

### 3.3 Workpackage 3

#### R&D INPUTS AND OUTPUTS AS DETERMINANTS OF PRODUCTIVITY GROWTH IN CEECS

The objective of research in **workpackage 3** is to determine and compare the role of R&D in CEECs for productivity levels and growth. The research was conducted by Slavo Radošević from the UCL. To achieve these objectives, analysis focuses on two separate fields: first, assessment of the determinants of levels of R&D expenditure and employment in individual CEECs. Second, assessment and comparison of the levels of efficiency of R&D in individual CEECs.

Research undertaken within this workpackage has been substantial, especially given the overall volume of only 8 person months dedicated to this workpackage. We were able to answer fully the second research question. The first objective has been framed within the broader framework of national innovation capacity rather than within the narrow focus on only R&D. This corresponds to the latest research in the contemporary state-of-the-art.

##### WP 3.1.1 R&D within 'broad' and 'narrow' national systems of innovation (NSIs) in CEE

Our first stage of research is broad, conceptual and based on an extensive literature review. At this stage, we analyse the prospects for science and technology (S&T) and economic growth in CEECs from a broad perspective, in which S&T is seen but a part of 'broad' national systems of innovation (NSIs). We hence distinguish between 'narrow' and 'broad' systems of innovation. The NSI in a narrow sense embraces those institutions which are directly involved in R&D and the dissemination of the results of R&D. The NSI in a broad sense embraces the social, economic and political context of technical and organisational innovation (Freeman, 1999, 2004). 'Narrow' and 'broad' national systems of innovation are interrelated but 'narrow' NSIs also has a certain degree of autonomy (Freeman, 1999). This distinction is an important one, as it explains why changes in 'narrow' NSIs are not immediately reflected in 'broad' NSIs and subsequently in economic growth and recovery and *vice versa*. In addition, the relationship between the narrow and broad systems is particularly specific in CEECs because of the considerable tension between the high 'catch-up' potential, indicated by the large sizes of R&D capacities and human capital, and the still sluggish outcomes in terms of growth and restructuring.

'Narrow' NSIs in CEECs are undergoing extensive functional, organisational, and financial restructuring (see Meske *et al.*, 1998 for evidence). However, despite these changes, the key weakness of the CEECs and of the other post-socialist systems remains the failure to reintegrate industrial institutes into enterprises [see several chapters in Meske, 2002]. Industrial enterprises that are short of long-term finance and that face fierce competition in foreign markets are not able to generate demand for more upstream activities like R&D. In such a situation R&D is perceived as a liability rather than an asset both at firm and macro level (Meske,2002). At firm level, it has been perceived as drain on cash flow without immediate direct benefits while at macro level support to industrial R&D has been perceived as breach of new role of state confined to market failure support.

During the 1990s, the main sources of technology were imports of capital goods and FDI. Endogenously generated R&D and technology then played a marginal role in the industrial upgrading of CEECs. The current patterns of industrial upgrading,

Important distinction  
between broad and  
narrow NSIs

Tension between the  
high 'catch-up'  
potentials in narrow  
NSIs and still  
sluggish outcomes

Lack of demand for  
R&D in industry

R&D perceived  
as a liability at the firm  
level

which are most often led by foreign enterprises, will eventually reach their limits without domestically generated R&D and technology. The lack of domestic in-house R&D cannot be fully offset by extra-mural or foreign R&D. The weaknesses in 'narrow' NSIs will become visible through inadequate in-house R&D, weak university - industry links and the lack of technological co-operation among enterprises. In order to grow, these economies will have to generate their own innovation dynamics in order to complement imported technologies. These innovation dynamics will have to be driven by local enterprises committed to R&D and innovation.

'Narrow' NSIs cannot be ignored if CEECs are to continue to grow and restructure. This might be possible for a limited period, as was the case during the transformational crisis of the 1990s. However, it is unlikely that CEECs can continue their industrial upgrading without restructuring their 'narrow' NSIs, which play a very important role in the development of technological capabilities in any economy. Its role cannot be reduced to the direct provision of technical information to industry. Research systems have several functions that are important for industrial upgrading, of which the provision of new and useful information is only one. Other functions include the creation of new instrumentation and methodologies, the provision of skills developed by engaging in research, participation in research networks, the resolution of complex technological problems and the establishment of spin-offs (Martin and Salter, 1996).

What we find today in CEE are fragments of the old R&D systems which are trying to adjust by adopting a variety of survival strategies, together with new pockets of innovation activities. We describe this system as the post-socialist or post-Soviet R&D system. Industrial research institutes have been left to their own devices and are slowly reinventing themselves as service firms or industrial enterprises. Academies of Sciences institutes, attracted by government funding as the only stable source, are shifting towards basic research. Universities are trying to build a new position based on the stability they derive from teaching and by reorienting towards research. Where they exist, in-house R&D departments are oriented towards their own needs and are trying to build up links with foreign sources of innovation. Domestic subsidiaries of foreign MNCs are entirely oriented towards the parent company in all the most important functions, including R&D, finance and marketing. Intra-organisational restructuring, that is the splitting of institutes into smaller organisations or the creation of spin-offs attached to institutes, has prevailed over inter-organisational restructuring involving several organisations from different sectors such as manufacturing industry, universities, academies, or industrial institutes.

