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PATTERNS OF INNOVATIVE ACTIVITIES IN COUNTRIES OF CENTRAL AND EASTERN EUROPE: AN ANALYSIS BASED ON COMPARISON OF INNOVATION SURVEYS

Slavo Radosevic

Science Policy Research Unit
Mantell Building
University of Sussex
Falmer, Brighton
BN1 9RF, UK

Tel: +44 (0) 1273 686758
Fax: +44 (0) 1273 685865
Email:
M.E.Winder@sussex.ac.uk
http://www.sussex.ac.uk/spru/

PATTERNS OF INNOVATIVE ACTIVITIES IN COUNTRIES OF CENTRAL AND EASTERN EUROPE:

AN ANALYSIS BASED ON COMPARISON OF INNOVATION SURVEYS[1]

SLAVO RADOSEVIC
SPRU

Dr Slavo Radosevic
SPRU, Science and Technology Policy Research
University of Sussex
Mantell Building
Falmer
BRIGHTON
BN1 9RF
UK

Tel: +44 1273 678169
Fax: +44 1273 685865
e-mail: s.radosevic@sussex.ac.uk

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ABSTRACT

This paper compares several innovation surveys from the countries of central and eastern Europe (CEECs) with the first EU innovation survey. Based on the innovation survey data it discusses the changes in the innovation activities in central and eastern Europe and points to differences and similarities with the EU. The main conclusion is that the differences in innovation activities come from differences in development levels. Similarities in innovation activities come from a strong convergence in the CEECs with the features of the innovation process in market economies. The paper also discusses the methodological issues involved in inter-country comparisons.

1 INTRODUCTION

The transformation of the economies of central and eastern Europe (CEECs) is accompanied by changes in the patterns of their innovation activities. In the socialist period innovation activity was organised and undertaken across a range of different institutions like ministries, branch institutes, Academies of Sciences, etc, whereby enterprises were not in the control of the whole innovation process. They were predominantly production units with very often limited responsibilities for innovation and the R&D process, in particular. With the opening and the introduction of market in the ex-socialist economies and the dissolution of the former S&T system enterprises were obliged to undertake the majority of innovation activities.

Our understanding of this process is still very unsystematic, partly, due to limited data on innovation activities. With the introduction of large-scale national innovation surveys in Russia, Poland and a few other small scale surveys undertaken within the umbrella of academic research in other CEECs it became possible to explore the innovative behaviour of enterprises on a more systematic way. The first analyses along these lines were conducted by Glaziev *et al* (1997), Gokhberg and Kuznetsova (1996, 1999), Niedbalska (1999), Inzelt (1999). These analyses were confined to individual countries and we still do not have any comparative insights. Numerous methodological problems and difficulties in interpretation of different national surveys make such comparative analysis difficult and hazardous. In this paper we try for the first time to compare the available innovation surveys from central and eastern European countries (CEECs) both with one another and with results of the EU - CIS (Community Innovation Survey). Such analysis is relevant both from the policy perspective but also from the following two academic aspects.

First, in terms of levels of development CEECs are far behind the EU their GDP per capita ranging from 14% (Ukraine) to 63% (Slovenia) of the EU average. Innovation surveys allow us to explore whether this common feature of the region - its relative backwardness in relation to EU - affects innovative activities in terms of their scale, scope and structure. Whether the shares of innovative enterprises different in CEE than in the EU countries? Whether the nature and patterns of innovative activities reflect differences in development levels?

Second, the specific transitional environment of the CEE economies with pervasive institutional uncertainties, blurred ownership boundaries and undeveloped capital markets is probably not very conducive to the long-term nature of innovation. However, we still do not know whether the specific institutional environment of the post-socialist economy influences the innovation activities in terms of their objectives, hampering factors, sources of ideas, etc? Are the differences in institutional reforms and recovery between central European (Poland, Hungary, Slovenia) and eastern European countries (Romania, Russia) visible in the innovation activities?

As we already pointed out the analyses based on innovation surveys are still dogged by methodological and interpretative problems. Comparisons of national surveys furthermore magnify these problems. In the next section we analyse some of these methodological problems although we will also come back to them several times during the analysis.

In the third part we undertake comparative analysis across the several dimensions of innovative activities (spread and types of innovative activities; sectoral differences; objectives, sources of information, etc). In the fourth part we summarise the main results and develop conclusions.

2 METHODOLOGICAL ISSUES

Innovation surveys are a new source of information on technical change. It was realised some time ago that R&D do not tell the whole story about technical change as innovation is essentially an interactive process which involves a variety of types and sources of knowledge. The multiform nature of innovation activities and their sectoral specificity have been explored in by now already a large

literature. Pavitt (1984), Kline and Rosenberg (1986) and von Hippel (1988) are only the most well known examples of research on innovation from this perspective.

As with any method, innovation surveys have their advantages and disadvantages. These have been analysed extensively by Archibugi and Pianta (1996). For the time being, innovation surveys are not yet fully harmonised although the Oslo Manual (OECD, 1991) is accepted as an international standard in this area. The methodological differences and the problems inherent in the interpretation of the innovation surveys data make international comparability of innovation surveys, as Mohnen and Dagenais (1998) point out, still hazardous. This is the result of, first, methodological differences between different national surveys, and, second, of inherent biases in innovation surveys arising from the subjective nature of responses. Hence, the data are probably better suited for cross-industry comparisons within countries than for cross-country comparisons (Mohnen and Dagenais, 1998). However, even cross-industry comparisons cannot eliminate the problem of the subjective nature of responses.

The CEECs had been collecting data on newly developed products and processes for a long time during the socialist period. In former socialist countries, innovations were recorded through indicators like “New prototypes of machines, equipment, apparatuses, instruments and automation means”, “Duration of development of new prototypes of machines, equipment, apparatuses, instruments and automation means”, and “Utilisation of new prototypes of machines, equipment and apparatuses” (accepted for serial production or individual production for research and for export). Such product innovations are defined as being developed in the country for the first time and being essentially different from those previously manufactured by principle of operation and functional destination. These data were the basis of innovation statistics in centrally planned economies and were confined to product innovations, and in particular to machinery production. Reporting these innovations was mandatory. For example, in the case of the former USSR data series have been in existence since the early 1970s.

Despite the long practice of collection of innovation statistics, the nature of these statistics is very much different from current innovation surveys. The conceptual and methodological differences are strong. The system in centrally planned economies did not look at the innovation process and the structure of innovation activities through indicators like R&D, patenting or publications. The objectives of innovation and factors which hampered these activities as well as the forms of technology transfer were not monitored. The counting of product and process innovations, many of which were not implemented, did not reveal the true innovation capacity of these economies. In this respect the units of measurement when compared to modern innovation surveys were methodologically different.

It was only recently that the CEECs started to collect innovation data within the framework of innovation surveys. In this endeavour they enjoyed some of the latecomers’ advantages as they all relied on the Oslo Manual methodology and benefited from the experiences of other national surveys within the EU. On the other hand, they also all to different degrees adapted the Oslo Manual methodology to their national circumstances. This does not ensure full comparability and the methodological differences remain important in understanding data. In this section we point to some of the methodological differences and problems in applying innovation surveys in the CEECs.

We already pointed to the important biases of innovation surveys which come from the subjective nature of many of the questions. Subjective responses on questions regarding the objectives, hampering factors, sources of information as well as on questions like share of sales based on new products are not only specific to CEECs. They have been noticed in almost all analyses of the CIS data. However, in the CEECs the problems in this respect are probably greater due to a load of new concepts and indicators. The mixed structure of the questionnaires combining quantitative and qualitative indices and, as Kuznetsova (1998, p 4) points out in the case of Russia, overloaded with new concepts and indicators, made the problem of analysing data rather complex. In some cases, as Kuznetsova (1998) reports, the greatest difficulty was caused by their not understanding the criteria of

subdividing innovations into product and process. Mohnen and Dagenais (1998) also point out that product innovations are usually more often declared than process innovations.

Among the methodological problems the most important are the following. First, the share of innovating firms, as an indicator of the spread of innovation activities, has several biases. The most important are: i) they do not take into account that innovations are of unequal value and that the number of innovations can differ significantly among firms[2] (weight insensitivity), ii) innovation occurrences do not take place every year at the same (time bias), iii) the numbers may simply reflect the concentration of firms in an industry/country (concentration bias). In other words, surveys cover establishments which may belong to one or to different companies. In the first case innovations in two establishments of the same company would be counted as one innovation while in second case they would count as two.

Another problem is that the samples can be biased towards innovating firms. For example, Evangelista *et al* (1997) report that in the case of the first CIS innovation survey there is a negative correlation between response rates and percentage of innovating firms across countries.

The second problem is that definitions of innovation may not be identical. The Polish and Bulgarian surveys include organisational innovations when they are related to technical innovations. The lack of organisational innovations is a weakness of the Oslo Manual and this discrepancy may be considered as an advantage. Nevertheless, this positive difference reduces full comparability between Polish and Bulgarian, and other surveys.

Innovation surveys in Russia show that diversification is often interpreted as innovation (Gokhberg and Kuznetsova, 1996, p 14; Kuznetsova, 1998). To overcome this problem the Russian survey introduces a third category in the full scale survey: 'other innovation products' whereby marginally improved products are recorded. Also, this category includes products based on borrowed non-patented rights. This not only expands the notion of innovation but in the structure of innovation costs of the Russian survey there is a new item "acquisition of non-patented licences, know-how, other technologies from unaffiliated institutions, enterprises or individuals" (Gokhberg and Kuznetsova, 1996, p 15).

In the 1995 Russian pilot survey, the definition of innovative firms has been enlarged so that it includes also those firms

> "that have purchased disembodied technologies - patents, licences for the use of inventions, industrial prototypes, utility models related to introduction of new or improved products/processes, or acquired technologies not protected by patents, know how, results of R&D projects performed for an enterprise by external legal entities or individuals, or have been engaged in any other kind of activity connected with introduction of new or improved products/processes"
>
> (Gokhberg and Kuznetsova, 1996, p 6; Gokhberg and Kuznetsova, 1999).

The second definitional difference in the Russian innovation survey is that innovation is not only defined at its final stage when the equipment is already in operation, ie, the production is settled and products are manufactured, but also 'the initial and interim stages of introduction are also registered, when for example, new equipment is still being assembled or is ready for exploitation but not yet started, has not been tested in action and is not engaged in products manufacturing' (Gokhberg and Kuznetsova, 1996, p 7; Gokhberg and Kuznetsova, 1999, p 7). They point to four categories of enterprises: those i) Active in innovation; ii) Inactive in innovation, iii) Planning innovation activity in the near future, and iv) Engaged in the main kinds of innovation activity (Gokhberg and Kuznetsova, 1999a). These two definitional differences could result in an overestimation of the number of innovations in Russia.

[2]The first Polish innovation survey tried to overcome this by requiring data on the number of innovations in an individual enterprise.

Third, an important weakness of innovation surveys is that they do not measure the weight of innovations. Surveys do not take into consideration the different scales of innovations and hence these should be treated as proxies rather than as direct measures. The dominance of the numerical approach to innovations is present in the most of the CEE' surveys and probably reinforces, as pointed by Gokhberg and Kuznetsova (1996), the tradition of domestic statistics.

This weakness is partly overcome through data on the share of sales based on new products but these exclude process innovations which are important in the CEE countries. On the other hand, process and product innovations usually accompany one other as we show later on. The new products require a new production method, while new processes are hard to introduce without a change in products (Mohnen and Dagenais, 1998).

