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The New Role of Intellectual Property in the 21st Century, a Comparative Analysis of the Development of Intellectual Property Market in Russia and the World

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ABSTRACT

Intellectual property (IP) in the 21st century is an indicator of the development of science, high-tech industry, and the quality of education and economy in general. This paper based on statistical data investigates the relationship of indicators of science financing, the growth of IP, industrial production and exports of high-tech products in Russia and the world. A comparative analysis of the development of intellectual property market in Russia and the world has been carried out and shown that the business situation and the IP market development in Russia differ from those in the world. The results of the correlation analysis prove that, in contrast with global trends, the growth of science financing in Russia does not lead to an increase in the number of patent applications. The paper is first to consider individual indicators related to the types of IP, patent applications, trademarks (TM) and industrial designs (ID). The results of the statistical analysis show that the increase in world exports of high-tech products of the countries is related to the growth of research expenditures and indicators of IP, protected in national patent offices (NIPs) and abroad. A small number of countries export almost 100% of the world's high-tech products. This situation does not change with time, i.e., high technology does not "diffuse" in the world. The business situation and IP market development in Russia have similarities and differences from the global trends: in Russia the growth of science, funding does not lead to an increase in the number of patent applications; and in Russia there is no connection between the growth of science funding, the growth of patent applications, and an increase in high-tech production.

INTRODUCTION

The development of industrial production in the 21st century is inextricably linked to scientific research, high technology, and intellectual property. Since the second, half of the 20th-century intellectual property (IP) has become a commodity in the market of innovative products. The intellectual property market shows faster growth compared with the growth of the gross domestic product (GDP), high-tech production and exports. According to the World Bank data (The World Bank Database) from 2001 to 2015, the growth of the total GDP of all countries in current prices was 2.17, the growth of total exports of high-tech products was 1.04, the growth of revenues from IP was 3.36, and an increase in payments for IP was 4.46 times. The IP market in 2015 was approximately estimated at 660 billion US dollars, and the market for high-tech exports was about 1,000 billion US dollars, i.e. these values have become almost of the same order.

The intellectual property includes both objects of copyright, e.g., artwork and software, and industrial property objects (IPO): inventions, useful models, industrial designs, and trademarks.

The main purpose of creating the IPO, as in the Middle Ages, at the dawn of the industry, is profit making and growth of industrial production. However, currently, the IPO, namely inventions, unlike in the Middle Ages, are created as a result of research and development (R & D) at research institutions that require a long time and considerable financial expenses. This necessitates public funding, highly qualified personnel, and equipment for scientific research. The IPO, as already mentioned, is becoming a commodity. Governments and businesses are heavily investing in the development of science and high technology. Therefore, IP is treated as an indicator of the development of science, high-tech industry, and the quality of education and the economy in general.

This poses the question about the relationship between indicators of science financing and growth of IP, industrial production, and exports of high-tech products.

The IPO, i.e. inventions, industrial designs, utility models and trademarks, differ in protected areas and rights holders, because they may belong to residents or non-residents, be protected either in the country of the resident or in other countries, belong to public or private enterprises or individuals. Inventions are primarily created in public research organizations or at research institutes within industrial enterprises, and industrial designs and trademarks, for the most part, belong to industrial enterprises.

Therefore, data for individual IPO types also serve as indicators of economic development. Over the past 10 years, from 2004 to 2013, all kinds of IPO in the world show approximately the same growth (table.1). The number of maintained trademarks exceeds the number of inventions, which, in turn, is larger than the quantity of industrial designs. So, the amount of trademarks exceeds the number of industrial designs by about an order that proves that creating inventions requires more time and financial costs.

Table 1: Global dynamics of inventions, trademarks and industrial designs justified in force.

IP type	2004	2013	Growth for 10 years
Inv.	5.89E+06	9.45E+06	1.60
TM	1.82E+07	2.63E+07	1.45
ID	1.84E+06	2.98E+06	1.62

Russia is among the top ten countries by the number of patents, owned by residents (6th in 2014), and by the number of applications for inventions, filed in the national patent office (NPO). However, the number of foreign patents (26th in 2014) and patent applications filed abroad lags far behind the number of applications to Rospatent. This indicates a weak competitiveness of Russian innovations in the world market. Russia also lags behind the world leaders in ID patenting and TM registration in Rospatent and especially abroad. Income from IP rights in Russia is much less than in other countries owning IP. In 2014, compared with the USA, whose residents had 1.28 million US patents and 0.8 million foreign patents and received a total of 126 billion U.S. dollars for IP rights, the Russian residents owned 0.14 million Russian patents (about 10 times less), 6 thousand foreign patents (about 100 times less) and received 0.67 billion US dollars (about 200 times less) for providing IP rights.