In terms of the institutional superstructure, all CEECs have a developed S&T system with a large number of R&D institutes. In terms of organisational structure, however, their S&T systems are far from fully developed. However, the extensive institutional infrastructure in CEE still has to contend with very low demand for its activities due to weaknesses at the enterprise level. Weakness in the reconstitution of enterprises as the main network organizers of innovation processes is hindering the restructuring and development of 'narrow' NSIs. The building of future NSIs will depend on how this process progresses in the various countries. The increasing divergence in terms of growth and restructuring between 'western' (central Europe and Baltic) and 'eastern' CEECs (Bulgaria, Romania and European CIS) suggests that the reconstitution of enterprises as the main actors in the innovation process may lead to a faster emergence of NSIs in central Europe. The reason for that is partly historical,

Post-socialist  
narrow NSIs  
of today...

...are highly developed  
in terms of institutional  
superstructure...

...but weak in  
organisational  
structure

as these countries, especially Hungary, the Czech Republic and Slovakia, have inherited a larger share of enterprises with in-house R&D activities from the socialist period. Moreover, 'in-house' R&D in some large enterprises survived the period of drastic cuts in R&D activities at the start of the transition process. Another reason is that these economies have experienced significantly higher levels of FDI and the process of Europeanization is far more advanced in their R&D systems and in their economies in general, as a result of the pre-accession process.

The establishment of a conducive environment by putting in place the necessary elements of 'broad' NSIs (privatization, finance, legal protection, communication infrastructure *etc.*) strongly influences enterprises' innovation activities. In the transition period, they were actually more decisive in this respect than 'narrow' NSIs. On the other hand, the new NSIs is also likely to be shaped by the way enterprises embody innovation activities. However, this process is not entirely micro or macro-driven. As Nelson (1997) argues, it is a mistake to ask whether it is national factors or strong firms that create comparative advantages, since in those cases where the national institutional environment or legal structures, or specific policies, seem to have made a big difference, one also sees firms effectively taking advantage of the potential. While firms take advantage of favourable national factors they themselves also upgrade national factors. This explains why it is difficult to foresee which countries among the CEECs will catch up and which will fall behind.

It is not yet clear what national systems of innovation are emerging in the CEECs. These systems are far from being fully formed and it would be more appropriate to search first for signs of the emergence of sectoral innovation systems. Sectoral innovation systems are groupings of enterprises and their related networks of public and private institutions that are involved in the development, diffusion and utilization of innovation. These systems will strongly shape the character of NSIs in CEE. Based on the current patterns of production networks in CEECs it seems that these systems will be very heterogeneous. In some countries, such as Hungary, NSIs may be based more on foreign enterprises. In Russia, they may be formed around large domestic industrial groups (Freinkman, 1995; Perotti and Gelfer, 1999; Popova, 1998). In countries like Estonia, they may be formed around small enterprises. In other countries, the NSIs could be dualistic in character, with sub sectors of small and large firms being unrelated to each other or with weak links between domestic and foreign firms. In some cases, they may be based on a few strong regions which are the drivers of growth. In these cases, the NSIs could be strongly shaped by a few regional systems of innovation. Alternatively, NSIs could be formed around one or two sectors in which the innovation process is developed on a collective basis, while in the rest of the economy the innovation links are very weak. For the time being, the innovation dynamic is strongest among foreign enterprises. Our conclusion is that this is the greatest strength but also, potentially, the greatest long-term weakness of the CEECs that have attracted large volumes of FDI. The way CEECs integrate into international production and innovation networks will strongly shape their NSIs.

During the 1990s, the integration process evolved between the two extremes of strongly foreign and strongly domestically-led technical modernization. Long-term growth can be achieved only when there is balance and complementarity between these two modes of modernization. This balance has been and will continue to be influenced by the way the state influences the interaction between domestic firms and Multi-national companies (MNCs) in 'narrow' NSIs, especially in sectors where regulations are important (pharmaceuticals, telecoms, energy). At present, it is

**Effective systems  
depend both on  
developed broad and  
narrow NSIs**

**Sector and country-  
specific NSIs  
in CEE...**

**...with FDI subsidiaries  
currently playing a  
leading role**

foreign enterprises that are exerting the strongest influence on the shaping of production networks in almost all CEECs. Moreover, innovation activities are emerging through various forms of alliances with foreign firms. However, this process of interaction between domestic and foreign capital is mediated by the state. This introduces an important political or control dimension to the process of technical modernization, which will have implications for the nature of the emerging NSIs in CEECs (Kuznetsova and Kuznetsov, 1999; Hayri and McDermott, 1998).

Transition policies have been far from sufficient for building 'narrow' NSIs, which in all countries are hybrid systems and require public-private cooperation. So far, the dominant response in most of the CEECs has been to radically reduce public funding but without any clear idea of what the new public R&D system should look like. The lack of active restructuring and the inability to formulate a coherent long-term policy in R&D could have been justified in the early years of transition, when a sharp decline in funding made orderly restructuring impossible. However, a wait-and-see policy on 'narrow' NSIs, especially in relation to industrial R&D, has become counterproductive because of the costs incurred.

