Science – industry links in CEE and CIS: conventional policy wisdoms facing reality

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An outline

- CEE/CIS countries and technology based competition
- Knowledge intensive enterprises in CEE: key features and obstacles
- Science – industry links: conventional policy wisdoms facing reality
- Limits and neglected dimensions of policies for science – industry links
- Conclusion

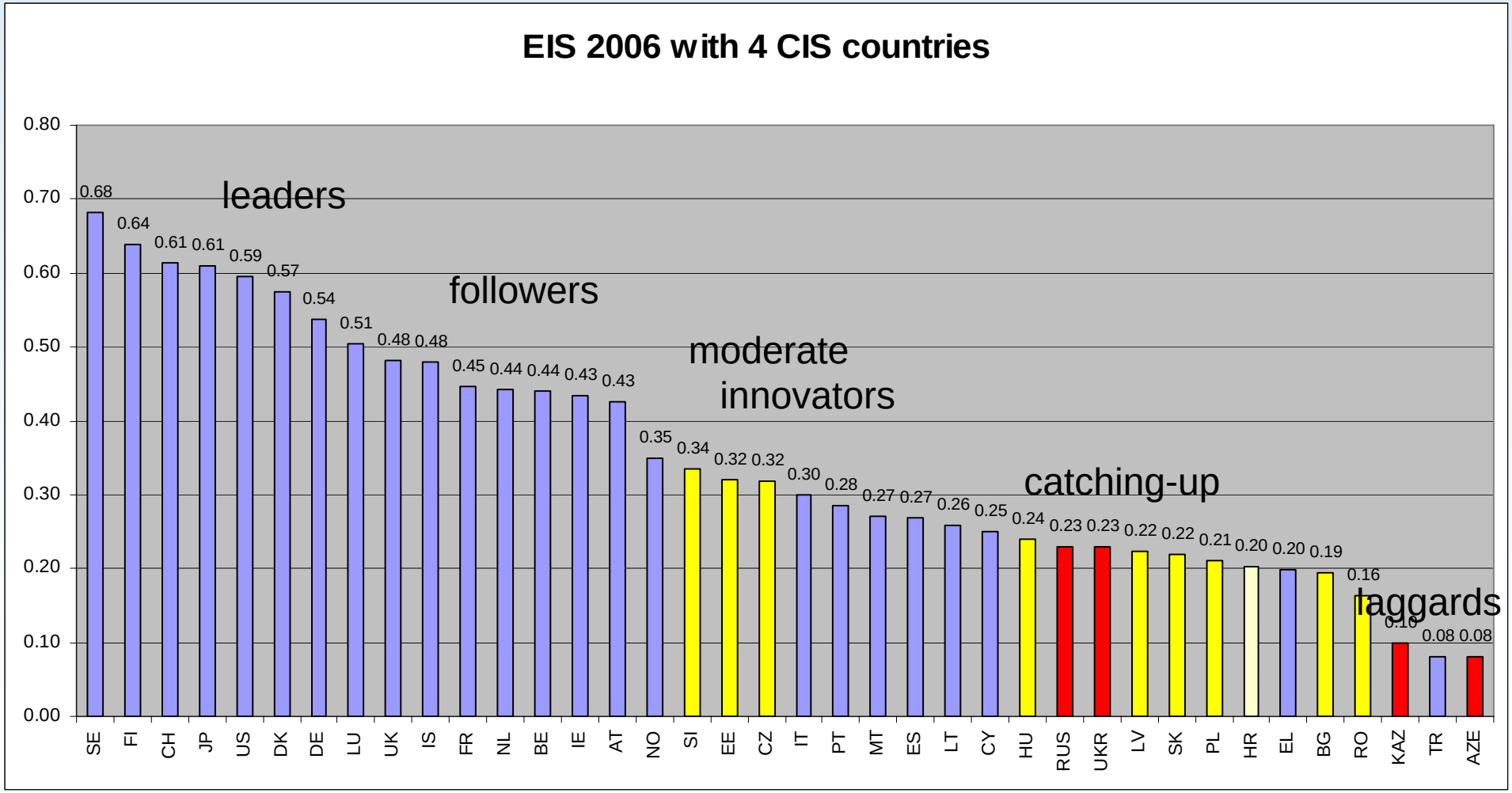
Technology based competition: challenges

