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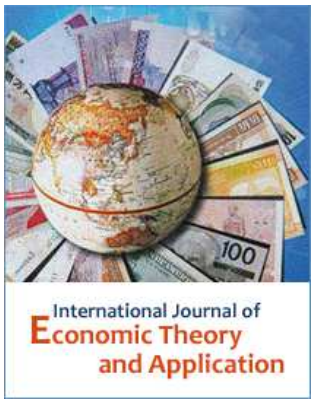

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Intellectual property as an indicator of national economic growth

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Abstract
In this paper, for the analysis of economic processes and predict the development of certain industries and technologies are encouraged to use the data on intellectual property and its dynamics. Secondly, it is emphasized an actual problem of Russia concerning the insufficient expansion of the innovative economy compared to European countries. The main conclusion is that the countries with positive trend in patenting of inventions abroad will have in the near future a high level of innovation-driven economy development and dominate in the global market of high-tech products.

1. Introduction

There are a large number of methods developed to forecast the global economy evolution as well as economic advancement of certain countries [1]. Different indicators are used to compare the economies of various countries [2-5]. There is the problem of a choice of the similar and reliable indicators of technological development and economic growth for different countries and regions. Information about the intellectual property (IP), patent applications and patents in every country, which is a member of the World Intellectual Property Organization (WIPO), is reliable, open, accessible, and uniform. A patent is a public document, and its authors, copyright holders, resident country of the owner, date of filing, area of industry, to which the invention is related, its analogs and the text of application can be found for any patent.

One of the main outcomes and indicators of successful economic development is production and export of the high-tech products. High technologies and intellectual property are inseparably linked. At the stage of implementation of scientific research, development of high-tech products protection of invention occurs mainly in the country-technology developer. Therefore, a high amount of IP or its fast dynamics in the country is a measure of development of research or innovation capability. To display the high-tech products at the international markets it is necessary to protect IP in these markets. The USA is the leading economy in the world, so IP protection in the USA means for the non-residents of the USA the ability to export the high technologies and demonstrate technological development.

This article offers simple IP-related indicators of economic growth. The number of patent applications in a given country, dynamics of this quantity are the indicators of innovation capability. The share of patent applications submitted to the U.S. Patent and Trademark Office (USPTO) by these countries in the total number of patent applications and dynamics of this quantity are the indicators of economic development.

IP is also an indicator of development of field of industry. If the faster growth in the number of patent applications occurs at any field, this industry is evolving technologically. By the ratio of patents in different countries, but in the same field of industry we can judge which country has the advanced technology in this field. This article analyses the several countries. The selection of countries was made as follows: representative countries of the advanced (post-industrial) economy, the so-called G-7 countries: USA, Germany, France, Great Britain, Japan, and Canada), the fast developing countries (BRICs: Brazil, Russia, India, and China) and Asian countries with no natural resources, developing through the use of imported high technology: South Korea and Malaysia. Except Malaysia, all of these countries are in the top-20 by number of IP according to WIPO [6].

2. The Importance of the Indicator Representing the Availability and Time History of National IP in a Specific Technical Area. Problems in Development of the Russian Economy

Currently human civilization is developing along the extensive way: the increase in energy consumption and natural resources, as well as production of consumer goods and food is disproportional in relation to population growth [7]. For example, from 2000 to 2010 the world population has grown from 6.1 to 7 billion people, whereas the gross world product (GWP) increased from $42.4 to $74.9 trillion. The cost and the service life of goods are reduced, vanishes such a thing as a repair. In this race of technology, GDP growth and living standards, the advantages pertain to the countries, which are the first to conquer the markets of the pioneer high-tech products.

The companies and the state protect their intellectual property for the following reasons:

1) scientists can get royalty fees on the sale of their rights to the invention to industrial enterprise;

2) companies protect their markets against the penetration of the competitors and profit maximization through mass production of high-tech innovative new products.

The intellectual property is protected both in the product manufacturing countries and the countries of product markets. At that, on the stage of the innovation life cycle, the number of inventions (IP) relating to a given innovation is maximal at the stage of design and development work, industrial engineering and production of pilot batches of the product.

