Patenting Activity for Innovation Capacity Building Process in Selected Central and East European Countries

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Abstract

A patent is the main result of R&D activities and the first step in the creation of intellectual property rights (IPR) system in a country. Patenting culture is predefined by the level of development of a particular National Innovation System (NIS), compatibility of country's IPR law with internationally adopted standards and norms and embedded innovation capacities and entrepreneurial behavior of individuals, organizations and institutions. Patenting activity in selected Central and East European (CEE) countries is analyzed in order to identify patterns of resident as well as non-resident patenting in these countries. Transformation of original patent data grouped under IPC (International Patent Classification) as WIPO defined units, into sectoral (HC – Harmonized Classification of sectors of economy) patent data using OECD proposed concordance programme, modified by the author for the use of publicly available national patent data, is made for a preliminary analysis of the validity of proposed transformation, as well as for the analysis of innovation capacity built into manufacturing sectors of transition economies.

Keywords: patenting activity, National Innovation System,. WIPO, Central and East European countries

JEL Classification: M31

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1 Introduction

It is a generally adopted finding that all technological advances have their origins in fundamental scientific research, sometimes based on research efforts which have not been predicted to have applicable results, and in most cases based on research and development (R&D) conducted 5, 10, and even 15 and more years ago! In a number of papers it is proved that scientific and technological (S&T) knowledge and advance are drivers for industrial competitiveness, but it still remains difficult to understand, evaluate and measure the socio-economic impact of R&D activities. This is, at least for the R&D community, an important issue, because of the need to establish an acceptable enough rationale for public and private investment in R&D activities, the cost of which is significantly increasing every year. Therefore, the role and contribution of, especially public S&T innovation, has been a major concern of S&T policy since the 1960s (OECD, 1991). A common conclusion of a number of studies is that *"absorption and utilization of new knowledge into new artifacts and industrial innovations is an extremely complex social process involving a range of corporate sources and external knowledge and skills where most relationships and two-way interactions between research and technological development are neither direct nor obvious"* (Tijssen, 2002).

Patents are one of the very rare *measurable* indicators of R&D activities, which can shine a light inside the "black box" of R&D activities, but still, patents are only intermediate outcomes of innovative-driven R&D. There is a need for further development, resulting in marketable new products or processes or services. In fact, some patents will never end with marketable outcomes; some (so called "generic" patents) could be used for several innovations; some complex systems could be arranged with a number of interrelated and/or incremental patents. An additional problem is the question about the *way* in which the transformation of scientific research into marketable technologies functions? Answers started in 1970s with the linear model of innovation process[1], which begins with laboratory science and moves through successive stages till the new knowledge is built into a commercial application that diffuses in the economic system. The S&T policy for this model fosters critical direction of S&T advancements and enhances the flow of knowledge down along the innovation chain, with emphasis on the process of designing market needs into R&D activities. Further work recognizes the

[1] *Linear Model of Technical Change is the conceptualization of technological change as a unidirectional sequence, in which innovation appears as a step or stage, following invention (or applied R&D), which follows basic R&D and precedes diffusion. There are no feedbacks among the stages in this sequence (MERIT, 2000).*

complexity of innovation process, illustrated with a “chain-link” model[2], characterized by many feedback loops between the different stages of the innovation process (Klein and Rosenberg, 1986). This model is supported with innovation policy, which recognizes the concepts of national, regional, sectoral and other sorts of innovation systems (Freeman 1987). The innovation policy is intended to: (a) enhance two-way communication across different nodes in the innovation process chain and (b) improve all sorts of innovation systems in order to inform decision makers about R&D, commercialization, technology adoption and implementation, etc. Although this model is still predominant in the present organization of public governance of R&D and other innovation activities, further improvements cope with process of networking between all actors in national innovation system (NIS), which is illustrated in figure 1 (EC, 2003a).

In this view, innovation could be considered as a result of learning process, which is by nature *interactive* and *cumulative*. Interactions within economy, which can result in a combination of existing knowledge or, in some cases, with new knowledge, are among companies, financial, educational, R&D, and other organizations, government agencies and other public and/or private institutions (Galli and Teubal, 1997). Therefore, technological development is a result of complex interactions between mentioned organizations, named by Richard Nelson first as *“capitalism engine of growth”* (according to: Albuquerque, 1997), and later as *“national innovation system”* (Nelson, 1993).

Intellectual property is an important part of infrastructure for NIS, as a basis for organization and functioning of the NIS. Knowledge codified in patent documentation represents a resource for further development into marketable products/processes /services. This wealth of knowledge has to be available to all other participants in national innovation system. Equal treatment of resident, as well as non-resident inventors in one country is the foundation and basic principle of world intellectual property organization (WIPO) and international relations in this area. The unification of patent laws, a process driven by WTO, brought national regulations and inventors into similar position worldwide.

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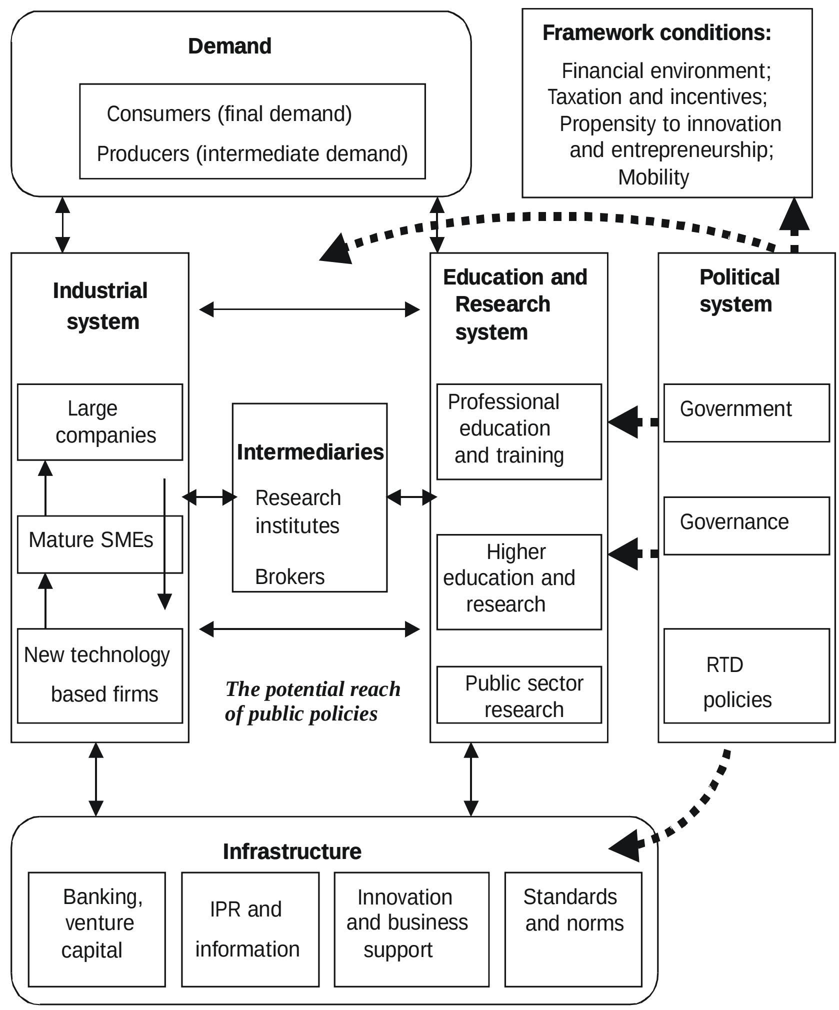
[2] *System Model of Technical Change is the approach that focuses on the interactive links approach that focuses on the interactive links between different stages in the innovation process and the composition of these linkages. It assumes that technical change is an emergent property of the whole set of interactions (MERIT, 2000).*

