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Scientometrical indicators of national science & technology policy based on patent statistics data

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1. Introduction

In recent times, the Science and Technology (S&T) government bodies have shown increased interest in the results of bibliometrical research work, i.e., statistical analysis of published documents. In that connection, many papers about the role and place of scientific publications have been written. It was often the topic of major research work in Bulgaria in the postsocialistical period.

The present paper discusses another kind of document – patents, as well as the possibilities of their application for the purposes of S&T policy.

Patent documents have three essential characteristics, making them an excellent source of information for S&T policy analysis. They are the following:

- *The patent document is an unchangeable written reflection of the R&D (research and development) output.* It describes a new technical development (design or technology), requiring patent protection.
- *The patent document reveals the new trends in technology*. Only by a patent can the inventor (a person or a legal entity: a company, agency, university, etc.) ensure protection for his invention. The legal system includes an assessment of its novelty, value and applicability, comparing the data from the application with the already published scientific and technology knowledge.
- *The patent document provides considerable information about the applicant's approach to the R&D activity and the marketing*. The company's strategy is very important here. It may be of interest, when the patent statistics are used for measurement and comparison of the technology developments.

Patent documents are not unique element serving for evaluation of the state of technology, but they can often be very useful combined with other R&D indicators.

2. Patents as scientometrical indicators

One of the most important tasks for researchers in this field is to describe the R&D activities in qualitative as well as quantitative terms, so that they could be explicitly included into models and combined with other economic variables. However, the main problem is that R&D activity could be measured indirectly by means of entry and output indicators. Besides it is more difficult, in theory and practice, to estimate the return of R&D activities than the expenditures. The results of R&D activity and the possible combination of new products and processes with their successful market realisation cannot be measured in the common scientific sense of "measuring" of a variable; there is not an eligible monetary or physical unit available. One of the resolutions of those problems would be the use of indicators, which, in such a context, have been the patent indicators used for current measuring of the results of R&D.

The industrial R&D activity is a fundamental factor for the economic condition of a country, and therefore its exact measurement is quite important. The great closeness of patents to the results of R&D activity is the main reason for their systematic use in economic analyses. No other indicator reflects to a similar extent, the state of R&D.

Even though the patent indicators reflect a considerable part of the general innovation process [6], for a variety of reasons they cannot be used in isolation. Firstly, they show only one aspect of an innovation, so that a complete picture of the technology transformation could be obtained only by combination of various indicators. In the second place, patent indicators have

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some disadvantages, which could be often found out by comparison with other indicators. This necessity of an integral idea for an innovation relates to other phases as well, and even such a classical phase as the expenditures for R&D must be considered in a broader context.

The validity of patent indicators depends very much on the extent to which they represent the results of industrial R&D activity, and this is a problem closely related to the economic value of the patents. The patent protection is not the only way to market success of innovations. Trade secret, rapid promotion, low prices, etc., can complement and even replace the patent protection. Various empirical investigations on the relative significance of patents have brought the following, in principle, similar results. Patents are an important tool of competition, at least as significant as the other factors. Not all technical innovations result in a patent application, but the range is generally wide, because patents are useful not only for protection against imitation, but also for receiving of licence incomes and contracting of transfer agreements. In practice all companies apply for patents at least for the most important results of their R&D activity, but there are great differences in applying for patent protection for the inessential products and processes.

The particular closeness of patents to the industrial R&D output means that there are no other equivalent indicators for analysis of the innovation process [4].

The second advantage of patent data is their coverage of practically all fields of technology. The main exceptions are: software, which is not directly connected to technical processes or products, as well as most results from the fundamental studies, which could be better reflected by bibliometrical indicators. This comprehensive coverage of technology is very useful in analysing the dissemination of some key technologies, for instance, or in creating of specialised country- or company-profiles.

Patents have a wide geographical scope, because most of the countries have patent systems, and besides they are presented in regional systems, such as American and European.

Another very important advantage is the highly detailed classification of patent documents, which gives an opportunity for almost unlimited choice of aggregation levels – from broad fields of technology to single products. Here the patent indicators are better than the expenditures for R&D activities, or trade and production statistics, where the degree of desegregation is much lower. In order to obtain significant results, we have to combine the patent, trade and R&D indicators by working on high aggregated levels, while for making narrower analyses only patent indicators can be used.