The question arises about the similarities and differences of indicators of innovative development in Russia.

Review of literature

To compare countries and world regions and to forecast economic development the world economic literature uses numerous indicators, associated with technological and social capital, science, industry, and labor forces (Fagerberg, Feldman & Srholec 2011; Crescenzi, Rodríguez-Pose, & Storper 2007; Perepechko 2014b). According to United States Department of Commerce (2012), such indicators of innovation, as the number of researchers, R & D investments (public and private), venture capital, productivity and trade indicators are used to determine the level of "innovativeness" and to solve the problem of economic growth slowdown in individual countries. The global innovation indexes (INSEAD ed. Soumitra Dutta 2012) help "to measure innovation" and are key tools for improving the innovation policy.

Another approach is associated with a limited, rather small number of indicators that define economic development. Innovative development and "innovation" can be determined only by the share of R & D investments in GDP (Romer 1990; Aghion & Howitt 1992); it is also necessary to consider the relationship between individual indicators, such as GDP growth and export growth (Heller & Porter 1978), since a rapid growth of exports accelerate the economy.

Intellectual property (IP) owned by the country's residents is an indicator of the availability of high technologies with export potential. There is a relationship between the share of patent applications submitted to the US patent office (share of IP) and the share of the country's GDP in the GWP (Perepechko 2014a). Analytical research in the field of IP is closely linked to the studies of innovation development, which began in the early 20th century when new concepts still used by economists and researchers were introduced.

According to OECD (2006), the generally accepted view is that patent statistics provide a measure of innovative activity. According to USPTO the ratio of the number of patent applications to the number of personnel, or patent intensity of companies, is one of the indicators of innovative development. The analysis based on the number of patents (Acs & Audretsch 1989) gives results that coincide with other more or less direct measurements of innovations, which makes the growth rate of patents a valid indicator of changes in the innovation superiority. Furthermore, the use of data of the European Patent Office and USPTO for comparative analysis has become a common practice both in political documents (according to European Commission (2005, 2007) and in academic research (Dosi, Llerena & Sylos Labini 2006).

Though being an important indicator the number of patents cannot be a measure of innovation in itself (Smith 2004). Patenting is used in some technological fields (chemistry, biotechnology) more widely than in others. Many inventors use patents to protect inventions that will never be released to the market; on the other hand, many innovations appeared in the market have never been patented. Therefore, although patents provide full information on certain issues of technological activities, still, there is a need for a wider view on the causes and conditions of economic development.

The key task is to find a way of measuring innovation. There is the universal methodology for measuring innovation activities of individual actors or countries, defined as a number of new products, processes or other innovations. In the meantime, many ways of measuring innovation have been proposed in the literature to evaluate innovation activities in the service sector of the economy, government organizations, etc.

Thus, in the literature on innovative development the IP is considered as one of many indicators of technological potential, but not as a tool for economic development forecasts.

Noteworthy are also numerous works of B.B. Leontiev devoted to IP (Leontyev 2013a, 2013b) and addressing issues of IP management, commercialization of scientific and technical development, and national innovation systems. The main idea of the author is that the government should develop a strategy for IP management as one of the most important mechanisms of national economic policy, determining the progressiveness and sustainability of the national innovation economy.

This work considers the influence of business and government investments in R & D, the dynamics of high-tech exports and the relationship between intellectual property, its dynamics and innovative development of countries.

RESEARCH METHODS

The chosen indicators of innovative development were 79 indicators for 194 countries related to IP, science, exports, and industrial production. The absolute figures for 2001 and 2010 and their change for 10 years were considered. Since IPO are used for the production and sales of high-tech products, data for the production, export, and import of metalworking machines (MWM) were used to assess the relationship between IP indicators and development of high-tech industrial production.

