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(MIS)MATCH BETWEEN DEMAND AND SUPPLY FOR TECHNOLOGY:

INNOVATION, R&D AND GROWTH ISSUES IN COUNTRIES OF CENTRAL AND EASTERN EUROPE

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Summary

Paper analyses the relationship between R&D and innovation in countries of central and eastern Europe. It 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. Analysis is based on innovation survey, R&D, patent and business survey data. Based on analysis the paper develops policy implications.

Introduction

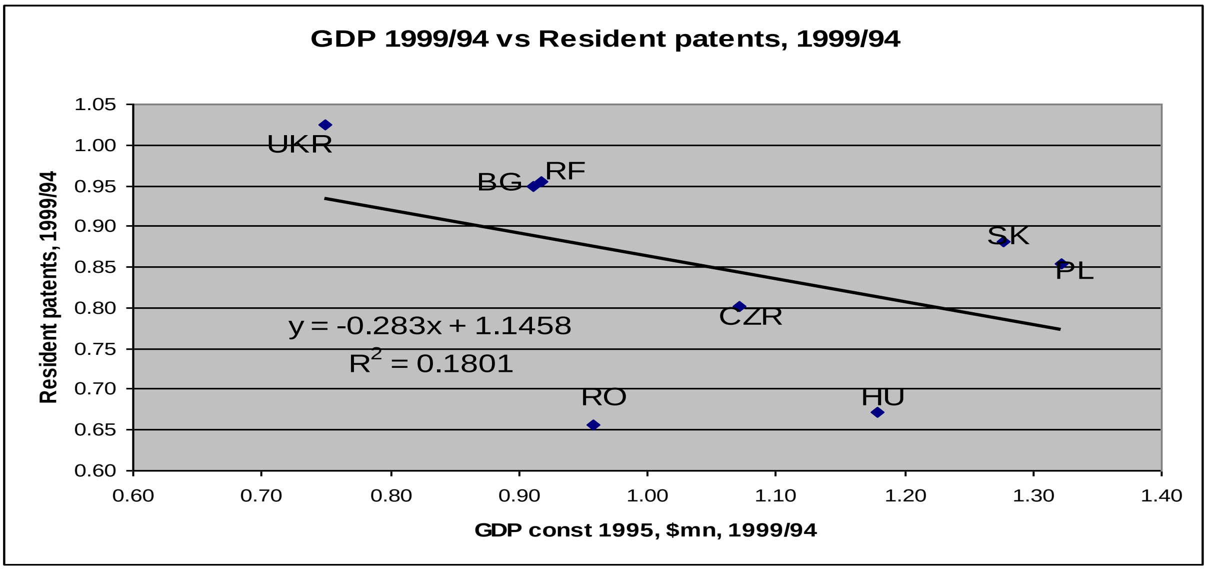
So far, growth and recovery of post-socialist countries of central and east Europe (CEE) was based on efficiency gains from reallocations between sectors and firms, and on the firm level productivity improvements. Growth was not based on local R&D and extensive innovation activities. In order to grow further, CEECs will have to accumulate new knowledge and acquire new technology. In the core of this problem is the (mis)match between local demand and supply for technology which we explore in this paper. 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 output in economic process and in an increasingly knowledge intensive economy it has become essential for understanding the growth and its structural problems. In this paper, we explore this issue in the context of the CEECs using primarily statistical data, leaving theoretical issues aside and by developing policy relevant conclusions from data analysis. Our evidence on the gap between demand and supply of R&D and innovation and its determinants is not systematic. Nevertheless, we believe that even with this constraint our analysis contains empirically and policy relevant insights and conclusions.

The first part points to the emerging gap between lacking demand for technology and growth. Due to absent demand for technology, there has been sizeable downsizing of R&D in the CEECs. The second part analyses the relationship between R&D and innovation activities as well as the main sources of knowledge for innovation. This points to the (mis)match between current S&T system and changing sources of innovation. Conclusions draw policy implications.

Growth, R&D and innovation

Growth and recovery in CEECs during the 1990s has not been linked to domestic R&D and technology effort. Moreover, recovery in demand has not been accompanied by recovery in demand for technology. Figure 1 shows that the relationship for eight CEECs has been slightly negative, i.e. countries that have grown faster in the period 1999-94 had relatively sharper fall in resident patent applications than economies that continued to decline. Although number of countries is far too limited to generalise the proposition on negative relationship, it is safe to conclude there seems to be not clear relationship between domestic technology activity and economic recovery. Recovery or decline are not strongly linked to domestic technological activity which seems to have its own autonomy. Elsewhere, we show that recovery and growth of Polish and decline in growth of Russia have led to similar decline of their R&D systems. This suggests that recovery of demand for local R&D and innovation may not emerge automatically with return of growth.