In all CEECs, the responses to restructuring are still weak although they vary greatly from country to country. In CEECs, Europeanization is the major component of the restructuring process. It has already reinvigorated S&T and innovation policy in these countries and is likely to have significant positive effects on the restructuring of their S&T systems. In that respect, Europeanization may have a greater effect on the building of NSIs in CEECs than public policy.

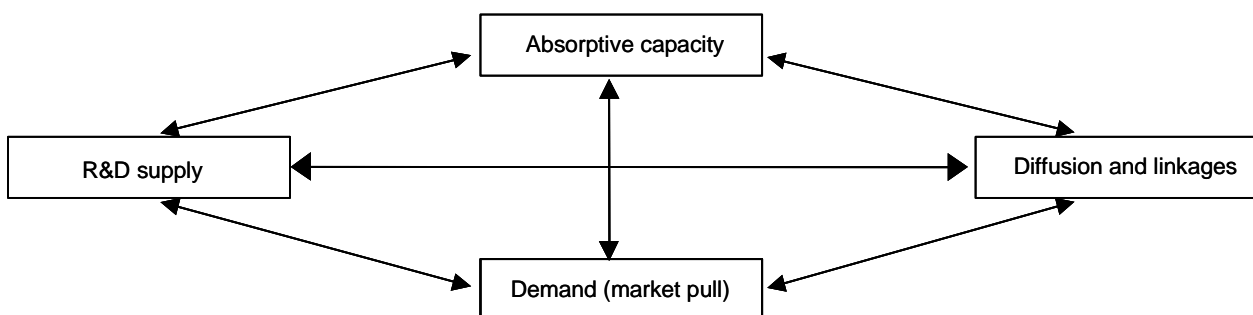
After 10 years of pursuing the transition policy agenda, CEECs are now searching for alternative policy solutions that will also address the problem of their technological competitiveness. In that respect, Europeanization comes as a time when the reinvigoration of policy under EU influence can be effectively coupled with the endogenous search for new policy solutions that try to address technology and innovation.

The role of policies in building efficient NSIs...

...and in particular the Europeanization process

*WP 3.1.2 Measuring R&D and national innovation capacity in the enlarged Europe*

In the second stage we move from broad, conceptual, and exploratory to a more detailed statistical examination of national innovation capacities of CEECs, and within that in particular of R&D capacities.



**Figure WP 3.1 National innovation capacity (NIC) framework**

We have developed a new concept, national innovation capacity, which represents a robust conceptual framework for understanding the factors that determine productivity and technical change. National innovation capacity (NIC) consists of

National innovation capacities (NICs) ...

absorptive, R&D, diffusion, and demand capacity. This concept is proxied by 25 indicators which assess the capacity for growth based on S&T and innovation.

This intermediate line in research falls in-between overly aggregate approaches of new and neo-classical growth theory on one hand, and case studies and exclusively micro-approaches on the other. By using a large number of indicators derived from the perspective of national systems of innovation, the conceptual framework for national innovation capacities is able to reflect the multi-dimensional nature of innovation capacities while retaining analysis at macro level. Following the national innovation system approach we organize indicators into four groups (R&D supply, absorptive capacity, diffusion, and demand). What underpins this grouping is the assumption that growth and innovation capacities of any given economy depends not only on the supply of R&D but also on the capability to absorb and diffuse technology and on demand for its generation and utilisation.

As a conceptual framework, the NIC carries significant power in explaining variations in labour productivity across different economies. Individual components of NIC also carry significant explanatory power in relation to labour productivity. However, regression results become poor when individual components of NIC are grouped together. This suggests that there is intense interaction between the different dimensions of NIC.

Pooling together CEECs with EU-15 countries lets the NIC index shift downwards. However, the range of values of NIC-coefficients is higher amongst the EU-15 members than between CEECs. The large range across the EU-15 suggests that we will find an even more complex pattern of innovation capacities within the enlarged EU. The ranking of countries does not follow a simple 'East-West' divide. In terms of NICs, the enlarged European space can be structured into three groups, of which CEECs are members of two. Those are incidentally the less and medium developed countries of Western Europe. The less advanced CEECs exhibit NIC-values that belong to a cluster which includes the EU cohesion countries, while the four most advanced CEECs are more similar to the group of medium developed West European countries.

Our clustering exercise of capacities for demand for innovation shows that here, CEECs are the most homogeneous but also the weakest: demand conditions for innovation are unfavourable across the entire region. South European countries (Greece, Portugal, Spain, and Italy) are located somewhere within the CEE range of countries. This ranking raises interesting issues regarding the differences between income per capita levels and NICs, and raises interesting issues regarding the potentials of advanced CEECs for catching up to the income levels of the Western cohesion countries.

What distinguishes the advanced from less advanced CEECs are better absorptive capacities and R&D capabilities, while in terms of diffusion and particularly demand, capacity differences are much smaller. Potentials for catch-up to the cohesion EU levels of income is very high for the four top CEECs in terms of NIC (Estonia, Slovenia, Czech Republic, and Hungary). The clustering analysis shows that in terms of NICs, the four advanced CEECs are actually more similar to the 'average EU' group than to the cohesion EU group. Here, relatively advanced absorptive and diffusion capacities, but not R&D (except Slovenia) and demand capacities seem to be decisive for their clustering close to medium level EU countries in terms of NICs. Less advanced CEECs are more similar to the cohesion EU than the cohesion EU

... as an empirical concept of national innovation systems

Predictive power of NIC

Interaction between components of NIC

NICs in CEECs are lower than in average EU-15...

