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# National and Regional Innovation Systems and Policies for Development: From Learning Regions to Research-Intensive Clusters

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# Outline

- Innovation models
- National and Regional Innovation Systems
- Measuring innovation in national and regional systems
- Regional development perspectives
- Learning regions
- Clusters
- Research-intensive clusters
- Policy issues for cluster support

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# Innovation – why is it important?

- Innovation is a core characteristic of the knowledge-economy
- Major source of competitiveness nationally, regionally, internationally
  - **Firm innovation** → particularly SMEs & start-ups, directly (own activities) and indirectly (interaction with mature firms).
  - **Social innovation:** public sector organisations, private firms and third sector organisations innovate in response to social needs
- Wide range of skills: S&T/R&D, managerial, marketing, organisational, social, economic, administrative knowledge
- Not standardised/uniform in the world → opportunities to learn from monitoring and benchmarking of successful policies elsewhere
- Cuts across many other policy areas (e.g. education, environment, IP, competition, taxation, etc.)
- Key priority for revival in current economic crisis

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# Evolving innovation models

## Five generations of innovation models (Rothwell)

| Generation | Key features |
|---|---|
| First, second (1950s -1970s) | Simple linear models – technology push, market pull |
| Third (1980s) | Simultaneous coupling model – interaction, feedback loops between different elements |
| Fourth (1990s-200s) | Parallel model, process integration within the firm, upstream with key suppliers and downstream with customers, emphasis on linkages and alliances |
| Fifth (1990s-200s) | Multi-actor process, systems integration, extensive networking, flexible and customised response, continuous innovation (role of Internet) |

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# National Innovation Systems

- Adam Smith (1776) – Wealth of Nations
  - relates knowledge creation and specialised services of scientists to production

- Friedrich List (1841) – national systems of production and learning
  - wide set of national institutions (incl. education and training) and infrastructures, e.g. networks for the transport of people and goods
  - development of productive forces rather than allocation of scarce resources → need to build *national* infrastructure and institutions,
  - lacks the analytical tools for developing ideas beyond loose suggestions.

- B.-A. Lundvall (1985) introduces the concept of 'innovation system'

- **Freeman (1988), Lundvall (1988, 1992), Nelson (1993), Edquist (1997)** - 'national systems of innovation'
  - Includes industries and firms + universities, research institutes, government
  - R&D activities, government policies viewed as components of a single national system; linkages at the aggregate level.

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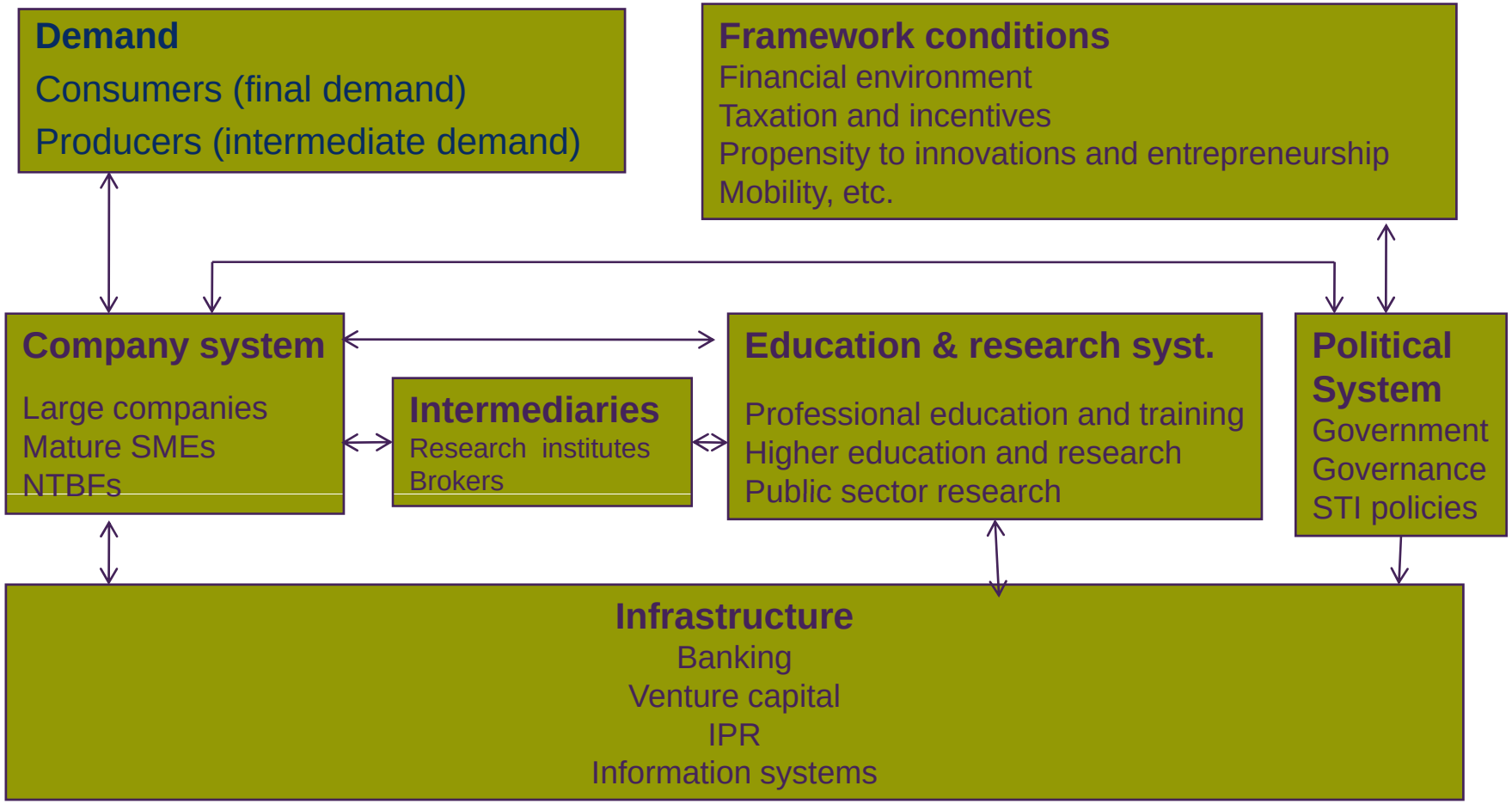
# Main features of innovation systems (IS)