Patent documents include very interesting details, such as year of invention (priority year), technical classification, applicant (applying company), etc., which are a valuable source for various kinds of analyses. The statistical processing of patent data can be characterised with high degree of reliability, because patents are legal documents, in which the details have been inscribed very diligently. So, for instance, the mistakes in the names of companies occur much more rarely, compared with publication databases, and therefore the establishment of statistics for the applicants is rather easier.

Application of patents for economic analyses is very effective, because they contain detailed information about R&D activities. However, it is necessary to have a careful methodological approach in order to eliminate the possibilities of deviations. Research, based on patent indicators, has already revealed some interesting concepts about the innovation process [5], as well as some starting points for future investigations.

3. Patent statistics data

The data of patent statistics are very valuable for the measuring of R&D activity. They have been annually published in the national statistical manuals of all developed countries. They are presented also in the specialised issues of World Intellectual Property Statistics (WIPO) – Industrial Property Statistics. It contains data about Bulgaria as well. In our country, however, National Statistical Institute and the Patent Office of Republic of Bulgaria do not publish that information (except some summary data, reviewed in the annual reports of the Patent Office). Therefore, although more detailed patent statistics data have been collected from the Bulgarian Patent Office, they could be obtained only from foreign publications, in a very generalised form and with a great delay of two or three years. Because of circumstances, the scientometrical patent research data could meet some research purposes and solve some scientific problems. They, however, are totally insufficient for the governing of science and for the national S&T policy making. According to us, such a state of affairs is not normal. In that connection we consider, that in line with some content analyses of patents it would also be necessary to have some annual information about the quantitative characteristics of the patent activities in the country. Besides it would be expedient for this information to be available for the governing bodies and for other organisations, related to the forming and realisation of S&T policy. In our opinion, for the Bulgarian science community and science governing bodies, it would be of interest to receive the following data:

1. Number of Bulgarian patent applications and granted patents;

2. Number of foreign patent applications and granted patents in Bulgaria (by states);
3. Distribution of Bulgarian patent applications and granted patents under classes of International Patent Classification (IPC);
4. Distribution of foreign patent applications and granted patents in Bulgaria under classes of IPC and with indication of applicants' countries;
5. Distribution of patents of Bulgarian citizens granted abroad under PCT (Patent Cooperation Treaty) with indication of the corresponding class of IPC;
6. Distribution of Bulgarian patent applications and granted patents under applicant organisations and classes of IPC.

We have asked the experts from the Patent Office to respond to our questions giving us the needed information. They have provided us with some patent statistics data (unfortunately not all the required), shown in the following tables and charts.

4. Patent activity of Bulgarian inventors

Table 1 shows the patent activity of Bulgarian inventors during the period 1991–1996 (except 1995) [1]. It is obvious, that this activity is not equal in the different classes of IPC. This irregularity of the patent distribution remains nearly constant in every investigated year. The greatest number of patents are in classes A61–A63; E01–E06; F01–F04 and F15; G01–G03; H01, H02 and H05. Smaller in number are the patents in classes from sections B and C (see Table 2). There are none from Section D.

In Recent years some classes have been better represented than before: A61K; C07 and A01N; C12–C14; G01–G03. It is interesting to note that in this case, we can reveal some correlation between the trends in patent and publication activity of Bulgarian researchers [3]. For instance, in field "biotechnology and microbiology", corresponding to the class of IPC C12, Bulgarian publications (according to SCI) have increased to 0.6% from the total number of documents (by mean value for Bulgaria of 0.2%). We have also similar data for the fields "spectroscopy" and "optics and acoustics", corresponding to class G01, as well as for "organic chemistry" and "agriculture chemistry" (classes C07 and A01N). Besides, the mean citing value of Bulgarian publications in these S&T fields has increased as well.

