SCIENCE – INDUSTRY LINKS IN CEE AND CIS: CONVENTIONAL POLICY WISDOMS FACING REALITY[1]

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Prof. Slavo Radosevic
University College London
School of Slavonic and East European Studies
s.radosevic@ssees.ucl.ac.uk

Abstract

This paper analyzes factors behind a widespread policy failure to support science – industry linkages in Central and Eastern Europe (CEE) and Commonwealth of Independent States (CIS). We explain this failure as being largely due to uncritical application of conventional policy wisdoms into the context of ‘catching up’ and ‘laggard’ economies. The argument is based on evidence of knowledge intensive enterprises in CEE and CIS countries and on analysis of innovation policies of these two regions. Our conclusion is that support to science – industry linkages for the CEE/CIS should be balanced with support to strengthening ‘actors’ (existing large and small firms; universities and public research organisations) and support to other linkages in national innovation systems, especially knowledge links between domestic and foreign firms

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1. INTRODUCTION

There is a widespread view among analysts that the central and eastern European (CEE) and Post-Soviet (CIS) countries have failed to capitalize on their science base in transition period (Meske, 2004; Schwartz, 2006, Watkins, 2004). This failure has taken place despite potential large R&D assets in terms of employed R&D labour force and despite policy initiatives which aimed towards commercialization of R&D assets or which tried to enhance science – industry linkages. This failure seems to continue also in a period of relatively high economic growth which for the majority of these economies started since year 1998 or earlier for some CEE countries. Moreover, science – industry linkages continue to be in the focus of innovation policy of these countries as they try to ensure long-term growth based on innovation and not only on production efficiency.

This situation calls for a more systematic inquiry in the causes of failure of policies for science – industry. We approach to this issue through prism of technology based competition and systems of innovation. Paper brings new evidence about the macro and micro environment of science industry links and shows the limits of current policies for supporting science – industry linkages in CEE/CIS. Our argument is that conventional policy wisdoms in this area are in stark contrast to the reality of these economies and hence require rethinking. We observe a widespread 'linkage failures' in this region due to largely uncritical application of conventional policy wisdoms into the context of 'catching up' and 'laggard' economies. A support to science – industry linkages for the CEE/CIS should be balanced with support to strengthening 'actors' (existing large and small firms; universities and public research organisations/PROs) and support to other linkages in national innovation system (NIS), especially knowledge links between domestic and foreign firms.

Attempt to probe this question for a region which in the World Bank parlance is called ECA (Eastern Europe and central Asia countries) is necessarily eclectic in terms of its empirical basis. Paper is based on results of several projects funded by the European Commission in which author has been involved over the last years and to which we refer when appropriate.

The argument is developed in four steps addressed in three different sections. First, we point to the gap between requirements for technology based competition and missing conditions in the CEE/CIS. Second, we demonstrate that knowledge intensive enterprises in CEE are specific type of enterprises which differ from new technology based firms. Third, we reviews current policy initiatives, assesses briefly their scope and effects and thus demonstrate the gap between reality of RD and innovation activities and objectives of policies. Finally, we point to limits and neglected dimensions of policies for science – industry links. Conclusions summarise the key points

2. CEE/CIS COUNTRIES AND TECHNOLOGY BASED COMPETITION: KEY REQUIREMENTS AND MISSING CONDITIONS

The majority of the CEE/CIS countries firms' operate in markets where cost and quality are the dominant mode of competition (see table 1). Five CEE economies

(Croatia, Czech Republic, Estonia, Hungary and Slovakia) are in transition stage towards innovation driven growth. This transition requires that countries meet specific requirements at micro and mezzo levels of technology based competition. This is a competition based on product/process innovations rather than on costs of labour. It requires sophisticated demand not only in export but also on local markets. Technology based competition is driven not only by technology based firms but also by sophisticated users and their requirements. Multiple technical interdependencies of new products and processes require certificates and standards, after sale services and warranty. Barriers to growth are in technological knowledge but also in marketing. IPRs is an important mechanism of competitive advantage in addition to secrecy, know how and technical complexity. Local firms competing on technology need affordable access to technical infrastructure as well as available finance to upscale production.

In continuation, we highlight through several pieces of evidence the extent to which CEE/CIS countries grow based on technology and a few features of their national innovation systems that are important for understanding science – industry links.
In terms of income levels, the CEE/CIS countries are in between above $2K per capita to above $17K. These significant differences in income level across two regions suggest that countries rely on different factors of growth. The approach of the World Economic Forum (WEF) is illustrative for our purposes here to show the extent to which technology based competition plays different role in different countries. The WEF approach distinguishes between factor, efficiency and innovation driven stages of growth. The 2007 edition of *The Global Competitiveness Report* (WEF, 2007) ranks countries into one of three groups and in transition stages based on different weights given to factors grouped as 'basic requirements', 'efficiency enhancers' and 'innovation and sophistication factors'. Data for 27 CEE/CIS countries show that the majority of them are in efficiency driven stage (9), or in transition from efficiency into innovation driven stage (5), or in transition to efficiency driven stage (6). Only 1 country (Slovenia) is innovation driven stage while 6 countries (all CIS) are in factor driven stages. Although this methodology could be criticised (see Lall, 2001) it does points to a limited role of technology based competition in CEE/CIS countries.

Table 1: CEE/CIS countries ranked based on drivers of growth

Factor driven (FD) stage	**Transition from FD to ED stage**	**Efficiency driven (ED) stage**	**Transition from ED to ID stage**	**Innovation driven (ID) stage**
Armenia	Albania	Bulgaria	Croatia	Slovenia
Georgia	Azerbaijan	Latvia	Czech Republic	
Kyrgizstan	Bosnia and Herzegovina	Lithunia	Estonia	
Moldova	Kazakhstan	Macedonia, FYR	Hungary	
Tajikistan	Ukraine	Montenegro	Slovakia	
Uzbekistan		Poland		
		Romania		
		Russia		
		Serbia		

Source: WEF (2007)

Factors driving technology based competition should be relatively more present in countries with the high rates of productivity. Total factor productivity (TFP) is one of measures of productivity which refers to increases in output not attributable to increases in labor or capital inputs. It is not quite clear what TFP actually contains but in its optimistic interpretation it captures 'efficiency gains from the technological progress embodied in firm-level improvements, such as better production management methods, better customer support, and better distribution channels for the delivery of goods and services' (Alam et al, 2008). Estimates of TFP for the CEE/CIS suggest that TFP growth accounted for over 80 percent of total output growth in the region over 1999–2005, which is much higher than other regions (ibid). However, it seems that much of it is actually higher capacity utilization rather than innovation activity (ibid). In addition, it may be an implicit technology effort at a firm level related to learning by doing and learning by using rather than the explicit effort related to organised R&D.

An alternative measure of the overall innovation activity is so called European Innovation Scoreboard (EIS)(see EC, 2006). This is a composite indicator composed of 25 indicators of different dimensions of innovation capacity (innovation drivers, knowledge creation, innovation and entrepreneurship, applications and intellectual property) with aggregate being their average. The EIS is available for all EU27 countries but not for the CIS countries. However, based on our work in projects (BRUIT, SCRPIT and RIPKA) funded by the EU we have managed in cooperation with local partners to compile comparable data and construct the EIS for four CIS countries (Russia, Ukraine, Kazakhstan and Azerbaijan) (see Radosevic, 2008).