- Key role of learning
  - Learning is a key element in both the *dynamics* of IS and in *binding* the whole IS together, helps the development and connectivity of IS.
  - Occurs at individual, firms and organisations, inter-firm and inter-organisations, institutional, cross-institutional levels --> **'learning economy'**
  - Learning is interactive and collective, but differs among players --> no single cognitive process
- Holistic , interdisciplinary, evolutionary nature: path dependency, little predictive insights into future events
- Incorporation of product technologies and organisational innovations
- Conceptually diffuse nature: flows, links and networks
  - **inter-industry technology flows vs. same industry flows (**'upstream' /'downstream' suppliers) --> quantitative measures of sectoral integration amongst industries
  - tacit and codified knowledge flows not captured by inter-industry technology flows indicators
  - system development can arise from development of its individual components, but also from increased flows between components -->. relatively little research on this
- Most studies at micro (firm) level or macro (national economies) --> meta level largely unexplored --> The Triple Helix model of U-I-G

# A generic NSI structure




Source: Arnold and Kuhlman (2001)



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# Interactions in NSI

- Provision of R&D and consultancy services
- Competence building
- Formation of new  product markets, development of existing ones
- Creating and changing organisations
- Networking
- Incubation activities
- Financing
- Collaboration
- Intermediation

- **Absorptive capacity** (Cohen and Levinthal, 1990).



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# Regional Systems of Innovation (RSI)

- Emerging in early 1990s as a framework for understanding innovation in regional economies (clusters)
- Interacting private and public interests, formal institutions and other organisations that generate, use and disseminate knowledge
- Origin:
  - (i) systems of innovation theory - innovation as an evolutionary and social process, stimulated by many actors internal and external to the firm;
  - (ii) regional science: innovation is a spatially localised process
- Rationale:
  - improve capabilities and business performance in local firms--> interactive learning between different actors (firms, universities, research institutes, start-ups, large firms etc.)
  - easier to manage economic policy at regional level rather than national level

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# Units of analysis in RSI studies

- **City** - cities generate innovation because they act as arenas for the confluence of innovative factors
- **Metropolitan regions** - offer firms spatial, technological and institutional proximity and specific resources
- **Local districts within cities or metropolitan areas** - e.g. the Garment district in New York, the software industry in Oslo, the electronic cluster in Toronto, media industry in Montreal, etc.
- **Nomenclature of territorial units developed by Eurostat (NUTS II, III)** - used in the Community Innovation Surveys
- **Supra-regional/sub-national scale** - e.g. the Canadian provinces of Ontario and Quebec , Belgium provinces of Flanders and Wallonia

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# Comparison of NSI and RSI

- **NSI:**
  - Explain differences in technological development, economic growth and competitiveness between countries in terms of differences between NSI components
  - Emphasise the policy aspects of innovation: nation as the primary level of political activity -> knowledge input to policy-makers to increase a nation's comparative advantage

- **RSI:**
  - Explain differences in sectoral patterns of innovation mainly in terms of ability to exploit **technological trajectories**, by technology transfer, intramural R&D, spillovers, networking, articulation of demand factors
  - Technological trajectory: "the dominant direction along which the opportunities offered by any technological paradigm are exploited" (Nelson and Winter, 1977)
  - Emphasise the firm and technology aspects of innovation

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# Measuring innovation in NSI – European Innovation Scoreboard

- **Summary Innovation Index** – composite indicator that measures the relative national innovation performance (relative ranking)
- 2008 - 29 individual indicators, 7 innovation dimensions, 3 blocks:

**1. ENABLERS:** main drivers of innovation that are external to the firm:

- **Human resources**
- **Finance and support**

**2. FIRM ACTIVITIES:** innovation efforts within the firm:

- **Firm investments**
- **Linkages & entrepreneurship**
- **Throughputs** (IPR)

**3. OUTPUTS:** outputs of firm activities as:

- **Innovators** – no. of firms that introduced innovations onto the market or within their organisations (technological and non-technological innovations)
- **Economic effects** – captures the economic success of innovation in employment, exports and sales due to innovation activities.