...yet differences do not follow a simple East-West divide

Potentials for catch-up according to NICs are largest in Estonia, Slovenia, Czech Republic and Hungary

countries NICs' are similar to medium and developed EU. However, in terms of levels of individual indicators most of the less advanced CEECs are behind the cohesion EU.

CEECs are relatively well placed within the wider Europe in terms of absorptive capacities which is the combined result of education and training indicators and the high share of employment in high tech sectors. If we take similarity to the EU-NICs as the main criteria, then the policy priorities for the CEE in order of priority would be: demand, R&D and diffusion. However, analytically based policy-prescriptions have to be country-specific: the points of departure for respective national policies are their own gaps in individual dimensions of NIC. For example, Slovenia is relatively better in R&D and absorptive capacities than in diffusion and demand capacities; Estonia is the only CEEC with positive demand and diffusion coefficients; although its weakness is in R&D, Estonia has the best potential for catching up if we take NICs as the criteria, because her strengths correspond best to the order of priority listed above.

From a policy perspective, the NIC framework hence suggests that innovation is a multidimensional and a multilevel activity. Policy should hence focus on all four dimensions simultaneously. For example, it would be undesirable to focus on absorption to the extent that the overall R&D stock is reduced. The assumption is that countries that spend more on R&D can make better use of foreign technology. Our analysis suggests that the CEECs' absorptive capacities are currently relatively better than their R&D capacities. The latter has become a bottleneck for improving NIC in CEECs after some 10 years of weak demand for R&D.

**Policy should focus on all four dimensions of NICs simultaneously**

Countries that are further behind the technology frontier have more to gain from increasing their R&D efforts since these efforts are more likely to result in capturing international spillovers from technologically advanced countries. In the context of CEE, this would mean that weak R&D should be strengthened much more than is currently perceived by policy makers in these countries. However, weak demand for innovation is the key obstacle to increased R&D. This means the problem cannot be solved by increasing public R&D spending without increased demand for innovation from business sector.

As research above has shown that demand capacity is the weakest dimension of CEECs' NICs, and additionally the only one where the East-West dichotomy is present, we explore the demand issue further in the following.

**Analytical focus on the demand-issue**

Our analysis points to a gap between local demand and supply for R&D and innovation as one of the key issues for long-term growth of the region. Economists are usually concerned with the issues of aggregate (mis)match between market demand and supply, or supply and demand for products. However, demand and supply for products are not identical to demand and supply for technology (R&D and innovation). Technology is an intermediate input and/or output in the economic process. In an increasingly knowledge intensive economy it has become essential to understand economic growth and its structural problems.

The latest data suggests that there is a clear improvement in demand side conditions in CEECs. The problems for innovators and entrepreneurs have now shifted to the supply side, especially to issues of access to credit, own funds, and liquidity of clients, despite indications by companies that clients are now less financially constrained. This may suggest that the problem is not the general lack of liquidity but the mismatch between liquid supply and demand. In addition, firms are increasingly

**Problems appear to have shifted to the supply-side...**

**...in particular to a mismatch between supply and demand for finance**

facing other supply side problems like a shortage of trained workforce, and a lack of technology. This is a quite new phenomenon and suggests that the CEECs are entering into a new stage of entrepreneurship where requirements for growth have become more variegated and related less to finance by itself but increasingly to the quality of supply and matching of supply and demand. From a policy perspective, this points to weak financial systems, insufficient mediation between supply and demand, and to the importance of national innovation systems.

Recovery and growth will be not automatically followed by recovery of demand for domestic R&D and innovation. In fact, some CEE countries may exhaust sources of growth which come from reallocations, closures, and lays offs, and face structural problems of further upgrading. This new threshold level for upgrading will be not exclusively related to the institutional system of market economy which has been addressed through transition-related policies but will be related to the weaknesses of national systems of innovation and their integration with FDI. Any national system of innovation is a system based on public-private and local-global interfaces and interactions. It is the challenge for policy makers to facilitate the emergence of public-private interfaces, which are essential to any market economy.

### *WP 3.1.3 Efficiency of R&D systems in CEE*

In the second part of analysis in this workpackage we explore the relationship between R&D and productivity in CEECs. We again approach the issue of productivity and R&D through the perspective of NSI and again distinguish between 'narrow' and 'broad' systems of innovation. In particular, we distinguish between inefficiencies within narrow and broad innovation systems. Inefficiencies of narrow NSIs emerge in the process of conversion of innovation inputs into innovation outputs. Inefficiencies of broad NSIs are rooted in the conversion process of production and technology inputs into productivity growth.