- Cost and quality based vs. technology based competition
- Requirements for technology based competition
  - competition based on product/process innovation
  - sophisticated demand
  - user requirements
  - certificates and standards
  - marketing barriers (brand)
  - after sale services and warranty
  - IPRs
  - affordable access of NTBFs to technical infrastructure
  - available finance to upscale production

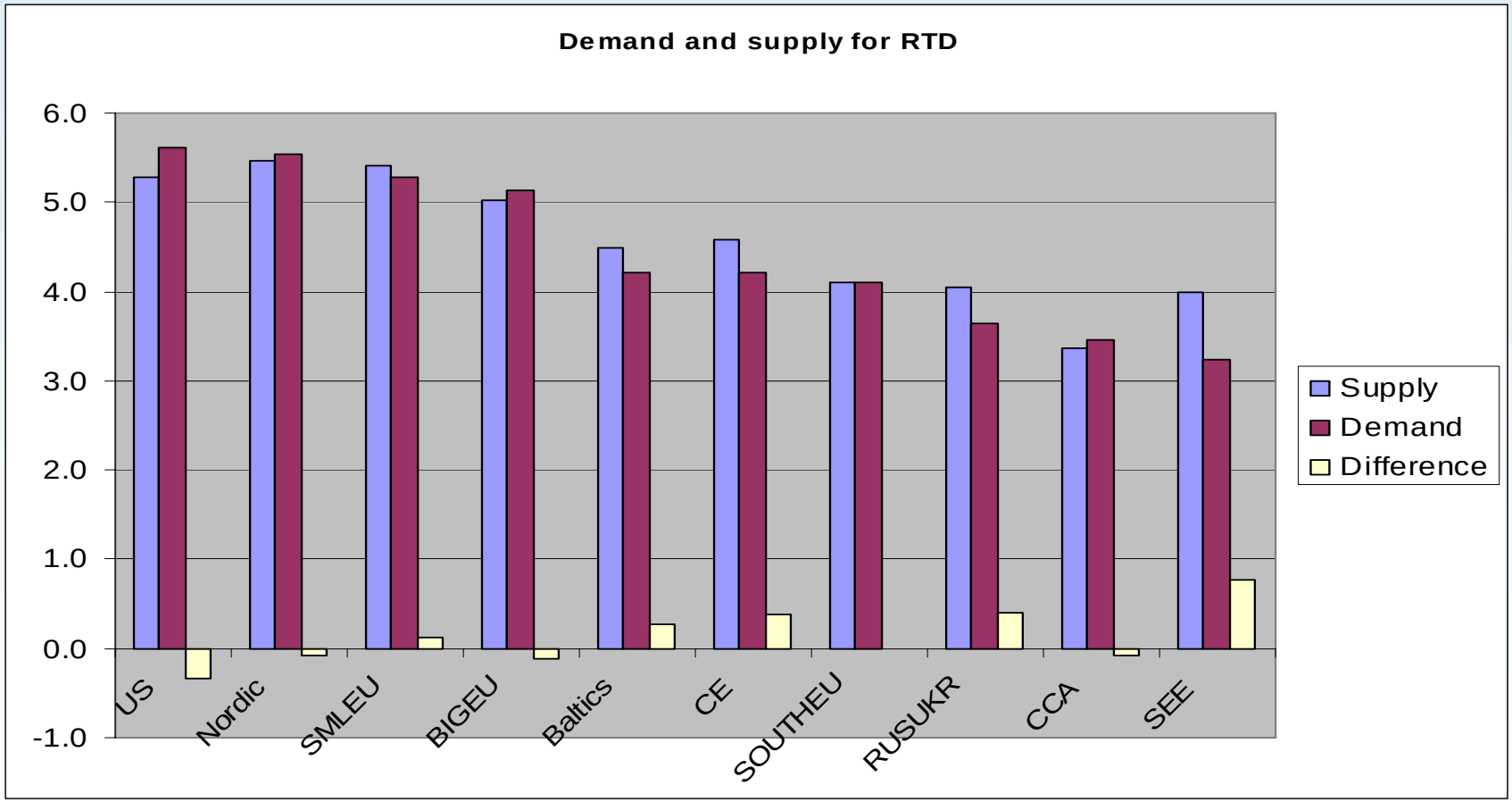
CEE/CIS countries and technology based competition