In Table 1, we compare the main methodological features of innovation surveys from CEE countries which form the basis of our comparison. It is important to bear in mind that the comparison is based on a mixture of original statistical reports and analytical papers based on surveys which have carried out. Results of the two Polish innovation surveys are available both as statistical reports but also through analytical papers. Slovenian and Romanian data are available as statistical reports as well as are some of the results of the first Russian survey. All other surveys as well as additional data are available only as secondary material. We compare CEE surveys with the first CIS survey results as reported by the EU (1998) and as analysed in several analytical papers to which we will refer later on. Wherever possible we confine the analyses to the aggregate results of the CIS as the expansion to individual EU countries would further complicate the picture already burdened with numerous methodological problems.

We also include in the comparison the two Yugoslav (Serbian) surveys which refer to the 1987-1991 and 1991-1995 periods. From being a semi-command but open economy during the 1980s, part of ex-Yugoslavia (Serbia) became economically isolated through international sanctions. This rare shift from an open to an isolated economy which resembles features of a closed economy represents a unique example for observing changes in the innovation activities. We use this example as a control case for understanding the inverse shift from a closed to an open economy in the rest of the CEE.

A serious limitation for international comparison of innovation activities and the limited number of innovation surveys in CEE make this paper highly exploratory. This means that the results cannot be devoid of the methodological assumptions and abstractions on which they are based. Despite these limitations we think that the comparative analysis of innovation surveys can produce a valuable result to help the understanding of technical change and the generation of useful hypotheses.

Table 1: The main features of compared innovation surveys*

Survey	Types of survey	Reference period	Realised sample size	Cut-off point	Sectors
Bulgaria[1]	Research project	1997	above 100 (?)	Unknown	?
Hungary[2]	Research project	1990-93	110	Three cut off criteria[b]	All
Poland I[3]	Pilot	1992	2430	Min 6 employees	Manufacturing
Poland II[4]	Regular	1994-96	7200	Min 6 employees	Mining/Manufact/Utilities
Romania[5]	Pilot	1993-94	1276	Min 20 employees	Manufacturing
Russia I[6]	Pilot	1992-94	16,979	**?**	**?**
Russia II[7]	Regular	1995-96	**?**	**?**	**?**
Slovenia[8]	Regular	1994-96	880	Min 20 employees	Manufacturing
Yugoslavia I[a9]	Research project	1987-91	48	Selected sample	Metal process; Chemicals; Textile
Yugoslavia II[a9]	Research project	1992-96	33	Selected sample (employment/sales)	Metal process; Chemicals; Textile

a only innovative enterprises
b employment and sales and their combination
* We also include in the analysis the results of the third innovation survey in Russia by ACIP (1996).

Sources:
1 Chobanova, 1998
2 Inzelt, 1996, 1999
3 Niedbalska, 1999; Korona, 1994
4 Niedbalska, 1999; GUS, 1998
5 CSO, 1995
6 Gokhberg and Sokolov, 1999; CSRS, 1996; Glaziev *et al*, 1997
7 Gokhberg and Kuznetsova, 1999; CSRS, 1998
8 SORS, 1998
9 Kutlaca, 1999

3 RESULTS OF THE COMPARATIVE ANALYSIS

In this part we analyse the following dimensions of innovation surveys: spread of innovative activities (3.1), firm size and innovation (3.2), the structure of innovation expenditures (3.3), R&D activities (3.4), types of innovative activities (3.5), sectoral differences in innovation activities (3.6), shares of sales based on new products (3.7), objectives (3.8), sources of information (3.9), and factors which hamper innovation activities (3.10).

3.1 THE SPREAD OF INNOVATIVE ACTIVITIES

The proxy for the spread of innovative activities is the percentage of innovating firms over the total number of firms. Innovating firms have been defined as those that have introduced at least one product or process innovation over the period analysed. Although we pointed to its several drawbacks this indicator is extremely important for understanding the scale of innovative activities in CEECs in a period when enterprises are faced with the pressures of large scale restructuring.

In Table 2 we rank the shares of innovative firms in the EU and CEECs. The shares of innovative firms in CEECs are clearly below the EU average of 53% of innovative firms. Moreover, they are clearly at the bottom of the EU league. (For the time being we will abstract of the results of the first Polish survey.) This conform to the overview of enterprise case studies in the CEECs which suggests that the most common form of restructuring is passive adjustment, not deep restructuring (Carlyn *et al*, 1995).[3] The introduction of innovation by definition requires a deep organisational change and long-term horizon, two objectives which are difficult to meet in the current institutional environment of most CEECs.

Table 2: Shares of innovative firms in EU and CEECs

Ireland	0.72
Germany	0.67
Poland I[a]	**0.619**
Belgium	0.61
Netherlands	0.57
Denmark	0.56
Norway	0.53
EU	0.5
France	0.39
Poland II[b]	**0.376**
Spain	0.37
Luxembourg	0.37
Italy	0.34
Slovenia	**0.319**
Romania	**0.283**
Russia I[c]	**0.224**
Russia II[d]	**0.06**

a 1992
b 1994-96
c 1992-94
d 1995-96

[3]Passive adjustments are responses like accumulation of debt and arrears, non-payment of suppliers, accumulation of inventories, etc. Active or deep adjustment are responses like new organisation, export orientation, cost control, quality development, altering product mix, etc.

A second feature of Table 2 is that ranking of the four CEE countries is very closely related to their growth rates.[4] When we correlate the shares of innovative firms with the levels of GDP in 1997 compared to their 1989 levels we get a very high correlation coefficient of 0.96.[5] This may suggest that broadly perceived innovative dynamics or the share of firms that are involved in innovative activities is closely related to the dynamics of economic recovery.

The third feature of the Table 2 is that in both Poland and Russia the share of innovative enterprises between the beginning of the 1990s and the mid-1990s has fallen. In Poland the share of innovative enterprises dropped from 62% (1992) to 38% (1994-96) while in Russia the share fell from 22% (1992-94) to 6% (1995-96). How should we interpret this downward fall in the scale of innovation activities in two countries with such different economic situations? Does it contradict to a strong correlation between the rate of economic recovery and the scale of innovative activities mentioned before? We should bear in mind that the shares of innovative firms do not reflect the economic relevance of innovative activities, but indicate the extent of search efforts by enterprises. A high share of enterprises involved in innovation does not mean that the share of sales based on innovations will also be high. As we show later, the link between the two is far from direct.

A high share of enterprises that were innovating at the outset of transition then becomes quite plausible. These innovative activities did not result in business relevant innovations, ie, in a high share of sales based on innovative products and processes. The data on Russia in Table 3 illustrate our argument. The machine building sector in Russia introduced a quite significant number of new products but they are still commercially marginal for the sector. Moreover, the share of output based on new products dropped between 1992 and 1995. This situation is in conformance with our proposition that the innovation illustrates the scale of search efforts and does not directly correspond to their economic relevance. As reported by Gokhberg and Kuznetsova (1999, figure 2), in Russia the share of innovative enterprises in the 1992-94 period has been rising in all sectors, including machine-building, and yet we see that the share of sales based on new products in that period was actually dropping. As a part of their diversification efforts, enterprises are launching new products which then have to be withdrawn from the market due to their marketing, cost or quality problems. The pure technical novelty of the product for enterprise and domestic market very often turn out to be insufficient for commercialisation. It seems that in both Poland and Russia a certain threshold has been reached whereby enterprises decreased the extent of their search efforts as innovation activities turned out to be not so profitable in new market conditions. Yet, at the same time, the difference in search efforts as expressed in the shares of innovative enterprises in Poland and Russia reflects strongly the different economic situations of these two countries.

Table 3: The share of new products of machine-building in total output

	percentage change					
	1990	1991	1992	1993	1994	1995
The share of new (first introduced) products in annual output	6.5	6.4	7.2	3.4	2.6	2.1
including principally new	3.0	3.0	3.0	1.6	0.9	0.8
in last three years	23.6	21.4	19.3	11.3	5.2	4.4

Source: Rosija v cifrah 1995: Kratkiii statistischeskiji zbornik/ Goskomstat, 1995, based on CSRS (1996, p15) and Gaponenko (1996, p15)

[4]Here we compare only the results of the second Polish and Russian innovation surveys.

[5]Indexes of economic recovery 1997/1989 is for Poland 111.8, Slovenia 98.3, Romania 82.5 and for Russia 57.5. Source: WIIW database, May 1998 and OECD Economic Outlook, June 1998 based on Hutschenreiter, Knell and Radosevic (1999b).

The general downward trend in the scale of search efforts of enterprises seemed to be accompanied by an increasing polarisation in the scale of innovative activities across individual sectors. In the case of Poland, in 1992 the most innovative sector had 80.1% of innovative enterprises while the least innovative had 49.5%. In the 1994-96 period the difference was 78% vs 8.3%. So, the intersectoral difference in the scale of innovative activities has broadened from 30.6% to 70.3%. This polarisation in the scale of innovative activities suggests that at the outset of transition most enterprises, irrespective of the difficulties, were searching for new products and processes. However, the search process became highly differentiated across different sectors as some sectors have managed to transform innovations into sales while others did not. In Section 3.8 we analyse sectoral differences in somewhat greater detail.

Explaining the share of innovative enterprises

The socialist system was characterised by the weak in-house innovative activities of enterprises (Freeman, 1999). In the post-socialist period the enterprises are embodying innovation by building their own technological capabilities. However, this process differs considerably between countries and the innovation system in CEECs carries still strong features of the past (for detailed accounts of this process see Radosevic (1998, 1999, 1999b). While intramural R&D activities are gaining importance there is still a strong dependence, in particular of the ex-Soviet Union countries on extramural R&D. For example, out of 3803 innovative enterprises in 1992-94 in Russia 47% have received unpatented licences, which includes R&D contracts and purchase of industrial know how, etc (Gokhberg and Kuznetsova, 1999).[6] These are mainly the R&D results of industrial institutes who often operate in quasi-arm's length relationships with enterprises. In order to explore the determinants of the innovative activities in the post-socialist period we use sectoral data on the share of innovative enterprises, enterprises with in-house R&D activities, with contracted R&D, and those that purchased industrial know-how from extra-mural organisations. These data are available only for Russia and therefore the results may not be applicable to other CEECs. First, we regress the share of enterprises with in-house R&D activities on the share of innovative enterprises. This should indicate the extent to which the scope of innovative activities is dependent on the scope of in-house R&D activities.

Y = 11.1 + 0.785 X1
t-stat (2.34) (4.5)
Prob (0.037) (0.000)
R2Adj. 0.6
Y = share of innovative enterprises
X1= share of enterprises with in house R&D

The result is that 60% of variation in the share of innovative enterprises can be explained by the share of R&D activities. However, a very high intercept coefficient suggest that there is a high share of innovative activity which is 'autonomous', ie, which cannot be explained by in house R&D activities. Therefore, we test the relationship in which the share of innovative enterprises is determined not only by in house R&D activities but also by the share of enterprises that had R&D contracts or that purchased industrial know-how.

Y=0.549X1 + 0.207X2 + 0.35X3
t-stat (1.98) (1.43) (2.39)
Prob (0.07) (0.180) (0.036)
R2Adj. = 0.75
Y = share of innovative enterprises
X1 = share of enterprises that acquired industrial know-how
X2 = share of enterprises that contracted R&D
X3 = share of enterprises with in-house R&D

[6]According to Gokhberg and Kuznetsova (1999), only 5.8% of innovative Russian enterprises use patent licences and 10.3% patent rights.

As expected, the explanatory power of the regression has increased but the significance of the coefficients has declined suggesting that the two variables for extra-mural innovative activities may be correlated. Indeed, their coefficient of correlation is 0.86. The regression where the share of innovative enterprises is a function of two types of extra-mural R&D activities has high coefficient of determination but the coefficients are not significant at 5% level.

Y = 0.6661X1 + 0.342 X2
t-stat (2.04) (2.13)
prob (0.06) (0.05)
R2Adj = 0.70
Y = share of innovative enterprises
X1 = share of enterprise that acquired industrial know how
X2 = share of enterprises with contract R&D

In order to take into account the role of both extra- and intra-mural R&D and to avoid the problem of multicolinearity we simply drop the acquisition of industrial know how as a variable and leave contract R&D to carry the proxy of extra-mural innovation activities.