The issue of 'inefficiencies' in NSIs in CEE is controversial as productivity increases during the 1990s in these economies have been accompanied by declining R&D. This suggests that productivity growth has been generated by non-R&D factors. Naturally, there is a plethora of factors that affect productivity but we are particularly interested in the impact of production and technology capabilities on productivity in these economies. Our analysis is based on OLS econometric testing of productivity-related variables combined with descriptive statistics. In addition to R&D data, we use data on resident patents and ISO 9000 certification as output indicators of technological and production capability respectively. By using these two indicators we generate new insights on the relationships between productivity, production and technological capability in CEE.

Our analysis shows that CEECs have lost some of their advantages in terms of size of R&D which they inherited from the socialist period. The main problem for policy has now reversed as the EC (2004) recommendations point to low R&D investments in most of the countries, low efficiency of R&D systems (Czech Republic, Slovenia) and of education and vocational training systems.

In our regression analysis, productivity differences across OECD and CEE countries are satisfactorily explained by production capabilities in combination with technological capabilities. In this way, our results point to the importance of quality and intra-firm productivity enhancing activities for growth and catch-up.

**Barriers to sustainable growth in future will lie in weaknesses of national systems of innovation and their integration with FDI**

**Efficiency of R&D and NIS...**

**...in narrow and broad systems**

**Today, R&D in CEE is not any more large, but small and still inefficient**

CEECs have lower levels of productivity than would be expected given their R&D capacities, innovation, and production capabilities. This may point to possible inefficiencies in the conversion of R&D and innovation outputs into productivity. We find that these inefficiencies cannot be identified within the 'narrow' national system of innovation but more likely within 'broad' national system of innovation: the problems are not rooted in the narrow S&T systems but in the broader issues of demand for technology. This particularly applies to the relationship between small and large firms and integration of foreign firms into their local economy.

Inefficiencies rooted in broad systems of innovation

**Table WP 3.1 Regression results**

Variable	Const.	BESRDPRSN	RDPRSN	RESPAT	ISOFDI	CEE-DUMMY	Adj. R-sq.	F-stat.	Prob (F-stat)
Coefficient	8.89	0.44		0.07			0.598	21.120	0.000
t-stat	39.99	2.82		0.67					
Probability	0.000	0.009		0.51					
Coefficient	9.06	0.46		0.00		-1.07	0.844	49.509	0.000
t-stat	64.14	4.70		0.01		-6.34			
Probability	0.000	0.000		0.991		0.000			
Coefficient	8.45		0.46	0.19			0.408	10.994	0.000
t-stat	13.47		1.47	1.53					
Probability	0.000		0.152	0.139					
Coefficient	8.63		0.53	0.09		-1.33	0.777	34.602	0.000
t-stat	22.97		2.76	1.18		-0.61			
Probability	0.000		0.011	0.249		0.000			
Coefficient	8.79	0.52			0.00		0.591	20.533	0.000
t-stat	36.99	6.12			0.00				
Probability	0.000	0.000			0.997				
Coefficient	9.04	0.45			0.01	-1.07	0.844	49.550	0.000
t-stat	59.44	8.39			0.13	-6.43			
Probability	0.000	0.000			0.897	0.000			
Coefficient	7.83		0.11		0.27		0.471	13.914	0.000
t-stat	22.66		3.06		3.06				
Probability	0.000		0.000		0.005				
Coefficient	8.05		0.67		0.13	-1.27	0.808	41.579	0.000
t-stat	29.47		6.16		2.41	-6.91			
Probability	0.000		0.000		0.023	0.000			
Coefficient	8.96			0.31	0.16		0.437	13.028	0.000
Std. Error	0.25			0.07	0.09				
Probability	0.000			0.000	0.107				
Coefficient	9.40			0.24	0.10	-1.21	0.745	31.189	0.000
t-stat	51.16			4.72	1.61	-6.00			
Probability	0.000			0.000	0.118	0.000			

Notes: Dependent variable is gross national income per capita in \$PPP (2002). The explanatory variables include BESRDPRSN ... business R&D personnel per 1000 employment (alternatively: RDPRSN...R&D personnel per 1000 employment) (2002 or nearest available year); RESPAT...resident patents per capita (2000); ISOFDI... number of ISO9000 certificates per capita (2002) corrected by share of FDI/GDP (2002 or nearest available year); CEEDUMMY...dummy variable for CEE countries.

Our sample includes 33 OECD/CEE countries (7) with the full model data available for 28 countries.

Sources: For GNI pc, World Bank Development Indicators 2003; for RDPRSN pe and BESRDPRSN pe, OECD Main S&T Indicators Data Base, 2003; for RESPAT pc, WIPO CD ROM; for ISO9000 pc, ISO CD ROM; for FDI, UNCTAD World Investment Report.

The exploration of the most robust of the regression models explaining different levels of productivity generates some interesting conclusions (see table WP 3.1):

- i The only satisfactory model is the one where productivity is determined by overall R&D employment and the number of ISO9000 certificates. Both variables are significant at the 1 *per cent* error probability level and the model explains 47 *per cent* of the variations in levels of productivity. This result confirms our conceptual

Variations in productivity levels best explained by overall R&D employment and number of ISO9000 certificates...

model which points to the importance of technological and production capability for explaining levels of productivity.