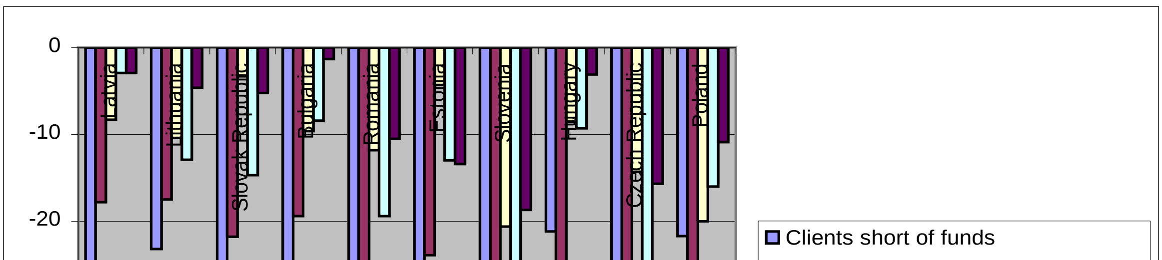
Figure 1: Index of GDP and resident patent applications in 1999-94 period



Source: World Bank Development Indicators, CDROM, 2002

Business surveys in CEECs suggest that there is clear easing of demand side difficulties in all CEECs for which survey data are available. Demand constraints were notable in the first half of the 1990s. Figure 2 shows that there has been significant decrease in demand side difficulties for 'young' firms in CEECs. On that basis, we would expect that demand side improvements would be followed by an increasing demand for technology.

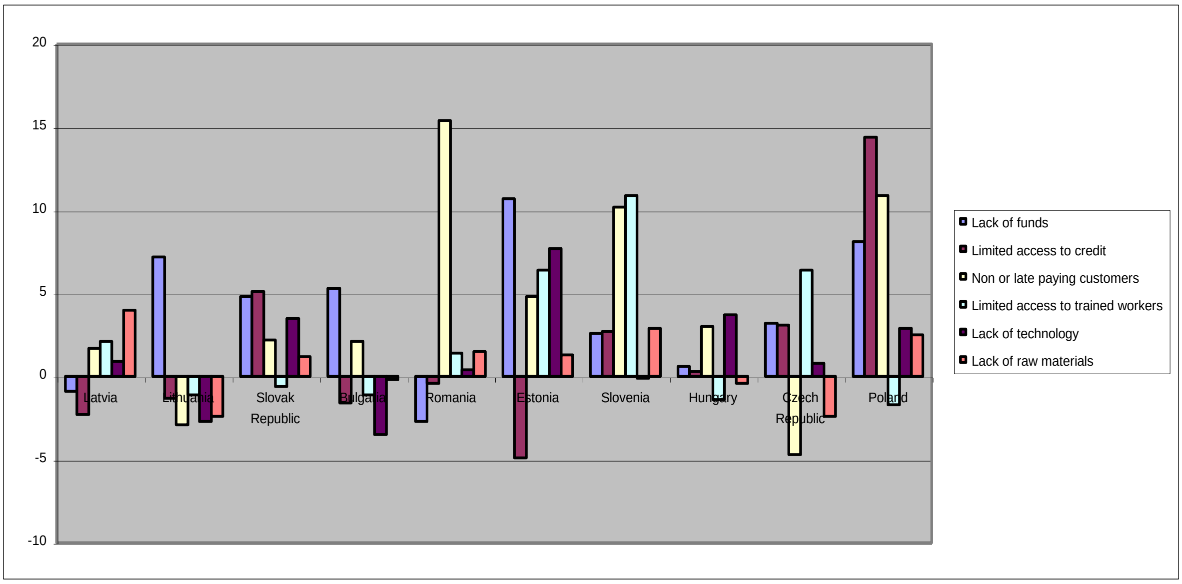
Figure 2: Change in proportion of demand side difficulties of enterprises today (2001) and at start up (established in 1998)



Source: Based on Eurostat, *New enterprises in candidate countries*, 2003

However, this improvement in demand side conditions has not been followed by equally strong improvement in supply side conditions. Figure 3 shows much more diversified picture regarding different supply side difficulties. Moreover, one of increasing constraints for new firms has been a lack of technology and limited access to trained workers.

Figure 3: Change in proportion of supply side difficulties of today (2001) and at start up (established in 1998)



Source: Based on Eurostat, *New enterprises in candidate countries*, 2003

This has been coupled by the lack of funds and by worsening in liquidity (non or late paying customers) in all countries, except Czech R.