Other classes keep a nearly constant value during the years (A01 except A01N; C01–C05; C09–C11; C21–C23; E01–E06; G04–G08; H01, H02 and H05). In most classes, however, we can note an essential decrease of patent activity for the investigated period; in some

Table 1
Bulgarian patent applications and patents granted classified in IPC

Year Classes of IPC	1991	1992	1993	1994	1996
A01 except	10	13	14	12	6
A01N	7	5	15	1	10
A21–A24	20	13	23	12	9
	13	6	5	6	14
A61–A63	33	16	28	17	17
except A61K	8	14	8	1	10
A61K	11	4	23	25	17
	5	2	0	0	20
B01–B09	17	18	16	12	12
	14	13	4	0	12
B21–B23	18	14	8	6	5
	7	6	3	0	7
B24–B32	16	11	7	7	5
	5	3	1	2	1
B60–B64	15	25	20	14	11
	1	4	2	8	11
B65–B68	14	9	13	7	5
	3	7	3	1	5
C01–C05	23	8	15	9	13
	6	12	4	1	9
C07 and A01N	3	5	7	8	7
	0	1	0	2	16
C09–C11	11	5	9	1	8
	2	5	1	2	3
C12–C14	3	9	15	8	10
	1	4	2	4	12
C21–C23	10	3	6	11	5
	5	4	1	2	5
E01–E06	29	26	21	17	26
	8	12	4	1	17
F01–F04 and F15	37	30	31	22	15
	6	5	4	3	5
F16 and F17	17	19	16	12	11
	6	7	1	4	10
F21–F28	18	8	16	3	9
	5	5	2	1	4
G01–G08	24	12	11	10	10
	10	3	1	0	9
H01, H02 and H05	22	31	18	23	22
	7	5	3	0	14
H03 and H04	14	14	6	2	9
	4	3	0	0	2

Table 2
Sections of international patent classification (IPC)

Section A	Human needs
Section B	Technological processes; transport
Section C	Chemistry and metallurgy
Section D	Textile and paper
Section E	Building
Section F	Mechanical techniques; lighting; heating; weapon; detonation
Section G	Physics
Section H	Electricity

classes it is about 50% and more: F01–F04 and F15; F21–F28; A21–A24; B21–B23.

5. Foreign inventors' activity in Bulgaria

Table 3 shows the foreign inventors' activity in Bulgaria during the period 1991–1996. While the national application activity gives an idea of the creativity potential and local enterprise, foreign application activity is a mirror of the foreign capital intentions to invest and to do business in Bulgaria.

The distribution of foreign patent applications under classes of IPC depicts the sectors of S&T of greatest interest to the foreign inventors. Although the number of applications is not the right criteria for determining how many the granted ones will be, it is a good indicator of the inventive activity.

Foreign applicants seek protection of their inventions mainly in the field of organic chemistry – class C07 (with highest activity of all countries); drugs and medicines – class A61K (USA, Germany, Switzerland, Hungary, Italy); pesticides, herbicides, etc., class A01N (Great Britain, USA, Switzerland).

As we can see, the same classes have been (or are getting) quite attractive for Bulgarian inventors as well.

Table 4 shows the number of foreign applications and granted patents by states in 1996. The majority of foreign applications filed at our Patent Office in 1996 belongs to the USA; Germany was the next in activity, followed by Great Britain, France, Switzerland, etc.

Table 3
Distribution of foreign patent applications in Bulgaria under states and under classes of IPC [a] (A61K – Drugs and medicines. A01N – Pesticides, herbicides, etc. B65 – Conveying, packing, storing, handling, thin or filamentary material. C07 – Organic Chemistry. C08 – Organic macromolecular compounds, their preparation or chemical working-up, compositions based thereon. C12 – Biochemistry; beer; spirits; wine; vinegar; microbiology; enzymology; mutation or genetic engineering. H01 – Basic electric components. H04 – Electrical connecting equipment.)

Country Class of IPC	A61K	A01N	B65	C07	C08	C12	C21	H01B	H04
BE-Belgium				1993–8					
				1995–6					
CH-Switzerland	1993–7	1994–7		1992–7					
	1994–8			1993–6					
				1994–23					
				1996–5					
DE-Germany	1991–5	1991–5	1992–6	1991–8			1994–5	1991–7	
	1994–10			1994–23					
	1995–7			1995–15					
	1996–11			1996–26					
DK-Denmark				1995–7					
FI-Finland				1994–6					
FR-France				1994–8	1991–5				
				1996–11					
GB-Great Britain	1994–6	1991–5		1991–16					
		1992–8		1992–6					
		1993–5		1993–13					
		1994–5		1994–9					
		1996–5		1995–19					
				1996–14					
HU-Hungary	1993–7			1991–9					
	1994–8			1993–5					
				1994–6					
IT-Italy	1994–11			1994–20					
JP-Japan	1994–7			1994–12					
SE-Sweden				1991–7					
				1992–7					
				1994–9					
US-USA	1991–8	1991–6		1991–10		1991–10			1995–5
	1192–33	1992–10		1992–44		1994–24			
	1993–9			1993–7		1996–7			
	1994–21			1994–34					
	1995–18			1995–22					
	1996–35			1996–21					

[a] Shown only countries and classes with five and more patents for each year.

