with incomes above average - from 16.1% to 25.8%. This indicates an increased attention to knowledge economy in this group of countries. For such countries relationship between GDP and R&D contribution as well as export increase became apparent due to high-tech and knowledge-intensive industries development.

Peripheral countries insignificant contribution to innovative development comparing to leading countries contribution is explained by the fact that peripheral countries both capital accumulation and replacement is extremely slow. Moreover not only capital surplus and its investment part but the overwhelming part of economic rent goes to leaders where capital conditions are more attractive. Therefore, periphery's financial capabilities in innovation sphere development are severely limited.

3.3 Science internationalization

Globalization has increased mobility flows and expanded services through the development of intellectual, financial, information and communication technologies as well as networks. On one hand science internationalization seriously affects academic degree holders migration, on the other hand, mobile data quickly respond to knowledge economy dynamics as the power of such flows increases.

R. Norden has noted that for the period 1981-2003 every eighth top quoted scientist in the world was born in a developing country while 80% of them moved to developed countries (mainly the US). In 2011 almost every second full-time post-graduate student in the United States was a foreigner [28]. At the same time more than 50% of all foreign PhD graduates in the US are from China, India and South Korea [21]. Young researchers who received a PhD in the US mostly remain in the country. On the other hand, successful researchers born in Canada, France, Germany, Sweden, soon after receiving PhD and entering the United States "elite" nevertheless returned to the country of origin [3, p.46].

In 2011 C.Franzoni while studying scientists' international mobility has noted three most important migration motivations that are opportunities to improve career prospects, research group with a high scientific reputation and inclusion in international collaboration [24]. The most important incentive is undoubtedly working conditions and opportunities for career growth, financial benefits at the second place, on the third - moral incentives. According to respondents' among the most effective measures attracting young people to science are: research financing and scientific infrastructure improving [26]. N. Shmatko in her paper [14] showed that intellectual mobility depends on a science state system as a whole and not on individual characteristics of a scientist.

Current science internationalization unfolds active development of digital economy, widespread use of information and communication technologies (ICT). Due to ICT introduction a physical movement was replaced by messages movement. Due to such information exchange in the on-line mode a collective model of innovation process has been created. At the same time this trend has not yet manifested itself in statistics. According to UNESCO data academic degree holders' migration despite Internet

development and online platforms dissemination is still a traditional trend. This is explained by the fact that having received doctor degree nevertheless there is an increased need for changing places [30].

3.4 Human capital quality

Nowadays there are serious challenges such as scientific confidence loss, intellect devaluation and academic degree holders de-qualification, researcher's overproduction etc. According to N.A.Asheulova [3] there are only 17% take permanent positions at university centers in Germany, the rest are having temporary positions, while in the US universities it is about 50%. In general unemployment rate and unemployment rate among doctors of science is higher in Germany than in the US. In its turn temporary postdoc positions as well as "extra people" in academic markets do affect scientists' mobility including the intersectoral one. For example, in Belgium almost a third of those who received a Ph.D.degree have jobs not related to their academic major, while in Poland their share is only 6%, and in Russia even less - 4.4% [13, P.41]. At the same time in Russia for the last 10 years two-thirds of the employees have not change their job places [13, P.44].

The outflow of academic degree holders affects the state negatively. A. Krasteva notes that having migrated to the EU academic degree holders often remain working at libraries and information centers. For several years they have been taking their "postdoc" position (temporary position with a small salary), before they receive a permanent position of a professor or a teacher at the university [27]. A similar situation is observed in donor states. J.Bhagwati and Delafar [20] illustrate it with an example of a Philippine doctor who instead of starting medical practice in his own country prefers working as a taxi driver until he has an opportunity to migrate to the United States. They came to the conclusion that academic degree holders migration from developing countries entails significant losses for economy, a higher level of public spending and a decrease in population welfare as a whole [19]. K.Wong and S.K. Yip [32] constructed an empirical model where economic growth was determined by human capital and academic degree holders migration caused a decline in growth.