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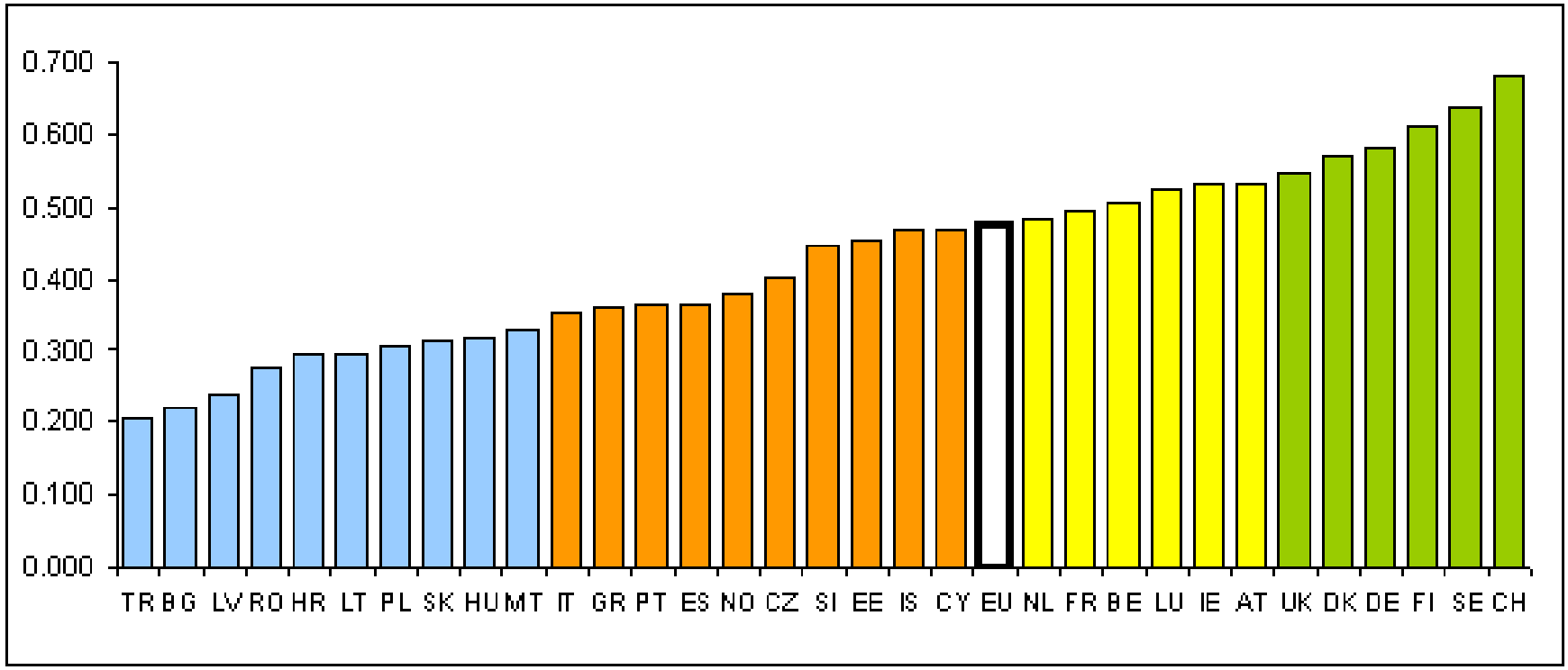
# 2008 Summary Innovation Index (SII)




- **Innovation leaders**: SII well above that of the EU27 and all other countries
- **Innovation followers**: SII below that of innovation leaders but above that of the EU27.
- **Moderate innovators**: SII below the EU27
- **Catching-up countries**: SII well below the EU average, but increasing towards the EU average over time, with the exception of HR and LT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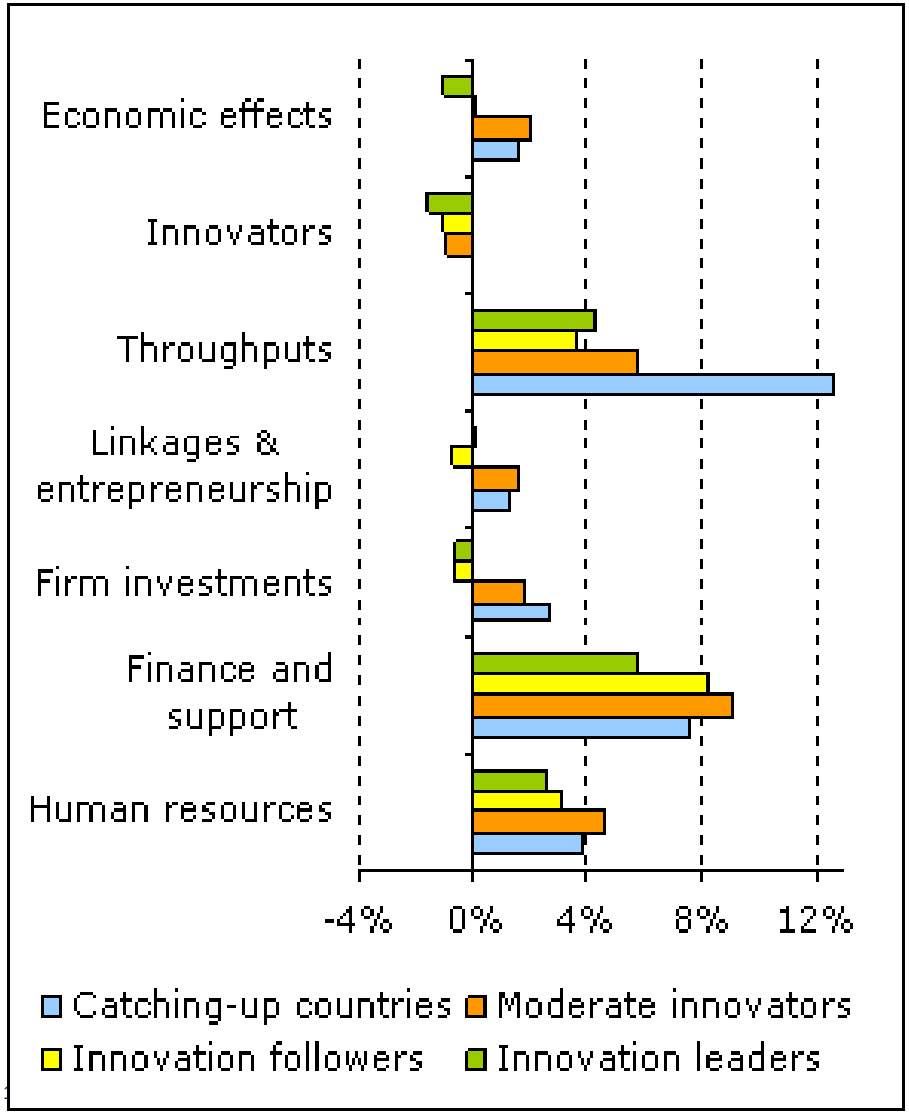
# Mobility between country groups

- Country group membership in 2008 remained the same for most countries group membership as in EIS 2007.