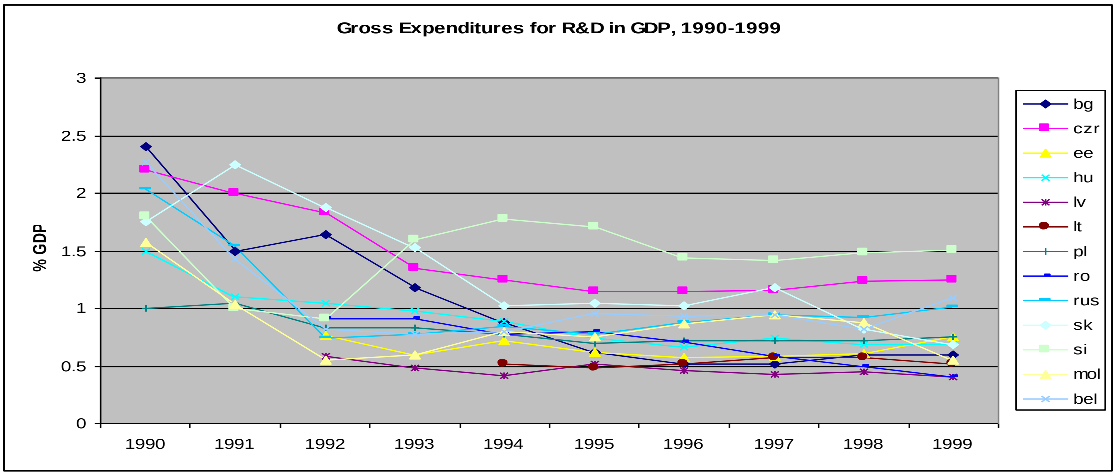
A clear improvements in demand side conditions suggest that the problems for innovators and entrepreneurs have now shifted to supply side, especially to issues of access to credit, own funds and liquidity of clients despite indications by companies that clients are now less financially constrained (see figure 2). 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 facing other supply side problems like trained workforce, and lack of technology. This is quite new phenomenon and suggests that the CEECs are entering into 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 policy perspective, this points to the problem of weak financial systems, which are mediating between supply and demand, and to the importance of national innovation system.

R&D in the post-socialist period

R&D system plays a relatively limited role in the current performance of the CEE economies. Given their income levels, the CEECs have still relatively large numbers of research scientist and engineers (RSE) while many of them have relatively favorable education structure of population. Both these factors should, according to new growth theory, produce much more robust growth than we have observed during the 1990s. Yet, recovery of the CEECs during the 1990s was unrelated to their R&D. Simple correlation coefficients between growth of GDP and share of GERD/GDP for 1992-1999 period are negative for six out of nine CEE economies.

However, we should not assess the importance of R&D system just based on its current role. Restructuring of R&D is one the key preconditions for further industrial upgrading. As figure 3 suggest, we observe for the first time that technology is seen as limiting factor for growth. During the 1990s, R&D has not been felt as constraint to growth. Growth has been generated from reallocations rather than from technology accumulation. Hence, demand for local R&D was quite limited. As a result, we have seen radical shrinking of R&D systems in all CEECs. Figure 4 shows the share of expenditures in R&D in GDP for CEECs.

Figure 4: Gross expenditures for R&D in GDP, 1990-99



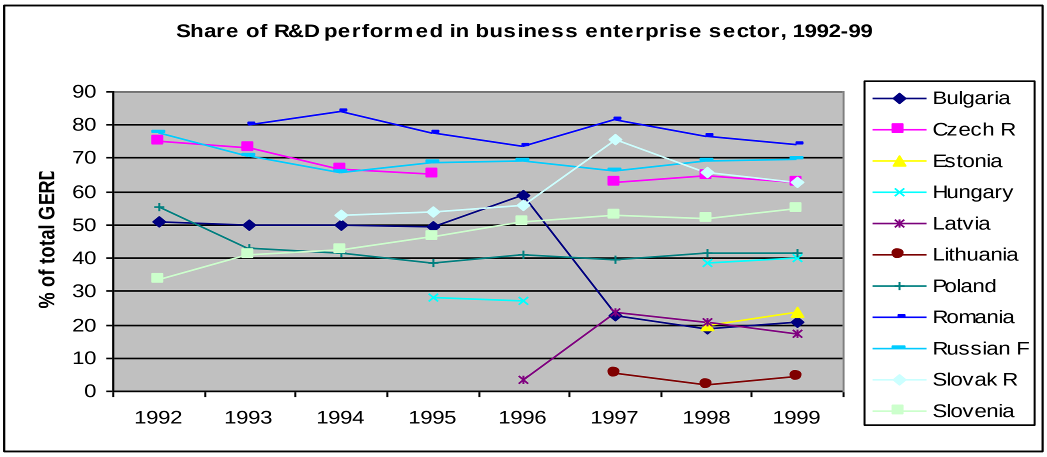
Source: EU (2002);
For Moldova and Belarus, DB of CIS Statistical Committee, data are not comparable to OECD definitions