Therefore, from the analysis of patents and patent applications filed in the patent offices we can get the following information:

1. what research direction is the most promising and relevant;
2. what kind of products and technologies are coming to market in the near future ;
3. which countries will be the suppliers of the equipment in certain areas;
4. which countries will be the leaders in terms of the GDP growth rate.

IP is an indicator showing the availability of high technology in the country possessing export capability.

At present, the development of innovative economy in Russia, as compared to developed countries and emergent nations, is encountered a problem of weak involvement of the scientific and technological results (R&D) in the national economic turnover (just a few percent of the created intellectual property is demanded in the market). This statement is supported by the following facts:

- low relative production of high-tech products as compared with developed countries;
- a small number of industrial enterprises engaged in technological innovation;
- small relative volume of investment into R&D of industrial enterprises and the private economy sector.

Over the last years, a discrepancy between the amount of expenditure on R&D and the return on scientific developments in the form of new products and employed advanced technologies is gradually increasing. The domestic public spending on R&D in monetary terms increased during the period from 2000 to 2008 more than 4 times (or 1.5 times if calculated at constant prices). The amount of research funding in monetary terms raised over the same period by factor of 5 (or twice if calculated at constant prices), whereas the impact of such costs decreased. By the end of 2007, the proportion of new products in the total amount of goods and services was just 5.5%, and the proportion of conceptually new products in the industrial production was 0.4%. [7, 8].

Low susceptibility of the real sector to innovations is related to the general status of fiscal and monetary policy of the state, the situation in the state's industry, the availability of high-tech manufacturing and its growth.

As an example, let us investigate the relationship between the growth rate of relative IP in various countries and growth rate of relative GDP.

Table 1 presents GDP data of the countries in the proportion of GWP.

Table 1. *GDP of the countries are presented in the proportion of GWP on an annual basis (1992-2009). The calculated values are based on the data from [9].*

Year	USA	Russia	China	Japan	Germany	Malaysia	France	Brazil	India	UK	Canada	South Korea
1992	22.75	4.19	4.31	9.22	5.85	0.40	4.00	3.30	3.04	3.61	2.04	1.48
1993	22.94	3.75	4.82	9.05	5.69	0.43	3.88	2.99	3.13	3.62	2.04	1.54
1994	23.15	3.18	5.29	8.85	5.66	0.45	3.85	3.07	3.22	3.66	2.08	1.63
1995	22.91	2.94	5.66	8.71	5.57	0.48	3.80	3.15	3.34	3.64	2.06	1.71
1996	22.93	2.74	6.01	8.62	5.43	0.51	3.70	3.18	3.46	3.61	2.02	1.71
1997	22.96	2.66	6.30	8.40	5.30	0.53	3.63	3.13	3.66	3.58	2.02	1.79
1998	23.39	2.46	6.62	8.03	5.28	0.48	3.67	3.10	3.76	3.62	2.05	1.65
1999	23.71	2.53	6.89	7.75	5.20	0.49	3.66	3.03	3.76	3.62	2.09	1.77
2000	23.56	2.65	7.13	7.61	5.13	0.51	3.63	2.93	3.75	3.59	2.10	1.84
2001	23.29	2.73	7.55	7.45	5.08	0.50	3.62	2.92	3.81	3.60	2.09	1.87
2002	23.07	2.78	8.01	7.27	4.94	0.51	3.56	2.90	3.87	3.57	2.10	1.95
2003	22.83	2.88	8.52	7.12	4.76	0.52	3.47	2.89	4.00	3.55	2.06	1.93
2004	22.54	2.94	8.92	6.96	4.59	0.53	3.37	2.82	4.11	3.49	2.02	1.93
2005	22.28	2.99	9.46	6.83	4.43	0.53	3.30	2.84	4.29	3.41	2.00	1.93
2006	21.76	3.08	10.14	6.63	4.36	0.54	3.21	2.79	4.48	3.33	1.95	1.94
2007	21.08	3.17	11.00	6.45	4.25	0.54	3.12	2.76	4.68	3.25	1.90	1.93
2008	20.52	3.25	11.74	6.20	4.18	0.55	3.04	2.79	4.84	3.16	1.86	1.92
2009	20.14	3.02	12.90	5.92	4.01	0.55	2.99	2.85	5.16	3.03	1.82	1.94

Over 20 years, the proportion of China's GDP grew by almost a factor of 3 (i.e. the growth rate of China's GDP overtake the world average growth rate of GDP). Besides China, the heightened rates of GDP growth have also India, South Korea and Malaysia. GDP growth rate in Russia, Brazil and Canada remain almost unchanged within a certain narrow range.