Figure 1. **National Innovation System – Concept modified and extended by S.Kuhlmann (EC, 2003)**



Process of adaptation of intellectual property rights (IPR) laws to EU standards in CEE countries became an integral part of transitional changes and one of the indicators of how successful this transition is in a particular country (WDR, 1996). Moreover, a precondition for a significant inflow of foreign direct investment (FDI) in CEE countries, preceded with protection of foreign inventions, was the adoption of IPR law fully adjusted with IRP laws in leading EU countries. One should have in mind that before 1989, "*the overall number of foreign patents in CEE countries, with exception of ex-*

Yugoslavia and ex-SU, was marginal" (Radošević and Kutlača, 1998). Not to forget that NIS in the form illustrated in figure 1 had existed in none of CEE countries before 1989. Therefore, progress in the adaptation of IPR regulation and increase of foreign patents are significant indicators in the process of transition, as well as the process of building of NIS in CEE countries.

In this paper we analyze patent activity in CEE countries in order to identify patterns of resident as well as non-resident patenting in these countries. Having in mind that patenting culture is predefined by the level of development of particular NIS, compatibility of country's IPR law with internationally adopted standards and norms and embedded innovation capacities and entrepreneurial behavior of individuals, organizations and institutions, in the following chapters we will present the analysis of the process in which patenting activity contributes to the *innovation capacity building process* in selected CEE countries.

2 Innovation Capacity

"National innovative capacity is the ability of a country – as both a political and economic entity – to produce and commercialize a flow of new-to-the-world technologies over the long term" (Furman, Porter, Stern, 2002). The authors of this concept of national innovative capacity distinguish three building blocks for this concept:

a) Presence of a strong innovation infrastructure;
b) Specific innovation environments present in a country's industrial clusters;
c) Links between the common innovation infrastructure and specific clusters.

Again, patents are the main visible innovative outputs, as a result of properly engaged national innovative capacity. The proposed model of national innovative capacity integrates R&D funding and performance, degree of technological specialization, knowledge spillovers, human capital, as well as public policies and institutions. Analysis is based on international patenting activity (defined by authors as the number of patents granted to inventors from a particular country other than United States by the US PTO (US Patent and Trademark Office) in a given year). The main findings suggest that *"public policy plays an important role in shaping a country's national innovative capacity – beyond simply increasing the level of R&D resources available to the* *economy, other policy choices shape human capital investment, innovation incentives, cluster circumstances, and the quality of linkages"* (Furman, Porter, Stern, 2002).

In this paper we shall use the concept of innovative capacity of the economy under the framework of national innovation system, but rather as *potential for interaction* between the actors of the NIS, than *ability to innovate*. This is so because of the choice of countries, NIS of which is the subject of analysis: developed economies use the already built ability to innovate; developing economies are in search for their potentials for innovation. In this paper we analyze patenting activity in CEE countries, and most of them are developing, some could be treated even as undeveloped economies, and just one, Slovenia, could be classified as a developed economy, in a way this is defined by UN (by the level of GDP *per capita*)!

3 Patents as a Technological Indicator

A number of authors have discussed justification for the use of patent data as a technological indicator. Usually, patents are compared with R&D expenditure as technology proxies: R&D expenditures are a measure for inputs and patents are a measure for outputs (Fai and Tunzelmann, 2001). There is consensus that patent statistics are a important, but imperfect indicator of innovative activities (Pavitt, 1988; Griliches, 1990).

There has been additional discussion on whether to use national patenting data or the US foreign patenting data, for the purpose of international comparison of technological performances between selected countries. The US foreign patenting data are most commonly used in the case of comparison between countries which are at the world innovation frontier. The relevance of the US foreign patenting is much less clear in the case of less developed or *latecomer* economies, because of relatively small numbers of patent granted by US PTO. Generally, the efforts for catching-up in technology development in latecomer economies may be divided into two components: *innovative* and *imitative* learning: imitative learning, which is in majority, is learning behind the world frontier; innovative learning, just sporadic and accidental, is technology development at the world innovation frontier.

Using the US market as the most competitive market, the US foreign patenting data measure primarily commercially relevant technological effort at the world frontier. The

US patents for latecomer economies measure only a minor part of the overall technological effort, that which is at the world innovation frontier. This implies that the interpretation of the US foreign patenting data for these economies should be different: the link between the US foreign patenting and the growth of the latecomer economy may either not be strong or completely absent in the early phases of catching up, because of different sources and national strategies for catching up process. For example, the cases of Korea and Taiwan whose economies had been growing vigorously for some time, whereas in terms of US foreign patents a visible increase is present only from the mid-1980s onwards (Choung, 1995).

Latecomer economies may grow over long periods based on imitative learning or improvements in production and organization which are not of patentable significance (Radošević and Kutlača, 1999). However, eventually long-term growth requires developed innovation capabilities, which then become visible in US patenting accompanied by a higher technological content of export. This is especially relevant in the case of CEE countries, where much of the technology effort was of imitative type either because of autarchic conception of development or foreign restrictions on importing high-tech. Even more, minor improvements such as adaptation of imported technologies for local use are needed, but usually not sufficient to be granted as patents. This implies another bias, bias of domestic patenting data, because *"local learning may exist without local patenting"*, therefore, domestic patenting data in developing countries do not capture a significant share of relevant domestic technological activities, which cannot be patentable (such as minor adaptations and improvements of imported technologies suited for local use, which are not straightforwardly translated into patents, etc.) (Albuquerque, 2000). A thorough analysis of the cumulative aspects of technology learning based on national patenting data is given in a survey of national patenting in Serbia in 1921-1995 period (Kutlača, 1998), where persistent, decades long highest share of resident patents in the field of mechanical engineering and agriculture, proved eventual country' competitiveness in these two sectors, as well as country' technological dependence in chemical industry, with the highest share of non-resident patents over the entire analyzed period.