Table 4
Foreign patent applications and granted patents by states (1996)

Country	Patent applications	Granted patents[a]	Patents by IPC
BE-Belgium	12	9	2
CA-Canada	6	7	5
CH-Switzerland	20	18	4
DE-Germany	78	32	18
DK-Denmark	13	6	6
FI-Finland	13	5	4
FR-France	24	17	7
GB-Great Britain	39	34	16
IT-Italy	14	23	8
JP-Japan	11	10	4
NL-Netherlands	18	8	5
SE-Sweden	7	16	14
US-USA	100	68	29

[a] Inclusive the patents by IPC.

6. Some general data and conclusions

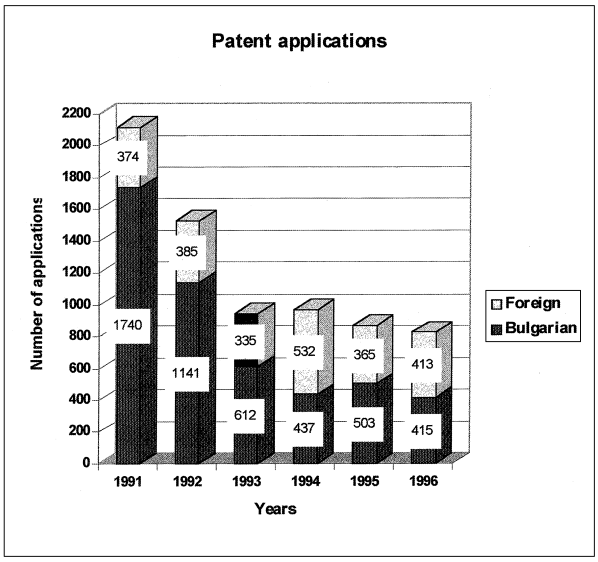

Chart 1 presents the dynamics of patent activity in Bulgaria for the period 1991–1996. The tendency of decrease in patent activity has been stabilised at relatively constant levels in the last three years. The main reason for the decline was the hard economic situation in the country making it difficult for private persons and legal entities to allocate funds for innovations. For the same period there has been a great reduction of institutions and people, engaged in R&D. The stabilisation is due to the new Patent Law, adopted in 1993, which meets all requirements of the modern patent legislation.

Meanwhile, foreign patent activity has remained almost unchanged throughout the years. The increased foreign activity in 1994 is due to the new possibilities provided by § 4 of the Transient and Final Acts of the Patent Law. After dropping of 31.4% in 1995, foreign patent activity grew again by 13.2% in 1996. The number of applications filed under the Patent Co-operation Treaty (PCT) was 72% of all foreign applications. Only two of the applications were for utility models, and 411 were for inventions [2]. The analysis indicates a lasting interest of foreign inventors in seeking protection in Bulgaria, although their level of activity could be considered as low compared to foreign patent activity in Hungary or the Czech Republic.

Table 5 presents the PCT patent application statistics of Bulgarian inventions. The Patent Office act as a filing office in the provision of protection under the PCT. It is notable that Bulgarian inventors are not used to seeking protection in other states (because of financial reasons mainly), but there is now increasing interest in seeking protection abroad.

Unfortunately, the lack of information about the distribution of Bulgarian patent applications under applicant organisations frustrated our intention to analyse, which Bulgarian organisations are most active in patenting. However other research work [7] assert, that the

Table 5
Bulgarian PCT patenting statistics

Years	1991	1992	1993	1994	1995	1996
Total	3	9	16	14	14	17

inventors of Bulgarian Academy of Sciences (BAS) were here in first place. Recently the patent activity of private companies has increased, which corresponds to the new economic situation in Bulgaria.

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