- Exceptions:
  - GR and PT moved from ‘Catching-up countries’ in EIS 2007 to ‘Moderate innovators’ in EIS 2008 --> strong growth in innovation performance and revised set of indicators used in calculating SII
  - IS dropped from the ‘Innovation followers’ in EIS 2007 to ‘Moderate innovators’ in EIS 2008 --> revised method of calculating countries’ SII

# Innovation dimensions by country groups




- In all groups, the strongest drivers of growth are the Throughputs, Finance and support and Human resources dimensions.
- 'Moderate innovators' and 'Catching-up countries' show improvements in Economic effects, Linkages & entrepreneurship and Firm investments,
- 'Innovation leaders' and 'Innovation followers' are on average stagnating or declining across these dimensions.
- All groups show some decline in the Innovators dimension.

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# EU 27 innovation performance

- EU27 average annual growth rate of 2.3% over a 5-year period due to:
  - Human resources (4.0%),
  - Finance and support (7.1%)
  - Throughputs (4.0%)
  - Linkages & entrepreneurship (0.0%)
  - Economic effects (1.1%)
  - Firm investments (-0.9%)
  - Innovators (-1.3%).

Highest growth since 2004

Small improvement

Slight worsening

- EU27 relative strengths in: Youth education, Public R&D expenditures, Broadband access, IT expenditures, Knowledge-intensive services employment, Medium-high and high-tech manufacturing exports, Knowledge-intensive services exports and Sales of new-to-market products

- EU27 relative weaknesses in: S&E and SSH doctorate degrees, Life-long learning, Innovative SMEs collaborating with others, Technology Balance of Payments flows and Resource efficiency innovators.