- CEE/CIS: moderate innovators, catching up, and laggards
  - ➢ Transformation from factor and efficiency driven to innovation driven economies (WEF)
  - ➢ Growth is not yet driven by innovation (despite high share of TFP)
- Demand gap in research technology and development (RTD)
- A limited market for knowledge based enterprises (KBEs)
- A limited re-orientation towards BES R&D

EIS with 4 CIS:
the extent to which growth is based on innovation



Factors of RTD: demand gap in CEE/CIS



Demand gap/supply surplus: Rus/Ukr, CE,SEE;
Demand surplus/supply gap: US

Source: Based on WEF

Legend

- ***Suply***
- 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***
- 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

A common barrier for knowledge intensive enterprises (KIES) in CEE: a limited market

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

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				

BES dominated R&D systems are feature of countries above $15Kpc

	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**

R&D employment: limited re-orientation towards BES in EE

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	

Increasing share of BES (China; Slovenia); Increasing shares of BES and HES (Czech R; Hungary, Lithuania); Increasing share of government sector (Russia); Increasing share of government and HES (Bulgaria); Increasing share of HES (Poland; Romania, Slovakia)

Key features of knowledge intensive enterprises in CEE

- Market demand as a key constraint for KIE
- They are mainly domestic market oriented and serve a diverse types of customers
- KIEs in CEE are not ‘gazelles’ but …
- … important players in a knowledge system which are heavily dependent on external knowledge networks (domestic and foreign)
- Key factor of KBE firms’ growth: firm specific capabilities which do not always involve R&D
- 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

Intensive value chain but also system of innovation relationships (sample 304 firms)

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

Beyond value chains: a strong knowledge networks underpin KBE

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

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.

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.

Cf. a very similar solution for importance of links

Three types of firms based on success factors:
networkers, NTBFs, and organisation capabilities oriented

	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.

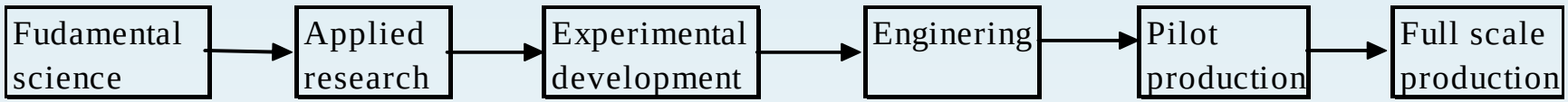
KBE in CEECs compared with the global model: a stylised picture based on case studies