- ii The inclusion of a CEEC-dummy greatly improves the overall robustness of the model, although the coefficient for quality certificates then becomes less significant, now only at the 5 *per cent* error probability level. Yet this model explains 80 *per cent* of the variation in levels of productivity across the countries of our analysis.
- iii All models including CEEC-dummies significantly improve the overall robustness of the models (which is confirmed by F-tests). This result was already indicated by the simple regression analysis and it suggests that CEECs contain an important specificity which could be related to 'inefficiencies' or unused potentials within 'broad' or 'narrow' NSIs. This we explored in the later analysis.
- iv The use of R&D personnel exclusively employed in business enterprises plus the number of ISO9000 certificates yields a negative coefficient for the ISO certificates. Partly, this may reflect problems in the Business Enterprise Sector (BES) data for the CEECs due to particularly high shares of extra-mural R&D there. This is inconsistently recorded as business or government R&D in the regression analysis.

...and country-dummies significantly improve the fit of the regression models...

...hence CEECs contain important country-specifics

However, we think that this also reflects different functions of the overall R&D as compared to BES R&D, as well as nature of quality indicators. Namely, ISO Certificates are registered in a large number of non-industry sectors while BES R&D is to a great extent confined to industry, in particular in less developed OECD and CEECs. Overall R&D systems could be used as a proxy for the overall absorptive capability while BES R&D seems to be a better proxy for innovation activities.

- v The model with BES R&D and resident patents shows that these indicators are capturing similar parts of variance in productivity levels which generates high collinearity between these variables. As a result of this we get a high coefficient of determination and insignificant results for resident patents. As the majority of patents are still generated within industry, the high significance of BES R&D employment may be expected. When patent data are used in combination with the overall R&D employment, the size and significance of coefficients for patents improves though they still remain insignificant.
- vi The combined use of output proxies – patents and ISO certificates – generates similar problems of multicollinearity.

In conclusion, the reduced model which explains differences in levels of productivity by differences in technological (R&D employment) and production (ISO9000) capabilities generate satisfactory results. This model points to the need to expand our understanding of determinants of productivity to non-innovation areas, i.e. issues of production capabilities. In addition, our analysis points to problems of the CEECs to generate levels of productivity which would be expected given their levels of investments in R&D and given their levels of production capability-related activities. This suggests that problems may root in 'broad' rather than 'narrow' systems of innovation.

Our analysis suggests that the narrow NSIs of CEECs do not seem to be 'inefficient' in terms of conversion of BES employment into patents. Inefficiencies do not seem to exist within 'narrow' national system of innovation but within 'broad' national innovation system. CEECs have not yet achieved levels of productivity which would

In total, the results suggest that inefficiencies may root in broad rather than narrow NSIs

be expected given their technological and production capabilities. Inefficiency of broad national systems of innovation is however a complex issue which cannot be handled properly even through much more sophisticated econometrics and data sets are available than the ones we have used here. Nevertheless, our analysis has identified several issues which are of importance in improving 'efficiencies' of both broad and narrow NSIs and which we discuss in the last section.

These findings, when interpreted from the perspective of technology-using *versus* technology-developing conceptual models and from the perspective of national systems of innovation, have several policy implications:

- i They point to the importance of production capability, i.e. intra-firm productivity or non-R&D activities. This aspect of policy, which is addressed only through vocational training, is essential for improving absorptive capabilities of the CEECs. By improving absorptive or technology using capabilities, firms can move to technology adopting and developing activities.
- ii The key productivity challenge of CEECs at the firm level is how firms can make the transition from mastery of production to technological capabilities. This process is not automatic and linear, and requires not only changes within firms but also changes in narrow NSIs or innovation infrastructure.
- iii This requires re-orientation of R&D systems from the current exclusive knowledge generation orientation to knowledge diffusion and absorption orientation. The capacity to diffuse knowledge throughout the economy becomes essential for catching-up in a knowledge based economy. By embracing additional functions of knowledge diffusion, (supply side) R&D systems could better match the changing demand requirements for innovation and technology which are generated through broad NSIs.

The issue is to what extent innovation policies of the CEECs have embodied these factors into their policy instruments. Table WP 3.2 summarize the state of innovation policy mechanisms in CEECs by classifying individual instruments according to the aspects of innovation/production capability they address. We group individual instruments according to four components of innovative capacity: absorptive capacity, R&D, diffusion and demand capacities.

This summary illustrates a variety of policy mechanisms across the CEECs. It does not tell us anything about the financial weight of individual instruments. For that, we would have to find the optimal number of instruments by some measure of their financial weight. Nevertheless, data gathered in this form correspond conceptually to our distinction between production (absorptive, diffusion oriented instruments) and technology (R&D) capabilities and it includes demand-oriented instruments which operate as signals for R&D and innovation within broad NSIs.

The assessment of the data in the tables indicate:

- i Policy is much more focused on the generation of new knowledge and diffusion (networking) than on absorptive capacities. The largest number of instruments are oriented towards R&D through traditional R&D programs. They focus on scientific excellence. Instruments oriented towards diffusion of knowledge and networking most often include support to different bridging institutions, like science and innovation parks, whose effectiveness is however still unclear.