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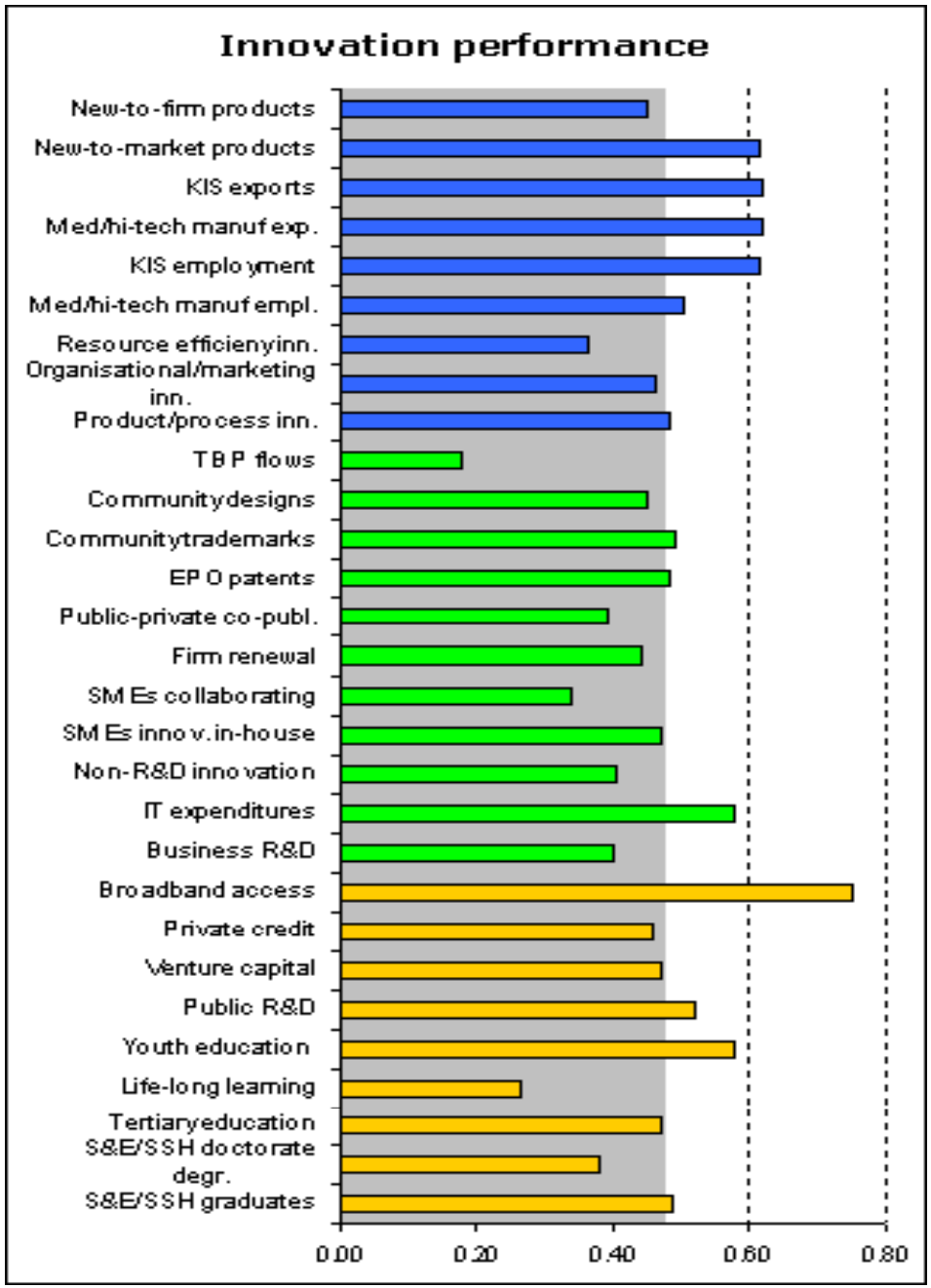
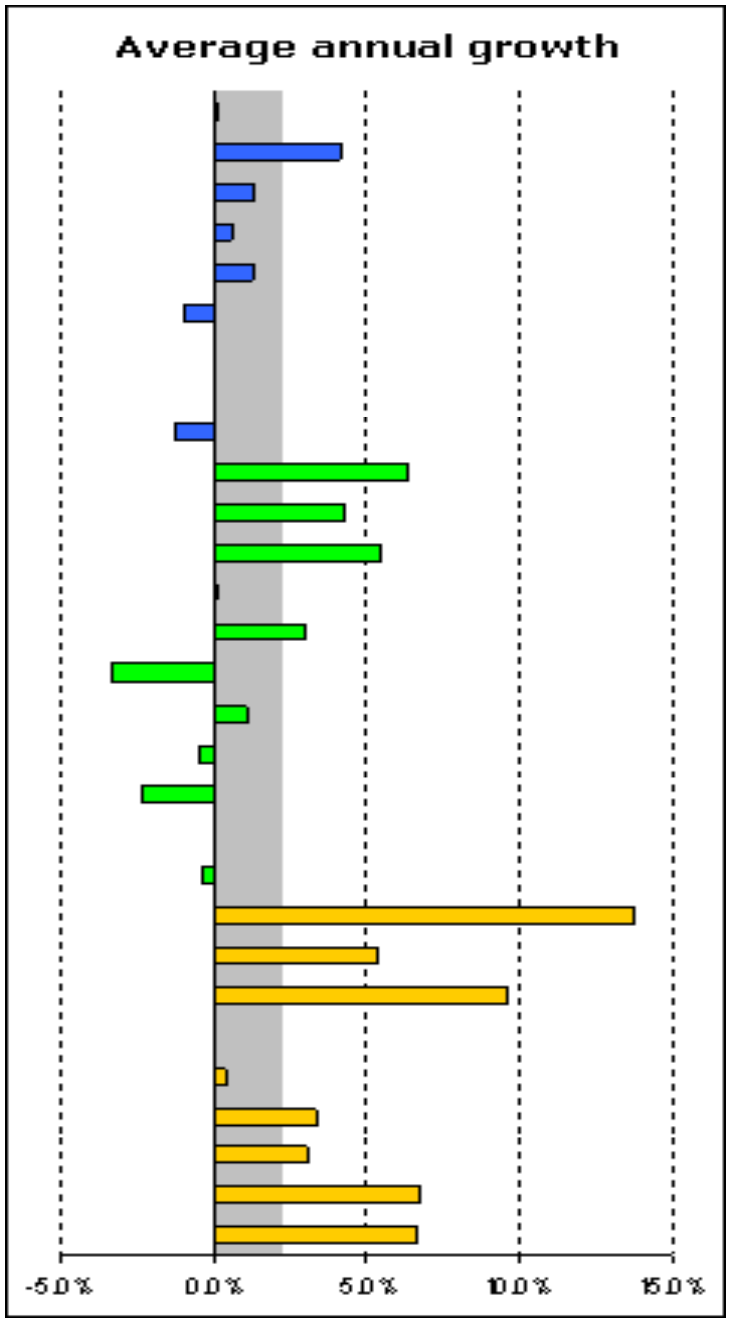
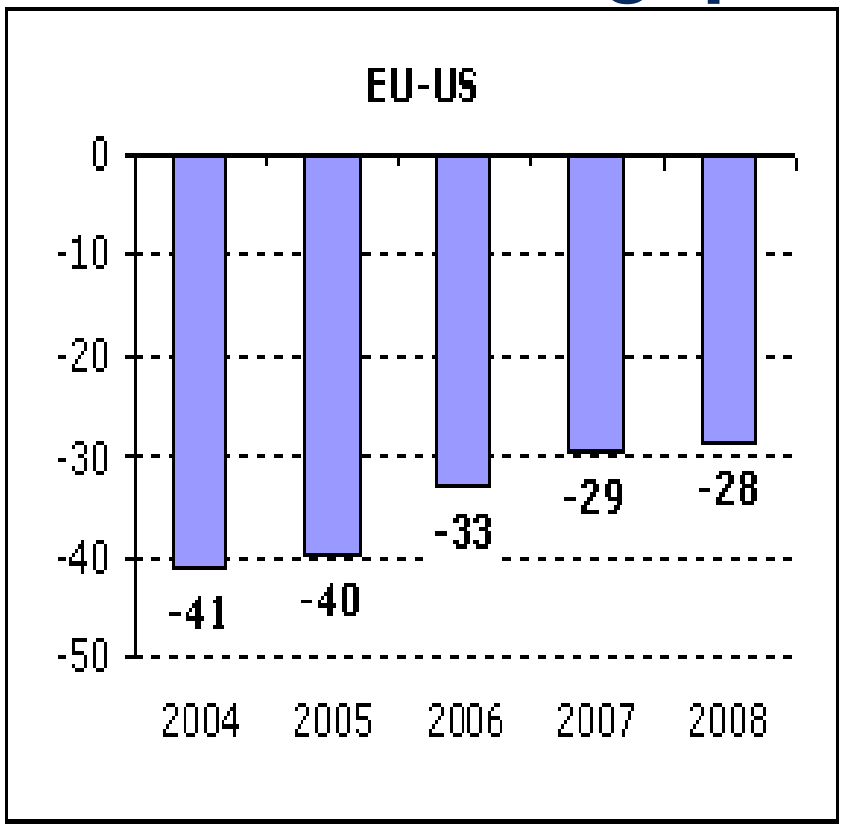
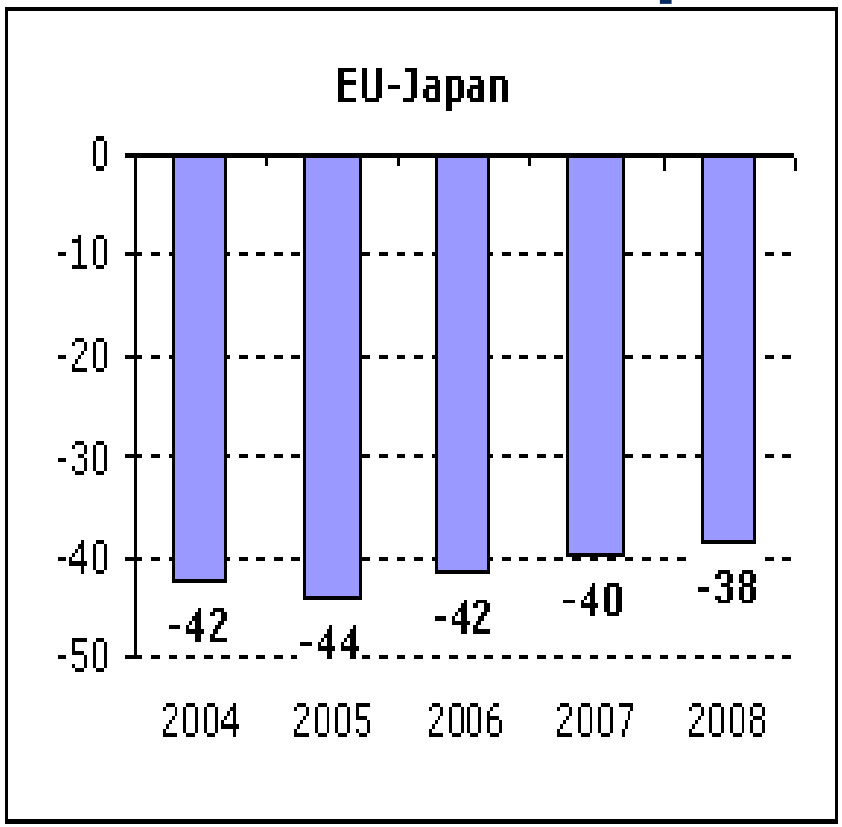