- GDP per capita at constant prices, 2011, 2001
- Business investments in R & D $ in current prices, 2001
- Spending on science, total, $, 2001
- Patent applications from residents / non-residents, 2001
- Patent applications filed by residents abroad, 2001
- Share of patent applications filed by residents abroad of the world total, %, 2001
- Applications for TM from residents / non-residents, 2001
- Applications for TM from, 2001
- Applications for TM filed abroad, 2001
- Applications for ID from residents / non-residents, 2001
- Applications for ID from, 2001
- Applications for ID filed abroad 2001
- MWM production, 2001, $
- MWM export, 2001
- MWM import, 2001
- GDP per capita at constant prices of 2011, $, 2010
- Business investments in R & D, $, current prices, 2010
- R & D expenditures, $ 2010
- Patent applications, residents / non-residents, 2010
- Patent applications filed by residents abroad, 2010
- Share of applications filed by residents abroad of the world total, %, 2010
- TM applications, residents / non-residents, 2010
- TM applications filed abroad, 2010

- Applications for ID from residents / non-residents, 2010
- Applications for ID, filed abroad, 2010
- MWM production, 2010
- MWM export, 2010
- MWM import, 2010
- MWM import gains
- Patents filed by residents of NPO and justified in force, 2004, 2010
- Applications from non-residents filed to the USA, 2001, 2010
- Patents justified in force, residents + non-residents, 2004, 2010
- The change in the number of patents from residents in force
- Percentage of patent applications to the United States in 2001, 2010
- The change in the percentage of patent applications to the U.S.
- High-tech exports in current prices, 2001, 2010
- Growth of high-tech USD/USD
- High tech share in the country's exports, %, 2001, 2010
- The change in the high-tech share in the country's exports
- The share of high tech exports in the world, %, 2001, 2010
- The change in the share of high-tech exports in the world from 2001 to 2010
- Number of new enterprises, 2004, 2010
- Growth of the number of SME
- Share of exports in the world, %, 2001, 2010
- The change in the exports share
- The change in expenditures on science USD/USD
- Researchers (people per 1 million population) 2001, 2010
- Patent intensity (applications per 1 million population) 2001, 2010
- Patent efficiency (patent applications per 1 researcher) 2001, 2010

- Change in expenditures on science as a share of GDP
- Change in expenditures on science USD/USD
- Funding for 1 researcher 2001, 2010
- Change in funding for 1 researcher
- Increase in the number of patent applications, residents
- Increase in the number of patent applications, abroad
- Increase in the number of TM applications, residents
- Increase in the number of TM applications, abroad
- Increase in the number of ID applications, residents
- Increase in the number of ID applications, abroad
- Share of MWM production in the world, 2001, 2010
- Change in the share of MWM production

Data for the analysis were taken from World Bank databases, reports of the UN Statistical Commission, WIPO databases, websites of national patent offices; and information on MWM was provided the courtesy to the Gardner Business Media company (The World Bank Database & UN Database). The term "resident" refers to the country's residents, individuals or legal persons. Accordingly, the non-residents are foreign individuals or legal entities. The concept of "abroad" means an application, filed by a resident director in a foreign patent office, bypassing the international procedure. The discussed here are patents for inventions (Inv), industrial designs (ID) and trademarks (TM). Utility models are not examined since not all countries acknowledge and protect this type of IP.

Since the important economic challenge for Russia is to increase exports of high-tech products, the study is focused on the relations of this indicator to other economic indicators. Ranking all countries (194 in our case) by their share in the world hi-tech exports suggests that a small number of countries, about 40, export almost 98% percent of the world's high-tech products (high-tech countries). This situation does not change with time, i.e., high technology is not "diffuse" in the world. For example, in 2001, 46 countries made up the core of the power-law distribution of high-tech industrial exports, the total value of which is 95% of the world's exports (Yagolnitser & Perepechko 2016). For 2010 this sample includes 37 countries, producing in total 98% of high-tech products. These are countries that produce, export, import MWM and own IP, namely China, Germany, USA, Singapore, Japan, South Korea, France, UK, Netherlands, Malaysia, Switzerland, Mexico, Thailand, Belgium, Italy, Canada, Ireland, Hungary, Czech Republic, Sweden, Philippines, Austria, Spain, India, Poland, Denmark, Brazil, Israel, Finland, Indonesia, Russia, Romania, Vietnam, Australia, Norway, Slovakia, Kazakhstan, Costa Rica, South Africa, Turkey. So, according to the classification of Polterovich (Polterovich 2011), this list includes both developed and developing countries.