	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

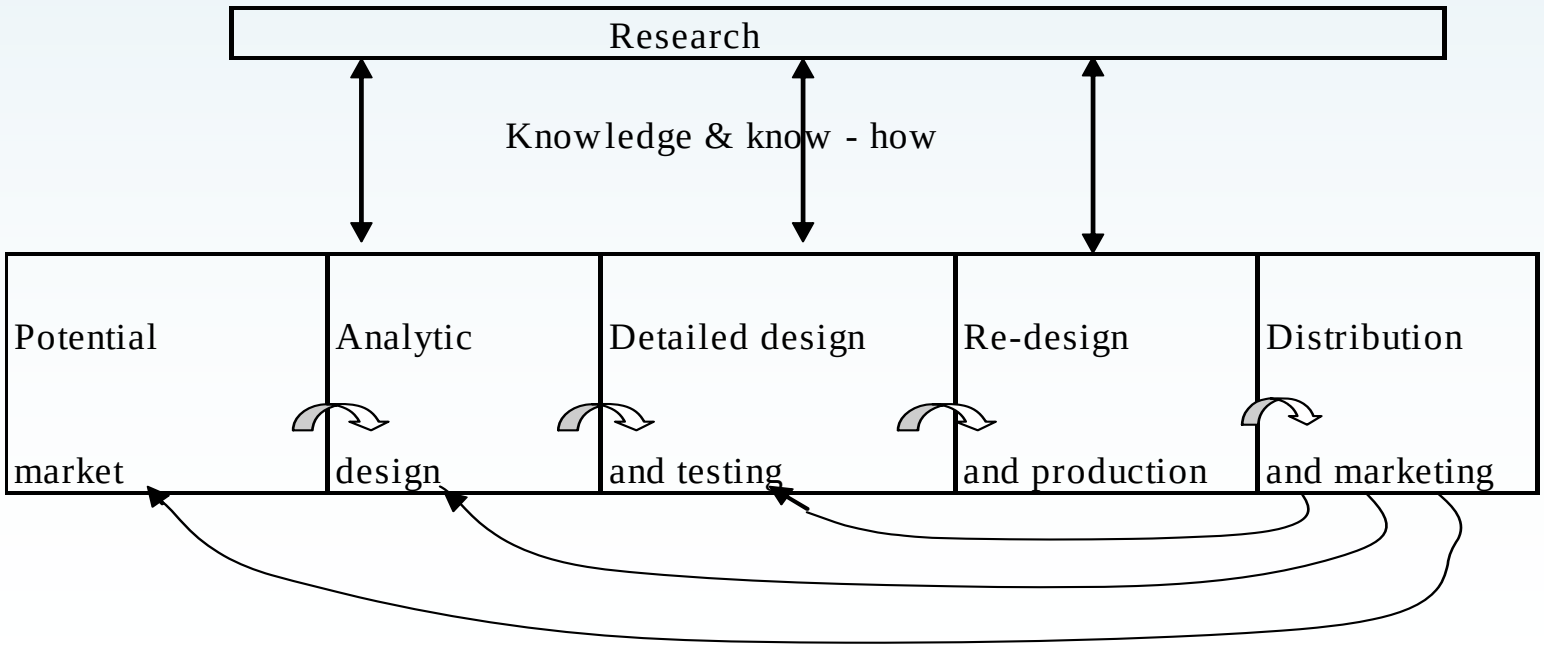
Source: Radosevic S. and R. Wooodward (2008) A comparative overview of case studies of knowledge based firms from Central and East European countries, mimeo

NTBFs / KBEs / technology based competition: conventional policy wisdoms facing reality ……

The Linear Innovation Model



Interactive innovation model



Different management and policy focus of different underlying models

LINEAR MODEL

- Technological opportunities
- Science push
- Innovation is well-defined homogeneous thing
- From research to marketing
- Well defined stages (discovery, invention, innovation, diffusion)
- R&D budget