Innovation performance
New-to-firm products
New-to-market products
KIS exports
Med/hi-tech manuf exp.
KIS employment
Med/hi-tech manuf empl.
Resource efficienyinn.
Organisational/marketing inn.
Product/process inn.
TBP flows
Communitydesigns
Communitytrademarks
EPO patents
Public-private co-publ.
Firm renewal
SMEs collaborating
SMEs innov.in-house
Non-R&D innovation
IT expenditures
Business R&D
Broadband access
Private credit
Venture capital
Public R&D
Youth education
Life-long learning
Tertiaryeducation
S&E/SSH doctorate degr.
S&E/SSH graduates
0.00
0.20
0.40
0.60
0.80


Average annual growth
-5.0%
0.0%
5.0%
10.0%
15.0%

# EU Innovation gap with the US and Japan




Performance for each year is measured using, on average, data with a two-year lag (e.g. performance for 2008 is measured using data for 2006).

The EU innovation gap is measured as the distance between the average performance of the EU and those of the US and Japan on 16 indicators (e.g. an EU innovation gap of e.g. -40 means that the US or Japan perform at a level of 140, or 40% above the EU.

# EU-US Comparison

- **US performing better than EU27 in 12 indicators** (relative values)
- EU performs better only in S&E graduates, Trademarks, Technology Balance of Payments flows and Medium-high and high-tech manufacturing employment.
- **Overall clear performance gap in favour of the US** --> better performance in Enablers, Firm activities and Outputs.
- BUT the **US innovation lead is declining** --> US innovation annual growth rate of 0.95%, EU27 annual growth rate of 2.65%.
- EU27 outperforms the US in **growth performance** in all of the indicators except Business R&D, EPO patents and PCT patents.

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# EU - Japan Comparison

- **Japan performs better than EU27 in 12 indicators**.
- EU27 performs better only in Trademarks, Technology Balance of Payments flows, Knowledge-intensive services employment and Knowledge-intensive services exports.
- **Overall clear performance gap in favour of Japan** --> better performance in Enablers, Firm activities and Outputs.
- BUT the **Japanese innovation lead is decreasing** --> JP annual innovation growth rate of 1.65%, while EU27 growth rate of 2.65%.
- The EU27 is increasing its lead in Trademarks, Technology Balance of Payments flows and Knowledge-intensive services employment.
- Japan improves its lead in Business R&D, EPO patents, PCT patents and Medium-high and high-tech manufacturing employment


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# Global Innovation Scoreboard (GIS) 2008

- Compares innovation performance of EU27 to other major R&D spenders in the world: Argentina, AUS, BR, CAN, CN, HK, IN, IL, JP, NZ, RoK, MX, RUS, SG, SA, US.