Further, the Pearson correlation coefficients were calculated for these 37 countries based on 79 indicators.

RESULTS

The analysis of correlations of the above indicators for the cluster of "high tech countries" shows that the growth of high-tech (USD/USD) from 2001 to 2010, similar to the growth of the country's high-tech exports share in the world hi-tech exports from 2001 to 2010, correlates quite well (correlation coefficient exceeds 0.8):

with the number of applications for TM, filed by residents to the NPO in 2001 and 2010,

with the number of applications for ID, filed by residents to the NPO in 2001 and 2010,

with the growth of patent applications, filed by residents to the NPO,

with the growth of applications for TM, filed abroad,

with the growth of expenditures on science.

The indicator "the share of high-tech exports in the world exports in 2010" correlates with GDP per capita in 2001 and in 2010, research financing in 2001 and in 2010, applications for inventions and ID, filed abroad in 2001, import of MWM in 2001, payments and receipts for IP in 2010, applications for inventions, filed abroad in 2010, the share of GDP in 2001 and in 2010, applications for patenting in the United States in 2001 and in 2010, the percentage of researchers in the population in 2010, and labor costs for 1 scientist in 2001 and in 2010. So, indicators of innovation and industrial development are related to each other.

The increase in the high-tech share in the country's exports correlates with IP protected abroad, with the number of patents for inventions, justified in force in the NPO, with production, export, and import of MWM and expenditures on science.

Below are indicators related to the growth of high-tech exports; let us see their values for Russia and compare them with average indicators for the "innovative developed" countries (Table.2).

Table.2. Indicators of innovative development: average for 40 countries and for Russia.

	Indicator	Average	Russia
1	The growth of hi-tech exports (USD/USD) from 2001 to 2010г.	3.89	1.56
2	Number of TM applications from residents to NPO in 2001	34 ths	39 ths
3	Number of TM applications from residents to NPO in 2010	64 ths	32.7 ths
4	Number of ID applications from residents to NPO in 2001	5.6 ths	2.1 ths
5	Number of ID applications from residents to NPO in 2010	16 ths	1.98 ths
6	Growth of patent applications for from residents to NPO	1.81	1.16
7	Growth of TM applications filed abroad	9.27	2.82
8	Growth of expenditures on science	2.9	4.8

From this analysis, it is evident that from 2001 to 2010, Russia even reduced the annual number of applications for TM and ID despite the above-average growth of science funding. The growth of TM applications filed abroad, and the growth of patent applications to the NPO also lag behind the averages. As a result, the growth of high-tech exports is also below the average for this group of countries.

By analogy with research on the world countries, for an in-depth study of the situation in the Russian regions, it was deemed necessary to perform the correlation analysis of 27 indicators for the years 2000 and 2015 and performance indicators for the regions of Russia.

- Population, 2000
- Population, 2015

- GRP, million RUB, 2000
- GRP, million RUB, 2015
- GRP per capita, million RUB, 2000
- GRP per capita, million RUB, 2015 год
- Share of manufacturing, % of the total, 2004
- Share of manufacturing, % of the total, 2015
- Number of personnel in R & D per 1 the population, 2000
- Number of personnel in R & D per 1 the population, 2015
- Internal research costs, million RUB, 2000
- Internal research costs, million RUB, 2015
- Patent applications filed in 2000
- Patent applications filed in 2015
- Patent intensity (number of applications per 1 inhabitant), 2000
- Patent intensity (number of applications per 1 inhabitant), 2015
- Patent efficiency (number of applications per 1 researcher), 2000
- Patent efficiency (number of applications per 1 researcher), 2015
- GRP growth (GRP in 2015/ GRP in 2000)
- Growth in the number of research personnel (2015/2000)
- Growth of internal expenditures on R & D (2015/2000)
- Growth in the number of patent applications (2015/2000)
- Increase in the share of manufacturing 2015/2000
- Volume of innovative products, million RUB, 2000
- The volume of innovative goods, works, services, mln. RUB, 2014
- Volume of innovative goods works and services in percentage of the total volume of shipped goods performed works and services, 2014
- Growth of innovative products 2015/2000 (million/million)