Finally, we shall end discussion about the use of national patenting data or US foreign patenting data, with the importance of both types of patenting activities: *"US patents capture only part of the technology effort in latecomer economies. Irrespective of their size they indicate the existence of technology effort at the world innovation frontier. Like the tip of the iceberg they indicate the existence of underlying, much greater imitative* *technology effort or R&D behind the world frontier. Both angles of technology effort, imitative and innovative, are important in a long-term for catching up."* (Radošević and Kutlača, 1999).

Besides the US PTO, there are two other types of patent systems, whose importance on the global level should be considered from the CEE countries' patenting activity point of view: common EU (or EPO – European Patent Office' patents) and Japanese system (or JPO – Japanese Patent Office' patents). A long tradition (more than a hundred years of existence) gives the US PTO a big advantage compared with EPO and JPO. The above discussions about latecomer economies, and rationales whether to apply for patent rights in world leading economies or not, are fully applicable here too. Additionally, a serious obstacle to inventors from CEE countries asking protection of patent rights in all three mentioned global systems is the level of costs one inventor must pay for the protection of one invention during the period of economic and political transition. According to OECD Patent manual, there is range of costs one inventor is faced with (OECD, 1994):

- Fees for the patenting procedure (filing, examination, and search fees);
- Fees for a patent agent of attorney;
- Renewal fees;
- If protection is sought abroad, inventor must pay translation charges;
- If protection is sought abroad, inventor must pay foreign patent agent of attorney.

Although it is difficult to calculate precise figures, estimates start from 2,000 EUR and could reach 14,000-20,000 EUR for more complicated patent applications (EPO, 2004). Economical situation in a majority of CEE countries, whether EU member countries or not, is too difficult, and costs for the protection of patent rights in US PTO, EPO and JPO are still too high for most of inventors, residents of CEE countries.

Clarification of all the above mentioned reasons why none of three global patent systems are attractive enough for inventors from CEE countries comes from the available data about international patenting from CEE countries, i.e. filing of patent applications abroad. Small figures for patenting in US PTO are already presented in (Radošević and Kutlača, 1999). Situation with patenting in EPO is illustrated with data in table 1. The second part of this table consists of data for so-called "triadic" patent families, i.e. for patents which are filed at the EPO, the JPO and are granted by the US PTO simultaneously. Figures for selected CEE countries are compared with the numbers of resident patents in those countries for observed years. Total figures (named as *"world* *total"* in table 1) for both EPO and "triadic" patent families differ by about 1% from OECD member countries totals, i.e. other CEE countries can not contribute significantly – three selected CEE countries are sufficient for this analysis. Therefore, one must conclude that *patenting from CEE countries in EPO (and JPO too) is too small and cannot be used as proxy for R&D and innovation activity in these countries.*

Additionally, the expansion of protection abroad, from one CEE country to a number of countries, particularly to all three biggest patent systems, observed as number of "triadic" patent families is decreasing, as this is shown with data in table 1 in the observed period.

Table 1. **EPO patent applications and Triadic[(2)] patent families by priority year and by inventor's country of residence for selected CEE and OECD member countries**

EPO patent applications	**Year**			**Triadic patent families**	**Year**		
Country	**1990**	**1995**	**1997**	**Country**	**1989**	**1993**	**1995**
Hungary	69	53	70	Hungary	43	24	15
Hungary - % of NRP[(1)]	3.00	4.74	9.04	Hungary - % of NRP	1.62	2.09	1.34
Czech Republic	22	19	42	Czech Republic	11	8	3
Czech R. - % of NRP	n.a.	3.03	6.99	Czech R. - % of NRP	n.a.	0.89	0.48
Slovak Republic	0	7	13	Slovak Republic	0	2	2
Slovak R. - % of NRP	n.a.	2.56	5.56	Slovak R. - % of NRP	n.a.	0.71	0.73
Japan	12976	11801	13974	Japan	9968	8031	8601
United States	17396	20579	24129	United States	10743	10971	11162
European Union	27016	30620	39712	European Union	10537	9941	10316
Total OECD	60393	66801	82846	Total OECD	32682	30461	31711
Total OECD - % of world total	1.28	1.62	1.99	Total OECD - % of world total	0.76	1.13	1.10
World total	61177	67902	84530	World total	32932	30810	32064

Notes: [(1)]NRP – National Resident Patenting [(2)]Patent is a member of the "triadic" patent families if and only if it is filed at the EPO, the JPO and is granted by the US PTO.
Source: (OECD, 2001).

4 Central and Eastern Europe: Patents as Indicator of Transition

Transition from central planning to market economy in Central and Eastern European (CEE) countries is, among others, a process of catching-up with the average level of income in the EU economies. This process requires high rates of growth sustained over a long time period, what could be achieved only through technical change and technological learning. The cumulative nature of technological nature indicates the necessity to analyze technological trajectories in CEE countries and check whether the technological history of this region is different, compared with western economies, as much as it is the case with political history, or not? One assessment of the basis and potentials for catching-up of CEE countries, based on the analysis of patenting activity in CEE countries and protection of their patents in the US patent office in the period 1969-1994, concluded that there is no such difference. The main findings of this analysis could be summarized in seven points (Radošević and Kutlača, 1998; Radošević and Kutlača 1999):

1) The US foreign patenting from CEE countries in the analyzed period was not below the levels of comparable market economies;
2) The levels and dynamics of US patenting activity of CEE as a region seem to be determined more by income levels and growth rates than by specific features of the command economy;
3) Despite the closed character of their economies in the socialist period, state policy allowed and supported the sale of technological knowledge abroad. This ranged from more or less independent patent activities by enterprises in Hungary, and, especially, ex-Yugoslavia, to controlled state sponsorship in the case of ex-Soviet Union or even direct State involvement in patenting process, as in Romania;
4) The US foreign patent trends in CEE reflect more their past capabilities than present strengths. The technological advantages of these economies are firmly rooted in their past successes and are very much based in metallurgical and mechanical technologies, and in chemicals/drugs;
5) There are significant intra-regional differences in the institutional basis of US foreign patenting which broadly follow inter-country differences in the institutional structure of R&D;
6) The basis for CEE for catching-up with the technological leaders is rather tenuous. The remaining strengths are in specific areas but not across sectors or industries. For example, in ex-Czechoslovakia, patenting activity is still strong in textile manufacturing equipment, in Hungary it is strong in drugs and organic chemicals, and Russia still obtains patents in mining and metallurgy equipment and processes. It is not likely that these countries can recombine world frontier R&D, design and manufacturing capabilities on a large scale but it is possible in the specific sectors that these economies still have patentable inventions. On the other hand, the level of human capital, size of R&D system, design and engineering capacities indicate that CEE countries may develop imitative capabilities not only in manufacturing but also in R&D and design.