Y= 0.09X1 + 0.162X2
t-stat (4.91) (2.467)
Prob (0.00) (0.03)
R2 adj. = 0.75
Y = share of innovative enterprises
X1 = contract R&D
X2 = in house R&D

The result is a robust regression which suggest that both, extra- and intra-mural R&D activities, play a role in the innovative activities of enterprises. First, the combination of extra-mural and intra-mural R&D activities explains 75% of variation in the share of innovative enterprises. Second, a coefficient for in-house R&D almost twice that for contract R&D suggests that the Russian innovation system is moving towards a situation where the in-house R&D activities of enterprises are playing a more important role than the extra-mural R&D activities. However, the role of extra-mural R&D activities still continues to be significant suggesting that some elements of the Soviet R&D model as described by Gokhberg (1997) are still operating. This also conforms with our more descriptive accounts of R&D in the CEECs (see Radosevic, 1999).

3.2 FIRM SIZE AND INNOVATION

During the socialist period there were no small firms in the industrial structure. This phenomenon became known as ‘the socialist black hole’ (Petrin and Vahcic, 1988). In the post-socialist period we have seen a fast growth of small firms in all CEE countries. While in this respect the industrial structure is becoming more heterogeneous it is not yet clear what is the role of small firms in innovation dynamics of these countries. For example, in the case of Hungary Gabor (1997) argues that small firms are technologically inferior and that they operate in an emerging dual economy. On the other hand, SMEs are regarded as the main sources of growth in CEE economies (for example, see World Bank, 1996). While the role of SMEs seems clear in terms of employment and income generation their role is much less obvious with regard to the generation of innovations in CEECs. Are examples of dynamically growing SMEs in sectors like software or PC assembly exceptions or signs of a broader tendency.[7]

The large socialist firms are usually portrayed as a burden on the economy due to their monopoly power, lack of entrepreneurship or ability to capture the government. This view became most obvious

[7]Kubielas (1998) provides a good account of the growth of the PC assembly and software industries in Poland which is based to a large extent on small firms and alliances.

in the privatisation process whereby large socialist conglomerates were usually split into more viable units. This process has taken place to the greatest extent in eastern Germany (see Meske, 1997, and Grenzmann, 1999) where large firms are now absent in the industrial structure. This has seriously undermined the scale of innovation activities in this economy. In other CEECs this tendency varies from country to country; it depends on the dominant mode of privatisation, and whether governments are keen to save 'national champions' or privatise them as a whole. So, the question of firm size and innovation in CEECs has a direct relevance for assessing the changing industrial structure.

In assessing the role of different firm sizes in innovation dynamics of the CEECs some of the recent results of their role in the EU countries should serve as a useful reference point. The EU innovation surveys show that we should sharply distinguish the population of innovative from non-innovative small firms (EC, 1997). SMEs which introduce innovations are not substantially less innovative than their larger counterparts. Data from the Italian innovation survey shows that innovation expenditures per employee in innovative firms vary from 18.3m liras for large to 14.7m liras for small firms (Evangelista *et al*, 1997).[8] In that respect, one could argue that large firms do not have inherent advantages. When EU firms introduce innovations, they invest amounts in the range of 8% to 10% of their sales independently of their size (Evangelista *et al*, 1996, Figure 11). Total innovation costs per sale for 8729 EU innovating firms are similar across different size groups. In the case of R&D/sales bigger firms do invest somewhat more. However, in terms of innovation expenditures per employee for both innovative and non-innovative firms large firms turn out to be significantly more innovative. The innovation expenditure per employee of Italian firms is 16.7m liras for large vs 4.0m liras for SMEs (Evangelista *et al*, 1997). So, for the population of both innovative and non-innovative firms the positive relationship between innovation intensity and firm size strongly re-emerges. However, there is not clear correlation between firm size and share of innovation costs in relation to sales for both groups of firms. For the EU sample as a whole large and small firms have a higher share of innovation outputs (measured as a share of sales based on innovative products) than medium sized firms (Calvert *et al*, 1996, p 20). In this case the distribution is not linear in favour of large firms but U-shaped. The analysis by Tether (1998) shows that it is important to bear in mind the differences in the values of innovations generated by firms of different sizes as the value of innovations tended to increase with the size of the innovating firms.

The available data for the CEE do not allow us to examine the relationship between firm size and innovation to the extent that it has been done within the EU surveys. However, the limited available data do provide us with some new insights. In Table 4 we compared the shares of innovative firms by firm size in four CEE countries and in the EU. The share of innovative firms is significantly larger in the group of large enterprises even though we could not make full comparisons due to different national classifications. In that respect the firm size - innovation relationship in CEECs seems to be the same as in the EU economies.[9] The only difference between the EU and CEECs is a very low share of small innovative firms in the category of up to 50 employees in the CEE. In Romania and Russia the shares of innovative firms in this group are 2.7% and 4.9% respectively. In Slovenia and in Poland (1994-96 survey) their share is 14.2% and 16% respectively. This is in stark contrast to the EU where the share of innovative firms in this group is 44%. If we take into account that the share of firms in this category of enterprises in CEECs is significantly smaller than in the EU than this difference becomes even more pronounced. This suggest that the share of new technology based firms which are usually in this category is extremely small in the CEECs.

So far we have abstracted of the results of the first Polish innovation survey which shows a very high share of innovative small firms in the group between 6-50 employees. How do we explain the decreasing share of innovative small enterprises in this group in Poland whose 48% share in 1992 was higher than the share in the EU of 44%? The data for Poland for the period between the two innovation surveys show that the share of small innovative firms has fallen by 77% while the share of innovative large firms has fallen by only 5%. Is it a sign of deteriorating innovative dynamics of

[8]See section 3.3 for discussion on innovation expenditures.
[9]For the time being we abstract of the data from the first Polish innovation survey.

SMEs in the Polish economy or something else?. Since the Polish economy was growing in the 1992-1994 period on average by 3.9% this decrease is hard to attribute to a decrease in innovation dynamics. We pointed out in section 3.1 that the decrease in the share of innovative firms may be a general trend in the CEEC which suggests that much of innovations at the outset of transition could not be transformed into viable commercial products later on. Second, as pointed out by Calvert *et al* (1996, p 20) small firms are often new firms which come into being to sell new products and hence by definition a greater share of their output would be innovative. At the same time, the change in their products should be much slower than in the large firms due to their limited economies of scope. Assuming an increase in the birth rate of SMEs we would expect the unchanged share of innovative SMEs. However, a big difference in the share of innovative SMEs between the EU and CEECs, including Poland in the second survey, suggests that the mechanism of generation of small firms in CEE is not working as in the EU. Also, this may suggest that the small firms are not introducing new innovative products at the same pace as in the EU countries.

Table 4: The share of innovation firms by firm size

Size distribution	**Romania**	**Size distribution**	**Poland I**[a]	**Poland II**[b]	**Size distribution**	**Slovenia**	**Size distribution**	**Russia II**[c]	**Size distribution**	**EU**
20-49	**0.027**	6-50	**0.482**	**0.16**	1-50	**0.142**	< 49	**0.049**	<100	**0.44**
50-199	**0.096**	51-500	**0.592**	**0.33**	51-250	**0.299**	50-99	**0.066**	100-500	**0.61**
200-499	**0.263**	501-2000	**0.779**	**0.725**	250 >	**0.629**	100-199	**0.124**	500>	**0.79**
500-999	**0.363**	2000 >	**0.922**	**0.875**			200-499	**0.183**		
1000 >	**0.529**			*0.33*			500-999	**0.282**		
				0.29			1,000-4,999	**0.464**		
							5,000-9,999	**0.71**		
							10,000 >	**0.798**		

a 1992
b 1994-96
c 1995-96

An interesting question for public policy is whether the relationship between firm size and innovation holds for the public as well as for private enterprises? The data for Poland in Table 5 show the distribution of the shares of innovative firms across different firm size and public/private ownership. Table 5 shows that there is not significant difference in the shares of innovative firms between public and private enterprises. In all groups, except partly in the group of medium-sized enterprises, differences in the share of innovative enterprises are negligible.

Table 5: Share of innovative enterprises, Poland, 1997

	Small	**Medium**	**Large**	**Very large**
Public	0.163	0.438	0.737	0.868
Private	0.159	0.288	0.697	0.9

Table 6: Single factor analysis of variance between the size and ownership of innovative enterprises, Poland

Source of Variation	*SS*	*df*	*MS*	*F*	*F crit*
Between different sizes of enterprises	0.648658	3	0.216219	68.80483	6.591392
Between public - private enterprises	0.01257	4	0.003143		
Total	0.661228	7			
R2	**0.98**				

A single factor analysis of variance shows that the variation across firm sizes is much more significant than the variation across ownership. As Table 6 shows, the 98% of variation of variables in Table 5 can be attributed to the variation between enterprises of different sizes. Although, based only on the Polish data we cannot generalise about all CEECs, the data suggest that for innovation dynamics the ownership incentives are secondary to firm size.

In conclusion, innovation and innovation expenditures in the CEE continue to be concentrated in large enterprises. In this respect the CEE conform to a general situation in market economies. This also suggests that the principle of privatization in the CEECs whereby a large enterprise is *a priori* a problem is likely to generate weaknesses in the industrial structure, as we have seen in the case of eastern Germany. Innovation dynamics in the economy depends on the high share of innovative firms in all classes. So, the problem in the CEE seems to be much more a low share of innovative firms in general rather than in a particular size group.

3.3 THE STRUCTURE OF INNOVATION EXPENDITURES

The differences in the structure of innovation expenditures should indicate differences in the main types of innovation activities. Taking into account differences in developmental levels between the EU and the CEE we would expect that the structure of innovation expenditures should be significantly different. Countries that are behind the technology frontier should spent relatively more on embodied technologies and on downstream innovation activities like reverse engineering, product and process imitation than on world frontier R&D.

The analysis of the innovation expenditures by Evangelista *et al* (1996) shows that, first, the distribution of innovation costs is relatively coherent over all EU countries. If costs reflect well the scope of different innovation activities than the mix of innovative activities appears rather similar across EU countries. The second conclusion based on the EU innovation survey is that the industrial innovative process consists, first and foremost, of the purchase and use of 'embodied' technologies (innovative machinery and plants), which account for 50% of total expenditures on innovation (*ibid*). Third, among the 'intangible' innovation expenditures R&D activities are confirmed to be a central

component of the technological activities of firms (see Evangelista *et al*, 1997, fig 2, p 529). Fourth, across all European countries expenditure-wise, the acquisition of 'disembodied' technology through patent and licences emerges as a secondary innovation component when compared to the technological sources (*ibid*).

In Table 7 we compare the structure of innovation expenditures of the EU and the six CEE countries as originally classified. For the time being we will not analyse the structure of innovation expenditures between the two Yugoslav innovation surveys. In Tables 8 and 9 we regrouped and normalised the primary data from Table 7 in order to ensure as much comparability as possible among countries.

Table 8 groups innovation expenditures on costs for physical investment related to innovative activities, R&D&Engineering costs and other activities. If we compare only the data for Poland, Romania and Russia with the EU data they show that the innovative expenses in CEE are devoted significantly more to the purchase of embodied technologies. The share of R&D&E activities is more than two times smaller than in the EU. These data seem to be consistent with the data on the number of enterprises involved in R&D activities in CEECs which we analyse in section 3.4. They also confirm our proposition at the beginning of this section that the latecomer countries should have a different cost structure of innovation expenditures. However, Slovenian data seem to be either inconsistent or reflect a rather different situation. We believe that they do not reflect under-investment into embodied technology in Slovenia but the differences in the 'coverage' of investments that are linked to innovative activities. If these figures were reflecting a fully comparable situation than we could conclude that the innovative activities in Slovenia are mainly focused on R&D and that there is a serious problem of physical under-investment in this country. However, the average growth rate of investment into gross fixed assets in Slovenia between 1993-97 was 10.6% while the share of investments in GDP was 26.5% in 1995.[10]

[10]Sources; EBRD (1998) and OECD (1997).