In the figure 1, we present the 2006 summary innovation index (SII) – a composite index calculated using EIS data – for Azerbaijan, Kazakhstan, Russia, Turkey and Ukraine along with the 30+ countries that participate in the annual EIS survey. The SII for the four CIS countries show that they belong to either a group of so-called 'laggards' (Azerbaijan and Kazakhstan) or to a group called 'catching up' (Russia and Ukraine). This terminology is used in the EIS 2006 report[2] to which we added a fifth category '(laggards') which reflects a very low level of innovation activities in Azerbaijan, Kazakhstan and Turkey. In order to understand this positioning and terminology, it is necessary to clarify a few conceptual issues.

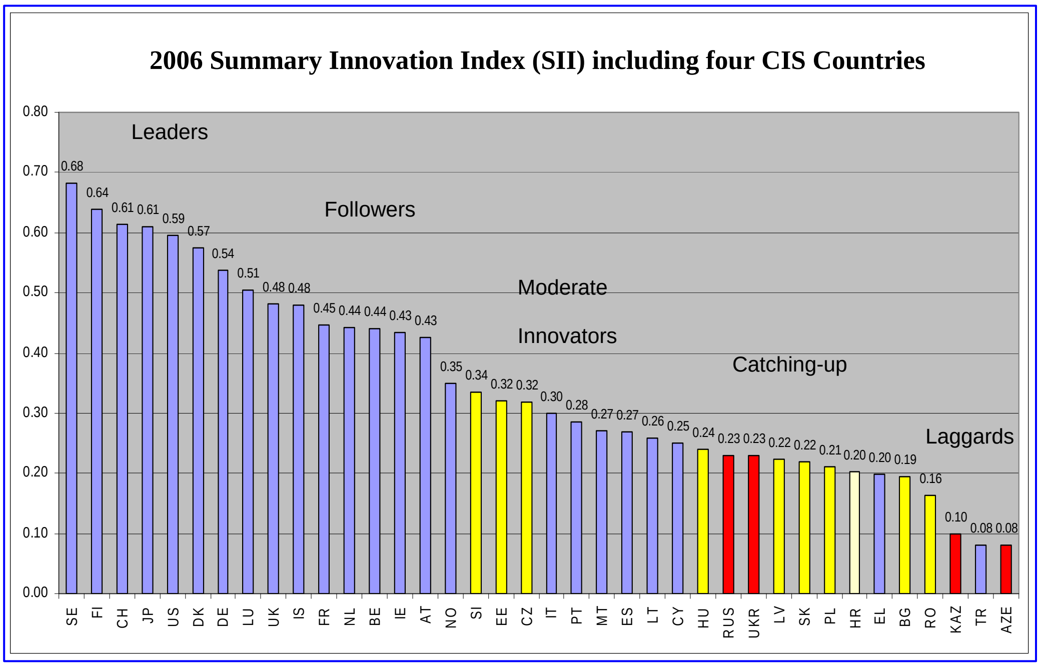
First, SII as a composite indicator shows the extent to which growth in a country is based on innovation. SII does not necessarily relate to economic growth of country, especially not in the short-term, but it shows the degree to which economic growth embodies innovation. Growth can be also based on factors like economic efficiency, which is not reflected in innovation but in production capability. Also, growth can be based on a low cost or abundant labour or natural resources. This latter factor is especially pertinent for resource rich CIS countries (Azerbaijan, Russia and Kazakhstan). In these economies it is very difficult to initiate growth based on innovation as the economy is dominated by resource based sectors and relative prices and economic rents favour these sectors.

Second, SII data in the figure below do not indicate trends but levels. In that respect, notions of laggards and catching up are somewhat misleading as they do not indicate

[2] http://www.proinno-europe.eu/doc/EIS2006_final.pdf

trends but levels i.e. countries which have potential to reach levels of moderate innovators (cf. catching up group) or countries which are significantly behind levels of moderate innovators (cf. laggards group).

Figure 1: **2006 Summary Innovation Index (SII) including four CIS Countries**



Source: EIS 2006 and BRUIT/RIPKA/CSRIPT project teams

Third, we should bear in mind that the EIS indicators are somewhat skewed towards measurement of world technology frontier innovation activities – and consequently SII calculations as well - which are marginal in both catching up and laggards' economies, as one would expect. An alternative composite indicator, which would take into account much more technology absorption as well as important technology acquisitions behind frontier innovation activities, would be a more appropriate reflection of technological activities in catching up and laggard countries.

Fourth, ranking of countries is partly influenced also by the availability of individual indicators. This is especially relevant for the innovation survey data where absence of these data may either improve or undermine the true innovation position of an individual country.

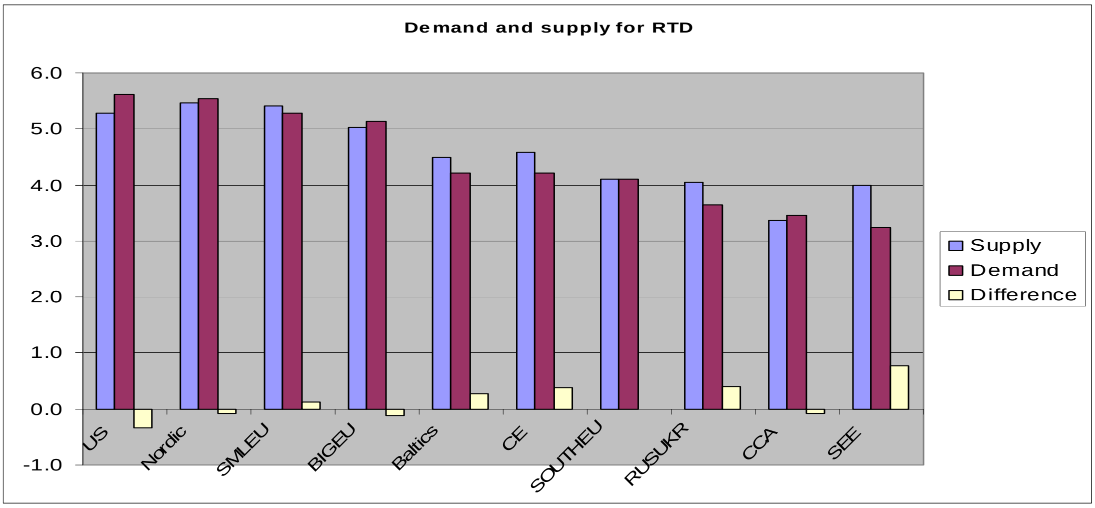
The 2006 SII chart shows 38 countries including four of the CIS countries. Russia and Ukraine are ranked in 27th and 28th places respectively, while Kazakhstan is ranked in 36th and Azerbaijan in 38th place. Azerbaijan and Kazakhstan, together with Turkey, form a distinct group with SII values that are half of those for the next and lowest ranked EU country – Romania. Meanwhile, Russia and Ukraine are in a group comprised of central eastern European countries.

Azerbaijan and Kazakhstan are clearly laggard countries in the sense that they are still faced with the challenge of building their innovation systems. Being resource rich countries, their main challenge is not a financial one but a politico-economic one of diversifying the economy towards technology intensive activities.