For 1990-1991 OECD, Centre for Co-operation with Non-Memebers

From having very high shares of R&D expenditures at the end of the socialism, which ranged from 2.5% to 1% (1990) of GDP CEE economies investments in R&D fell to a range between 0.5% to 1.4% (1999) of GDP. This downfall can be disaggregated into three distinct periods. First, in the period between 1990 and 1993/94, with the falling GDPs the share of expenditures for R&D also declined sharply leading to a very high absolute declines in funding of large R&D systems. This was followed by the period of stabilisation (1993/94 to 1996) in which decline continued but at significantly lower rate. From 1996, signs of recovery in some economies, in both absolute and relative funding of R&D, have emerged. However, in some CEECs, like Romania R&D decline continued uninterrupted. In overall, after average annual decrease of 13% in 1991-96 period, the relative share of R&D on average grew by 3.2% annually in 1997-199 period.

From perspective of growth and restructuring, it is important what has happened to business enterprise sector R&D. Data show that that the shares of R&D funded by business enterprise sector in CEECs have remained relatively stable over the whole period. In other words, business enterprise sector has shared the destiny of the overall decline, absolute and relative, of R&D sector. (See figure 5).

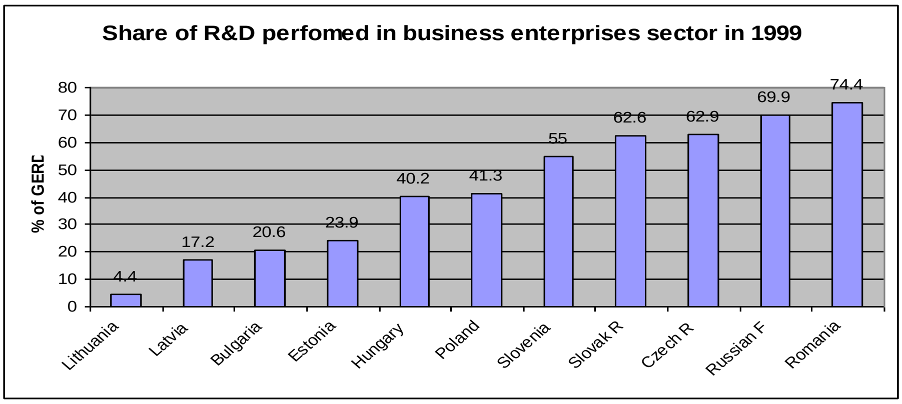
Figure 5: Share of R&D performed by business enterprise sector, 1992-1999



Source: EU (2002)

National differences in the share of R&D funded by business have remained suggesting that the transition could not change strong structural and nationally specific features in R&D systems. A high shares of R&D funding by business sector in Czech Republic and Slovakia and very low in Baltic states are the result of differences in industry structure, especially in terms of the role of large firms as well as of neglect of R&D in Baltic states during the early 1990s. A high share of R&D *performed* by business enterprise sector in Russia and Romania indicates primarily unreformed R&D sector which is dominated by extra-mural industrial R&D institutes rather than strong in-house R&D. At the same time, in both countries there is a low share of R&D *funding* by industry and high share of government funding of business sector R&D. This situation is generally rare in market economies and can be taken as an indicator of the slow restructuring in R&D. Our research (see Radosevic, 1999) 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 continues to be significant suggesting that some elements of the Soviet R&D model as described by Gokhberg (1997) are still operating.

Figure 6: Share of R&D performed by business enterprise sector, 1999



Source: EU (2002)

A simultaneous fall in government funding and weak demand for R&D from industry have blocked sectoral structural change within R&D systems which adjusted to lacking demand by overall shrinking. As we analyzed elsewhere, (Radosevic and Auriol, 1999) downsizing of the R&D systems in CEE was not systematically linked to a specific individual factor on the demand or supply side. Probably, it is the combination of demand side factors (annual changes in GDP and investments) and supply side policies (budgetary R&D policy) that in the end have shaped trends in R&D spending. Neither government nor market demand for R&D could buffer this fall. However, this does not mean that there was not change at micro-level in R&D system. For analysis of Russian situation in S&T from this perspective see Radosevic (2003)