In the 60s T. Shultz [29] and G. Becker [17] noted the high role of education in human capital and the latter in economic development. Negative effect arises from a human capital quality change in donor states. S.Di Maria and P. Strizovski noted that the prospects for migration limit motivation to increase agents' skills severely [23]. Negative influence from academic degree holders outflow on states' development both in Europe and Asia was analyzed by J. Bernstein, J. Shuval [18], J. Bhagwati [19], S. Canibano [22], L. Akers [16]. Thus, a country that aspires leadership in world economy needs to achieve a positive balance in brains export and import. Lack of academic degree holders adequate support let alone their outflow, undermines country's ability to successful social and economic development and to modernized agenda.

3.5 States' R&D strategy

In a present-day globalizing world there is a strong trend in state's intellectual potential increase through some mechanisms in order to stimulate innovation economy and budgetary spendings for social purposes. The state, within the framework of its overall development strategy, aims at efforts achievement for a high level of human potential development (including intellectual). Knowledge component transformation as a space synergy source occurs through knowledge regulation flows, academic degree holders' migration, infrastructural support to innovation process and information space development.

In 2013 researcher's R&D absolute indicator (PPP in thousand dollars), the USA took the leadership - 313.6 thousand dollars followed by Germany (232.3), Japan (214.1), Republic of Korea (200.9), China (195.4), Russia (56.3). Generally, low-income countries in 2013 equaled this figure to 37.6 thousand dollars [30]. The European states are divided into two clusters: states with a significant contribution to global R&D (Germany, France, the UK) and states with insignificant contributions (South-Eastern Europe).

The strategy of new strategic economic zones development is carried out by China, France, Germany, Republic of Korea, the USA, Japan. At the same time, China intensified its publication activity while the EU, Japan and the United States intensified their patent work. Peripheral Europe countries and Russia are still among the outsiders and do not show a clear strategy. It might be known as a strategy of strategic economic zones retaining.

The formation of a new economy has been recently prioritized by leading actors in global politics and economics - the EU, the US, and Japan. China is rapidly approaching this cluster of fundamental

scientific and technical centers. China along with the US and the EU is becoming third scientific superpower. In the long run successful states that attract necessary "brains" and finances will remain the winners providing a strong leadership in a new world order. The key factor for them is scientific and technological schools availability as well as developed research and production bases.

As a result of both globalization and crisis consequences revision certain state strategies were outworked. Analyzing the UNESCO data [30] we might conclude that the developed countries shifted in favor of problem-oriented studies and applied science. Periphery due to inadequate resources and qualifications are not able to provide information and legal support for the whole chain "from knowledge into practice" and create a portfolio rights for an innovative product. A different role in this chain is shown in comparison at Figs. 3 and 4.

Leading countries losing their share in GDP do increase their superiority in innovations on one hand changing the economy structure and on the other - strengthening dominance in legal field and concentrating on control retaining over information, intellectual and financial flows (Figure 4).

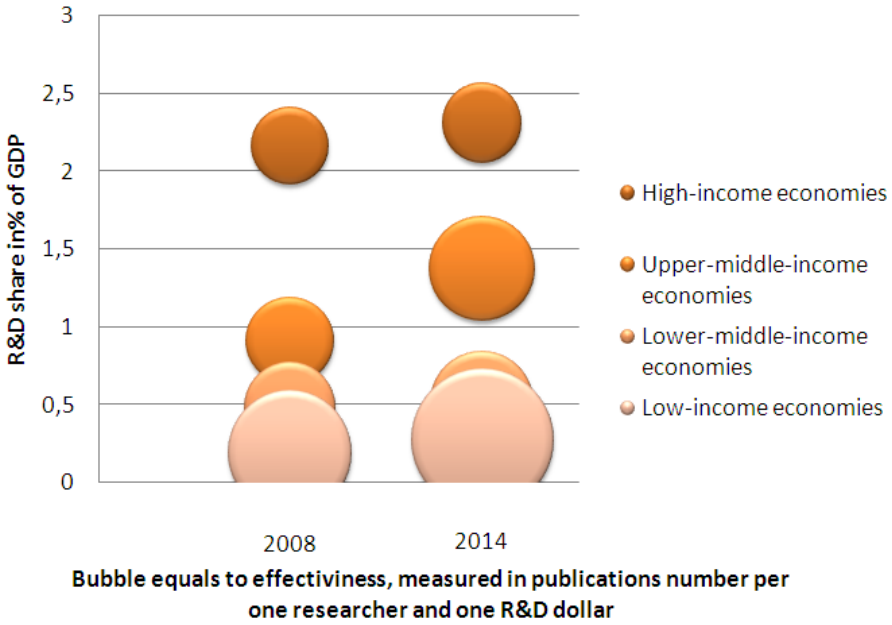

Figure 3. Innovation policy states clusters effectiveness measured in a number of publications (Thomson Reuters Web of Science Citation Index Expanded) per one researcher and one R&D dollar