It is interesting to trace the relationship between the relative GDP and relative IP for these countries.

According to WIPO [10], the number of patent applications is growing every year, and from 1990 to 2009 has increased by almost a factor of 2. Moreover, the proportion of patent applications of non-residents in the total number of patent applications is also growing, as patents are increasingly being used to protect the IP rights on foreign markets.

Russia ranks 6th in the world in the number of patent applications received by the national patent office from the country residents, i.e. Russia is among the top-10 countries of inventive activity. In 2007, Russian residents have filed with Russian Office for Patents and Trademarks (Rospatent) 27.5 thousand applications (2.75%) of total 1 million patent applications filed worldwide. But, on the other hand, Russia ranks 21st in the number of international patent applications filed under the Paten Cooperation Treaty (655 out of 163,600 applications in 2008, or 0.4% of the total). This discrepancy testifies that Russia protects national inventions in the international market very weekly; this country exports little amount of high-tech products and it is involved in high-tech manufacturing in other countries weekly.

It is of interest to study the trend of filing international patent applications by Russian residents, and how the situation has changed over the past 20 years since the emergence in Russia of a new economic order and new laws.

The USA is the first economy of the world. Illustrative is the relative number of applications for inventions supplied by the residents of various countries to the USPTO, as well as its rate of growth. According to the annual reports of USPTO [11], a total number of patent applications supplied to US during the period from 1991 to 2009 has increased almost 3 times (from 164 to 456 thousand). What means such a figure as the protection of inventions in the US? It means that the US market will be saturated with high-tech knowledge-intensive products, manufactured either in the country that holds technology right, or produced at the US enterprises owned by the right holder country. Thus, this indicator shows the high-tech development in a country, which protects its products in the US market.

Table 2 shows the percentage of applications from national residents, served in the USPTO by the year.

Table 2. *The relative number of applications from national residents, served in the US Patent Office during the period from 1992 to 2009.*

Year	USA	Russia	China	Japan	Germany	Malaysia	France	Brazil	India	UK	Canada	South Korea
1992	53.40	0.11	0.07	22.32	6.73	0.01	2.79	0.06	0.04	2.65	2.13	0.85
1993	57.20	0.09	0.08	19.92	6.01	0.01	2.47	0.06	0.03	2.53	2.22	0.93
1994	56.48	0.11	0.05	19.89	5.96	0.02	2.38	0.08	0.04	2.56	2.17	1.24
1995	58.37	0.10	0.07	17.78	5.58	0.01	2.35	0.05	0.04	2.45	2.24	1.33
1996	54.76	0.13	0.07	20.24	5.89	0.02	2.30	0.07	0.06	2.45	2.24	2.18
1997	55.95	0.12	0.05	19.40	5.73	0.03	2.21	0.06	0.06	2.39	2.23	2.29
1998	55.74	0.11	0.07	18.62	5.71	0.02	2.16	0.07	0.07	2.51	2.28	2.24
1999	55.45	0.14	0.10	17.70	6.28	0.03	2.30	0.07	0.10	2.57	2.18	1.86
2000	55.69	0.13	0.16	17.87	5.99	0.04	2.24	0.07	0.15	2.54	2.34	1.93
2001	54.37	0.13	0.19	18.76	6.09	0.04	2.10	0.07	0.20	2.56	2.28	2.06
2002	55.09	0.11	0.27	17.56	6.11	0.04	2.04	0.07	0.27	2.51	2.30	2.37
2003	55.17	0.10	0.30	17.62	5.52	0.07	1.93	0.08	0.34	2.25	2.21	3.04
2004	53.10	0.09	0.46	18.16	5.55	0.09	1.91	0.08	0.37	2.18	2.21	3.82
2005	53.20	0.09	0.54	18.43	5.29	0.08	1.78	0.08	0.37	2.04	2.26	4.41
2006	52.07	0.10	0.88	18.04	5.25	0.09	1.68	0.08	0.45	1.96	2.30	5.09
2007	52.91	0.10	0.86	17.27	5.18	0.07	1.76	0.08	0.52	2.01	2.21	5.04
2008	50.75	0.12	0.98	18.06	5.52	0.07	1.88	0.10	0.63	2.14	2.27	5.17
2009	49.31	0.11	1.51	17.97	5.52	0.07	2.05	0.10	0.68	2.32	2.28	5.25