None of the CEECs is in the followers' group although some Central European countries are ahead of Southern EU countries (Italy, Spain and Portugal).
This reinforces our view that the EIS should be interpreted as the degree to which countries' growth is based on innovation in the way that the EIS captures it (primarily as explicit R&D and high-tech activity). The EIS framed ranking suggest that for the majority of the CEE/CIS the demand for science – industry links will be relatively limited. An increasing market demand which is a natural accompaniment of growth does not necessarily induce demand for local R&D and knowledge. Demand for technology is derived demand i.e. demand filtered through organisational fabric of an economy and is influenced by the size of enterprise as well as types of strategies of enterprises.

We touch upon this complex issue by using results of the WEF survey from which we select several variables considered to be the best proxies for demand and supply for research-technology and development (RTD). In footnote below [3] we list variables included which are based on business survey where respondents are asked to evaluate the level in their country on scale from 1 to 7. Figure 2 aggregates these answers across several sub-regions (US, Nordic countries, Small EU15 countries, Big EU15 countries, Baltic states, Central Europe; Southern EU15 countries, Russia/Ukraine, Central Asia and Caucasus, and South East Europe) by averaging values.

Figure 2: Assessing Factors of RTD: demand gap in CEE/CIS



Source: Based on WEF 2007

[3] *Supply variables* (Availability of scientists and engineers; Quality of math and science education; Local availability of specialized research and training services; Quality of scientific research institutions; Quality of public schools; Quality of the educational system).
Demand variables (Degree of customer orientation; Firm-level technology absorption; Buyer sophistication; Production process sophistication; Extent of staff training; Capacity for innovation; Company spending on research and development; Government procurement of advanced technology products)

Figure 2 suggests that developed regions tend to have relatively higher levels of demand for RTD than supply. On the contrary, post-socialist countries tend to have relatively better evaluated supply of RTD than demand. This may reflect inherited R&D capacities but also quite low levels of demand for RTD. For example, US as world technology leader, has relative demand surplus or supply gap for RTD. Russia/Ukraine, Central Europe and South East Europe have demand gap or supply surplus for RTD. Naturally, we should consider this to be extremely rough measure of RTD demand and supply. In addition, supply and demand should be considered relative to each other and not only as absolute values.

A demand gap for all the post-socialist countries that is indicated by the WEF survey is also confirmed by our survey of knowledge intensive enterprises in 6 CEECs (see Radosevic et al, 2008). Table 2 presents results of the survey of 308 enterprises which ranked barriers to their growth on the local market. Limited market for knowledge intensive products and services is the most often cited as the major barrier to growth of knowledge intensive firms.

Table 2: Major barriers to growth of knowledge intensive enterprises

High and medium important barriers on domestic market (% of firms)

	All countries	Hungary	Checz R	Lithuania	Croatia	Poland	Romania
Limited market	**78**	**78**	**70**	**74**	**80**	**79**	**88**
High cost of labour	**71**	68	68	60	**88**	**93**	**88**
Increased competition on market	54	59	**82**	59	**80**	**80**	**75**
Lack of access to finance	59	**78**	48	49	**84**	**81**	**75**
Lack of public support	**75**	52	50	43	**72**	**84**	**90**
Lack of skill and know how	65	42	40	44	**72**	52	**88**
Other	57	100	0	50	100	67	10

Note: % as a percentage of all firms that answered the relevant question.

Note: High and medium importance= answers 3-7 on scale 1-7

Source: Radosevic et al, 2008

In continuation we explore supply side of R&D. We classify countries into groups based on the dominant performing and funding sector[4]. Data are taken from the UNESCO 2007 database and refer to the latest available years. We are able to distinguish between four organisational models: first, countries where business enterprise sector (BES) is the major funding source and performer of R&D; second, countries where BES is the major performer of R&D while government (GOV) is the major funding source; third, countries where higher education sector (HES) is the major performer while GOV is the major funding source, fifth, countries where government is both major performer and funding source. Kazakhstan is a specific case in the sense that government labs are the major performer while BES is the major funding source. This may be expected as BES himself has not been yet able to build stronger R&D capacity.

[4] A dominant sector is the one with the highest relative share in the overall R&D employment.

Table 3 suggest that development is accompanied by stronger role of BES in both performing and funding R&D. This may suggest than the organisational models of the post-socialist countries are partly determined by their income levels and not only by the institutional legacies.

Table 3: Different institutional profiles of R&D systems

Dominant performing sector < Dominant source sector				
Model 1	*Model 2*	*Model 3*	*Model 4*	*Model 5*
BES < BES	**BES < GOV**	**HES < GO**	**GOV < GOV**	**GOV < BES**
USA	Slovakia	Portugal	Bulgaria	Kazakhstan
Ireland	Hungary	Estonia	Azerbaijan	
France	Poland	Lithuania		
UK	Belarus	Turkey		
Austria	Croatia			
Belgium	Russia			
Finland	Romania			
Germany				
Spain				
Korea (Rep)				
Slovenia				
Czech R				
Latvia				

Source: based on UNESCO 2007 database

Hence, in table 4 we rank countries by their levels of income and by the model of R&D funding and performing from table 3. Table 4 shows that BES dominated R&D systems are a feature of countries above $15K per capita. A stronger role of government in funding (either of BES or HES) is present in the majority of economies with income levels below $15k per capita. This suggest that the low share of BES R&D in post-socialist countries is largely a developmental issue or the issue of catching up.

Table 4: Countries ranked by income levels and models of R&D funding / performing

	GDP pc 2003	Model type	Model Dummy
USA	**29,037**	**1**	**1**
Ireland	**24,739**	**1**	**1**
France	**21,861**	**1**	**1**
UK	**21,310**	**1**	**1**
Austria	**21,232**	**1**	**1**
Belgium	**21,205**	**1**	**1**
Finland	**20,511**	**1**	**1**
Germany	**19,144**	**1**	**1**
Spain	**17,021**	**1**	**1**
Korea (Rep)	**15,732**	***1***	**1**
Estonia	*14,340*	*3*	*0*
Slovenia	*13,995*	*1*	*1*
Portugal	*13,807*	*3*	*0*
Czech R	*9,905*	*1*	*1*
Latvia	*9,722*	*1*	*1*
Slovakia	**9,392**	2	**0**
Lithuania	**7,986**	3	**0**
Hungary	**7,947**	2	**0**
Poland	**7,674**	2	**0**
Kazakhstan	**7,655**	5	**0**
Belarus	**7,387**	2	**0**
Croatia	**7,233**	2	**0**
Turkey	**6,731**	3	**0**
Russian Fed	**6,323**	2	**0**
Bulgaria	**6,278**	4	**0**
Romania	**3,510**	2	**0**
Azerbaijan	**3,394**	4	**0**

Source: author

In all countries with 0 dummy (those below $10k per capita) the government plays the dominant role in funding of R&D with its share in funding ranging from 65% (Lithuania) to 51% (Turkey).

This suggests that transformation in the model of R&D could tell us something about transformation of an economy towards innovation or R&D based growth. For example, although countries may record high medium term rates of growth these may be not sustainable in the absence of structural changes like increasing role of the BES R&D. Table 5 shows changes in shares of R&D employment by major institutional sectors. It shows data for all countries for which data are available in UNESCO database 2007 for at least 5 years. As we are interested in trend of change data are used for the first and the last available year and hence differ across countries. Table 5 shows that changes in employment towards BES were quite limited in the majority of the post-socialist countries.