Finally, one of the main messages of this analysis is that *"in order to catch-up technologically, CEE will have to generate innovations which are relevant for the world market"* (Radošević and Kutlača, 1998; Radošević and Kutlača 1999). One argument which supports this conclusion came from the analysis presented with data in table 1, concerning patenting from CEE countries in EPO. Patenting in EPO is more and more important since the enlargement of EU became a reality for several CEE countries and membership in EU emerged as the first national priority for a number of other CEE countries. Therefore, increase of importance of EPO for CEE countries is a natural process and a change in patenting structure, could be used as the *indicator of integration into EU innovation system*. This is something what is identified with data in table 1 – although not sufficient for a thorough analysis of innovation activities, in all three selected CEE countries one can notice increase of EPO patent application as the share of national resident patents, i.e. EU market becoming a target market for CEE countries! For example, the share of EPO patent applications in national total resident patent applications in Hungary jumped from 3% in 1990 to 9.07% in 1997; in Czech Republic it increased from 3.03% in 1995 to 6.99% in 1997; in Slovak Republic from 2.56% in 1995 to 5.56% in 1997 (see table 1).

This is a starting point in our analysis of national patent activity in selected CEE countries, which has to give answers to the three questions:

1) *What are the patterns of resident as well as non-resident patenting in CEE countries?*
2) *How national patenting activity in CEE countries could play a role as an indicator of transition and catching-up process?*
3) *How patent data could support the analysis of innovation capacity building into manufacturing sectors of transition economies?*

5 National Patenting Activity in CEE Countries in the Period 1989-2000

Using national patenting activity in selected CEE countries, we shall try to explore what are the main patterns of resident as well as non-resident patenting in these countries. Figures 1, 1a, 2 and 2a illustrate resident and non-resident patenting activity in 12 selected CEE countries (in brackets are abbreviations used in all figures in paper): Bulgaria (BU), Croatia (CRO), Czech Republic (CZ), Estonia (EST), Hungary (HU), Poland (PL), Romania (RO), Russian Federation (RF), Serbia and Montenegro (SMN), Slovak Republic (SLR), Slovenia (SLO), Ukraine (UKR). Also data for former Czechoslovakia (CZ+SLR), former Soviet Union (SU), and former Yugoslavia (SFRY), are used for better understanding of differences between patenting activities in period 1985-1989 and in period since 1989, when transition processes in all these countries started.

Rationale for a logarithmic view in figures 1 and 2 lies in strong differences between absolute numbers of patents in former Soviet Union and other CEE countries; figures 1a and 2a illustrate patenting in 10 CEE countries, without Russian Federation and Ukraine, which makes these illustrations more visible; and all these figures lead us to the following conclusions:

a) Resident patenting almost disappeared in the first 2-3 years of transition, falling to the app. 10% of the level in 1988 patenting! In a majority of analyzed CEE countries *recovering* phase in domestic patenting activity started in 1993-1994. None of these countries had achieved 1988 level in last observed year, 2000. This indicates:

    1) How strong was the process of disintegration of former R&D system;
    2) How slow is the process of establishing a new, market oriented national innovation system; and the
    3) How vulnerable and slow is the process of innovation capacity building in a country!

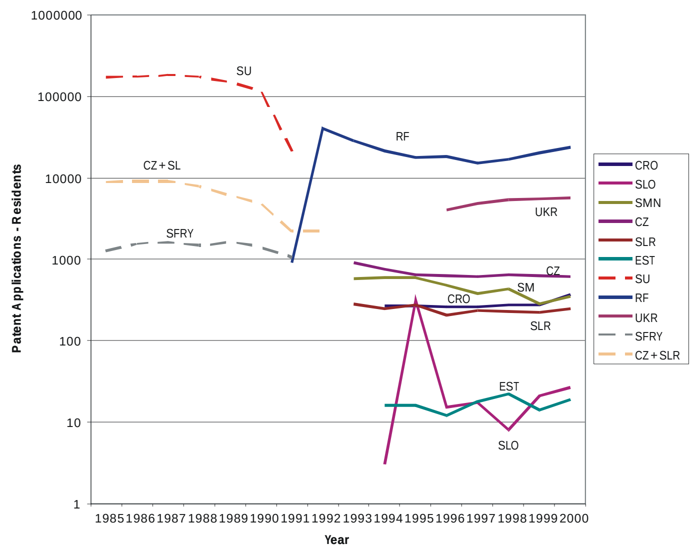
    Relatively big numbers of resident patents in Russian Federation and Ukraine, after the year 1993 could be partly explained with preserved innovation capabilities, despite rather bad situation especially in manufacturing sectors in these two countries. Therefore, the analysis of patenting activity should be combined with the analysis of further exploitation of inventions, i.e. with the analysis of effectiveness of other chains in "chain-link" model of innovation system, which brings invention into marketable processes / products / services. Due to a limited size of the paper, we shall quote one the crucial findings of research of transition in CEE countries: "*To date, restructuring in Central and Eastern European countries has led to a more autonomous and competitive science base, but it has not yet produced a science system which is relevant to its changed economic and technological structure. Hence there remains a large gap between the region's level of potential in labor skills and R&D, and the current low levels of growth and recovery. To achieve growth, the economies of Central and Eastern Europe must restructure their science and technology systems, reintegrate them into EU* *innovation networks and initiate a structural shift towards a knowledge-based economy that supports innovation and learning at level of every institution and industrial sector."* (Radošević, 1999).

b) A completely different situation is with non-resident patenting activity in CEE countries, illustrated by figures 2 and 2a (again, a logarithmic view is used because of possible misleading disproportion between absolute numbers in former Soviet Union and other analyzed countries). As it was already mentioned in the introduction, the number of foreign patents in this region before 1989 was marginal. Since 1991 foreign investors launched "technological invasion" of CEE countries. One can notice that not all countries were "attacked" by a strong inflow of foreign patents. There are three groups of countries:

1) The first group are "leaders" in transitional changes: Hungary and Poland, surprisingly joined by Romania – foreign patents emerged very quickly, already in 1992;
2) The second group consists of: Czech Republic, Slovak Republic, Estonia, Bulgaria and Slovenia – foreign patents significantly emerged in 1993-1994; and
3) Countries in the third group are Croatia and Serbia and Montenegro – because of the very fragile political situation, foreign inventors started with significant filing of patent applications in these two countries in 1996-1997.