- GIS (Dimension Composite Innovation Index): 9 indicators, 3 dimensions

**1. Firm Activities and Outputs:**

- Triadic patents per population (3 years average)
- Business R&D (BERD) as a % of GDP

2. Human Resources and Infrastructures

- S&T tertiary enrolment ratio
- Labour force with tertiary education (% total labour force)
- R&D personnel per population
- Scientific articles per population

3. Absorptive Capacity

- ICT expenditures per capita
- Broadband penetration per population
- Public R&D (HERD + GERD) as a % of GDP


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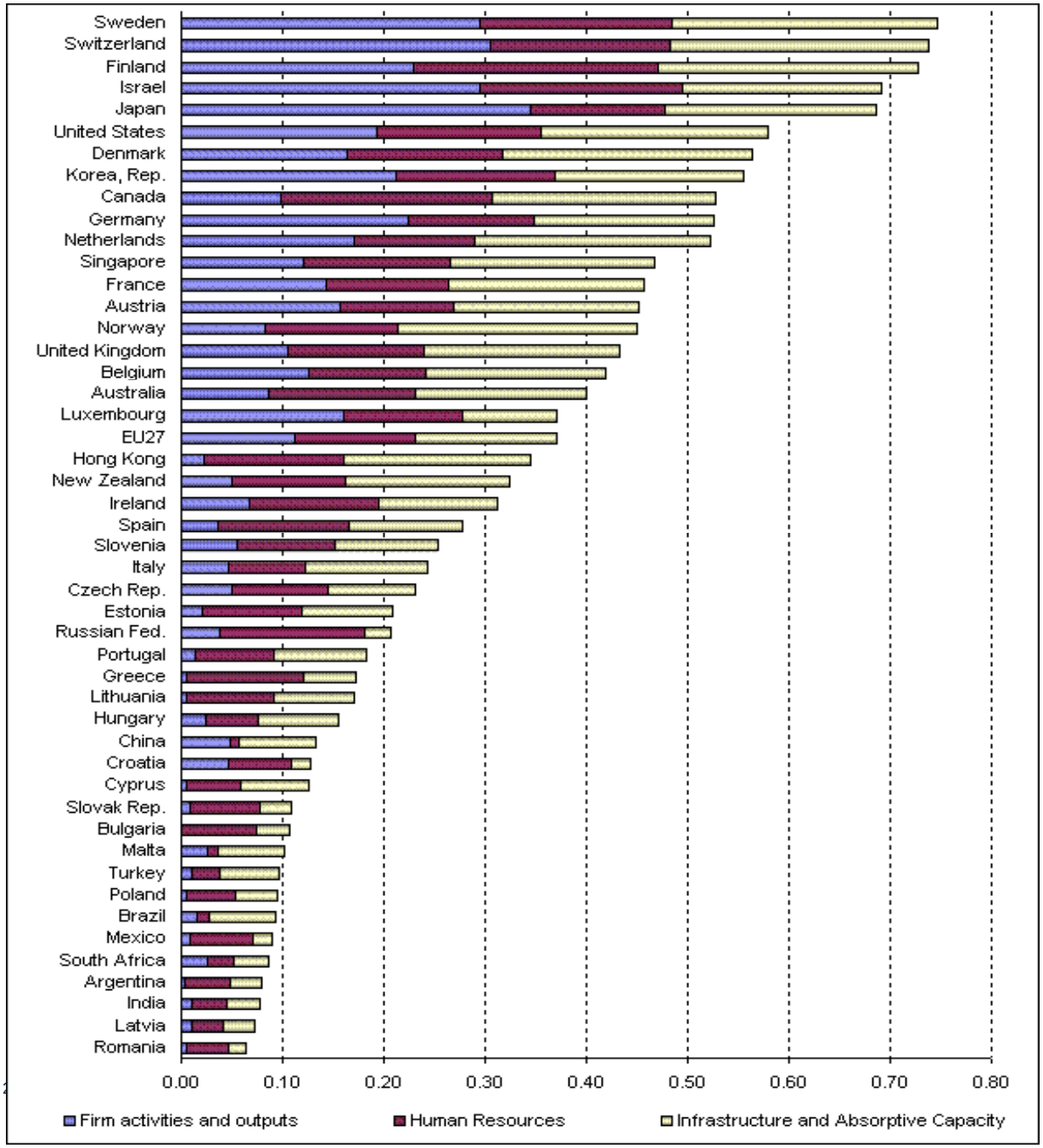


Relative contributions of the three dimensions to GIS 2005

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# Country performance in GIS 2008

http://www.proinno-europe.eu/index.cfm?fuseaction=page.display&topicID=437&parentID=51#

- Countries rank fairly stable over ten years
- Fastest improving countries: China (+8), Portugal (+7), Singapore (+7), Spain (+6), Cyprus (+5), Turkey (+5) and Brazil (+5).
- Singapore: increase based on Firm Activities and Human Resources
- Spain and Portugal: Human Resources.
- China: best performance in Firm Activities and Infrastructures and Absorptive Capacity, while it looses 3 positions on Human Resources.
- Brazil: strong increases in Firm activities and Infrastructures and Absorptive Capacity, moderate increase in Human Resources.
- Other BRIC countries: India (+1), Russian Federation (-2).
- EU27 ranks 20th -> good performance particularly on Firm Activities, relatively “balanced” innovation performance in the three dimensions
- US: similar composition to that of EU27,
- Japan: innovation performance more based on business activities.