Table 5: Changes in shares of R&D employment (first and last available year)

Country	Business enterprise	Government	Higher education	Private non-profit	Not distributed
China	0.47	0.29	0.18	0.00	0.20
China	0.60	0.23	0.17	0.00	
Slovenia	0.42	0.34	0.22	0.03	
Slovenia	0.56	0.23	0.18	0.04	
Czech Republic	0.48	0.34	0.19	0.00	
Czech Republic	0.52	0.26	0.21	0.01	
Hungary	0.31	0.36	0.33	0.00	
Hungary	0.29	0.33	0.37	0.00	
Lithuania	0.03	0.48	0.49	0.00	
Lithuania	0.09	0.29	0.62	0.00	
Russian Federation	0.64	0.26	0.10	0.00	
Russian Federation	0.60	0.30	0.10	0.00	
Bulgaria	0.14	0.58	0.27	0.01	
Bulgaria	0.14	0.66	0.19	0.00	
Poland	0.28	0.25	0.47	0.00	
Poland	0.17	0.25	0.58	0.04	
Romania	0.71	0.23	0.06	0.00	
Romania	0.49	0.30	0.21	0.03	
Slovakia	0.32	0.41	0.27	0.00	
Slovakia	0.24	0.24	0.51	0.01	

Source: Based on UNESCO 2007 database

An increasing share of R&D employment in the BES took place in China and Slovenia indicating the right direction of structural change for catching-up economies. Increasing shares of the BES and the HES took place in Czech R, Hungary and Lithuania indicating both favourable structural change as well as change typical for post-socialist countries which had marginal R&D in the HES. In other countries, an increasing share of R&D employment took place in government sector in Russia. An increasing share of government and HES took place in Bulgaria and increased share of R&D employment only in the HES took place in Poland, Romania, and Slovakia. In summary, we observe catching up pattern in China and Slovenia, and partly in Czech Republic. In majority of countries there was some reorientation towards R&D in the HES with the BES remaining in a weak position. This suggests that despite high growth rates the CEE/CIS countries (with exception of Slovenia and partly Czech Rep) are not yet transforming towards greater role of the BES R&D which is essential partner in establishing science – industry link. However, there is a strengthening of R&D capacities in the HES so that R&D systems of some CEECs have become dominated by university R&D (Lithuania, Poland, Slovakia). However, the absence of structural change towards BES R&D may indicate the limited scope for catching-up.

In summary, a broad developmental context of the CEE/CIS countries is not favourable to development of science – industry linkages. Their growth is not yet driven by R&D and innovation and the majority of countries are in potentially catching up stage towards being moderate innovators. Their major constraints are in weak quantity and quality of demand for RTD with limited market for growth of local knowledge intensive enterprises (KIE). A symptom of that situation is a limited re-orientation towards the BES R&D despite their relative high growth rates since 1998.

In continuation, we look more specifically into the key features of knowledge intensive enterprises in CEE so that we can understand better micro-context of science – industry linkages.

3. KEY FEATURES OF KNOWLEDGE INTENSIVE ENTERPRISES IN CENTRAL AND EASTERN EUROPE

Knowledge intensive enterprises (KIE) should have close links with a variety of knowledge sources, including links with the R&D sector. Based on contemporary understanding of innovation as a systemic process (see Fagerberg et al,2006) we would expect KIEs to operate in rich network of relationships. Our survey of 308 KIEs in six CEECs has shed some new light on this issue (see Radosevic et al, 2008).

Table 6 shows percentage of firms with high and medium importance intensity of relationships with different partners. The most important links are with the value chain partners (domestic and foreign buyers and sellers). This pattern of networking is similar to 'normal' firms. However, what distinguishes KIEs is also relatively high importance of universities, research institutes as well as alliances i.e. partnerships with other firms including licensing partners. This points to the importance of links that go beyond the commodity / service flows as well as to the importance of institutions of national innovation systems (universities and research institutes) for KIEs. In this respect the pattern of networking is similar to the pattern of importance of sources of knowledge for innovation (table 7) which also goes beyond value chain partners. For analysis of country differences see full paper by Radosevic et al (2008).

Table 6: Share of knowledge intensive firms with high and medium important relationships for their success (in %)

High and medium important intensity of relationships (% of firms)

	All	Hungary	Checz R	Lithuania	Croatia	Poland	Romania
Domestic firm (buyers)	**86**	**76**	**92**	**75**	**94**	**94**	**88**
Domestic firm (suppliers)	**77**	**64**	**86**	55	**84**	**84**	**88**
Foreign firms (buyers)	**70**	**76**	**88**	**76**	**63**	57	54
Foreign firms (suppliers)	**67**	52	**70**	**78**	**65**	**61**	**72**
Public authorities	59	54	54	**67**	58	59	**64**
Vocational/Higher education institute	56	**68**	36	53	**63**	**61**	54
Strategic alliances	57	**70**	48	44	46	**70**	**63**
Public/Private research institute	52	**68**	28	39	44	**64**	**69**
Licencing	49	51	26	34	56	**64**	**62**
Consultants	46	34	38	37	56	52	58
International joint ventures	38	26	26	40	32	49	56

Note: % as a percentage of all firms that answered the relevant question.

Note: High and medium importance= answers 3-7 on a scale 1-7

Source: Radosevic et al (2008)

We further explore how important networks are for knowledge transfer of KIEs. Table 7 shows the major sources of knowledge as a basis for innovation. In house knowledge, customers and suppliers are major sources followed by other sources. In European Community Innovation Survey data in house and value chain partners (customers and suppliers) are also major sources of information for innovation. However, in the case of KBEs the importance of other sources which go beyond the value chain is quite high. Fairs and exhibitions, patents and journals, and research organisations have also very high share which range from 71% to 68%. It is also interesting that other sources of innovation (most often Internet) are playing are very

often major source of knowledge for innovation. The share of enterprises which cite this as being of high and medium importance is 85%.
A share of KIEs where in house and value chain partners are of high and medium importance is high in all six countries. For discussion of country differences see Radosevic et al (2008).

Table 7: Share of knowledge intensive firms with high and medium important sources of knowledge as a basis for innovation

High and medium importance of sources of knowledge as a basis for innovation

	All countries	Hungary	Checz R	Lithuania	Croatia	Poland	Romania
In house	99	98	100	98	100	98	98
Customers	84	64	84	96	74	94	95
Suppliers	76	62	62	74	88	87	85
Fairs and exibitions	71	50	58	82	80	83	73
Patents, Journals	69	62	44	65	84	89	70
Research organizations	68	82	46	69	62	74	75
Other (internet etc)	85	100	100	100	100	100	10

Note: % as a percentage of all firms that answered the relevant question.