A comparison of two tables clearly shows the relationship between relative GDP growth rate and the rate of growth (decrease) in the relative number of patent applications.

In China, India, Malaysia and South Korea the growth rate in relative number of applications is above mean value. The growth rate in relative number of applications filed by the residents of Russia, Brazil, and Canada remain almost unchanged.

For nearly 20 years residents of Russia file in the US just 0.1% of the total number of applications filed by USPTO, while China has increased the relative number of applications during this time more than 20 times. In other words, China is expanding its share in the US market of high-tech products, whereas Russia – does not.

These sentences are confirmed by the data on Fig.1 and Fig, 2. Fig 1 shows the number of patent applications filed by residents and non-residents in the Chinese Patent and Trademark Office in period from 2000 to-2010. Fig. 2 shows the number of patent applications filed by different countries in the Chinese Patent and Trademark Office in period from 2003 to 2011.

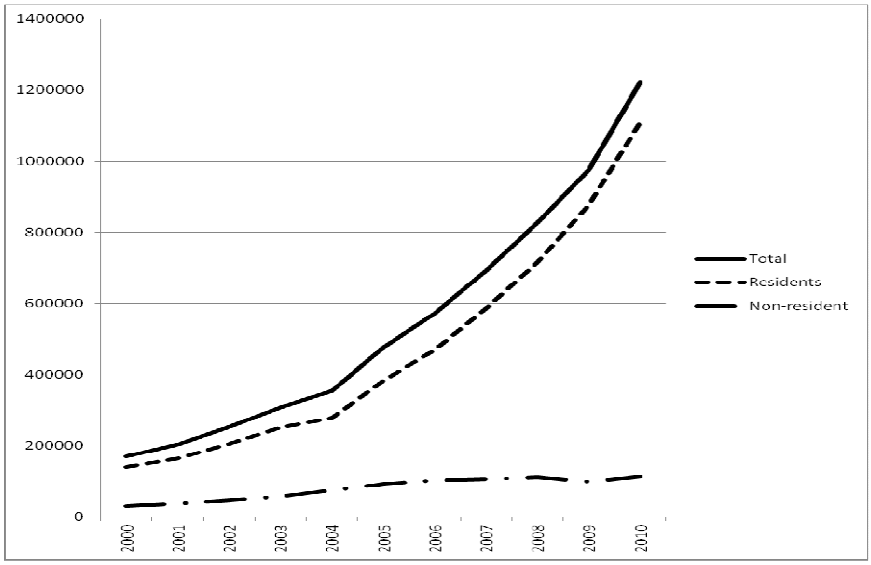

Fig. 1 *Patent applications filed by residents and non-residents in the Chinese Patent Office in 2000-2010.*