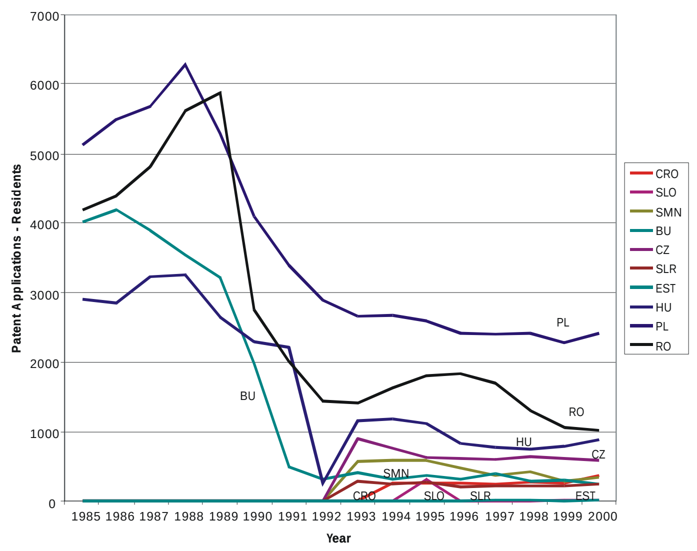
Although transitional processes in Russian Federation and Ukraine were (and still are) very slow, the size, potential market and geo-political position could be the main reason for early entrance of foreign investors in these countries, aligning them into first group countries.

Figure 1. **Resident patent applications in CEE countries, in 1989-2000 period, selected countries, Logarithmic view**



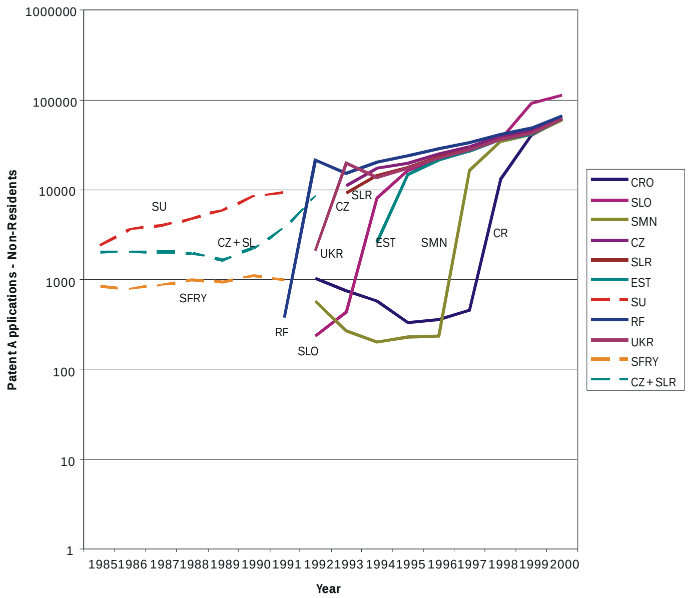
Source: (WIPO, 1985-2002).

Figure 1a. **Resident patent applications in CEE countries, in 1989-2000 period – selected countries, Linear view**



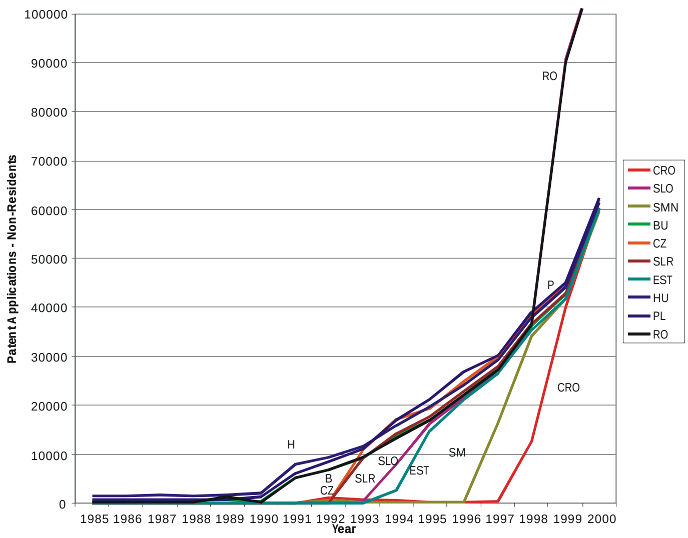
Source: (WIPO, 1985-2002).

Figure 2. **Non-resident patent applications in CEE countries, in 1989-2000 period, selected countries, Logarithmic view**



Source: (WIPO, 1985-2002).

Figure 2a. **Non-Resident patent applications in CEE countries, in 1989-2000 period – selected countries, Linear view**



Source: (WIPO, 1985-2002).

Tables 2, 2a, 3 and 3a illustrate patenting activity in the analyzed CEE countries in 1985-2000 period from another angle. The *Coefficient of Inventiveness* (CI) is the indicator of a country's inventive production, calculated as the number of resident patent applications per 10,000 inhabitants. Average value for OECD countries has increased from 5.77 in the period 1985-1990 to 6.16 in the period 1995-2000. Average figure for OECD member countries is misleading because of the extremely high value for Japan (25.01 and 28.23 in two periods respectively). Figures in table 2 indicate that high inventive production is in the countries where CI varies between 3 and 8. Values for CI between 1 and 3 represent moderate inventive production, and values under 1.00 represent countries with modest or very low inventive production. One should notice that in all OECD member countries, except Greece, CI has increased in the second analyzed period (countries are grouped in table 2 according to CI value in 1995-2000 period).

In table 2a are CI data calculated for selected CEE countries. In the first analyzed period, 1985-1990, CI values were rather good, comparable with highly inventive OECD countries (in Soviet Union, like in Japan, CI values are extremely high, 16.44). Situation has changed in the second analyzed period. CI values dropped under 1.00 in all analyzed countries except Russian Federation, but figure for this country has also shrunk to 1.27. Situation in former Yugoslavia and successor countries is quite specific. Small figure in the first period (0.62) revealed technological policy in former Yugoslavia, based on import of foreign technologies, without domestic "value added" development leading to domestic inventions and innovation, because of detached industrial and R&D sectors. In the second analyzed period figures remain small in all three selected countries: 0.62 in Croatia; 0.34 in Slovenia and 0.50 in Serbia and Montenegro. This is another proof that the process of innovation capacity building, as well as the process of establishing a new, market oriented national innovation system in all three countries is slow.