The obtained results are similar to the results for the world countries and the ones from previous works (Yagolnitser 2014). In just the same way, large regions (in terms of population, gross regional product or GDP, the volume of industrial production, availability of research personnel, high-tech production and substantial funding of science) lead in terms of economic indicators. About half of the regions provide 98% of all manufactured innovative products and the same percentage of patent applications, in contrast to the world where about a fifth of countries provide about 98% of the hi-tech exports. On the other hand, the situation is similarly not balanced with time, since "large and innovative developed" regions continue to lead in innovative production, protection, and ownership of IP.

The correlation analysis was performed for 40 "innovative developed" regions of Russia.

In Russia, the growth of innovative production correlates only with the share of innovative products in GRP. That is "innovative developed" regions lead also in terms of the growth of innovative production. The volume of innovative products correlates (correlation coefficient is over 0.72) with the number of research personnel, patent applications in 2000 and internal expenditures on research and development in 2014.

Correlations between the growths of patent applications, expenditures on science, high-tech and a specific quantity of researchers in the world/Russia are given in a table. 3. In the world, the increase in hi-tech exports correlates with the growth of patent applications to the NPO and increase in spending on science. In Russia, these indicators are not related to each other. Meanwhile, in Russia, there is a functional dependence (correlation coefficient equals 1) between the growth of spending on science and the increase in the specific quantity of researchers that suggests that the main part of research financing is spent on researchers' salaries.

Thus, in Russia, there is yet no connection between the growth of science funding, the growth of patent applications, and the increase of high-tech production. The growth of innovative production is not yet correlated with any of the above figures.

Table. 3. Correlations between the growths of patent applications, expenditures on science, high-tech and the specific quantity of researchers in the world / Russia.

	Growth of patent applications filed by residents to NPO/ growth of patent applications to Rospatent	Growth of expenditures on science	Growth of high-tech exports/ growth of high-tech production	Growth of specific quantity of researchers
Growth of patent applications filed by residents to NPO/ growth of patent applications to Rospatent	1	0.57/-0.06	0.92/0.11	0.3/-0.06
Growth of spending on science	0.57/-0.06	1	0.85/-0.03	-0.6/1.0
Growth of high-tech exports/ production	0.92/0.11	0.85/-0.03	1	-0.1/-0.02
Growth of specific quantity of researchers	0.3/-0.06	-0.06/1.0	-0.1/-0.02	1

The growth of expenditures on science in the world is weakly correlated with the growth of patent applications filed by residents to the NPO, but the correlation coefficient between the growth of spending on science and the growth of patent applications filed by residents abroad is high (0.84).

That is, the current IP situation and IP market development in Russia differs from the world state and development. According to the results of the correlation analysis, in contrast to global trends, the growth of science funding does not lead to an increase in the number of patent applications.

CONCLUSIONS

Starting from the 21st-century intellectual property is becoming a commodity and an indicator of economic development. The indicators related to IP, are also indicators of the development of technological and human capital.

According to the results of the statistical analysis the increase in the world exports of high-tech products is associated with the growth of expenditures on science and indicators of IP protected in the NPO and abroad:

with the number of TM applications, filed by residents to the NPO in 2001 and 2010,

with the number of ID applications, filed by residents to the NPO in 2001 and 2010,

with the growth of patent applications, filed by residents to the NPO,

with the growth of TM applications, filed abroad.

The increase in the high-tech share in the country's exports correlates with the IP protected abroad, with patents for inventions, justified in force in the NPO, with production, export, and import of MWM, and with spending on science.

A small number of countries are exporting almost 100% of the world's high-tech products. This situation does not change with time, i.e., high technology is not "diffuse" in the world.

The business situation and the IP market development in Russia have similarities and differences in global trends:

in Russia, the growth of science funding does not lead to an increase in the number of patent applications;

in Russia, there is no connection between the growth of science funding, the growth of patent applications, and an increase of high-tech production.

On the other hand, the results for Russia are similar to those for the world countries in terms of the leading of large regions on economic indicators. About half of the regions provide 98% of all manufactured innovative products. The situation is not balanced with time because "large and innovative developed" regions continue to lead in innovative production, protection, and ownership of IP.

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