**Too much focus on generation of new knowledge rather than on increasing absorptive capacities**

**Table WP 3.2 Summary of innovation policy mechanisms in CEECs (as of end 2003)**

	Absorptive capacity and human capital	Generation of new knowledge (R&D)	Diffusion of knowledge and networking	Demand for innovation
Bulgaria		National R&D programme; National Council for applied studies funding	Support for 6 incubators	Profit tax rate reduced
Czech Republic		National R&D Programme; Programmes Technos; Pokrok; Impulse; Tandem	Programmes: Park ; Transfer, Counselling, Konsorcia	Programmes Credit, Start, Guarantee
Hungary		National R&D Programme; Program TechStart; Support for R&D job creation in SMEs	Network of Cooperative Research Centres; Programme Integrator; Support for patenting abroad	Several R&D and ICT tax credit schemes (4)
Estonia	(Action Plan for Vocational Training System; 20010-04)	R&D Programme of Estonian Science Foundation; ESTAG financing scheme for innovative enterprises and R&D institutes; Co-funding of Eureka projects	Spinno programme; Competence Centres programme; Tiger's Leap programme and Village Road project; Estonian Quality Award project.	Zero profit tax if profit reinvested
Latvia		R&D Programme of Latvian S&T Council	Funding of Latvian Technology Centre and of Electronics Industry Business Centre	Gradual reduction in corporate income tax
Lithuania	Training of entrepreneurs linked to innovation	National R&D programme; Subsidised participation in Eureka program	Support to Lithuanian Innovation centres, Business Innovation centres and Innovation centre of Kaunas Technology University	Reduced profit tax rate
Poland	National systems of support for life long learning	R&D Programme of Ministry for Scientific Research and IT; Funding of Centres of Excellence; FIRE Foundation support for support to commercialisation of R&D	ISO subsidies to SMEs	Financial Support to Investments; Loans for investment and implementation of new technologies by Technology Agency; Reduction of corporate income tax
Romania		National plan for R&D – Relansin; National Fund for technology development for R&D in SMEs	Support for business incubators and SW parks	R&D organisations exempt from VAT; Tax support for innovation – import duties, VAT postponement. Salaries of IT specialists are exempt from taxation; Grant support for SME start-ups
Slovakia		Innovation Fund for applied R&D projects; R&D programme of Academy of Sciences	Support for establishing industrial zones and parks; Support for quality management system	Corporate income tax rate reduction
Slovenia	Programme education for entrepreneurship; Program to increase productivity in large enterprises (20 key business areas); Young Researchers Programme	R&D programme of Ministry for S&T; Co-financing of investments in new technologies; Stimulation of FDI to carry out R&D in companies; Support for the purchase of equipment by private companies to be used at universities for common purposes	Development of spin off incubators at the Universities; Program for encouragement of clustering; Technology centres' support; Promotion of linking enterprises in production chains; Stimulation of internationalisation of SMEs; Co-financing of improvements in technology processes by demonstration	Support for the establishment and growth of young companies; Support for investments in SMEs

Source: Author's compilation based on national Trendchart reports ([www.cordis.lu/trendchart](http://www.cordis.lu/trendchart)) accessed in April 2004.

- ii Second, if we rank countries based on the scope of their operating policy mechanisms i.e. in terms of coverage of all four components, then Slovenia, the Czech Republic, Hungary, and Estonia are situated at the top of the list. In the middle of the range we find the rest of the CEECs with Bulgaria clearly at the bottom end. This shows very differing degrees of development and orientation of innovation policies among CEECs. Slovenia has the most diversified innovation policy in terms of mechanisms that address different components of innovation policy. Hungary, the Czech Republic and Estonia belong to the group with a relatively large number of policy mechanisms. Bulgaria has a very limited number of innovation policy mechanisms.

In a ranking according to our policy predicaments, Slovenia has the most advanced policy mix...

...and Bulgaria the least advanced

**Table WP 3.3 Number of innovation policy mechanisms in CEECs (as of end 2003)**

	Absorptive capacity and human capital	Generation of new knowledge (R&D)	Diffusion of knowledge and networking	Demand for innovation	Total
Bulgaria		1	1	1	3
Czech Republic		4	4	3	11
Hungary		3	3	4	10
Estonia	1	3	5	1	10
Latvia		1	2	1	4
Lithuania	1	2	1	1	5
Poland	1	3	1	3	8
Romania		2	2	4	8
Slovakia		2	2	1	5
Slovenia	3	4	5	2	14
Total	6	25	26	21	78

Source: Author's compilation, based on table WP 3.2.

- iii Third, demand oriented instruments are surprisingly quite numerous in CEECs. These are mainly tax incentives which currently seem redundant and with limited effects given the sharp reductions in corporate tax rates in the run-up to EU accession. Hungary and Romania have the largest number of tax measures which try to induce demand for innovation.
- iv Fourth, absorptive capacity is the area which is the least often addressed by innovation policy. Yet, innovation studies suggest that the production capability or capability to efficiently use existing technologies is the key first step in closing productivity gaps. Slovenia is the only country which has more than just one policy measure to promote absorptive capacities.

Policy in CEECs are ineffectively oriented towards demand-determinants...