The *Coefficient of Attractivity* (CA) is the indicator of a country's eligibility for inclusion in global economy, calculated as the number of non-resident patent applications per 10,000 inhabitants. CA average value for OECD countries has jumped from 6.76 in the period 1985-1990 to 21.25 in the period 1995-2000. Figures in table 2 indicate that highly attractive markets for technologies are in the countries where CA scored more than 10. Values for CA lower than 10 indicate either some degree of closeness of one country for import of technologies (for example Japan), or how strong is one country in technology development (for example USA, Germany, France). Increase of CA value for more than three times in just 10 years indicates how strong and fast the process of globalization and technology development in developed countries is.

Table 2. **Coefficient of inventiveness and coefficient of attractivity for OECD member countries**				
Country (Countries are grouped according to decreasing CI value in 1995-2000 period – see text)	**CI = Resident patent application / 10.000 population**		**CA = Non-Resident patent application / 10.000 population**	
	CI for 1985-1990	**CI for 1995-2000**	**CA for 1985-1990**	**CA for 1995-2000**
Japan	25.01	28.23	2.95	5.76
Sweden	4.14	9.30	39.24	139.06
Switzerland	5.56	8.34	47.96	173.39
Germany	5.22	7.96	8.35	15.49
Finland	3.82	6.56	14.92	220.52
Denmark	2.09	5.38	25.05	232.34
United States	3.04	5.19	2.83	4.62
Australia	3.93	5.05	9.42	24.56
United Kingdom	3.51	4.82	10.09	23.23
New Zealand	2.66	4.38	10.38	102.10
Luxembourg	2.13	4.37	586.23	2891.00
Netherlands	1.67	3.64	24.71	60.61
Norway	2.19	3.60	18.88	88.31
Austria	2.96	3.47	37.50	154.62
France	2.24	3.27	9.37	17.55
Ireland	2.07	2.49	8.88	249.05
Belgium	0.89	1.64	32.24	92.57
Canada	0.94	1.44	10.81	18.95
Iceland	0.87	1.16	3.80	1173.67
Italy	n.a.	1.09	n.a.	17.29
Spain	0.51	0.77	6.06	32.37
Greece	0.84	0.18	10.69	87.44
Portugal	0.08	0.11	2.61	124.08
Mexico	n.a.	0.05	n.a.	4.39
Turkey	0.03	0.04	0.14	5.36
Total OECD	5.77	6.16	6.76	21.25
North America	2.83	3.67	2.97	5.66
European Union	2.31	3.00	6.02	27.35
Nordic countries	3.22	6.70	24.65	179.54

Source: (WIPO, 1985-2002).

Table 2a. **Coefficient of inventiveness and coefficient of attractivity for selected CEE countries**

Country	CI = Resident patent application / 10.000 population		CA = Non-Resident patent application / 10.000 population	
	CI for 1985-1990	CI for 1995-2000	CA for 1985-1990	CA for 1995-2000
Bulgaria	3.87	0.39	0.73	41.51
Czechoslovakia	4.81	n.a.	1.25	n.a.
Czech Republic	n.a.	0.60	n.a.	35.52
Slovakia	n.a.	0.43	n.a.	64.46
Estonia	n.a.	0.12	n.a.	243.26
Hungary	2.70	0.85	1.59	35.69
Poland	1.41	0.63	0.23	9.69
Romania	2.01	0.65	0.23	22.58
Soviet Union	16.44	n.a.	0.50	n.a.
Russian Federation	n.a.	1.27	n.a.	2.73
Ukraine	n.a.	0.83	n.a.	6.87
SFRY	0.62	n.a.	0.39	n.a.
Croatia	n.a.	0.62	n.a.	42.04
Slovenia	n.a.	0.34	n.a.	255.08
Serbia and Montenegro	n.a.	0.50	n.a.	30.25

Source: (WIPO, 1985-2002).

The absence of foreign patents in CEE countries before 1989 resulted in CA values around 1 (Table 2a). During the process of transition from centrally planned to market economy, one country could become interesting for foreign investors only if legal requirements (intellectual property rights regulations in our case, combined with other laws, especially financial, company and similar laws), and openness of the domestic market to foreign technologies, goods and services suit international standards. Therefore, the Coefficient of Attractivity (CA) could be used as the *indicator of transition* too. This is the main explanation why situation has dramatically changed with CA in the second analyzed period. CA values jumped in all analyzed CEE countries. The largest value has been recorded in Slovenia (255.08), but in all other countries CA values are also very high. Differences reflect either the degree of compatibility of a particular country with EU market regulations (Hungary: CA=35.69; Croatia: CA=42.04; etc.) or how influential is the size of the country (Russian Federation: CA=2.73), somewhere combined with the slow process of changes in economy (Ukraine: CA=6.87).

Table 3. **Dependency ratio (DR) for OECD member countries**		
Country (Countries are grouped according to decreasing DR value in 1995-2000 period – see text)	**DR = Non-Resident patent application / Resident patent application**	
	DR for 1985-1990	**DR for 1995-2000**
Portugal	33.66	1102.64
Iceland	4.38	1012.45
Luxembourg	275.00	660.91
Greece	12.73	484.11
Turkey	5.01	121.98
Ireland	4.29	100.07
Mexico	n.a.	94.25
Belgium	36.25	56.46
Austria	12.65	44.55
Denmark	11.99	43.21
Spain	11.99	41.99
Finland	3.91	33.61
Norway	8.60	24.50
New Zealand	3.90	23.33
Switzerland	8.63	20.79
Netherlands	14.77	16.64
Italy	n.a.	15.83
Sweden	9.49	14.95
Canada	11.48	13.12
France	4.17	5.36
Australia	2.40	4.86
United Kingdom	2.88	4.82
Germany	1.60	1.95
United States	0.93	0.89
Japan	0.12	0.20
Total OECD	1.17	3.45
North America	1.05	1.54
European Union	2.61	9.12
Nordic countries	7.66	26.78

Source: (WIPO, 1985-2002).

Table 3a. **Dependency ratio (DR) for selected CEE countries**		
Country	**DR = Non-Resident patent application / Resident patent application**	
	DR for 1985-1990	**DR for 1995-2000**
Bulgaria	0.19	106.94
Czechoslovakia	0.26	n.a.
Czech Republic	n.a.	59.18
Slovakia	n.a.	148.64
Estonia	n.a.	1979.80
Hungary	0.59	42.19
Poland	0.16	15.47
Romania	0.11	34.92
Soviet Union	0.03	n.a.
Russian Federation	n.a.	2.16
Ukraine	n.a.	8.28
SFRY	0.62	n.a.
Croatia	n.a.	67.63
Slovenia	n.a.	750.87
Serbia and Montenegro	n.a.	60.93

Source: (WIPO, 1985-2002).