INTERACTIVE MODEL

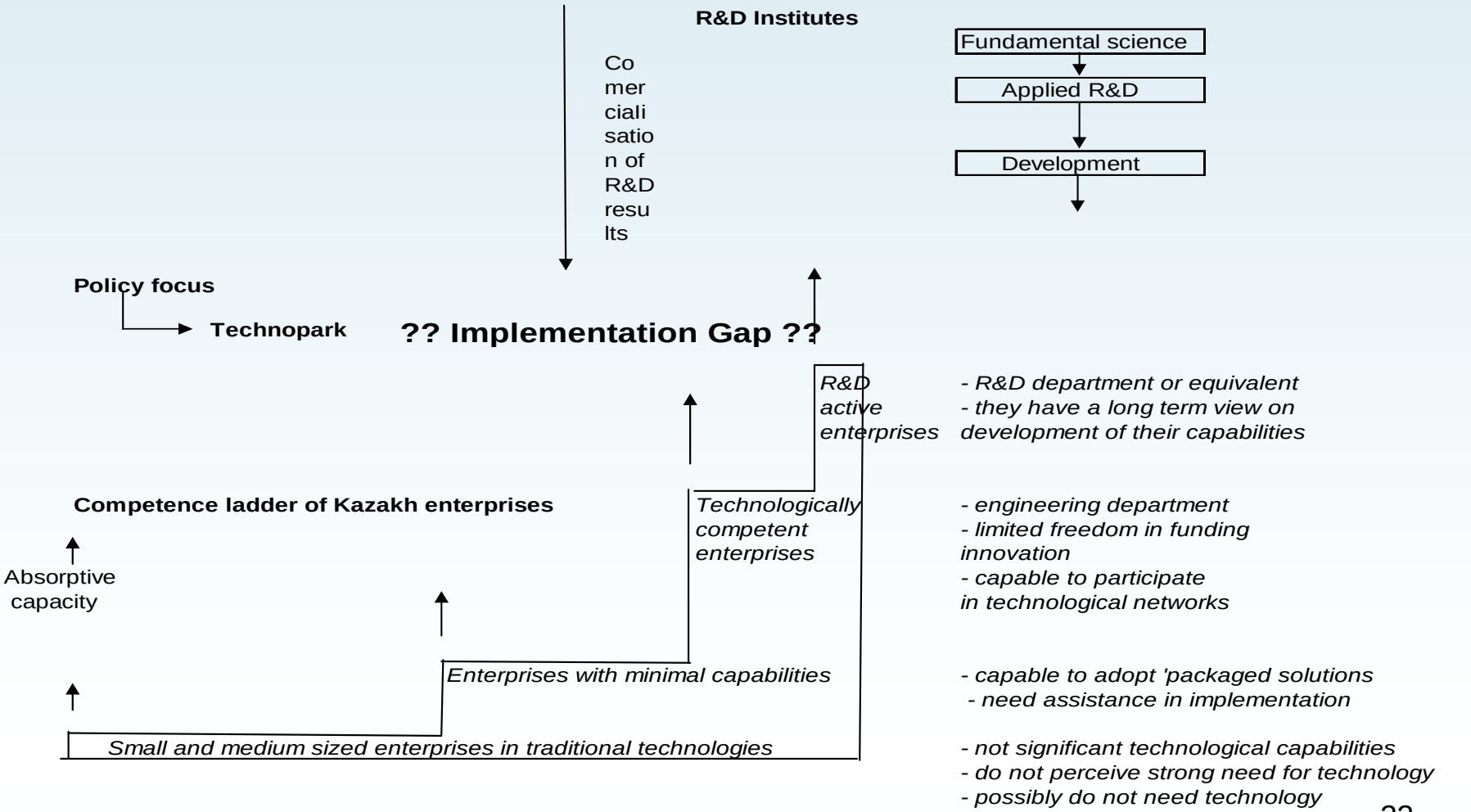
- Focus on the social process underlying economically oriented technical novelty
- Design (engineering)
- Subsequent improvements may be more important than the original inventions
- Process of interaction within a firm and with the system in which it operates

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

published by the Ministry of Education and Science (2003)

	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%

The linear innovation model logic that underpins the innovation policy of (country X) and its problems



Source: Radosevic (2007)

Novisibirsk *Akademgorodok*: Reality of NTBFs contradicts underlying (implicit) linear innovation model