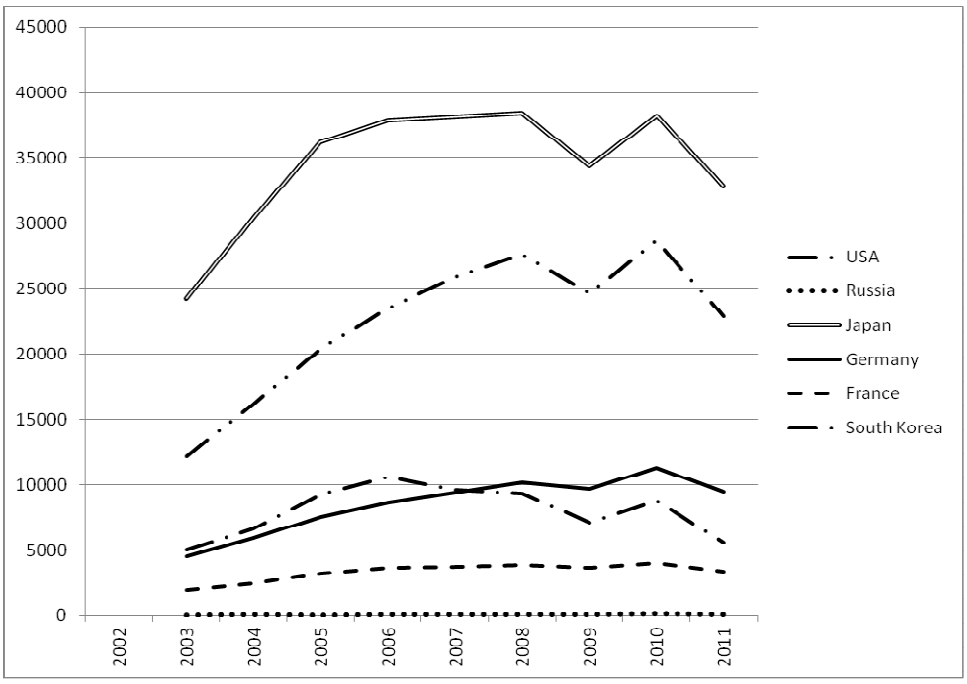

Fig. 2 *Patent applications filed with the Chinese Patent Office in 2003 to 2011.*

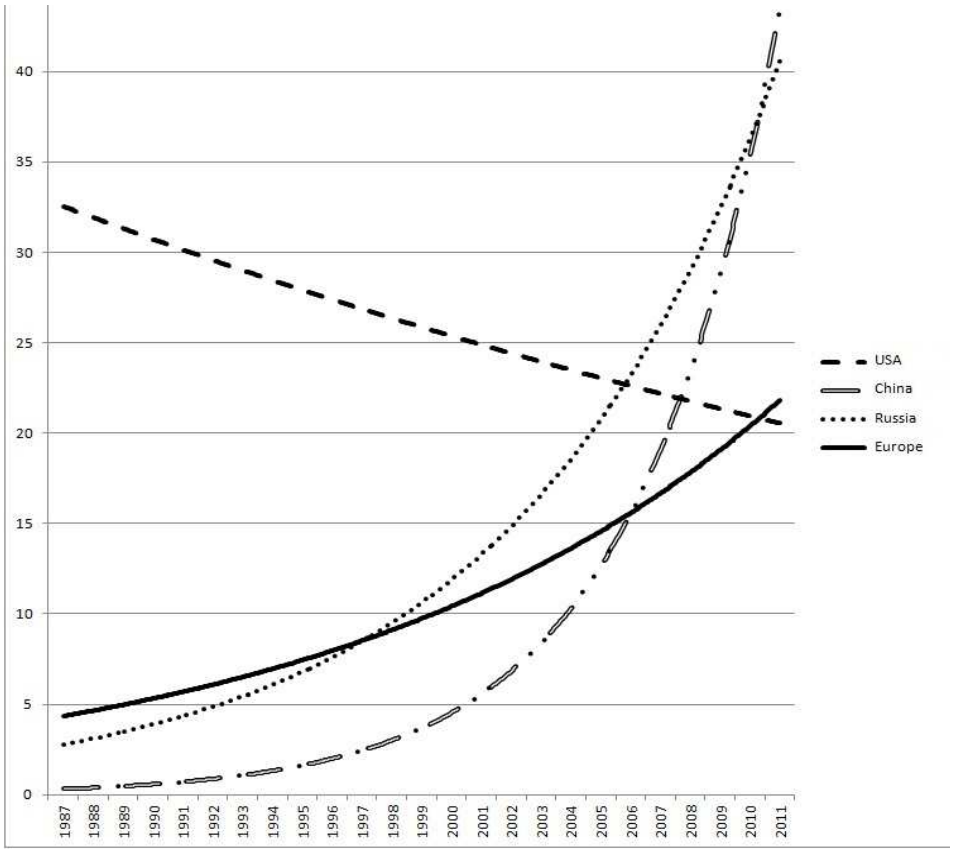

Fig. 3. *The number of patents on MSW disposal technologies obtained by year and country: USA, China, Russia, and European countries.*

This analysis leads to several conclusions: for particular country, GDP is associated with the protection of intellectual property abroad, because it is determined by the growth of high-tech production and export of high-tech products or their manufacturing abroad. Compared to other countries, Russia does not increase its presence in foreign markets, therefore it is too early to talk about the availability of the conditions for the transition of the country to the innovation stage of economy development.