Note: High and medium importance= answers 7 - 3 on a scale 1 - 7

Source: Radosevic et al (2008)

The key message from table 7 is that knowledge networks that underpin KIEs are going beyond value chains. In that respect, KIEs do represent a distinctively different segment of firms in CEECs. In continuation, we want to explore whether sources of knowledge used in firms as the basis of product/process/service innovation have some underlying logic which could better explain patterns of innovation and knowledge acquisition. For that purpose, we have undertaken factor analysis on sources of knowledge in order to explore whether there is a systematic pattern.
Table 8 shows that sources of knowledge are grouped into three underlying or latent factors. We can distinguish between those firms where value chain partners are the main source of knowledge as both variables - suppliers and customers – load highly on one factor with the majority of other being unrelated. Also, we can distinguish those firms where formalised R&D knowledge (as contained in patents, journals and research organisations) is the major sources and those firms where in house knowledge is the key source. In both cases, factor loadings are very high and results quite robust. Fairs and exhibitions are the only source which loads relatively high on two factors – value chains and formalised R&D knowledge. This may be expected given that knowledge for innovation very often resides and is easily accessible through social and business networks. Fairs and exhibitions seem to be important for both meeting business partners as well as for catching up with the developments in R&D area.

Table 8: Sources of knowledge used in the firm as the basis of product/process/service innovation

Rotated Component Matrix

	Value chain	Formalised R&D knowledge	In house
Suppliers	0.827	0.113	-0.067
Customers	0.813	-0.046	0.228
Fares/ Exibitions	0.581	0.430	-0.190
Patents/Journals	0.197	0.847	-0.044
Research organisations	-0.027	0.819	0.183
In house	0.036	0.091	0.953

Rotation Method: Varimax with Kaiser Normalization.

Source: Radosevic et al (2008)

In summary, factor analysis has simplified structure of sources of knowledge for innovation and generated three factors which are robust proxies for three major sources of innovation: value chain partners, formalised R&D and in house knowledge. In continuation we explored whether firms could be grouped in terms of different patterns of underlying network relationships. We undertook factor analysis using data on intensity of network relationships. Table 9 shows results of factor analysis for intensity of links.

Factor analysis shows that there are four types of firms based on intensity of their links with external partners. This factor solution is quite robust with high loadings on underlying factors.

Foreign network dependent firms are those whose links with other firms, licensors, joint venture partners, consultants and public authorities are highly correlated. It seems that most of firms in this group are dependent on foreign partners but not on foreign buyers and suppliers i.e. value chain partners. In addition, these firms are to some extent also dependent on public authorities but are not dependent on public research system.

Second group of firms are those that dependent on institutions of national innovation system like universities, research institutes and public authorities. Hence, it seems appropriate to define these firms as *Public research system dependent firms*.

Third and fourth types of firms are those that are dependent on either foreign or domestic buyers or suppliers ie. *value chain dependent*.

Factor analysis solution has demonstrated different network orientations of KIEs in CEE. It shows that although in aggregate KIEs are dependent on both value chain links as well as on national innovation system links (universities, research institutes) this dependence is highly differentiated. Some firms are indeed dependent on public research system and some on foreign networks while some KIEs are very similar to ‘ordinary’ firms by being dependent mainly on value chain partners, domestic or foreign. This is very important for innovation policy which assumes that only links with PROs matter for KIEs.

Table 9: Four types of firms in terms of intensity of their links

Rotated Component Matrix

	Network dependent	Public research system dependent	Foreign value chain dependent	Domestic value chain dependent
Strategic alliances	0.798	0.166	0.183	0.046
Licencing	0.757	0.170	0.019	-0.006
International joint ventures	0.665	0.066	0.330	0.074
Consultants	0.546	0.223	-0.112	0.369
Public authorities	0.468	0.453	0.039	0.297
Vocational Higher education institute	0.096	0.888	0.091	0.032
Public/Private research institute	0.281	0.805	-0.039	-0.029
Foreign firm suppliers	0.069	0.071	0.844	0.195
Foreign firm buyers	0.189	-0.021	0.782	-0.168
Domestic firm suppliers	-0.062	0.140	0.221	0.839
Domestic firm buyers	0.324	-0.155	-0.223	0.681

Rotation Method: Varimax with Kaiser Normalization.

Source: Radosevic et al (2008)

Table 10 presents results of factor analysis which gives very robust grouping of firms based on success factors into three groups based on latent factors or variables shared across different types of firms. Factor analysis shows that there are three groups of KIEs in CEE:

a) *Networkers* or firms highly dependent on links with other scientific organisations, on EU Framework programs, on government support and links with other firms.

b) *New Technology Based Firms* or firms whose competitiveness is based on unique technology, and on patents and licences.

c) Firms whose competitiveness is based on *Customer oriented organisational capabilities.* These firms are strong in knowledge of customer needs, in management and are able to offer expected services/products at low cost.

Table 10: Types of firms based on success factor (based on factor analysis)

	Networker	New technology based firms	Customer oriented organisational capabilities
Links with scientific organisations	**0.754**	**0.313**	-0.071
EU Framework programs and other EU support	**0.749**	0.086	0.095
Government support	**0.681**	0.239	0.172
Alliances/partnerships with other firms	**0.639**	-0.108	0.185
Links with previous employer	**0.489**	0.139	-0.179
Uniqueness of product/ technology/knowledge	0.062	**0.813**	0.076
Patents and licences	**0.400**	**0.716**	0.028
People and training	**0.245**	**0.410**	**0.369**
Knowledge of customers needs	-0.023	0.230	**0.663**
Management	0.396	0.014	**0.603**
Capability to offer expected services/products with low cost	0.014	-0.146	**0.601**
Quality	-0.115	0.376	**0.576**

Rotation Method: Varimax with Kaiser Normalization.

Source: Radosevic et al (2008)

Factor loadings on each of three factors are very high and three factor solution is very neat and robust. A very interesting finding which arises from table 10 is that KIEs are not homogenous entities who are competing based on new technologies. In fact, new technology based firms i.e. firms which base their operations on unique technologies, patents and licences are only one of three types of KIEs. In addition to NTBFs, our sample indicates presence of networkers or firms which are dependent on a variety of public and private networks and sources. In addition, there are firms whose base for success is organisational capabilities. However, unlike large firms for whom organisational capabilities are also important this type of KIEs base their competitiveness on organisational capabilities which are very much customer oriented i.e. they are dependent on knowledge of customer needs.

As part of our research on KIES in six CEECs we have undertaken 12 case studies which have been summarised in Radosevic and Woodward (2008). These cases complement survey based research and demonstrate that the knowledge-intensive firm in the CEEC are knowledge-localisers or customisers, adapting global knowledge to local needs on the domestic market, rather than knowledge-creators generating new solutions for global markets (see stylized summary in table 11 below). The entrepreneurs who start and run these businesses are skilled at spotting trends early and bringing them to local markets. They have established themselves as strong local brands but they are struggling with the challenge of entering export markets with products and services that can achieve global, or at least regional, recognition. Based on examples of studied companies CEE firms seem to be still in early stages of this strategic shift.

In comparison with the stylised new technology based company, we observe a dearth of linkages of strategic importance for processes of innovation and product development. The role of networks with other firms (in the form of strategic alliances, research joint ventures, cooperation with supply chain partners, etc.) as well as with universities and research institutes has been richly described in the literature on innovation. While the CEEC firms also engage in such cooperation, it tends to take place ‘on the margins’, as it were, of the innovation process: customers supply raw ideas, universities and research institutes provide access to equipment with which to test raw materials and finished product quality, and so on. But these partners are not integrated into the product development process itself. That is kept quite strictly in-house. On the other hand, it seems that knowledge intensive firms in CEECs are far more networked than innovating firms in these countries as depicted in innovation surveys.