- Initial expectations: commercialisation (*vnedrenye*) based on linear innovation model logic
  - Outcome: assessment in 1993: - 5 out of 200 technologies with immediate commercial potential in Akademgorodok; 2001: after extensive learning this potential seems to be bigger
- Reality: innovation as an interactive process where RI and NTBFs operate as:
  - specialized suppliers (testing equipment, niche products, scientific instruments),
  - consultants or 'knowledge brokers' (facilitating adoption of new technologies)
  - education (methodologies, instrumentation)

A strong policy focus on science – industry links……

Central Europe: key challenges
(based on ProINNO Trendchart Reports for CECs)

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**
3. Human resources for R&D and innovation/ for KBE

Science – industry links: ‘the most populated’ policy area: number of policy measures (instruments)

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

ProINNO Trendchart Database: 41 countries, as of 2007

A high importance given to NTBFs: Russian innovation policy in TC database

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

Technology Transfer Support Infrastructure: CIS 6 (BRUIT/RIPKA/SCRIPT projects)

- Big differences across the six CIS
- Russia: developed support for NTBFs ('Start') and technoparks
- Ukraine: waves of changing policies towards technoparks
- Armenia: successful cases of policy and bottom up initiatives with international participation
- Kazakhstan: 'Start Up' Kazakhstan – 7 technology based incubators
- Azerbaijan (one incubator) and Georgia (blank spot)

A strong policy focus on science – industry links……

- ……. But obsession with organisations (‘bricks and mortars’), not functions
- … neglect of coupling funding of NTBFs with business support assistance …
- … and neglect of actors to be linked …
- … as well as other links in NIS

Supporting functions, not organisations: example of technoparks (TP)

- Focusing on the TPs as an organizational form ?
- Or priority should be given to the support of the functions of TPs ?
  - cooperation with R&D and higher education institutions,
  - active management of technology transfer,
  - support for technology-intensive activities.
- The danger of overinvestment in ‘bricks and mortars’ (in both CIS and EU NMS)
- Priorities:
  - First, innovation projects,
  - Second, people involved in the management of innovation projects,
  - Third, supporting technoparks as organisations.

Funding gap

- VC, if available then it is available for relatively larger and less risky projects
  - **venture capital:** targets projects that have passed the early stage (VC funds try to avoid uncertainties connected with early stage companies)
- Funding gap
  - **mini-grants**: to explore commercial feasibility of technical idea
  - **matching grants:** to encourage risk sharing with firm + potential to create linkages
- VC does not provide a solution to the market failure in early stage technological development (World Bank, 2006, p.28)

Integrated and complementary support to KBE

Public R&D ◊ Minigrants ◊ Matching Grants ◊ Venture Capital

〈 Business support services 〉

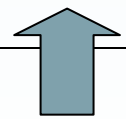
- Reality: Policy support is focused on opposite edges of new technology venturing
- Neglected issues: minigrants and matching grants & linking up each of stages with business support services

Linkages failure vs. organisational failures

- Limits of ‘bridging’ policies: linking up weak enterprises with unreformed universities / PROs?
- Links are as strong as actors to be connected
- 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) > effective in the transfer of simple information and as intermediaries
- Comparatively much less focus on enhancing demand for technology within enterprises (innovation grants) and on restructuring, often inadequate, R&D supply (PROs, HES).

Technological capability depends on a variety of learning mechanisms: upstream, downstream and laterally.

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), von Tunzelmann and Wang (2007)

Science – industry linkages are one among several major links in systems of innovation

- Large firms – small firms (horizontal links and value chain links)
- Foreign firms – domestic firms linkages
- International R&D networking and sourcing
- Intra-regional linkages

Conclusion

- Probably widespread ‘linkage failures’ (?) ... due to largely uncritical application of conventional policy wisdoms into the context of ‘catching up’ and ‘laggard’ economies (EIS)
- … a strong need to learn from success stories and success instruments (‘policy as discovery process’)
- 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