Table 7: Breakdown of innovation expenditures (%)

	Eu[b]	EU[c]	Slovenia	Poland Ii[d]	Hungary	Yugoslavia I[e]	Yugoslavia II[f]	Romania	Russia Ii[gh]
R&D	41	20	54	13	42.80	45.9	40.9	17.80	26.90
- Intram R&D			48			41.1	34.3		
- Extram R&D			6			4.8	6.6		
Product design	22	10			8.00				na
Experimental development						16.7	18.3		na
Trial, training, tooling	27	11			16.90				na
- Trial production						20.1	30.5		
- Training			1	1		4.3	1.7		0.60
- Preparation of prod.			5						
Subtotal	90	41	60	14	67.70	87.0	91.4	17.80	
Market analysis	5	3	6	4	4.30	6.3	7.3		0.40
Patents, licences, know-how	3	2	6	6	27.00	3.3	1.1	1.50	2.40
Acquisition of machinery/equipment		50	28	52				72.80	60.00
Investment in land/buildings				18					
Other	2	2		7		3.4	0.2	7.90	
Total[a]	100	98	100	101	99	100	100	100.00	na

a Differences are due to rounding
b source: EU (1998)
c source: Evangelista et al (1996)
d 1994-96
e 1987-1991
f 1992-1996
g 1995-96
h costs for product design, experimental development, trial and market analysis for Russia are not available

Sources: For EU, EU (1998), Evangelista *et al* (1996). For Slovenia SCSO (1998).
For Poland, Niedbalska (1999a). For Hungary, Inzelt (1996). For Russia, Kuznetsova (1998, p 7)
For Romania, RCSO (1996). For Yugoslavia, Kutlaca (1999).

Table 8: Breakdown of innovation expenditures which include fixed investments (%)

	EU	Slovenia	Poland II	Romania	Russia II
R&D&E	**41.0**	**60.0**	17.1	17.8	na
Acquisition of machinery/equipment	50.0	28.0	**63.4**	**72.8**	**60.0**
Other	9.0	12.0	19.5	9.4	na
Total	100.0	100.0	100.0	100.0	na

In order to ensure greater comparability, in Table 9 we compare innovation expenditures reduced to 'intangible' investments. Our attempt to regroup expenditures to ensure comparability could not resolve all methodological differences. First, the shares of R&D for Slovenia (75%) and Romania (65.4%) seem to be exceptionally high when compared to other CEE countries as well as when compared to EU. In the case of Romania that is partly the result of grouping market research cost into R&D (see CSO, 1995). In Slovenia, the share of engineering costs is unusually low and it is very likely that some part of the engineering costs is included in R&D costs. The original Romanian data do not contain engineering cost but have a very high share of 'other' costs which we grouped into engineering costs. We did the same for all other countries as the engineering costs represent all 'downstream' activities after R&D, excluding marketing and costs of purchasing patents, licences, etc. This conforms to our expectations regarding the position of the CEECs as catching-up countries. However, the picture is not so neat as the R&D share in innovative expenditures for some EU countries is similar or even below the share of the CEECs. Hence, the low share of R&D in innovation expenditures of CEECs applies only a as rough tendency in relation to the EU.[11]

Table 9: Breakdown of innovation expenditures (without fixed investments)[d]

	EU	Slovenia[b]	Poland II	Hungary	Romania	Yugoslavia I
R&D[b]	41.0	75.0	43.3	42.8	65.4	45.9
Engineering[a]	51.0	8.3	26.7	24.9	29.0	44.5
Market analysis[b]	5.0	8.3	13.3	4.3	c)	6.3
Patents, licences, know-how	3.0	8.3	20.0	27.0	5.5	3.3
	100.0	100.0	103.3	99.0	100.0	100.0

a engineering includes product design, experimental development, trial, training, tooling, preparation of production and others
b for Slovenia and Romania R&D figures are probably overestimated and includes part of engineering costs
c For Romania R&D includes market research as well as trials, prototypes and experimental development
d differences are due to rounding

First, Table 10 shows that the share of R&D costs is below the overall EU share in all analysed CEECs, except Slovenia for which we think that the R&D data are overestimated. Second, the structure of costs without fixed investments produces a picture where the share of some components is difficult to explain. The share of costs of marketing in all CEE countries except Hungary is above the overall EU share. The share of costs for patents, licences and know-how is in all CEE countries above

[11] Although our aim here is not to discuss the differences among the EU countries some observations are needed regarding the ranking of the EU countries. Evangelista *et al* (1996, 1997) point out that in large firms more innovation expenditures goes on R&D, while in SMEs significantly more goes on physical investment. As this pattern holds across most European countries then we would expect that the countries with higher share of SMEs should naturally have a much lower share of R&D in innovation costs. Indeed, this may explain the low share of R&D in innovation expenditures of Denmark and Ireland but cannot fully explain a very low share in Germany.

the overall EU share, while in Poland and Hungary it is substantially above. A higher share of patents, licences, etc is consistent with our expectations. However, the structure of R&D and engineering costs is difficult to explain especially when compared to the EU. Despite the problems in separating R&D from engineering costs a common feature of CEECs is the lower share of engineering costs than in the EU. This may be the result of a higher share of costs for patents and licences as well as a higher share of physical investment which reduced the need for own design and engineering or re-engineering activities. However, without a disaggregated sectoral structure of innovation expenditures our conclusions remain highly speculative. A higher share of costs for embodied technologies and for patents and licences suggests that there are significant differences as compared with the EU costs structure. Also, the share of R&D costs suggest the different structure of innovation costs. However, difficulties in ensuring comparability between R&D and engineering costs make these conclusions very tentative. Based on the EU data Evangelista *et al* (1996) conclude that the mix of innovation inputs, especially R&D and investment, is strongly correlated with firm size, but displays great variations across industries, it also displays little change across countries. So, if we are to search for robust differences in innovation activities based on innovation surveys data these should be sought at firms and industries levels.

Table 10: R&D share in innovation expenditures (%)

Slovenia[a]	**75.0**
Italy	61.0
Netherlands	56.0
Norway	55.0
Belgium	54.0
EU	50.0
Yugoslavia I	**46.0**
Luxembourg	44.0
Poland	**43.0**
Hungary	**43.0**
Spain	41.0
Yugoslavia II	**41.0**
Denmark	36.0
Ireland	29.0
Germany	27.0
Russia	**26.9**
Romania	**18.0**

a probably overestimated

Innovation expenditures from open to closed or isolated economy and vice versa

In section 2, we explained why we had included in the comparison the two Yugoslav surveys which cover the periods 1987-1991 and 1992-96. Here we are interested in whether the shift from an open to a closed (isolated) economy which Serbia underwent in this period has changed the structure of innovation activities. The data on Yugoslavia from Table 7 contain several interesting features in this respect. First, there is a significant decrease in R&D expenditures on account of increased expenses of trial production. An economy that is not able to freely import equipment is forced to increase expenses for its own 'reinventing the wheel' technological development. Second, 'the sanctions wall' has also led to a decrease in expenses for patents and licences as technology is not longer freely available in the market. Third, a slight increase in extramural R&D may be compatible with the previous two trends as enterprises that cannot import technology freely from abroad must try to compensate for this by closer contacts with domestic R&D institutes. Yet, later on in section 3.10. we show that the importance of extra-mural organisations as a source of innovative ideas decreased. Probably, we should not read too much into these relatively small changes. This also applies to a

slight increase in the share of expenses for marketing which is incompatible with the previous three trends.[12]

The Yugoslav situation represents a reverse process from the liberalisation and the opening of the other CEE countries. In this respect, it may serve as a comparative basis for understanding the changes in innovation activities of the CEECs. By deduction from the Yugoslav case, the shift from closed to open economies in CEE should have resulted in three trends. First, the decrease in the share of R&D&E expenses as new embodied technologies became available and the need to 'reinvent the wheel' was removed. Second, the opening of the economy leads to an increase in import of foreign technology in the form of physical investments but also in the form of patents and licences. Fourth, the ability of enterprises to purchase state-of-the-art technologies from abroad leads to a diminution in the role of domestic extra-mural R&D. Finally, in a pure stylised situation we would expect also an increase in expenses for marketing of innovations by companies that in the past did not have significant marketing expenses. Although, we do not have comparative data for different innovation expenditures before and after 1989 for CEECs, an increase in the relative importance of marketing expenses seems the most likely. The shares of physical investments, R&D, and patents and licences do correspond to our predictions derived from the Yugoslav case.

3.4 ENTERPRISES AND R&D ACTIVITIES

A comparison in section 3.3. shows that among the 'intangible' innovation expenditures R&D activities are the central component of the technological activities of firms in the EU as well as in CEE. In Table 10 we also showed that despite 'noise' in the data the share of R&D in innovation expenditures is lower in the CEECs than in the EU. In Table 11 we compare the shares of enterprises with R&D activities for the EU with Slovenia and Poland, the only two CEE countries for which we have these data. The share of enterprises with R&D activities in these two CEE countries is much lower when compared to EU countries. A very low share of only 11% of Polish enterprises with R&D activities is the result of the socialist heritage characterised by the low share of in-house R&D and high share of extra-mural R&D activities.

Table 11: Share of enterprises with R&D activities (%)

Ireland	86.0
Belgium	78.0
France	72.0
Luxembourg	70.0
Germany	66.0
Netherlands	65.0
Norway	64.0
Italy	57.0
Spain	54.0
Denmark	36.0
Slovenia	**22.7**
Poland	**10.7**

A comparison between R&D shares in innovation expenditures (Table 10) and shares of enterprises with R&D activities across countries (Table 11) shows that there is no similarity between them. The coefficient of correlation is -0.295. The reason why there is no positive correlation is not just due to the 'noise' in the data but is mainly due to the fact that the firm size and industry are the main

[12]We believe that there are two complementary explanations. In an effort to bypass 'the sanctions' wall enterprises could have increased the expenses for marketing of their new products. Alternatively, since the period 1992-96 encompasses a few years during which sanctions were not officially in place, though in practice the situation was far from free trade, this may have led enterprises to invest more into marketing of new products in order to return to old markets.

determinants of innovation activities, and R&D in particular. The link between the shares of R&D in innovation expenditures and shares of enterprises with R&D activities across countries is mediated by differences in industrial structure. Otherwise it is difficult to explain why, for example, Ireland has 86% enterprises with R&D activities while the share of R&D in innovation expenditures is only 29%. Or, why Slovenia has 23% of enterprises with R&D activities while the share of R&D in innovation expenditures is 75%, a very high share even if we discount for a probably overestimated R&D share.

In both CEE countries, Slovenia and Poland, an important aspect of industrial structure - firm size - shows a positive relationship with the frequency of R&D activities. Table 12 shows that the share of enterprises with R&D activities is, in both countries, significantly higher in large enterprises. This conforms to the situation in the EU and to conclusions in section 3.2.

Table 12: Share of enterprises with R&D activities (%)

Poland II		**Slovenia**	
Small	2.3	**Small**	7.7
Medium	7.5	**Medium**	20.9
Large	29.5	**Large**	49.4
Very large	53.3		

In Table 13 we compare the shares of firms with R&D activities for public and private enterprises for Poland. In total, the share of public enterprises with R&D activities (17.6%) is higher than the share of private enterprises (7.3%). This difference is present across all size groups, except for small firms where it is private small firms that more often carry out R&D rather than public ones. However, the difference in shares of firms with R&D activities between public and private firms is not statistically significant[13] (t-statistics is 0.2557).