Business R&D and innovation

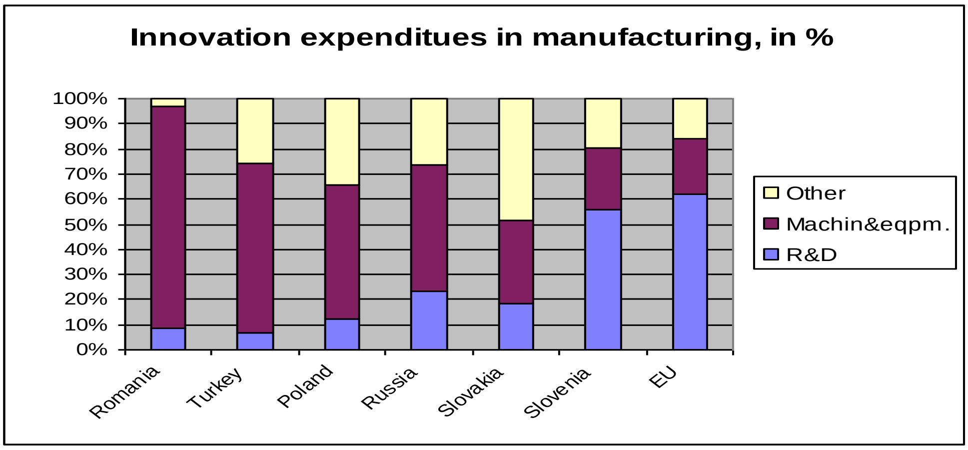
The supply of R&D is only a part of the overall process of innovation that leads to a finished product being placed on the market or to economic growth at national level. The fall in aggregate R&D spending hides the changing nature of innovation and its sources. So, if we want to understand why there has been decrease in demand for R&D we should look beyond R&D sector to the nature of innovation process.

Research and development data measure the size of institutionalized knowledge generation activities. Small and discontinuous R&D activities usually closely linked to production are not covered by R&D surveys (Sirrili, 1998). Moreover, continuous and institutionalised research activities are not necessarily used as input into innovation process. This is especially apparent in 'catching-up' economies where behind the frontier R&D work is usually much less integrated with innovation activities than in economies at the world technology frontier.

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 R&D.

The analysis of the innovation expenditures by Evangelista *et al* (1997a) shows that, first, the distribution of innovation costs is relatively coherent over all EU countries. If innovation costs reflect the scope of different innovation activities than the mix of innovative activities appears rather similar across EU. 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*, 1997b, 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*).

Figure 7: Innovation expenditures in manufacturing, in %



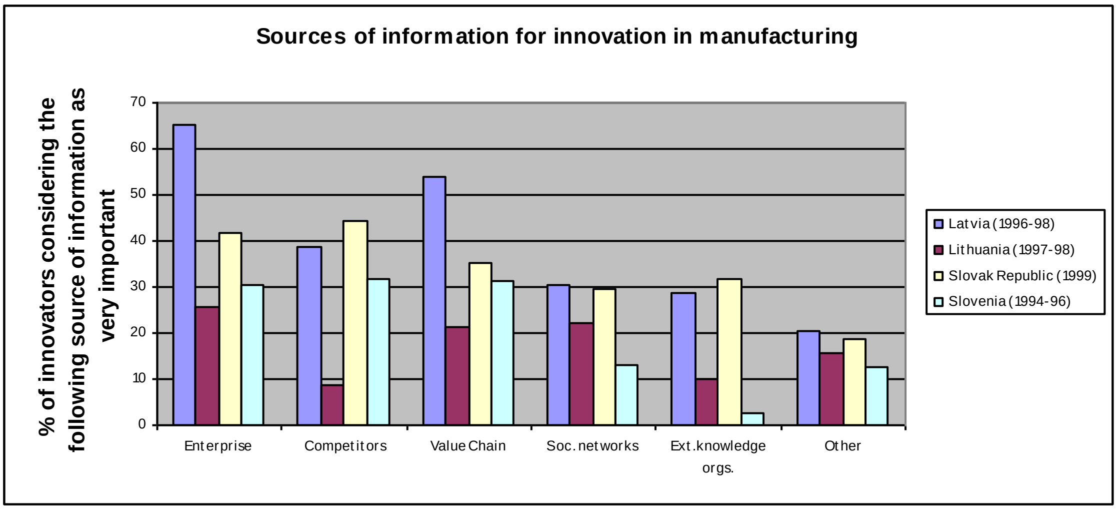
Source: R&D and innovation statistics in candidate countries and the Russian Federation Data 1996-97, EC, Theme 9, R&D, 2000
For Slovakia, Slovak Statistical Office. For Turkey, Turkish Statistics Institute
For EU (2000) Statistics of Innovation in Europe, Eurostat, Luxembourg

A comparison of structure of innovation expenditures for the group of non-EU countries in figure 7 shows that there are significant differences as compared with the EU costs structure. R&D cost amount to smaller share of innovation expenditures than in the EU. Only Slovenia, which is the most developed CEECs, has share of R&D similar to the EU. Acquisition of machinery and equipment amounts to the biggest item among innovation expenditures. In particular, in Romania, innovation activity is essentially about installing new equipment. This cost structure reflects the nature of innovation in CEECs, which is primarily based around new equipment, most often imported.