3. Intellectual Property and the Progress in the Field of Municipal Solid Wastes Processing and Disposal

Waste disposal problem has the technical and social aspects. Municipal solid waste (MSW), which is continuously mass-produced by urban population, consists mostly of crude hydrocarbons that allow one to consider waste as a kind of renewable fuel resource. Every year Russia produces about 35-40 million tons of solid waste, or 200 million cubic meters of MSW [12].

On the other hand, in Russia there is a need of continuous heat supply. Historically, in Russia the large cities are dominated by district heating. It would seem logical to realize in Russia large-scale construction of environmentally sound waste-to-energy plants using MSW as a fuel, as well as availability of a significant number of technologies and IP in the field of MSW processing and disposal.

To identify the countries which possess technologies for MSW processing and carry out R&D in this field as well as start production of the relevant equipment, the patent search was carried out through the databases of the European Patent Office (http://worldwide.espacenet.com), Rospatent (http://www.fips1.ru), as well as China patent and Trademark Office (http://www.chinatrademarkoffice.com), and USPTO. First, studies were conducted on all of the MSW disposal technologies. The data obtained is presented in Figure 3.

Analysis of data in Fig 3 results in conclusion that in total the most MSW processing technologies are available in the US, though R&D in this area is gradually reduced. China has only recently begun to develop and apply the MSW disposal technologies, though started to do so with maximum activity as compared with other countries.

Russia and European countries are carrying out development studies as well, though according to the time history of patent filing, the equipment for solid waste processing and disposal in the future will be mainly produced in China.

Different methods of solid waste disposal such as recycling after sorting, dumping, thermal processing, etc. have been developed both in Russia and throughout the world. Solid waste disposal technologies are divided into the disposal, recycling and incineration technologies. Waste dumping does not solve the environmental problems, though only postpones the need for recycling of solid waste, as the natural decay periods of its components are up to 200 years. Recycling of solid waste (sorting) is economically unviable, since the revenue from sorting mixed solid waste can not cover the cost of sorting under any circumstances, it requires tariff-cross subsidies on processing and further landfilling [13, 14].

Incineration of unsorted waste involves the lowest processing costs when treating solid waste at its receiving (when just bulky waste is sorted out) and obtaining commercial products in the form of heat, ferrous and non-ferrous metals, and constructional raw materials. [13]