Table 13: Share of enterprises with own R&D

	Public	**Private**
Total	**17.6**	**7.3**
Small	0.7	2.8
Medium	10.6	5.3
Large	31.5	24.5
Very large	54.5	48.4

Do large and public firms also do more co-operative R&D than private firms? Table 14 compares the shares of innovative Polish enterprises with R&D activities as well as the shares of enterprises with different co-operation agreements. Large firms are much more often undertaking R&D activities as well as co-operating with external organisations in R&D than small firms. A correlation coefficient between the share of firms with R&D and with different R&D cooperation agreements is very high and ranges from 0.98 to 1.00. While high correlation by itself is not proof of complementarity between own R&D and co-operative

Table 14: The share of innovative Polish enterprises with R&D co-operation agreements in 1996 with external organisations

	Own R&D	**Other enterprises**	**Academy of Science**	**Branch R&D**	**Universi-ties**	**Foreign**
Small	0.023	0.025	0.007	0.036	0.02	0.009
Medium	0.075	0.057	0.012	0.077	0.041	0.024
Large	0.295	0.144	0.051	0.308	0.224	0.085
Very large	0.533	0.349	0.145	0.592	0.507	0.191

[13]T-test assuming equal variance gives t-statistics of 0.256 which is below the t-critical value of 2.447.

R&D, it does suggest that large firms more often use external R&D and at the same time themselves engage in R&D than small firms. This holds, irrespective of whether firms are public or private. Correlation coefficients between the shares of firms with R&D activities and share of firms with R&D co-operation for public and private firms are identical 0.99. However, there are important differences in the frequencies of R&D co-operation across different forms of co-operation between public and private firms. In Table 15 we show the differences in the shares of R&D co-operation between public and private firms. The larger the public firms the more often they conduct co-operative R&D when compared to large private firms. Public firms co-operate in R&D more often than private firms with external organisations, with the exception of foreign partners. Public firms are more networked in R&D domestically while private firms are more networked in R&D with foreign partners. However, this difference is not statistically significant.[14]

Table 15: Public - private difference in R&D cooperation frequency across different firm sizes (%)

	Share of co-op. R&D	Other enterprises	Academy Sciences	Branch R&D	Universi-ties	Foreign
Small firms	0.90	**-0.40**	1.00	**-0.80**	0.30	0.80
Medium	15.90	3.00	1.10	8.70	3.40	**-0.30**
Large	24.20	5.50	3.90	10.00	8.70	**-3.90**
Very large	41.60	11.40	6.00	17.60	15.00	**-8.40**

3.5 TYPES OF INNOVATION ACTIVITIES

In the classical analysis of innovation in the Soviet industry Berliner concludes that the decision rules in orthodox centrally planned system "offer some positive support for process innovation but very little for product innovation" (Berliner, 1976, p 418). In the reformed Soviet-type economies the new incentive structure was more hospitable to process innovation than the classical, but the development of product innovations was seriously neglected (*ibid*). Gomulka (1986) also argues that in socialism process innovations was dominant.

> "When faced with supply difficulties, firms would use the same tools and equipment but investigate the use of somewhat different intermediate inputs (ingredients) top produce essentially the same product. Consequently, many of the new process innovations reflect the widespread phenomenon of forced substitution, and as such represent technological necessity rather than actual improvement" (Gomulka, 1986, p 46)

Although the empirical basis for the evidence on product and process innovations in the socialist period is limited we take Berliner's and Gomulka's conclusions as a point of departure for understanding changes that have taken place in the post-socialist period.

Table 16 shows the shares of enterprises which introduced different types of innovations. A common feature based on Polish and Russian data is that the share of introduced product innovations is somewhat higher than the share of process innovations but this difference is not significant. Based on the sample of 416 Slovenian firms Bross and Zenker (1998) found that 70% of innovating firms undertake both process and production innovation, while the shares of only process innovations with 8.2% and only product innovations with 22% of innovators are much smaller. A significantly greater importance of product than process innovation emerges in the case of Hungary. Bonin and Abel (1998, p 11), based on a survey that contained also questions on innovation, discover that 62% enterprises in the sample changed products while only one third of enterprises had process improvements. This suggests that there is a shift from process to product innovation in the post-socialist period. However, we should bear in mind that the distinction between process and product innovation is extremely blurred. Simonetti *et al* (1995) show, based on the SPRU innovation data base, that 96.9% of the innovations fall into the 'grey zone', ie, they can be products or processes

[14]T-test assuming equal variance gives t-statistics of 0.4335 which is below the t-critical value of 2.447

according to the type of definition adopted. This is also confirmed by the data from the CEECs in Table 17.

Table 16: Shares of enterprises which introduced different types of innovations

	New technologies and techn. proces.	Mechanization and automatization	Organisational innovations
Poland 1992	**34.20**	**28.50**	**26.40**
	New or improved products	New technological processes	Substant. organisational innovations
Poland 1994-96	**30.00**	**25.00**	**24.00**
	New or improved products	New or improved techn. processes	
Russia 1992-94[a]	**18.00**	**14.10**	

a Recalculated based on the share of enterprises engaged in innovation activities in the total number of innovative enterprises and the share of innovative enterprises

Table 17: Correlation coefficients of shares of enterprises which introduced different types of innovations

	New technologies and tech processes	Mechanization and automatization	Organisational innovations
Poland 1992			
New technologies and tech processes	**1.00**	**0.85**	**0.83**
Mechanization and automatisation		**1.00**	**0.72**
Organisational innovations			**1.00**
	New or improved products	New technological processes	Substant organisational innovations
Poland 1994-96			
New or improved products	**1.00**	**0.90**	**0.70**
New technological processes		**1.00**	**0.84**
Substant organisational innovations			**1.00**
	New or improved products	New or improved techn processes	
Russia 1992-94			
New or improved products	**1.00**	**0.80**	
New or improved tech processes		**1.00**	

In Table 17 we show the correlation coefficients for different types of innovations from Table 16 based on shares across industrial sectors. The picture that emerges is the following.

First, there is a strong correlation between the spread of process and product innovations across sectors. In the case of Poland (1992) the correlation coefficient is 0.84; in the 1994-96 period in Poland this coefficient is 0.90; in the case of Russia the correlation is 0.8. These are correlations of the shares of enterprises in total number of enterprises in sectors, indicating that sectors that are innovative tend to be innovative in both respects, in terms of product and process innovations.

Second, Polish data show that the introduction of product/process technologies or embodied technologies often goes together with organisational innovations though these correlations are not so strong as in the case of links between products and processes. Correlation coefficients are in the range 0.70 to 0.84.

Table 18: Shares of different types of innovations introduced in Romania

	New and improved products	Modernised products	New technological processes	Modernised technological processes
Romania 1995[a]	**30.00%**	**26.00%**	**15.00%**	**30.00%**

Correlation coefficients between different types of innovations across sectors

Romania 1995[a]	New products	Modernised products	New technological processes	Modernised technological processes
New products	**100.00%**	**-0.08**	**0.57**	**-0.81**
Modernised products		**1.00**	**-0.11**	**-0.81**
New tech processes			**1.00**	**-0.68**
Modernised tech processes				**1.00**

a The share of new and improved products is summation of new and improved products: new to domestic markets and new to enterprise

Table 18 shows the distribution of different types of innovations in Romania. In aggregates, the distribution is fairly balanced. The share of incremental changes in processes and products (56%) is only slightly higher than the share of new products and processes. However, the correlation coefficients of these shares across sectors indicate that the types of innovations when classified into radical/incremental process/product innovations across sectors are not positively linked. The correlation between shares of radical product and process innovation is mildly positive (0.57), while the link between shares of incremental process innovations, or between radical and incremental innovations across sectors is strongly negative ranging from -0.68 to -0.81. This may suggest that the types of innovations are not sector specific in the case of Romania. We explore the variations between sector and types of innovations in Table 19.

Table 19: Single factor analysis of variance between sectors and types of innovation[a b]

POLAND I

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between sectors	0.242638	7	0.034663	**8.9842**	0.000155	**2.6572**
Between types of innovation	0.061731	16	0.003858			
Total	0.304369	23				
R2	**0.80**					

POLAND II

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between sectors	1.513921	23	0.065823	**8.92847**	1.32E-10	**1.75676**
Between types of innovation	0.353867	48	0.007372			
Total	1.867788	71				
R2	**0.81**					

RUSSIA I

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between sectors	2346.935	14	167.6382	**0.99752**	0.499417	**2.42436**
Between types of innovation	2520.815	15	168.0543			
Total	4867.75	29				
R2	**0.48**					

ROMANIA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between sectors	2.904762	20	0.145238	**0.00044**	1	**2.09603**
Between types of innovation	7007	21	333.6667			
Total	7009.905	41				
R2	**0.00041**					

ROMANIA[c]

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between types of innovation	4958.524	3	1652.841	**13.2288**	4.27E-07	**2.71879**
Between sectors	9995.429	80	124.9429			
Total	14953.95	83				
R2	**0.33**					

***a* 5% level of significance**

***b* Types of innovation**

Poland I

New technology and technological processes
Mechanisation and automatisation of technical processes
Organisational innovations

Poland II

New or improved products
New technological processes
Substantial organisational innovations

Russia I

New or improved products
New or improved processes
New or modernised techn. processes

Romania

New or modernised products
New or modernised techn. processes

Romania *c*

New products
Modernised products
New process technologies
Modernised technological processes

Single factor analysis of variance for the 1992 and 1994-96 periods for Poland shows that around 80% of variations in types of innovations can be attributed to sectoral differences (Table 19). This seems logical as we would expect that the process of marketisation will lead to clearer sectoral patterns of

technological advantages. However, the same is not true for Russia and Romania where sectoral variations in types of innovations are not significant when compared to variations between types of innovations. For Romania, we also analysed the sources of variation using four-types of innovation classification. As would be expected at this level the sectoral variations become even less significant. However, when we test the opposite proposition, ie, whether the variations between types of innovations at this level are significantly different from variations between sectors, we get significant result although this explains only 33% of variation.

How can these results be explained? We should bear in mind the problems in classifying process vs product innovations which may produce a 'noise' in the data. However, if we take into account this problem we could hypothesise that the economic reforms and growth in Poland have produced sectorally distinctive patterns of innovation. On the other hand, in two economies that are slower in this respect (Russia and Romania) and who are lagging far behind in terms of economic recovery the sectoral differences have not yet worked through.

The Polish data conform to the conclusion produced from an Italian innovation survey on the strong sectoral nature of innovation processes which coupled with the firm size are its important determinants. Possibly, in Russia and Romania the search efforts by enterprises are still unsystematic and do not reflect the differences in the sectoral patterns of innovation. In the fast reforming economies the sectoral determinants are significantly influencing the types of innovations suggesting the operation of the competition process. Given the very limited data we should recognise the highly speculative nature of this conclusion.

A 'classical' analyses on the innovation in socialism, like Berliner (1976) and Gomulka (1986) emphasised the role of incentives in the types of innovations. In the post-socialist period the role of ownership on the types and even the pace of innovations seems a bit exaggerated. By focusing only on ownership incentives as determinants of innovation we do not capture the most important sources of differences in innovation dynamics. As shown in section 3.2. for Poland the variation in the innovation is much better explained by enterprise size than by ownership. Similarly, based on the Hungarian survey data, Benin and Abel (1998, p 21) conclude that there is little difference between state owned companies and foreign majority owned ones' in the choice between product imitation vs product development strategy. They find that the foreign majority owned companies are much more likely to be engaged currently in creating new production processes. However, the ownership type is not found to be a significant determinant of planning for future process innovation' (*ibid* p 23)

The analyses on innovation in socialism were right emphasising that the diffusion of innovation cannot be separated from the incentives to produce it. However, the ownership incentives are only one element among the determinants of innovation. Factors like demand prospects, type and intensity of competition, market structure as well as supply factors governing the production of knowledge, like technological opportunity, play a dominant role as determinants of innovation activity (see Arvanitis and Hollenstein, 1996). A complex understanding of determinants of innovation activities is of great importance in the post-socialist period where ownership changes are often perceived as the most important for growth and economic recovery. In view of the complexity of factors or determinants of innovation this view seems rather restricted.