Firms in both case studies and for which data are collected through survey demonstrate broader set of capabilities which form the basis of their growth and competitive advantage. In addition to advantages based on specific new technologies, majority of firms base their competitive advantages on broader sets of competencies which are related to localisation, knowledge of customer needs and ability to differentiate themselves on local markets. The companies studied generally enjoy a strong public sector share in their client base. This should not be considered so surprising, as demand for knowledge intensive products and services on private local markets are still underdeveloped in the post-socialist economies. On the other hand, public sector has strong needs in IT services related to modernisation of public administration.

Table 11: KIE in CEECs compared with the global model: a stylised picture based on case studies

	New technology based firm	CEE knowledge based firm
Mode of growth	Generic expansion	Productivity based expansion
Strategic objective	Commercializing results of IPR	Diversifying to exploit organisational capabilities
Model role	'Gazelle'	Knowledge broker/Specialized supplier
Structural feature	Trendsetter	Trend spotter
Market orientation	Global market	Domestic market
Key competitive advantage	New world frontier technology or product	Customer oriented organisational capabilities
Threshold barrier	IPO	From domestic brand builder and networker to established exporter

Source: Radosevic S. and R. Wooodward (2008)

In summary, KIEs are mainly domestic market oriented and serve a diverse types of customers. They are not 'gazelles' type of companies but important players in a knowledge system which are heavily dependent on external knowledge networks (domestic and foreign). Key factor of KIEs firms' growth are firm specific capabilities which do not always involve R&D. Very often KIEs operate as specialized suppliers (cf. Pavitt, 1984 taxonomy). Unlike standard companies which are very much value chain dependent in their growth networks of KIEs are much broader and involve local systems of innovation actors including professional networks. From a policy perspective it is important to recognise that the KIEs in CEECs are somewhat different organisations which require polices which go beyond typical new technology based firms.

4. CONVENTIONAL POLICY WISDOMS FACING REALITY

In sections 2 and 3 we presented both the macro and micro context of science – industry links of the CEE/CIS countries. Although our evidence does not cover all post-socialist countries, especially in analysis of micro-environment, it is nevertheless quite relevant for all post-socialist countries. The evidence in two previous sections provides a good background for understanding of policy issues for science – industry linkages in CEE/CIS. It demonstrated that the overall macro and micro context works against science – industry links (section 2). In addition, knowledge intensive enterprises in CEECs are different types of organisations and their support cannot be reduced to support typical for new technology based firms.

Our argument is that current policies for science – industry linkages are based on the logic of linear innovation model while reality of these countries is very much based on the logic of interactive innovation model (OECD, 1992). The focus of linear model is on technological opportunities and science push. Innovation is perceived as well-defined homogeneous thing which evolves from research to marketing and with well defined stages (discovery, invention, innovation, diffusion). The policy focus is mainly on R&D budget. The focus of interactive model is on the social process underlying economically oriented technical novelty and on design (engineering). The idea is that subsequent improvements may be more important than the original inventions. Policy focus is on process of interaction within a firm and with the system in which it operates.

A good example of linear innovation model thinking are policy actions of a number of CEE/CIS during the 1990s. Table 12 summarises the data from the Catalogue of innovations developed within the public R&D system of Kazakhstan. The underlying idea is that the policy should focus on commercialising results from R&D system. This thinking shares many of the underlying features of linear innovation model like belief that innovation is a well –defined homogenous thing and that the main issue is to move it from research to marketing stage. The catalogue shows that only 20% of developments (42/206) are ready for introduction from the technical point of view. Our interviews with local specialists who are familiar with Kazakhstan's technology market suggest that only one or two R&D results from this list are interesting from a commercial point of view (Radosevic and Myrzakhmet, 2003). Of course, this is very imperfect and possibly very partial assessment, but it nevertheless illustrates the nature of the problem. How far can R&D institutes be pushed to substitute for firms by commercialising results of their R&D? Could the solution be in re-framing the problem and orienting policy more towards problems of innovation within industrial firms?

Table 12: Catalogue of innovations developed within the public R&D system of Kazakhstan

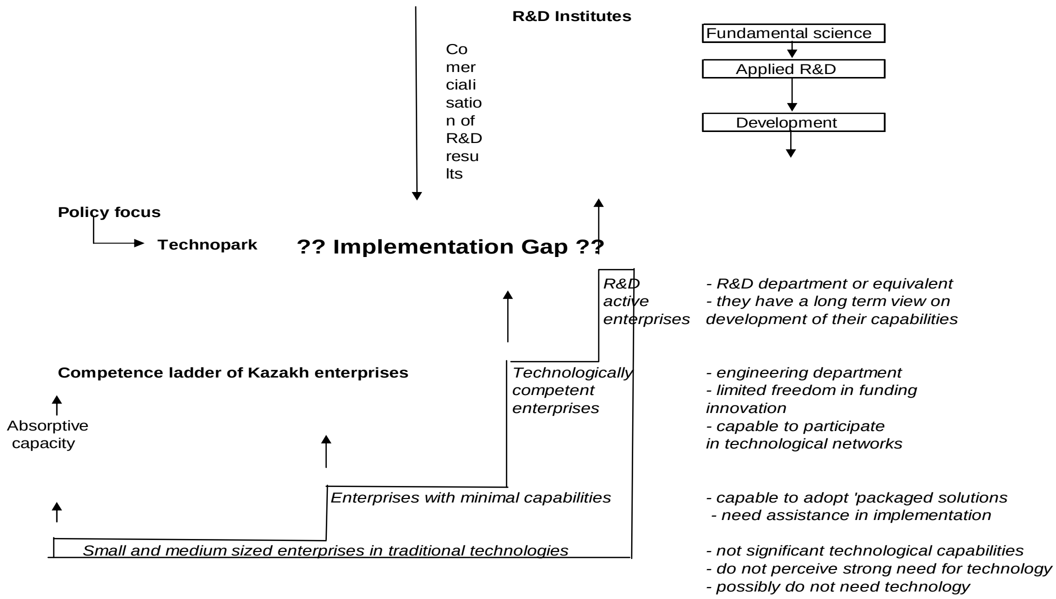
	Number	Share
Developments ready for introduction	41	20.0%
Developments that have passed industrial pilot stage	50	24.4%
Developments that have passed experimental stage	46	22.4%
Developments at the technical documentation or patent stage	68	33.2%
Total	205	100.0%

Source: Based on publication of the Ministry of Education and Science (2003)

Figure 3 summarises the linear innovation model logic that underpins the innovation policy (based on example of Kazakhstan) and its problems. It shows the nature of the problem, by highlighting the implementation gap between the capabilities of Kazakhstan enterprises and the nature of 'supply' from R&D institutes. The majority of Kazakhstan's enterprises are either SMEs in traditional technologies, many of which inhabit Kazakhstan technoparks, or enterprises with minimal capabilities. There is a much smaller number of enterprises which are technologically competent, and there are only a few R&D-active enterprises. The number of people in enterprises that work exclusively on R&D is only 378, or 2.5% of the total number of R&D workers in Kazakhstan (Kembaev, Aitmambetov, and Ordabaeva, 2001)[5]. On the other hand, R&D institutes are rarely able to offer R&D results in a form which would be acceptable to industrial firms, especially given the latter's limited absorptive capabilities. There is an idea that technoparks should be able to close the implementation gap between the limited absorptive capability of enterprises and the R&D outputs of R&D sector.