Tables 3 and 3a illustrate another indicator of patenting activity: dependency ratio (DR), or the number of foreign patents per 1 domestic invention. In almost all OECD countries DR scored above 1, only in USA and Japan are less than 1. Like CA values, DR values jumped in the second analyzed period extremely high (almost 1000 times more in some countries!).

Again, DR values are very close to zero in the first analyzed period in all selected CEE countries, and very high in the second analyzed period. Similarities between DR values in OECD and in selected CEE countries indicate not only the degree of compatibility between market conditions in analyzed CEE countries with OECD member countries (for example: Slovenia – DR=750.87; Estonia – DR=1979.80), but the respect of inventors from OECD countries to potential inventive capabilities in CEE countries too: foreign inventors apply for protection of IPR in order to anticipate expected domestic inventions (for example: Croatia – DR=67.63; Serbia and Montenegro – DR=60.93)!

6 National Patent Data Transformed into Sectoral Patent Data in Selected CEE Countries in the Period 1989-2000

In previous chapters it has been pointed that the use of US patents has been dominant in quantitative analysis of S&T. Moreover, decreasing costs of access to US PTO data as well as capability to use them in analysis at all levels (country, region, sector, firms) has led to proliferation of papers based on this source. US patents are extremely useful for measuring technology frontier technology effort. However, their relevance is lesser for understanding the whole spectrum of technology activities in countries behind technology frontier like CEE acceding countries and less developed EU economies. The key obstacle why there are no analyses based on national patents is methodological. Patents recorded under International Patent Classification (IPC) system are not compatible with international industry classification. Classification of economic activities (ISIC – International Standard Industrial Classification ver.3.0; HC – Harmonized Classification) is based on company's manufacturing, production or service activity. However, Daniel Johnson's (OECD 2002) methodological work has removed this obstacle (or, is an important contribution in this direction). Based on his work it is possible to establish concordance between IPC A-H classes and HC 4-digit level classification of industries in OECD countries.

The author of this paper has improved concordance between IPC Units (1-32) and HC 4-digit level classification of industries, and has implemented it with CEE countries' patent data. National patent data with industry level data, derived in that way, are then used for analysis in order to test different determinants of technological capacity at industry level. Figures 3, 4 and 5 illustrate the results of described transformation: non-resident (Figure 3), resident (Figure 4) and total patent applications (Figure 5) in selected CEE countries are distributed in 14 manufacturing sectors[3].

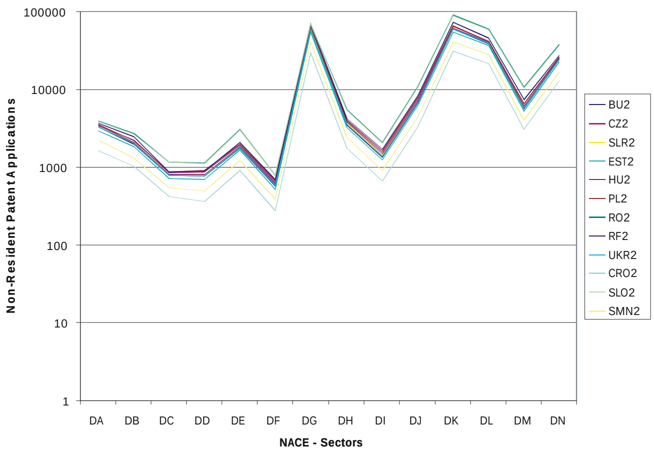
Although it is too early to make strong criticism of the proposed procedure, one can notice a completely equal distribution of patents between manufacturing sectors in all analyzed CEE countries for all sorts of patent applications. Further analysis of patenting

[3] *Manufacturing sectors are:*

DA – Food products; beverages and tobacco; DB – Textiles and textile products; DC – Leather and leather products; DD – Wood and wood products; DE – Pulp, paper & paper products, publishing & printing; DF – Coke, refined petroleum products & nuclear fuel; DG – Chemicals, chemical products and man-made fibers; DH – Rubber and plastic products; DI – Other non-metallic mineral products; DJ – Basic metals and fabricated metal products; DK – Machinery and equipment n.e.c.; DL – Electrical and optical equipment; DM – Transport Equipment; DN – Manufacturing n.e.c.

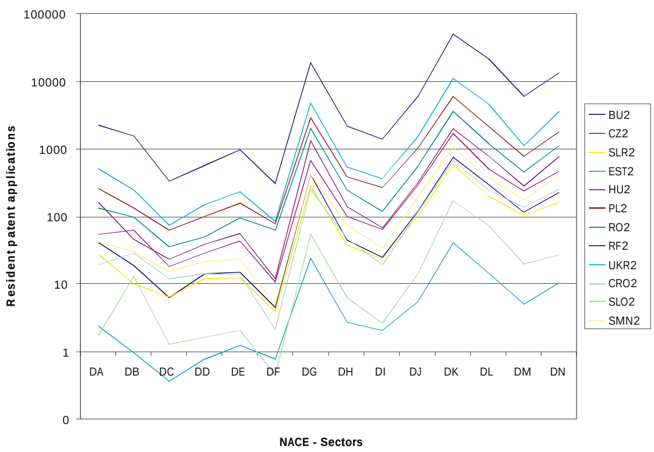
activity in countries with available sectoral patent data could support the evaluation of proposed concordance between IPC and HC classifications. Interesting results, after all, are highs in sectors DG ad DK, which are traditionally competitive sectors in selected CEE countries, and lows in DF and DI, again traditionally sectors of low competence in most of selected Central and East European countries!

Figure 3. **Non-resident patent applications in CEE countries, in 1989-2000 period, selected countries, logarithmic view**



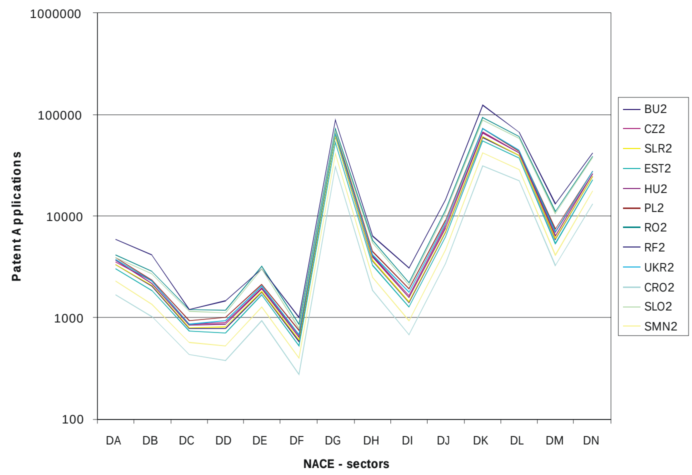
Source: (WIPO, 1985-2002; OECD, 2002).