3.6 THE SPREAD OF SECTORAL INNOVATION ACTIVITIES

We showed in section 3.5 the fact that the sectoral differences play an important role in the spread of innovation activities. The evidence based on the Italian innovation survey shows that the industry in which firms are located and firm size are important factors for explaining the presence of innovating activities, irrespective of one from another (Evangelista *et al*, 1997). The probability of firm's being both innovative and performing R&D increases monotonically with firm size and increases considerably for industrial sectors which are usually labelled as those characterised by high technological opportunities (Aerospace; Radio and TV equipment and telecommunications; Precision instruments; Mechanical machinery; Pharmaceuticals).

A full comparison of the spread of innovative activities across sectors between CEECs and the EU is still not possible due to differences in industrial classifications. Although, industrial classifications in Slovenia and Poland are harmonised with the EU classification a full comparison is not possible due to a high level of aggregation of the EU data. Nevertheless, the existing data give us a basis for generating a few conclusions or hypotheses. The analysis of the EU innovation surveys showed the variety of sectoral innovation intensities across countries. This diversity is the result of differences in industrial structures, in particular firms size, as well as differences in sources and direction of technical change among sectors but also of different country factors. In Table 20, we rank the top five sectors based on shares of innovative enterprises in four CEECs and in the EU. The diversity of national patterns which has been recognised in the case of the EU is also strongly present in the CEECs. Despite differences in industrial classifications Table 20 shows that among the top five sectors there is not single common sector among the four CEECs and the EU. The sector which is most often present is the chemical sector. It is amongst the top five sectors in Slovenia, Poland, Russia and the EU but not in Romania.

Table 20: Top five sectors based on shares of innovative enterprises

SLOVENIA	**POLAND II**	**EU**
Electric machinery	Coke, petroleum	Machinery
Radio, TV equip	Chemicals	Electrics, electronics
Chemicals incl pharm	Electric machinery	Chemicals
Machinery & equip	Medical & precision instr	Transport equipment
Medical & precision instr	Basic metals	Basic metals

ROMANIA	**RUSSIA**
Electrotechnics	Non-ferrous metallurgy
Pulp and paper	Oil extracting and refining, gas extracting
Metallurgy	Medical equipment and pharmaceuticals
Prelucrarea titeiului	Chemicals (excluding pharmaceuticals)
Fine mechanics	Microbiological industry

A full comparison of sectoral differences is possible only between Slovenia, Poland and the EU for high-tech sectors (chemicals/pharmaceuticals; electrical machinery; instruments; motor vehicles; electronics; other transportation; and computers) (Table 21). Correlation coefficients of shares of innovative enterprises in high-tech sectors for Slovenia, Poland and EU are negative between Poland and EU, zero correlated between Slovenia and EU, and have a positive correlation (0.65) between Poland and Slovenia. The biggest differences in the shares of innovative enterprises are in the computer sector where the shares for Poland, Slovenia and EU are 14.3%, 23.1% and 72% respectively.[15] We also correlated the sectoral shares of innovative enterprises for Slovenia and Poland for all industrial sectors and the correlation coefficient to be quite high (0.78).[16] This may suggest that similar sectoral spreads of innovation are linked to similar levels of development. Unfortunately, we do not have comparable data to test this proposition. The available data allow us only to explore the differences in the distribution of relative shares of innovation across sectors.

[15]Once we eliminate this sector the correlation coefficients for both Slovenia and Poland with the EU improves to 0.22 and 0.31 respectively.

[16]A comparison is possible only if we exclude recycling and coke petroleum for which in each of the countries there are data for only one of these two sectors.

Table 21: Shares of innovative enterprises
Correlation coefficients between EU, Slovenia and Poland in high tech sectors

	Poland	*EU*	*Slovenia*
Poland	1.00		
EU	-0.15	1.00	
Slovenia	0.65	0.00	1.00

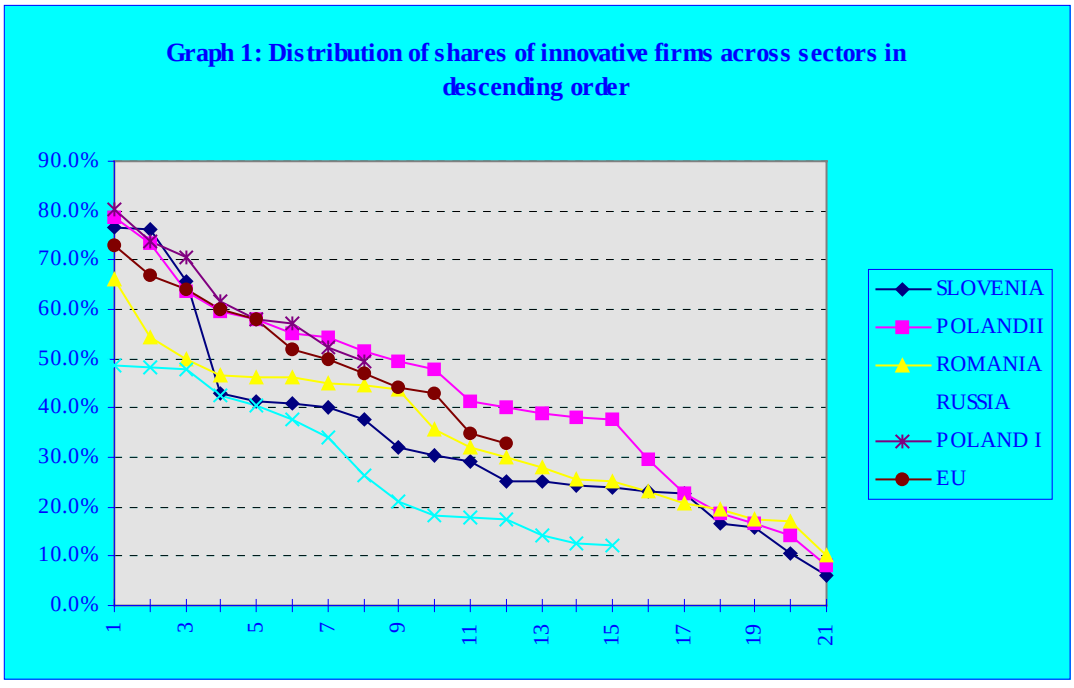
Our analysis suggests that the levels of development play a role in the scale and patterns of innovation activities. If so, than less developed countries should have a smaller number of sectors with higher shares of innovative firms while more developed countries should have more even distribution across sectors. In less developed countries innovative enterprises are concentrated in few sectors. If we take into account that the GDP per capita of the CEECs is several times lower than the EU GDP per capita this proposition seems quite plausible. In order to explore this proposition we ranked all sectors in descending order based on the share of innovative firms. Table 22 and graph 1 show surprisingly similar distributions of descending shares of innovative firms across sectors. The slope coefficients or rates of change along the line range between -2.33% to -3.64%.[17] When we regress the shares of innovative sectors on descending ranking of sectors we get very high coefficients of determination which are above 0.95, except for Slovenia (0.84). Also, regression coefficients are highly significant.

Why are the distributions of shares of innovative enterprises so similar? The slopes of the distributions are very similar even though the classifications are different in terms of number of sectors. In the case of CEECs, we would expect the distribution to be much more skewed, ie, concentrated in only few sectors where these countries have technological advantages. For the EU, we would expect a less skewed distribution indicating a more balanced shares of innovative enterprises in different sectors. The result is that the distributions of shares of innovative firms across sectors are very similar when sectors are ranked in descending order while the technological structure or leading sectors are nationally very specific. This suggest that the diversity of national technological advantages are distributed in a very similar fashion but the content of this diversity is nationally very specific. The national determinants influence the sectoral technological structure but they do not determine the distribution of shares of innovative firms across sectors. This distribution seems insensitive to country specific conditions and levels of development.

[17]A standard deviation of distributions primarily reflects the number of the sectors or the degree of disagregation. Namely, the correlation coefficient between number of sectors and the difference between sectors with maximum and minimum share is 0.91, and the correlation between standard deviation and the number of sectors is 0.89.

Table 22: The distribution of shares of innovative enterprises across sectors ranking in descending order (%)

	SLOVENIA	POLAND II	ROMANIA	RUSSIA	POLAND I	EU
1	76.5	78.6	65.9	48.7	80.1	73.0
2	76.2	73.3	54.5	48.1	73.9	67.0
3	65.8	63.8	50.0	47.9	70.5	64.0
4	42.9	59.5	46.7	42.5	61.8	60.0
5	41.4	58.1	46.4	40.5	58.0	58.0
6	40.9	55.2	46.2	37.6	57.0	52.0
7	40.0	54.2	45.2	34.2	52.2	50.0
8	37.8	51.6	44.7	26.2	49.5	47.0
9	32.1	49.5	43.7	20.9		44.0
10	30.4	48.0	35.8	18.3		43.0
11	29.3	41.5	31.9	17.7		35.0
12	25.0	40.3	30.0	17.6		33.0
13	25.0	39.1	27.9	14.0		
14	24.4	38.3	25.4	12.6		
15	23.8	37.7	25.0	12.3		
16	23.1	29.7	23.3			
17	22.7	22.9	20.7			
18	16.7	18.6	19.4			
19	15.9	16.7	17.3			
20	10.5	14.3	17.0			
21	6.1	8.3	10.0			
SLOPE	**-2.86**	**-3.08**	**-2.33**	**-3.06**	**-4.37**	**-3.46**
MAX	**76.47**	**78.60**	**65.90**	**48.70**	**80.10**	**73.00**
MIN	**6.12**	**8.30**	**10.00**	**12.30**	**49.50**	**33.00**
STDEV	**0.19**	**0.19**	**0.15**	**0.14**	**0.11**	**0.13**
R2ADJ.	**0.84**	**0.97**	**0.96**	**0.95**	**0.96**	**0.99**



3.7 SHARE OF SALES BASED ON NEW PRODUCTS

In section 2 we pointed to the weight insensitivity of innovation counts, ie, innovations are of unequal value. The share of sales based on new products is an output measure of innovation activities which partly corrects for the problem of the economic relevance of different innovations. The data for Italy show that as much as 62.5% of sales have not been affected at all by innovation (Evangelista *et al*, 1997, table 8, p 533.). This is characteristic not only of traditional industries but also some of the most typical science based industries (*ibid*). This incremental nature of technical change is a feature specific not only to Italy but to all the EU countries (Calvert *et al*, 1996, p12).

Unfortunately, the sectoral data for sales based on new products which would allow us meaningful comparisons are not available for the CEECs. Hence, we have to restrict ourselves to comparisons at country level. Table 23 compares the shares of innovative products in total sales of innovating enterprises. Three conclusions can be derived from these data. First, the shares of sales based on innovative products are significantly lower in the CEECs than in the EU. This suggest that the innovation driven structural changes in the CEECs are relatively weaker than in the EU despite faster sectoral structural changes in the CEE economies (Urban, 1999). Second, the decrease in the share of innovative products in Poland between the two innovation surveys is compatible with the decrease in the share of innovative firms in Poland. Despite the decrease in both the share of sales based on innovative products and the number of innovative enterprises this did not prevent the Polish economy from growing at 3.9% per year in the period between the two surveys. Third, we cannot compare data for countries where shares are calculated based on new *or* improved products with those countries that have calculated them as sales based on new *and* improved products. The differences between countries where data are grouped differently can be explained only by methodological differences. However, despite this we observe in each of these groups a great similarity in the shares of sales of innovative products which we would not expect taking into account the differences in the economic restructuring between countries. For example, the share of sales based on innovative products in the mid-1990s is higher in Romania than in Poland. The share of sales of innovative products in total sales of innovating enterprises is similar in Slovenia, Russia and Yugoslavia, countries which are in three very different economic situations. This suggest that the levels of shares of sales based on innovative products are not directly linked to the degrees of structural change or growth rates. The relationship between the extent to which industry as a whole has changed and its production output in relation to innovation, and the link between these factors and growth itself is a much more complex than the simple correlations at a country level could reveal.