...whilst absorptive capacity-oriented policy is rather under-represented

#### WP 3.1.4 Assessing innovation policy in CEECs

We tried to assess whether current innovation policies in the CEECs are able to meet the challenges of growth based on innovation and knowledge based activities. Evaluations of national innovation policies are an inherently difficult exercise. An undeveloped theoretical basis of innovation policy and its multi-dimensional character makes this task quite challenging. Hence, our analysis should be taken as very preliminary and tentative but nevertheless revealing.

Recovery and growth of the CEECs has not led to an automatic recovery of demand for R&D and technology. European Innovation Scoreboard indicators for 2002 show that there has not been a sufficiently strong catching up in innovation based activities. The technology effort in the CEECs is still very much concentrated on mastery of production capabilities. This raises important policy implications.

Insufficient catching up in innovation based activities in CEECs

An overview of innovation policy mechanisms of CEECs shows a variety of levels of developments of CEECs' innovation policies (see tables WP 3.2 and 3.3). These differences reflect different national situations and traditions, as well as different political commitments towards innovation policies. Yest, tables WP 3.2 and 3.3 suggest that among innovation policy mechanisms, R&D and diffusion (networking) are areas which are most frequently addressed. Absorptive capacity is the area the least often addressed by innovation policy. Hungary and Romania have the biggest number of tax measures which try to induce demand for innovation. Slovenia and Estonia have the highest number of policy mechanisms which address diffusion and networking. The Czech Republic and Slovenia have the highest number of policy mechanisms for supporting R&D. Slovenia is the only country which has more than one measure promoting absorptive capacities.

Based on a comparative assessment of innovation polices, we point out to innovation policy challenges which these countries are facing in early 21<sup>st</sup> century.

A limitation of our analysis is that we still cannot explain differences in innovation policies among CEECs. Should causes of differences in the levels of development of innovation policies be sought only in differences in the orientation of innovation policies? Each institutional model is context-dependent and if we want to understand these differences, we would have to take into account also differences in the development, organisation and self-organisation of 'innovation constituencies' (enterprises, associations, public organisations). How strong are organisations that form NSIs, how strongly do they operate in favour of innovation and how successful are they in aligning their interests? These can be important features when trying to explain the level of development of innovation policy. For example, the existence of large enterprises active in business R&D reduces the need for governments and S&T infrastructure to compensate for weak in-house R&D and thus reduces the pressure for innovation policy. An economy dominated by a large number of SMEs raises demand for innovation policy to complement their technology activities.

During the 1990s, the pressure for innovation policies in the CEECs has increased as the average size of enterprises has decreased and is now below the EU average. An economy dominated by FDI requires different types of innovation policies in dependence of whether foreign MNCs are active as innovators or are primarily confined to low-cost operations. These differences in 'innovation constituency' strongly determine the nature of demand for innovation policy. Hence, benchmarking of innovation policies would ideally have to take into account differences in 'innovation constituencies' when assessing the levels and effectiveness of different innovation policies.

Whether countries have separate or merged departments for science and technology, whether they have separate 'design' from 'delivery' bodies, whether they have adopted innovation policy documents or not; all these features seem to be secondary to the degree of development of 'innovation constituency'. A common feature of CEECs is their very weak and disorganized constituency in favour of innovation policy and innovation activities. Innovation policy is of inter-sectoral and multi-dimensional nature. Its constituency is dispersed and difficult to self-organize. Thus, despite potential demand, innovation policy may not be established due to difficulties of the constituency to articulate its interests and reach a 'critical mass'.

**For NSIs reforms: the relevance of national 'innovation constituencies'...**

**...prohibiting simple benchmarking methods in the design of policies**

We would expect, given this structural problem shared by all CEECs, that differences in innovation policy would arise primarily due to:

- i differences in the state of development of 'innovation constituency', and
- ii differences in the activism and attitude of the state.

Differences in the degree to which innovative firms can self-organize may be idiosyncratic, long-term features of different countries. This is less the case with those states where we could observe changes in state orientation regarding innovation. The positive role and attitude of the state may facilitate the establishment of innovation policies ahead of the current level of demand for innovation policy, i.e. despite a weak 'innovation constituency'. Equally, the level of innovation policy may be behind the actual or latent demand from enterprises and other organisations.

*WP 3.1.5 Analysis of R&D capacities based on national patent data - work in progress*

As we pointed out in several progress reports, we have spent a substantial amount of time to adapt to CEECs concordance between WIPO and industry classification which has been developed on the pilot basis by Statistics Canada. This means that we have been able to collect data on resident and non-resident patents (WIPO) and we group them based on ISIC classification. Slavo Radošević has been working on this in cooperation with Djuro Kutlaca, director of S&T Policy (Institute M. Pupin) group from Belgrade, who is one of the leading specialists in patent statistics, on these data. Now that we have produced a data set we have been struggling to resolve and interpret some puzzles in these data. The most puzzling detail is the very strong similarity across CEECs in industry structure of resident patents. We are not sure whether these puzzles are possibly due to our methodology or due to strong regional specificity of patenting trends during the 1990s. We have work on several draft papers but those will not be released before we are not fully sure on the methodological issues related to the data.

If data do not suffer from methodological weaknesses, this would point to a dominant role of demand for technology as resident patenting data have been falling at very similar rates across industries in all countries. This sharply contrasts with the recovery of product demand and would point to a strong detachment of demand for technology from demand for products.