Figure 4. **Resident patent applications in CEE countrie, in 1989-2000 period, selected countries, logarithmic view**



Source: (WIPO, 1985-2002; OECD, 2002).

Figure 5. **Total patent applications in CEE countries, in 1989-2000 period, selected countries, logarithmic view**



Source: (WIPO, 1985-2002; OECD, 2002).

7 Concluding Remarks

The presented analysis of patent activity in selected CEE countries could be summarized in the following 5 points:

1) Patenting behavior in selected CEE countries has undergone the process of change in the same degree and scope as other transitional changes started in 1989. Patenting inventions have become an important part of business activity in new, innovative climate, triggered and forced by market as well as by R&D impulse;
2) Indicators of patenting activity could explain the directions, trends, speed and degree of transition! Some of them, such as the coefficient of attractivity (CA) could be used as *indicators of transition* too;
3) The recovering of the intensity of domestic patent activity is an important process of innovation capacity building in CEE countries;
4) The strong inflow of foreign patents in CEE countries, which is aimed to conquer domestic market, could reduce areas to domestic inventors for competition too. Another aspect for treatment of foreign patents is use for the purpose of technological learning, increase of technological capabilities and competences, as this was case with import of technologies in Japan, South Korea and other countries in second part of XX century. Therefore, the presence of such a big number of foreign inventions, with available patent documentation, could become a source of technological development in analyzed CEE

countries. This is, again, one aspect of the process of innovation capacity building in CEE countries;

5) Although necessary for different purposes, patent data transformed from IPC to HC sectoral classification are still not fully available and applicable. Achieved results could only raise the issue of importance, but cannot be used for a thorough analysis.

Patent data remain a very rare measurable indicator of innovation activity. Therefore, the analysis of patent activity in Central and East European countries could support better understanding of the process of innovation capacity building and creation of national innovation system, which has happened under a new framework, predefined by the rules of the 20th century market economy as well as by the rules of knowledge-based development in the 21st century.

References

Albuquerque, Eduardo da Motta e (1997): "National systems of innovation: notes about a rudimentary and tentative "typology", SPRU, Sussex University, Brighton.

Albuquerque, Eduardo da Motta e (2000): "Domestic patents and developing countries: arguments for their study and data from Brazil (1980-1995)", *Research Policy*, No. 29, pp. 1047-1060.

Choung, J-Y (1995): "Technological Capabilities of Korea and Taiwan: An Analysis Using US Patent Statistics", *STEEP Discussion Paper*, SPRU, Brighton, No. 26, November.

Drilhon, G. (1991): "Choosing Priorities in Science and Technology", OECD, Paris.

EC (2003): "Future directions of innovation policy in Europe", *Innovation papers European Commission, Directorate-General for Enterprise*, No. 31, Luxembourg.

EPO (2004): "EPO patent information products and services – prices", available from: http://www.european-patent-office.org/epo/fees1.htm

Fai, Felicia and Nicholas von Tunzelmann (2001): "Industry-specific competencies and converging technological systems: evidence from patents", *Structural Change and Economic Dynamics*. No.12, pp. 141-170.

Freeman, Christopher (1987): "Technology and Economic Performance: Lessons from Japan", Pinter, London.

Furman, Jeffrey L., Michael E. Porter and Scott Stern (2002): “The determinants of national innovation capacity”, *Research Policy*, No. 31, pp. 899-933.

Galli, Riccardo and Morris Teubal (1997): “Paradigmatic Shifts in National Innovation Systems”, in Edquis, Ch., ed., *Systems of Innovation – Technologies, Institutions and Organizations*, Pinter, London.

Griliches, Z. (1990): “Patent statistics as economic indicators: a survey”, *Journal of Economic Literature*, Vol. 28, pp. 1661-1707.

Klein, S. J. and N. Rosenberg (1986): “An overview of innovation”, in R. Landau and N. Rosenberg (eds.) *The Positive Sum Strategy – Harnessing Technology for Economic Growth*, National Academy Press, Washington..

Kuhlman, Stefan (2003): “Future governance of innovation policy in Europe”, in European Commission, *Future directions of innovation policy in Europe*, Proceedings of the innovation policy workshop held in Brussels on 11 July 2002, pp. 40-48.

Kutlača, Djuro (1998): “Patent-Related Activities in Serbia from 1921 to 1995”, *Scientometrics*, Vol. 42, No. 2, June, pp.171-193.

Lundvall, B. A. (ed.) (1992): *National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning*, London, Pinter.

MERIT (2000): “Innovation Policy in a Knowledge-Based Economy”, study commissioned by the European Commission Enterprise Directorate General, Brussels-Luxembourg, Publication, EUR 17023, June.

Nelson, R. (1993): *National Innovation Systems: a Comparative Analysis*, Oxford University Press.

OECD (1994): “The measurement of scientific and technological activities: Using patent data as science and technology indicators – Patent manual”, OECD Paris, OECD/GD 114.

OECD (2001): “OECD Science, Technology and Industry Scoreboard: Towards a Knowledge-Based Economy”, OECD, Paris.

OECD (2002): “The OECD technology concordance (OTC): Patents by industry of manufacture and sector of use”, OECD Paris, DSTI/DOC 5, JT00121716, 2002.

Pavitt, Keith (1988): “Uses and abuses of patent statistics”, in A. F. J. Van Raan (ed.): *Handbook of Quantitative Studies of Science and Technology*, North Holland, Amsterdam.

Radošević, Slavo and Djuro Kutlača (1998): “Assessing the Basis for ’Catching-up’ of Eastern Europe: an Analysis Based on US Foreign Patenting Data”, *STEEP Discussion Paper*, SPRU, University of Sussex, Brighton, UK, No. 42, March .

Radošević, Slavo (1999): “Restructuring and Reintegration of Science and Technology Systems in Economies in Transition”, project funded by DGXII, EC TSER Programme, 1996-98, project coordinator Slavo Radošević, SPRU, University of Sussex, UK, Summary of the project, April.

Radošević, Slavo and Djuro Kutlača (1999): “Technological ’Catching-up’ Potential of Central and Eastern Europe: An Analysis Based on US Foreign Patenting Data”, *Technology Analysis & Strategic Management*, Vol. 11, No. 1, 1999, pp. 95-111.

Tijssen, Robert J.W. (2002): “Science dependence of technologies: evidence form inventions and their inventors”, *Research Policy*, Vol. 31, pp. 509-526.

WIPO (1985-2002): *Industrial Property Statistics – Part I: Patents, Utility Models*, World Intellectual Property Organization (WIPO), Geneva.

WDR (1996): *From plan to market*, World Development Report 1996, The International Bank for Reconstruction and Development, The World Bank, Published by Oxford University Press, Inc., New York.