Table 23: Share of sales of innovative products in total sales of innovating enterprises

Definition	Russia II	Poland I	Poland II	Slovenia	Romania	Yug I	Yug II	EU
New *or* improved products		0.19	0.08		0.19			0.44
New *and* improved products	*0.30*			*0.36*		*0.40*	*0.39*	
Innovative products	0.16							
Radically new products	0.14							
Technologically improved products				0.23				
Technologically new products including radically new				0.12				
Products with incremental improvements						0.20	0.17	
New products and processes						0.20	0.21	

3.8 OBJECTIVES OF INNOVATION

The specificities of an economic environment are shaping innovation not only in terms of its speed but, probably, also in terms of its objectives. The different relative prices, different demand conditions and company strategies should influence the objectives of innovation activities. A specific economic environment of the economies of the CEE with significant changes in relative prices, in supply and demand conditions as well as changes in ownership incentives are likely to have effects on the objectives of innovation.

In Tables 24 and 25 we grouped the objectives of innovation from different innovation surveys for the CEECs and the EU. We normalised them on the same 10-1 scale though the differences between objectives based on frequencies and on intensities should be taken into account. A comparison shows that the objectives are much more similar than we would expect given the differences in the economic conditions. There are several elements that are common to the EU and most of the CEECs.

First, product quality is one of the most important objectives in the EU as well as in the CEECs. The second most frequent objective in the CEE and the EU is an increase in or maintenance of the market share. Extending the product range within the main field is the third most important objective in the EU as well as in the CEECs. This indicates that the enterprises in CEECs do not differ from the enterprises in the EU in terms of the most important objectives of innovation.

Nevertheless, the comparison also shows two interesting differences which support our proposition that differences in the economic environment should have effects on the objectives of innovation. First, the creation of new markets is not as important objective for the EU as for the CEE enterprises. This seems logical in view of the previous closeness of the CEE economies as well as in view of demand problems for the CEE enterprises. Second, among the objectives of reducing production costs there are differences in the importance of wages, energy and material costs. In the EU firms, the importance of the reduction of the share of wage costs ranks very high while in the CEE the reduction of material and energy consumption stands as a much more important objective.

The comparison also shows that in both, the CEE and the EU, the objectives of quality, market share and product range are relatively more important than the innovation activities to reduce costs. From this we could hypothesise that in both, the EU and CEE, the dominant type of competition is Schumpeterian (market share, quality) or Smithian (product differentiation) rather than Ricardian type of competition based on prices.

Table 24: Objectives of innovation*

		Russia II[c]	Poland II[b]	Hungary	Russia II	Slovenia	EU[e]
		Ranking based on frequencies			*Based on intensities*		
Preserving position on domestic mkt	MSH1	**10**			**4**		
Increasing or maintaining market share[d]	MSH1/2		**10**			**10**	**9**
Creating new markets	MSH2		**3**		**9**		
Creating new markets nationally	MSH2	**9**		**8**			**6**
Create new markets within EU	MSH2			**5**			**6**
Creating new markets in CIS	MSH2	**7**					
Creating new markets in other countries[f]	MSH2	**2**					**1**
Improve product quality	PQ	**9**	**7**	**10**	**10**	**9**	**10**
Extending the product range	PR		**3**			**8**	
Extend product range within main product field	PR	**9**		**9**			**9**
Extend product range outside main product field	PR	**2**		**7**		**4**	**3**
Replace products being phased out	PR	**4**			**4**	**7**	**4**
Low production costs	PC		**3**				
Reducing material consumption	PC	**7**		**5**	**6**	**7**	**5**
Reducing energy consumption	PC	**4**		**3**	**3**	**1**	**1**
Reducing the share of wage costs	PC	**1**			**2**	**1**	**8**
Reducing product design costs	PC						**1**
Improving working condition/safety	E/S	**4**			**7**		**6**
Reducing environmental damage	E/S	**7**		**2**	**5**	**3**	**3**
Improve production flexibility	PF			**6**		**3**	**7**
Other objectives	O			**1**	**1**		

* ranking scale 1-10, 10 - the most important, 1 - the least important
a Applies only to product innovations
b share of innovative rating objective as crucial
c share of enterprises by goal of innovative activity in the total number of innovating enterprises, 1995
d for Slovenia 'Preserving market share'
e Average ranking based on the number of countries that answered, scale 1-17
f For Russia and EU the indicator is the average of indicators based on rankings of export to North America, EU, SE Asia and other countries

Table 25: Top five objectives of innovation

Russia II[c]	**Poland II**[b]	**Hungary**	**Russia II**	**Slovenia**	**EU**[e]
ranking based on frequencies	ranking based on frequencies		based on intensities		
MSH1	**MSH1/2**	**PQ**	**PQ**	**MSH1/2**	**PQ**
MSH2/PQ/PR	**PQ**	**PR**	**MSH2**	**PQ**	**MSH1/2**
PC/PC/E/S	**MSH2/PC/PR**	**MSH2**	**MSH1**	**PR**	**PR**
		PR	**E/S**	**PC/PR**	**PC**
		PF	**PC**	**PR**	**PF**

a Applies only to product innovations
b share of innovative rating objective as crucial
c share of enterprises by goal of innovative activity in the total number of innovating enterprises, 1995
d for Slovenia 'Preserving market share'
e Average ranking based on the number of countries that answered, scale 1-17
f For Russia and EU the indicator is the average of indicators based on rankings of export to North America, EU, SE Asia and other countries

We also used the Polish data which have disaggregated objectives across public and private enterprises to explore whether the ownership variable has an impact on the objectives of innovation. The analysis of variance in Table 26 and the correlation coefficient of 0.97 show that the differences in ownership are not linked to differences in innovation objectives. Both, public and private enterprises, follow a similar mode of competition. Whether enterprises are private or public they pursue almost identical objectives in innovation activities.

Table 26: Objectives of innovation in Poland II, 1994-96 (%)

	Public	***Private***	***Difference***
Replacing products being phased out	**29**	24	5
Extending products range	60	**68**	-8
Increase/maintain market share	78	**81**	-3
Creating new markets	62	**66**	-4
Lower production costs	**67**	62	5
Reducing environmental pollution	**51**	40	11
Improving product quality	73	**77**	-4
Improving working conditions/safety	**51**	50	1
Other objectives	**10**	10	0

Single factor analysis of variance between the objectives of innovation and ownership

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.834711	8	0.104339	**67.8014**	3.89E-07	3.229587
Within Groups	0.01385	9	0.001539			
Total	0.848561	17				
R2	**0.98**					

3.9 SOURCES OF INFORMATION FOR INNOVATION

An important feature of innovation surveys is the opportunity to explore the sectoral and national differences in the sources of ideas and knowledge for innovation. Although these sources are strongly industry specific the use of national data enable us to analyse whether there are important institutional differences between the EU and the CEECs in the sources of knowledge for innovation. Table 27 shows that there are no significant differences in this respect, ie, the sources of information for innovation are not nationally specific. Internal sources and customers are the main source of information for innovation in both, the EU and CEE. This confirms that the survival of the CEE firms depends on the market and hence the important role of clients. Fairs and exhibitions stand as the third most important source of innovation ideas indicating the important role of networks as well as markets, in the innovation process.

Table 27: Ranking of sources of ideas/information for innovation*

	Poland II[a]	Hungary[b]	Slovenia[c]	EU
	Based on frequencies		*Based on intensities*	
INTERNAL SOURCES	**10**	**10**	**9**	**9**
EXTERNAL SOURCES	**8**			
Customers/clients			**10**	**10**
- domestic		**10**		
- foreign		**9**		
Competitors			**9**	**6**
- domestic		**6**		
- foreign		**5**		
Suppliers			**6**	
- of materials and components		**4**		**7**
- of equipment		**5**		**8**
GENERALLY AVAILABLE INFORMATION	**7**			**0**
Fairs, exhibitions			**7**	**8**
- domestic		**9**		
- foreign		**8**		
Conferences, journals			**5**	**5**
Conferences				
- domestic		**7**		
- foreign		**8**		
Journals				
- domestic		**6**		
- foreign		**8**		
Patents			**4**	**2**
- domestic		**3**		
- foreign		**3**		
OTHER EXTERNAL SOURCES	**5**			
Other organisations				
Consultancies			**1**	**3**
- domestic				
- foreign		**1**		
Other firms e				
EU programmes			**4**	
Universities	**3**	**5**	**4**	**3**
Academy of Sciences	**2**			
Government labs/AoS		**2**		**1**
Technical institutes				**4**
Technology transfer organisations		**2**		
Professional orgs, chambers				
- domestic		**4**		
- foreign		**1**		
Other external sources				

* Ranking normalised to the scale 10-1, 10 = most often; 1=the least present

a - Proportion of firms ranking source as crucial

b - Proportion of firms with answer 'very significant' and 'crucial'

c - The importance of sources ranked on the scale from 0 - 3

d - Proportion of firms with answer 'important' and 'very important'

e - Licences, patents, technical know how of foreign enterprises

We can assess better this convergence of the CEE economies in the source of ideas for innovation if we take into account that only 10 years ago these were relatively closed economies with very different sources of innovative knowledge. The example of Yugoslavia may again serve as an illustration since there we have an inverse shift from an open to a closed (isolated) economy. In Table 28, we ranked the importance of different sources of innovation and in graph 2 we plotted changes in ranks between the two Serbian (Yugoslav) surveys. A picture that emerges shows:

- increased importance of internal sources, especially R&D, as enterprises lose opportunities to purchase inputs and reserve parts freely from abroad;
- the relative importance of all external sources of information (competitors, clients or suppliers) also increases as the opportunities for free trade get reduced;
- the ability to acquire previously generally available information decreases as the access to networks like exhibitions, fairs, conferences becomes difficult, if not impossible. However, journals as the only available channel of contact to developments abroad remain among the most important sources;
- with the shrinking of domestic economic activities the role of some parts of the domestic knowledge networks is reduced.

Although the use of the Yugoslav shift from an open to a closed (isolated) economy cannot serve as a full control case due to the specific situation of international isolation it does shows that the sources of information ideas are not independent of the economic environment in which companies operate. A change in the openness of the economic environment changes the relative importance of sources of knowledge for innovation. A convergence in information sources for innovation of the CEECs to the EU suggests an increasing convergence in terms of features of market competition (see section 3.8).

3.10 FACTORS WHICH HAMPER INNOVATIVE ACTIVITIES

Similar to the objectives of innovation we expect that the factors that hamper innovation activities should carry strong features of the economic environment in which enterprises operate. Hence, we want to explore to what extent the differences in the economic environments between the EU and the CEECs are shaping the factors that hamper innovative activities. From Table 29 and its summary in Table 30 we can derive several conclusions. First, internal financial factors are the most important in the CEECs as well as in the EU. External financial factors are considered to be the second most important factor deterring the pace and scale of innovative activities. So, as with the objectives of innovations and the sources of ideas for their development there are not significant differences between the EU and the CEE enterprises.