Enterprises do not innovate on their own. Their technological upgrading is dependent on the supply chain (suppliers and buyers) within which they operate, on degree of competition and on 'social networks' on which they can rely. Figure 8 shows the main sources of information for innovation in four CEECs. Data confirm the importance of direct business environment of firms as the main source of knowledge for innovation. Quality of clients, competitors, buyers, and of social networks within which enterprises operate are the key to their innovation. Universities, consultants and R&D institutes are not the source of direct knowledge or at least seem to be a secondary source. This is not surprising and corresponds to EU innovation surveys. Universities serve as sources of skilled professionals i.e. as indirect knowledge providers rather than as direct sources of knowledge for information.

Figure 8: Sources of information for innovation in manufacturing

(% of innovators considering the following sources of information as very important)



Source: *R&D and innovation statistics in candidate countries and the Russian Federation* 1990-1999, Eurostat

Note: External knowledge organisations (average of importance for universities, consultants and R&D institutes)

Value chain (average importance between clients and suppliers)

Social networks (average importance of professional conferences, meetings, fairs, exhibitions, electronic networks)

Other (patents,)

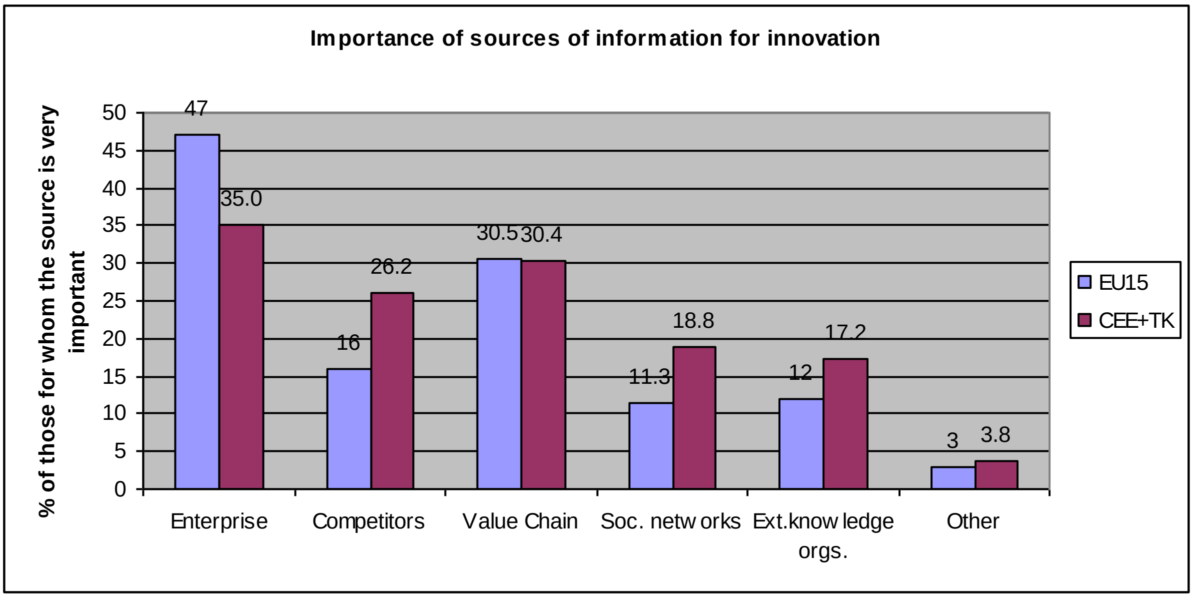
However, when we compare the importance of external vs. internal sources of information for innovation between EU and the average of four CEECs and Turkey we observe that in less developed economies the external sources of knowledge are more important than knowledge within enterprise[1].

Figure 9 shows that competitors, social networks and external knowledge organisations all play more important role for innovators in than in the EU. One the other hand, own sources of knowledge for innovation are more important in more developed context than in less developed CEEs and Turkey.

[1] We compare weighted EU average with the unweighted average of five countries. This makes sense as our EU indicator becomes biased towards bigger and technology developed countries like Germany, France and UK. In addition, we do not have data for the CEECs and Turkey to calculate weighted average.