Figure 3: The linear innovation model logic that underpins the innovation policy (based on example of Kazakhstan) and its problems

[5] Kembaev, B.A., R.M. Aitmambetov, S.I Ordabaeva (2001): *The Dynamic of S&T Potential of the Republic of Kazakhstan for 1991-2000*, KazgosINTI, p.30



Source: Radosevic amd Myrzakhmet (2003)

Similar results have been found in our research on Novisibirsk Akademgorodok (Radosevic, unpublished) based on the case studies of the majority of institutes of this Science City. Reality of new technology based firms of Novosibirsk contradicts underlying (implicit) linear innovation model. Initial expectations on commercialisation (*vnedrenye*) were also based on linear innovation model logic. Assessment undertaken by Siberian Academy of Sciences in 1993 found that there are 5 out of 200 technologies with immediate commercial potential in Akademgorodok. Unlike this underlying policy model we have found in practice that innovation is an interactive process whereby research institutes and new technology based firms operate as: specialized suppliers (testing equipment, niche products, and scientific instruments), consultants or 'knowledge brokers' (facilitating adoption of new technologies) and as generators of learning (education) by developing methodologies and instrumentation). Our conclusion from this research is that the absence of NTBFs in Russia cannot be understood within the linear innovation process perspective but only within the interactive innovation process perspective. In institutionally undeveloped environment, the scope for technology based growth and competition is extremely limited. Technology based growth in Russia would require inter-linkages among all four groups of technology based sectors (scale intensive, supplier dominated, science based, specialized suppliers)

A strong policy focus on science – industry links currently also dominates innovation policy of Central European countries (Hungary, Czech Republic, Poland, Slovenia and Slovakia). Our overview of ProINNO Trendchart Reports for CECs for 2007 found that the three key challenges of innovation policy are:

1. Weak innovation and R&D activity of business enterprise sector
2. Weak ties between public R&D and BES /transfer of R&D results/innovation cooperation (science – industry links)
3. Human resources for R&D and innovation/ for KBE

Table 13 summarises the count of innovation policy measures as collected in ProINNO Trendchart database. Science – industry links are 'the most populated' policy area not only in the CEE/CIS but also worldwide[6].

Table 13: Number of innovation policy measures in ProINNOTrendchart database

Support for science - industry and NTBFs	364
Support for universities and public research organisations	148
Support for BERD	134

Source: ProINNO Trendchart Database: 41 countries, as of 2007

For example, a high importance of new technology based firms in innovation policy of Russia is a good example of this trend. Table 14 summarises all major Russian innovation policy instruments where support to new technology based firms, as the main conduits of science – industry links, fare prominently.

Table 14: Major innovation policy instruments of Russia as of 2007

RUSSIA: KEY INNOVATION POLICY INSTRUMENTS 2007	
	State R&D programs
1	Federal Goal-Oriented Program "National Technological Basis" for 2007-2011 years
2	Federal Goal-Oriented Program "R&D in Priority Directions of Development of Science-Technological Complex of Russia in 2007-2012"
3	Federal Goal-Oriented Program "E-Russia"(2002-2010)
4	Federal Goal-Oriented Program "Development of civil aviation technology in Russia in 2002-2010 and till 2015"
5	Federal Space Program for 2006-2015
6	Federal Goal-Oriented Program "Ecology and Natural Resources of Russia for 2002-2010 years"
7	Draft Plan of Measures for Light Industries Development for the period 2006-2008
	Support to new technology based firms
1	Co-financing of R&D at small innovative enterprises
2	Support of R&D at start-up innovative companies – program START
3	Creation of Russian venture company
4	Creation of the open joint-stock company "Russian Investment Fund of Information and Communication Technologies"
5	Creation of technology park in high tech
6	Creation of technical-promotional special economic zones
	Regulatory measures for innovation
1	Reform of Technical Regulations – Technical Regulation Act 2002
2	Tax remissions for organizations working in information technologies
3	Decree on temporary import tariff for certain sorts of technical equipment
4	Control over the legal protection of the results of civilian R&D created under budgetary expense

Source: ProINNO Trendchart Report on Russia, 2007

Elsewhere (see Radosevic, 2007) we summarised the key issue in restructuring of R&D of the six CIS countries, including science – industry initiatives[7]. There are big

[6] As this database covers 41 countries with the biggest technology potential we believe that it does represent a good sample worldwide
[7] Georgia, which is a part of our review, has left CIS. However, we still include it in our analysis as we use CIS term in developmental and economic rather than political term.

differences in support to science – industry linkages across the six CIS but they have to do more with the overall development of innovation policy rather than with differences in priority given to this area. In fact, innovation policy initiatives in these countries usually start with initiatives to support science – industry links. Early 1990s were dominated in both CEE and CIS by foreign support initiatives to various programs of this kind. This has continued today but to very different degrees in terms of scope and budgetary support. From 2004, the CEECs started to benefit from substantial support through EU Structural Funds and other EU programs, part of which includes science – industry linkages. In financial terms, this support is comparable to Russia which recently developed support for NTBFs through programs like 'Start' and support to technoparks. Other countries CIS are much behind in that respect. Ukraine's innovation policy is characterised by waves of changing policies towards technoparks. Armenia has successful cases of policy and bottom up initiatives with international participation. Kazakhstan has only recently started 'Start Up' program which aims to support 7 technology based incubators but which temporarily has been interrupted due to budgetary problems related to global financial crisis. Azerbaijan, except support to one incubator does not have policy to support science – industry links while Georgia is a complete blank spot in this respect.

Although very different in scope, focus and budgetary weight there are some common features of science – industry initiatives across the two regions. First, there is overwhelming support to organisations, not functions, in science – industry initiatives. By this we mean that there is focus on organisations like incubators, innovation centres, science parks ie. on organizational forms. There is much less or not priority at all given to support of the linkage functions like: cooperation with R&D and higher education institutions, active management of technology transfer, and support for technology-intensive activities. There is danger of overinvestment in 'bricks and mortars' (in both CIS and EU NMS) and neglect of what we consider as the logical set of priorities. First priority should be given to support for innovation projects; second, to people involved in the management of innovation projects, and only third, support to bridging organisations.

Direct investments by government in bridging organisations may create the illusion that the money is being well used, and that working of a physically closed organisation like innovation centre or Science Park can be controlled. However, buildings are secondary to the key objective of the bridging functions, which is technology transfer and successful innovation management. These are highly 'intangible' activities which can only be influenced by those close to the ground. Even where this is recognised, there is a high failure rate in fashioning new organisations. Building an efficient management teams requires i) monitoring and coaching of management and an effective early warning system for problems; and ii) a performance driven pay system for the organisations management team. These can be best designed and implemented at the local level. The only public investments into physical property and equipment should be investments into individual projects (ventures), and should be restricted to those cases where these investments are indispensable.