Table 28: The importance of different sources for innovation in open and isolated economy Ranking normalised to scale 10-1*

	Yugos I[a]	Yugos II[a]
INTERNAL SOURCES		
Administration	3	5
R&D department	8	10
Marketing	8	8
Production	5	6
Other internal sources	1	2
EXTERNAL SOURCES		
Customers/clients	9	9
Competitors	6	7
Suppliers	3	3
GENERALLY AVAILABLE INFORMATION		
Fairs, exhibitions	9	8
Conferences	8	8
Journals	10	9
Patents	5	4
OTHER EXTERNAL SOURCES		
Consultancies	1	4
Software firms	3	3
Other firms[e]	5	3
Universities	6	6
R&D institutes/Technic inst	7	6
Technology transfer organisations	3	2
Other external sources	4	2

* 10=the most important; 1=the least important
** Differences between Table 28 and graph 2 are due to rounding of figures in Table 28

Source: Recalculated based on Kutlaca (1999)

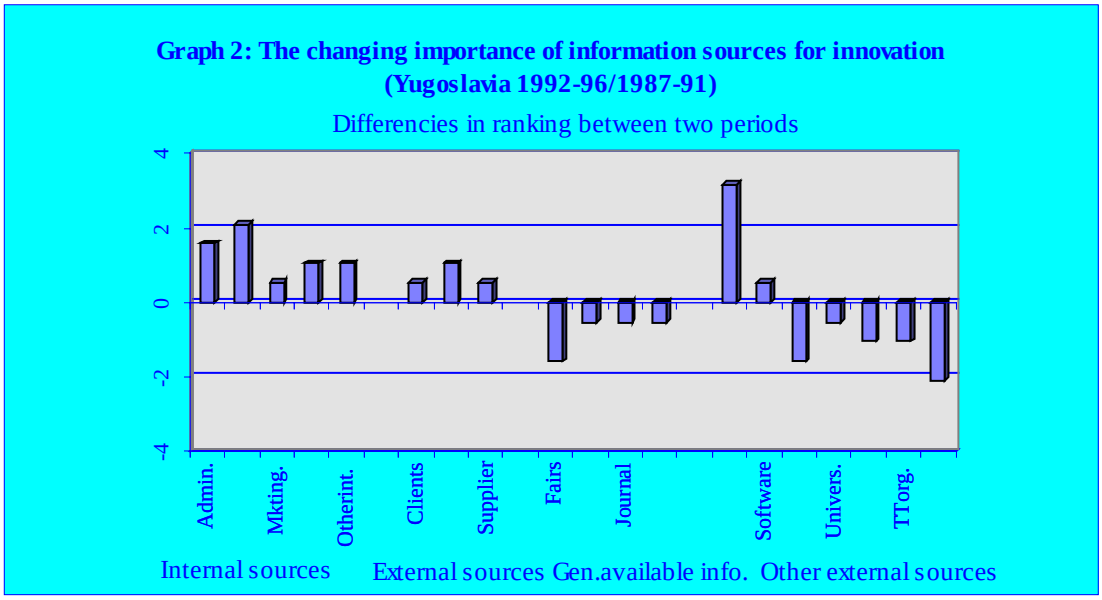


Table 29: Factors which hamper innovation activities (normalised to 10-1 scale)*

			Ranking based on frequencies					*Based on intensities*	
			Russia[f]	**Poland I[d]**	**Bulgaria[a]**	**Hungary[c]**	**Romania**	**Slovenia[b]**	**EU**
Lack of appropriate sources of finance	I	F	10	10	10	10		10	9
Financial difficulties	I/E	F					10		
Innovation costs too high	I	F			8				10
Pay off period too long	I	F			8	9			9
R&D expenditures too small	I	F			9				
Poor R&D basis[g]	I	T		3		8			8
Lack of skilled personnel[e]	I	T	1		1	3	5	9	7
Poor understanding of demand/market	I	MNG		2					
Qualitative weakness of own R&D	I	MNG			6				
Innovation costs too hard to control	I	MNG			3	6			6
Env inside the enterprise	I	MNG						4	
Organisational weaknesses	I	MNG				6			
Innovation management weaknesses	I	MNG				5			
Resistance to change in enterpr	I	MNG				2			1
Uncertainty in timing of innovation	I	MNG				5			2
High cost of loans	E	F	9	8					
Shortage of budgetary funds	E	F							
Insufficient state orders	E	F	8						
High economic risk	E	EC		7	7	7		8	
Excessive perceived risk	E	EC	6						8
Difficulties in supply	E	EC	2						
Lack of demand	E	EC	7						
High rate of inflation	E	EC							

			Ranking based on frequencies					*Based on intensities*		
			Russia[f]	**Poland I[d]**	**Bulgaria[a]**	**Hungary[c]**	**Romania**	**Slovenia[b]**	**EU**	
Lack of compet dom R&D inst	E	T	4							
Lack of technological opportunities	E	T				7				
Innovation too easy to copy	E	T				3			4	
Lack of info on (foreign) technol	E	MKT	3		3	3	8	4	4	
Deficiencies in the ext techn services	E	MKT			3	5			1	
Lack of customer response to new prods	E	MKT						6	5	
Lack of informat on markets	I	MNG			5	6		6	6	
Lack of opport for co-operation with other firms/orgs			E	INST			5	2		3
Laws, standards	E	INST				8		1	4	
Ownership structure	E	INST						1		
Others				5		1	3		3	

* 10 = the most important (the most often present); 1= the least important (present)

a - proportion of responses ranked as 'often'
b - based on ranking from 0 (not important) - 3 (decisive)
c - proportion of firms with answers 'very significant' and 'crucial'
d - in proportion of responding enterprises
e - in Romania, difficulties with personnel
f - source: ACIP, 1996
g - Alternative: Enterprises innovation potential too small

Table 30: The most important generic factors which hamper innovation activities*

	Ranking based on frequencies					*Based on intensities*	
	Russia	***Poland I[d]***	***Bulgaria[a]***	***Hungary[c]***	***Romania***	***Slovenia[b]***	***EU***
Lack of approp sources of finance	IF	IF	IF	IF	I/E F	IF	IF
Financial difficulties	E F	E F	IF	IF	E MKT	IT	IF
Innovation costs too high	E F	E EC	IF	IF	IT	E EC	IF
Pay off period too long	E EC	O	IF	IT	O	E MKT	E EC
R&D expenditures too small	E EC	I T	E EC	E INST	-	E MKT	IT

Legend:

I = internal
E = external
F = finance
MNG = management
EC = economic
MKT = market
INST = institutional

a - proportion of responses ranked as 'often'
b - based on ranking from 0 (not important) - 3 (decisive)
c - proportion of firms with answers 'very significant' and 'crucial'
d - in proportion of responding enterprises
e - in Romania, difficulties with personnel
f - source: ACIP, 1996
g - Alternative*:* Enterprises innovation potential too small

The most important difference with the EU is that the CEE enterprises underestimate the magnitude of internal factors as those hampering innovation activities. For example, in the Russian survey internal management weaknesses are not even mentioned as a problem. Inzelt (1999) points to an inherent bias of postal surveys which underestimate the state of internal factors hampering innovation. This becomes obvious during the interviews following the postal surveys. However, this cognitive bias should be present in both, the CEE and the EU, countries to a similar extent. This may suggest that underestimation of internal factors is relative to the importance of the external factors.

The ranking of hampering factors in the EU shows that among the top five only one external factor (excessive perceived risk) is reported. If we take into account that this factor is not fully 'external' but greatly depends on the internal financial situation of the enterprises than the difference becomes significant. In contrast, in the CEE economies external hampering factors are much more common (see Table 30). In Russia, among the top five factors, four are of the external character. The role of internal factors among the CEECs is much less important in Bulgaria and Hungary. However, the small scale of surveys in these two countries leads us to believe that they do not truly represent the situation.

This suggest that CEE enterprise do not underestimate the role of internal weaknesses but the external financial constraints for innovation are relatively much greater than in the EU economies.

4 CONCLUSIONS AND SUMMARY

The paper analysed the differences in patterns of technical change among the CEECs as well as between the CEECs and the EU by using the data form several CEE innovation surveys and the CIS. As pointed out in section 2, analysis based on inter-country comparisons of innovation surveys faces serious methodological problems and interpretative shortcomings. Therefore, our conclusions relate not only to an understanding of innovation activities in the CEECs but also to the methodological aspects of innovation surveys as statistical tools.

Given the discussed methodological problems of innovation surveys, and the small number of the CEE countries analysed, our conclusions should be considered as highly exploratory rather than conclusive. However, even being of this nature they improve our understanding of technical change in the CEE.

4.1 Among a great number of findings based on very different degrees of empirical evidence we list below those that seems to be the most important:

- the share of innovative enterprises in the CEECs is at the bottom of the EU league reflecting a limited scale of innovative activities in these countries;
- using the example of Russia we showed that the determinants of innovative activity are extra-mural and intra-mural, suggesting that the innovation system in the CEECs is still characterised by a strong role of extra-mural R&D organisations;
- the shares of innovative firms in the CEECs are related to their economic recovery but not to the share of sales based on new innovative products. This suggest that the link between different input and output indicators is a complex and needs further investigation;
- the shares of innovative enterprises in Poland and Russia are decreasing indicating, probably, a decrease in search efforts which characterised all the CEE economies at the outset of transition;

- the structure of innovation expenditures of the CEECs is different from the EU cost structure in two important respects. The CEECs purchase relatively more embodied technology than the EU; they spend relatively more on patents and licences; and have a lower share of R&D expenditures in total innovation expenditures. However, we were unable to disentangle the full structure of the intangible innovation expenditures.
- the share of enterprises with R&D activities is significantly lower in the CEE than in the EU countries. This is compatible with a low shares of innovative enterprises and the lower share of R&D in innovation costs.
- the patterns of sectoral shares of innovative activities are nationally specific. Differences in industrial classifications do not allow us to make a full analysis of these differences.
- product innovations are somewhat more frequent than process innovations but there is also a strong correlation between them. This situation is the converse to that in the socialist period when according to Berliner (1976) and Gomulka (1986) product innovation was much less frequent than process innovation.
- the shares of sales based on innovative products in the CEECs are lower than in the EU but their levels and changes are not related to growth and restructuring of individual countries. Why this link is not present at a country level would require further research.
- the main objectives of innovation activities between the CEE and the EU are similar, with product quality, market share and extensions of product range being at the top of the list in both cases. Also, objectives related to market share, quality and product differentiation in both cases rank much higher than those related to production costs. Differences in objectives seem to be secondary and they are present in the more important role of new markets for the CEECs and of reduction of costs of material and energy rather than wages as in the EU.
- sources of ideas for innovation in the CEECs and the EU are rather similar with clients and internal sources being the most important;
- among the factors that hamper innovation, internal factors are the most important in the EU while in the CEECs external financial and other constraints are the most important

4.2 A comparison with the EU innovation survey shows several important factors of similarity as well as differences. The most important differences come from differences in the development levels. These are differences in:

- the lower share of innovative enterprises, of R&D expenditures, and of firms with R&D expenditures in the CEE than in the EU;
- the higher share of expenditures for embodied technology, patents and licences in the CEE than in the EU;
- nationally specific sectoral differences in innovation intensities;

The economic system specific differences are of lesser importance in new markets, energy and material costs as objectives in innovation, and in the differences in the relative weight of internal vs external factors that hamper innovation.

Similarities in innovation activities between the EU and the CEE come either from features of the innovation process that are present in all market economies or from convergence in the innovation process of the CEECs in their assimilation of features of market economies. These similarities are in the:

- higher innovation intensity of large firms;
- similarly skewed distributions of sectoral innovation intensities;
- the main objectives of innovation activities;
- sources of innovative ideas.

4.3 The analysis has generated also several methodological insights that are relevant for further comparative research based on the innovation surveys:

- the share of enterprises and the structure of innovation expenditures have turned out to be much more robust indicators of national and developmental differences than initially expected.
- ensuring the comparability of definitions and the reduction of the subjective nature of responses are essential for further comparative work based on innovation surveys.
- the link between the shares of enterprises and shares of sales based on new innovative products, and their link to economic growth and restructuring needs to be explored further through sectoral and national level data.

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