Figure 9: External and internal sources of information for innovation between EU and four CEECs and Turkey

(% of innovators considering the following sources of information as very important)



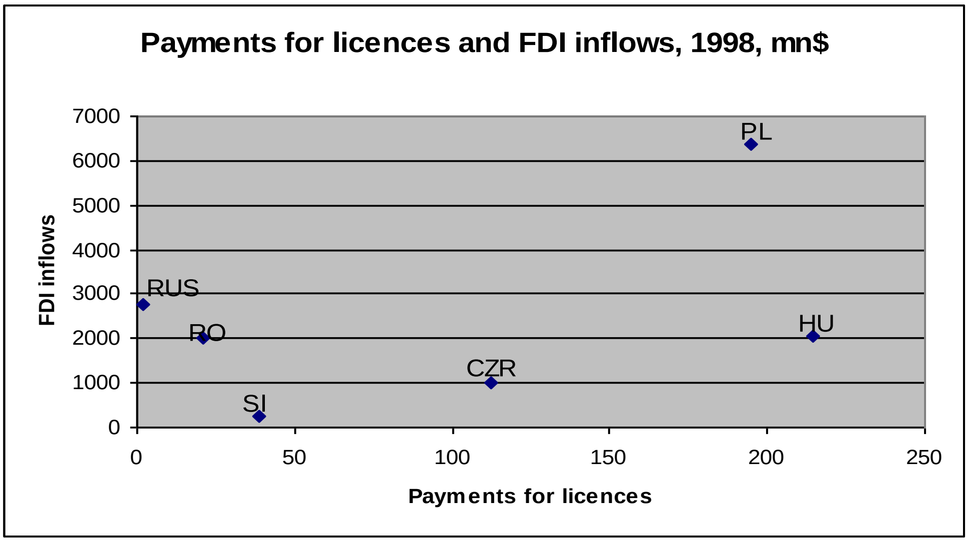
Source: *R&D and innovation statistics in candidate countries and the Russian Federation* 1990-1999, Eurostat; Turkish National Statistical Office and EU (2002)
Notes: see figure 8

Value chain (suppliers and buyers) play similarly important role in both groups of countries. This finding has important policy implications. First, it points to the relatively bigger importance of national system of innovation (competitors, social networks, external knowledge organisations) for innovators in the CEECs. Their innovation capabilities are dependent on systemic features of external environment in which they operate. Secondm weak innovation capability of local firms, which are not able to generate new knowledge within their own R&D activities, points a need to support firm level R&D or to induce demand for internal knowledge.

Relatively bigger dependence on external sources of knowledge in less developed environments suggests that CEECs are dependent on FDI for new knowledge. Weak innovation capabilities of local firms and the gap between 'old' S&T system and new sources of knowledge for enterprises led to increasing reliance on foreign technologies. Limited data for the CEECs suggest that the FDI is an important channel for inflow of new knowledge as expressed through payments for licences. Correlation coefficient between payments for licences and FDI inflows for the six CEECs for which data are available is positive and moderate (0.455)[2] (figure 10).

[2] Identical correlation coefficient for 10 'catching up' economic (China, India, South Africa, east Asian and Latin American economies) is low (0.122) suggesting that channels of technology inflows are not confined only on FDI.

Figure 10: Payments for licences and FDI inflows, 1998, $mn



Source: UNCTAD, World Investment Report, 2003, Geneva

This suggests that local firms have to rely on FDI in order to gain new knowledge. A comparatively high presence of FDI in some CEECs like Poland, Hungary and Czech shows that they have been relatively successful in that respect. This is the strength but also the weakness of innovation in the CEECs. Exclusive reliance on knowledge from abroad as well as on weak national system of innovation, coupled with very weak innovation capability of domestic firms represent the most vulnerable aspect of the CEE economies. In short and medium term, the exclusive reliance on FDI leads to quick productivity improvements. However, in a long-term, this creates fragile economies whose narrow specialisations in FDI related activities and weak national system of innovation may become obstacle to further upgrading. Trade off between short term efficiency and long-term strategic orientation and flexibility are the key emerging issues for frontrunner economies of central Europe, like Hungary, Czech R and Poland. Other CEECs, in particular east European economies (Romania, Bulgaria, Russia, Ukraine) will have to reply on FDI as the way to gain quick access to new technologies. However, in both groups of countries the key long-term issue is how to achieve complementarity between domestic and foreign sources of knowledge.

Conclusions

Our analysis has several important implications for the development policy in the CEECs.

First, 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 levels 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 weakness of national systems of innovation and its 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 market economy.

Transformation of the CEECs during the 1990s shows that innovation does take place even with ineffective innovation policy. Slovenia, Poland and Hungary are clear examples of this. If so, is innovation policy indispensable? Indeed, impact of innovation policy should not be overestimated. However, we should bear in mind that the sources of growth in CEECs are changing. During most of the ten years of transition growth has been unrelated to domestic technology accumulation. Large-scale reallocations from unproductive parts of industry to services, from less to more efficient firms have ensured growth for some period. However, there are signs that the sources of productivity growth, which have been mainly in realm of 'reallocations', are now coming to an end and that the CEECs will have to grow based on technology accumulation. For example, Kubielas (2003), in case of Poland, argues that Ricardian adjustment based on reallocations has been exhausted and that Polish growth is now dependent on imported technology. Since Poland has lost chance that it had during the 1990s to strengthen absorptive capacity of its R&D system it is now entirely dependent on FDI to ensure continuous technology accumulation.