Another area of science – industry linkages where there is a strong policy focus, though much more rhetorical than in practice is support to venture capital. World Bank (2006) study on this issue in ECA region has pointed that venture capital, if

available then it is available for relatively larger and less risky projects. The conclusion of study is that ‘venture capital does not provide a solution to the market failure in early stage technological development’ (World Bank, 2006, p.28).
In figure 4 we summarised the alternative model of support as depicted by World Bank (2006) study. The key weakness of public support to knowledge intensive firms in CEE/CIS is funding gap or area in between support to public R&D and venture capital. Venture capital usually targets projects that have passed the early stage so that investors can avoid uncertainties connected with early stage companies. On the other hand, policy support is focused on opposite edge of new technology venturing while minigrants and matching grants & linking up each of stages with business support services are very much neglected issues[8]. Business support is essential in all stages of this process and should be an essential ingredient of support.

Figure 4: Integrated and complementary support to Knowledge intensive enterprises

Public R&D <> Minigrants <> Matching Grants <> Venture Capital
< Business support services >

Source: Based on World Bank (2006)

In overall, there is an overwhelming linkages failure in CEE/CIS countries which can be understood only if we take into account organisational failures. By organisational failures we mean failures of local firms to restructure and develop ‘linkage capabilities’ as well as failure of public research organisations (PRO) to restructure to meet new R&D demand. Our argument is that there are strong limits of ‘bridging’ policies in the current context which are basically trying to link up weak enterprises with unreformed universities and PROs. It is forgotten that links are as strong as actors to be connected. Hence, the bridging function should develop much less often as a stand-alone function and much more often it will be a complementary function of R&D institutions or enterprises. Stand alone bridging function (cf. innovation centres) is effective in the transfer of simple information and as intermediaries. Comparatively there is a much less focus on enhancing demand for technology within enterprises (innovation grants) and on restructuring, often inadequate, R&D supply (PROs, universities).

Finally, from innovation policy perspective there seems to be actually too much focus on science – industry linkages and neglect of other linkages in national innovation system. Science – industry linkages are one among several major links in systems of innovation. Links which may be currently equally or even more important are links between large and small firms (horizontal links and value chain links), links between foreign firms and domestic firms linkages (international value chain links), international R&D networking and sourcing relationships as well as intra-regional linkages. This point rests on understanding that technological capability depends on a variety of learning mechanisms: upstream, downstream and laterally. Table 15, which is developed by von Tunzelmann and Wang (2007) based on Malerba (1992) indicates position of science - industry links within so called ‘dynamic interactive capabilities’ approach to growth. Capabilities are essential to growth in order to harness

[8] Mini-grants are those given to explore commercial feasibility of technical idea; matching grants are to encourage risk sharing with firm plus with potential to create linkages.

competencies effectively. They are interactive as they are necessary to produce products that are compatible with the capabilities of customers' needs and suppliers' knowledge. They are dynamic are they have to be reproducible in 'real time' i.e. they are changing. Learning takes place not only among producers (learning by doing) but also among consumers (learning by using) and technology suppliers (learning by search). Technology suppliers can be any organisation that is involved in formalised search activities, i.e. firms which undertake systematic R&D, public research institutes, universities, users' organisations which strategically improve the use of technology, etc.

Table 15: Taxonomy of learning mechanisms

Source	Internal	External
From production	**Learning by doing**	**Learning by spillovers** from competitors and from horizontal linkages
From consumption	**Learning by using** products, inputs, mach.	**Learning by interacting** with suppliers and buyers
From technology suppliers	**Learning from R&D and training**	**Learning from education and /S&T of 'technology/ knowledge suppliers'**

Science – industry links

Source: Malerba (1992) and von Tunzelmann and Wang (2007)

In essence, we consider this as a system of innovation approach which embeds an alternative production theory. It assumes that "all agents in this system act variously as suppliers, producers and consumers" and "it replaces traditional demand–supply duality with a threefold classification of demand–production–supply. Each producer, whether it be of products (firms), labour (households), capital (banks), technologies (laboratories), and so on is looking both ways – to the supply of its inputs and the demand for its outputs (Von Tunzelmann and Wang, 2007). It assumes that inputs and outputs do not have independent existence but are closely connected through mutually determined production processes – thus for instance on-the-job learning in the course of production ('learning by doing') raises the quality of skills in the workforce, and so on. In that respect, this approach breaks with the traditional logic of production functions based on a sharp distinction between inputs and outputs. What drives technological change are the different types of learning mechanisms: internal to the firm/producer and external to the firm/produce.

From our point of view this approach basically highlights and re-confirms from theoretical perspective the importance of a variety of linkages in national innovation system and points to the position of science – industry linkages in the overall growth. It clearly points out that support to science – industry linkages should be seen in the context of the overall linkages within the NIS.

In summary, in this section we argued that innovation policy in CEE/CIS has an overwhelming focus on bridging organisations ('bricks and mortars'), not functions in supporting science – industry linkages. Too much emphasis has been given to new bridging organisations instead of reorienting the existing PROs to serve needs of new medium sized enterprises. In addition, the best way to support science – industry links may be supporting other linkages in NIS, especially FDI – local firms' knowledge links. In overall, the issue is the balance of innovation policy which should reflect more local sources of productivity improvements rather copying models of science – industry support from technologically advanced countries.

5. CONCLUSION

In this paper we pointed to a variety of missing requirements for technology based competition which are essential to science – industry linkages. The CEE/CIS belong to countries behind technology frontier and the majority of them are in stage of transformation from factor and efficiency driven to innovation driven economies. Their growth is not yet driven by innovation (despite high share of total factor productivity), they have substantial demand gap in research, technology and development (RTD), with limited market for knowledge intensive enterprises (KIEs) and limited re-orientation of R&D towards business enterprise sector.

Local knowledge intensive enterprises are not 'gazelles' but important players in a knowledge system which are heavily dependent on external knowledge networks (domestic and foreign). Key factor of KIE firms' growth are firm specific capabilities which do not always involve R&D. Very often these firms operates as specialized suppliers rather than as new technology based firms. Unlike standard companies which are very much value chain dependent in their growth networks of KIEs are much broader and involve local systems of innovation actors including professional networks

Within this broader macro and micro context policies for science – industry links are of mainstream character and very often supported by foreign funding and thus represent transfer of policy models developed for countries at technology frontier. This has created a situation where conventional policy wisdoms have faced reality of post-socialist economies and has generated modest effects.

Results of linkage policies are meagre and points to other missing links which are indirectly affecting industry - science linkages. There is a strong policy focus on science – industry links but obsession with organisations ('bricks and mortars'), not functions. There is a neglect of coupling funding of NTBFs with business support assistance and neglect of actors to be linked as well as other links in NIS. Different bits and pieces of evidence accumulated in this paper point to probably widespread ‘linkage failures’ in CE/CIS. This failure largely comes due to uncritical application of conventional policy wisdoms into the context of ‘catching up’ and ‘laggard’ economies.

In view of this failure there is a strong need to learn from success stories and success instruments. It is not our aim to derive policy implications but to point that there is a need for more policy experimentation based on through understanding of the local context. Indeed, policy itself should be a ‘discovery process’ (Hausmann and Rodrik,2003) rather application of toolboxes developed for other contexts. Support to science – industry linkages for the CEE/CIS should be balanced with support to strengthening ‘actors’ (existing large and small firms; universities and PROs) and support to other linkages in NIS, especially knowledge links between domestic and foreign firms.

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