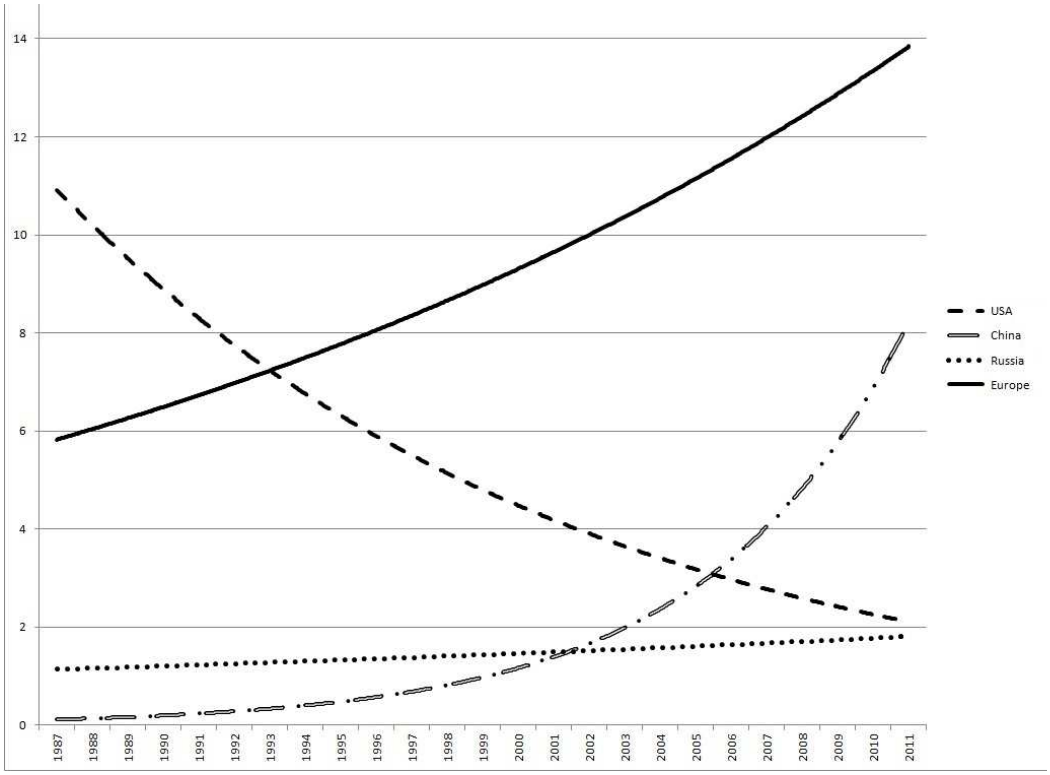

Fig. 4. *The number of patents on the MSW incineration technologies obtained by year and country: USA, China, Russia, Europe.*

Solid waste incineration technologies are divided into the combustion on the grate (the most common in the world technology), incineration in rotary drum furnaces, and incineration in low temperature plasma with advanced pyrolysis and production of synthesis gas. Today, there are more than 2 thousand plants operating in the world to combust solid waste on the mechanical grates, about 200 furnaces for thermal treatment of waste in a fluidized bed, about 20 rotary kilns to burn MSW, as well as single plants using pyrolysis and gasification [15]. Environmentally friendly technologies for solid waste combustion have been developed and patented in Russia. In 2012, Federal Service for Supervision of Natural Recourses (RPN) admitted combustion of solid waste for the best technology for waste disposal in Russia [16].

Therefore, when working with above mentioned databases, we also searched for patents on incineration technologies applicable for MSW combustion. Based on the data obtained, we have drawn the graphs providing the exponential trend lines to show the time history of patenting by year since 1987 (Fig. 4).

Analysis of the results presented in Fig. 4 shows that the combustion of solid waste is the fastest growing technology in Europe and China. In Russia this trend is almost not developed. The US already have acquired a significant number of technologies and thus reduce R&D in this area. Based upon time history of patenting, one can conclude that in the future the equipment for incineration of solid waste will be mainly manufactured in Europe.

When comparing the conclusions made with the today's situation in the field of solid waste disposal, it becomes obvious, that our findings are strongly supported by tangible evidence that the production of modern equipment and the construction of numerous plants for the thermal disposal of solid waste is mainly concentrated in the USA, China and European countries. In Russia the successful examples of such plant constructions are quite rare, moreover they are built based on the use of foreign technologies and imported (European) equipment.

4. Conclusions

The conducted analysis shows that intellectual property is a good indicator when comparing the economies of individual countries. It serves as a criterion for the availability of high technologies in the country and indicates the stage of high-tech involvement in the country's economy.

The share of IP in the international markets (namely, in the USA) is an indicator of economic growth and relates to dynamics of the share of country's GDP in GWP. One can expect that the countries with positive trend in patenting of inventions abroad will have in the near future a high level of innovation-driven economy development and dominate in the global market of high-tech products.

Among the fast developing countries (BRIC) the fastest dynamics of IP, protected at home and abroad, is shown by China, which aims to be the largest economy in the world in future. China will have high technologies and high-tech industry. India also shows high growth in IP and, accordingly, in technological development and GDP increase. Brazil is developing much more slowly than China and India. As for Russia, in the early 90s Russia surpassed other BRICs in IP protected in international markets. Now, despite the high innovation capability, Russia is not increasing its share of IP abroad, and this is an indicator of stagnation and a warning signal for the Russian government about a lack of technological development.

Among the developed countries (G7 and South Korea) the most favorable outlook for economic development can be done for South Korea, which has no natural resources, but, according to IP dynamics, has the great potential for technological development and GDP growth.

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