It may happen that innovation will continue to develop in some CEECs entirely based on local or export demand. However, if growth is to depend on the strength of national innovation system than innovation policy is one of important factors to facilitate domestic technology accumulation and diffusion. National systems are everywhere hybrid systems and require public - private co-operation. CEECs may still grow for some time unrelated to domestic R&D and without innovation policy. However, they may soon reach limits to this type of growth and face structural barrier or threshold level, which will require new national system of innovation and policies to be overcome. Innovation policy is not a quick fix. In order to be successful it requires a broader consensus of various stakeholders. As CEECs show this policy is easier to establish in periods of growth rather than depression. However, this also reduces pressure for its development. In addition, its long-term nature does not ensure clear benefits in 4-year cycle politics. All this suggest that demand for innovation policy is not articulated easy and that we should not be too optimistic regarding its establishment in CEECs.

Second, high tech seems to be the dominant paradigm in innovation policy in CEECs despite data which suggest that innovation in these countries is very much linked to equipment and with limited R&D component. As pointed in example by Nauwelaers and Reid (2003) this leads to narrow client base of 50 large companies for Estonian innovation policy. In other countries this means that attracting high tech through S&T parks actually functions as substitute for innovation policy. In the best case, this route can create isolated pockets of competencies in new technology but will leave untouched majority of local firms. This is not to argue that this route should not be pursued but only that it should not serve as substitute for innovation policy.

The relevance of this policy can best be seen when comparing marginal relative position of CEECs in US or EPO patenting. On the other hand, innovation surveys and R&D data, which show gradual increase in BERD, suggest that innovative firms are increasingly involved in technology activities but these are not necessary high tech. This points to increasing wedge between R&D and innovation policy, (see Kubielas, 2003, for the case of Poland). CEECs will have to close the gap, which currently exist between dominant R&D policy and subservient innovation policy. As CEECs increasingly try to emulate EU policies and try to restructure towards knowledge-based activities this gap will become unviable. Shift towards knowledge based economy in CEECs will mean (i) shift towards diffusion oriented activities within R&D system, and (ii) transformation towards enterprises based R&D system.

As interactive innovation model suggest this will not mean irrelevance of R&D but integration of R&D and innovation activities. While this may sound simple in conceptual terms this shift is very difficult to make in policy terms. How to move form current situation where 'science' and 'innovation' are seen in policy terms as zero sum game between science establishment and weak 'innovation community' towards positive sum game situation or situation where reorientation of both areas will be of mutual benefit.

Third, policy should assist transformation of the S&T system into market oriented technology or knowledge infrastructure. For this transformation to take place it is essential to develop explicit innovation policy.

After ten years of implementation of transition-based policies, central European economies have started to introduce innovation policy measures. The emergence of innovation policy in these economies shows that there are important changes taking place in their political philosophies. From being reduced to building the institutional framework of 'open market economy' and promotion of, at least rhetorically, minimalist role of the state we observe the shift towards more pro-active role of the state. However, innovation policy should be squared with the specific context in which it has to operate.

Innovation surveys show that direct market and social environment of enterprise is the main source of information for innovation[3]. Yet, this aspect is not taken into account by innovation policy, which is rarely sector specific or technology specific. Innovation surveys show that sector and technology specific measures could matter more for innovativeness of enterprises when compared to general measures like tax incentives or horizontal measures like innovation centres and S&T parks.

As innovation surveys in CEECs suggest innovation links are value chain based, i.e. they are the strongest with suppliers and buyers immediately after intra-firm sources. This is the strength but also the weakness of innovation systems in CEECs. Production integration through FDI led value chains ensures high productivity, innovation linkages and regular sales to local firms. However, in the long-term, product and technology upgrading does not necessary follow value chain logic, especially when value chains are changing or breaking-up. Again, this means that innovation policy will have to strike balance between supporting integration of local firms into global value chains (FDI, subcontracting) and domestic linkages with universities, S&T parks, cooperative centers, etc. Integration of local firms through value chains and FDI is policy which has been relatively undeveloped in CEECs. Hungary and Czech Republic are the only two candidate countries which have developed elements of this policy which goes beyond marketing of country as production location. There has been much more policy focus on linkage mechanisms like S&T parks, innovation centers, etc. i.e on linkages for which weak and dependent local firms may not have immediate demand rather than on value chain linkages. This explains their irrelevance to local firms and their innovation activities, which are, primarily value chain driven. A challenge for CEECs is how to integrate FDI and innovation policy.

[3] This is what interactive model of Kline and Rosenberg would suggest to be the typical situation.

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