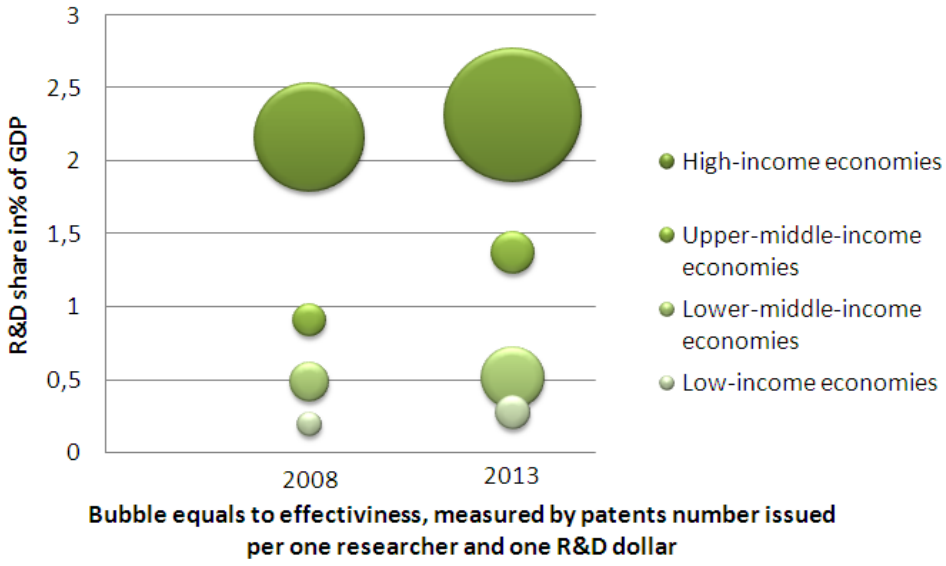

Figure 4. Innovation policies of states clusters effectiveness, measured in a number of patents issued per one researcher and one R&D dollar

According to absolute indicator the EU still leads in publications number (34%) followed by the United States (25%) [30]. They are catching up with China where knowledge economy was officially recognized as a state strategy [2, P.12]. Over the past ten years China has brought up publications number from 5% to 20%. At the same time peripheral countries turned to be more effective - they create more publications per researcher and one dollar of R&D (according to Thomson Reuters Web of Science Citation Index Expanded). However, they are less effective in other. They have far fewer patents per researcher and one dollar of R&D. Developed countries aspire their leadership in innovations providing ready-made technologies and information products for intellectual license (royalty) to peripheral licensees. The reason for such exclusive appropriation of new knowledge advantages lies in institutionally established dominance of innovation leader over the periphery.

4 CONCLUSIONS

Geo-economic order that regulates knowledge externalities institutionally both determines and shapes a strategic contour where behavioral state's strategy shall be aimed at positions retaining in terms of geo-economic rivalry. By the year 2030 when up-to-date research-intensive industries are gaining momentum, the US science expenditures shares will reach out 3.1% of GDP, in Japan - 3.5%, in the EU - 2.1%, in China - 2.3%, in India – 2.0%, and in Russia - 1.9% (while globally - 2.32%) [10, P.128].

As a result of market resources concentration and extractive institutions activities knowledge flows are managed and controlled by an innovative leader. Knowledge flows can be defined as "knowledge externalities bound in space" [4, p.163]. We shall add a clarification that follows up with economic space architectonics. The aim of knowledge externalities is to maintain status quo by means of innovation development and periphery discrimination in financial management flows. In this case a good strategic solution for peripheral states is their integration into collective models of innovations. This would create favorable prerequisites for intellectual potential concentration as well as its transformation into space synergy.

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