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# European Regional Innovation Scoreboard (2006)

| | RIS 2002 | RIS 2003 | RIS 2006 |
|---|---|---|---|
| Countries: | EU15 | EU15 | EU25 |
| Regions: | 148 | 173 | 208 |
| Indicators: | 7 | 13 | 7 |

**RIS 2006**

- Human Resources in Science and Technology – Core (% of population)
- Participation in life-long learning per 100 population aged 25-64
- Public R&D expenditures (% of GDP)
- Business R&D expenditures (% of GDP)
- Employment in medium-high and high-tech manufacturing (% of total workforce):
- Employment in high-tech services (% of total workforce):
- EPO patents per million population

- Revealed Regional Summary Innovation Index (RRSII)


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# Regional development

- Spatially uneven regional development in recent decades as a result of technological change and capital accumulation
- Important roles of R&D and innovation in these processes → knowledge spillover effects on the regional economy
- Techno-economic development dependent on education, R&D, innovativeness, capacity for regeneration
- Interplay between different factors involved is highly complex and difficult to demonstrate →various theoretical approaches and models adopted in economics and geography:

  **1.General macro-level perspective** (techno-organizational paradigm, new growth theory, evolutionary and industrial economics, institutional economics, NSI, technological trajectories

  **2. Regional perspective**: New industrial spaces, Learning regions, Industrial clusters

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# Learning regions

- High learning capacity and absorptive capacity
- Emphasis on codified and tacit knowledge, accumulation of knowledge, lifelong education and training
- Collective interactive learning is a socially embedded process that is the fundamental element of innovation
- Innovation as concurrent technical and social processes →non-linear process
- Territorial and institutional embeddedness of learning organisations, key role of PPPs as ‘regional development coalitions’

# Learning regions (cont.)

- **'Learning organisations'**: implement organisational innovations (e.g. transition to non-hierarchic, flat and flexible organisational structures) at intra- and inter-organisation level and regional level.

- Dependent on:
  - human capital (individual know-how),
  - structural capital (organisational know-how)
  - social capital (know-how embedded in the region/community)
  - **density and quality of networking** within the regional productive system → inter-firm and PPPs providing complementary investment in R&D as well as the institutional framework for innovation
  - **absorptive capacity** → assimilate and utilise knowledge, depends on the internal capabilities of a firm and region and existing stocks of knowledge → cumulative causation in learning and innovation.

# Learning regions - typology

**a. Industrial districts** (Becattini, 1979 based on Alfred Marshall's concepts**)**

- Small-firms, shift in R&D and innovation from the single firm to the local or regional system

**b. Innovative milieus:**

- Universities, financial institutions and geographic proximity to markets.
- Creativity and continuous innovation as a result of a collective learning process, intergenerational transfer of know-how, imitation of successful managerial practices and technological innovations, face-to-face contacts, formal or informal cooperation between firms, circulation of commercial, financial or technological information
- Technological innovation as a product of **social innovation** at intra- and inter-regional level

c. **Industrial clusters:** "geographic concentrations of interconnected companies and institutions in a particular field…an array of linked industries and other entities important to competition…universities, standards-setting agencies, think tanks, vocational training providers, and trade associations - that provide specialized training, education, information, research, and technical support." (Porter, 1999:78*)*.

# Research-intensive clusters (RICs)

**1. Strong science base**

- quality research infrastructure and labs, high level talents and skills
- public & private funding for infrastructure, to motivate or attract talents, skills.
- balance basic and applied research activities to be attractive for enterprises

**2. Strong entrepreneurial culture** → growth and jobs, public sector support

**3. Fast firm formation**: high growth start-ups (gazelles), spin offs (from universities or firms) , increase RDTI absorption capacity of SMEs

**4. Attractive to talented people and students:** virtuous cycle: talent develops new ideas which create an attractive environment to students→ new ideas.

**5.** S**killed workforce** at each stage of the innovation process



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# Research-intensive clusters (RICs)

6. **Availability of finance**, seed and venture capital, R&D funding, business angels, banks and guarantee providers, investment readiness schemes.

7. **Availability of value-added business support services:** testing facilities, incubation spaces, mentoring, economic intelligence, IPR protection advice, access to a wide range of funding tools.

8. **Good location for research centres of large corporations:** science based environment, good quality of life, good transport infrastructures (e.g. science parks)

9. **Effective formal and informal networks for** interactions and cross-fertilisation of ideas between TH players → strong RIC identity among the stakeholders.

10. **Provision of international co-operation framework as part of transnational networks**.

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# RIC typologies

1. **Spontaneous "bottom up" vs. publicly-supported 'top-down' ones**

   **Spontaneous bottom-up**: started from a few regional stakeholders addressing needs or opportunities through sharing knowledge and experiences in a loose informal network of committed organisations.

   **Publicly supported ones**: "top down" strategy initiated by ministries (industry, research, education, regional development) to facilitate or urge stakeholders to work together to improve their competitiveness.

2. **By sectoral focus**: strong sectoral focus vs. multisectored and/or technology focused.

3. **By aims:** strengthen the trade capacities of their members vs. create or exploit new knowledge → collaboration and a renewed portfolio of activities such as market research, research, supply chain linking or integration of technologies in other product or process innovations.

c) **By openness and formal organisation:** formal memberships based on fees vs. loose, no defined boundaries, open to new partners, networks.

d) **By geographical coverage:** regional impact zone , transregional or national..


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# Importance of collaboration within RICs

**1. Knowledge transfer and innovation**

Spillovers through proximity, face-to-face interactions between firms with complementary assets and skills → new ideas, trust.

**2. Economies of scope:** less costly to combine two or more products in one production system than to produce them separately. E.g. joint bids of companies with complementary skills for large projects which each individual firm would have been unable to compete for alone.

**3. Economies of scale***:* further specialising production within each firm, by joint purchasing of common raw materials to attract bulk discounts, joint marketing, sharing knowledge about best practice and reduce costs by jointly sourcing services and suppliers.


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# What types of collaboration?

1. **Strategic alliances** to achieve corporate objectives (international licensing agreements, management contracts)
2. **Joint ventures for specific projects**
3. **Project-based bids**
4. **Supply chain partnering (**between same industry)
5. **Product development teams (i**ntra-organisational)
6. **University-industry collaborations (**European projects)
7. **Non-competitive collaborations for knowledge sharing**
8. **General project teams (**smaller groups/teams that are together over a period time or a period of a project)


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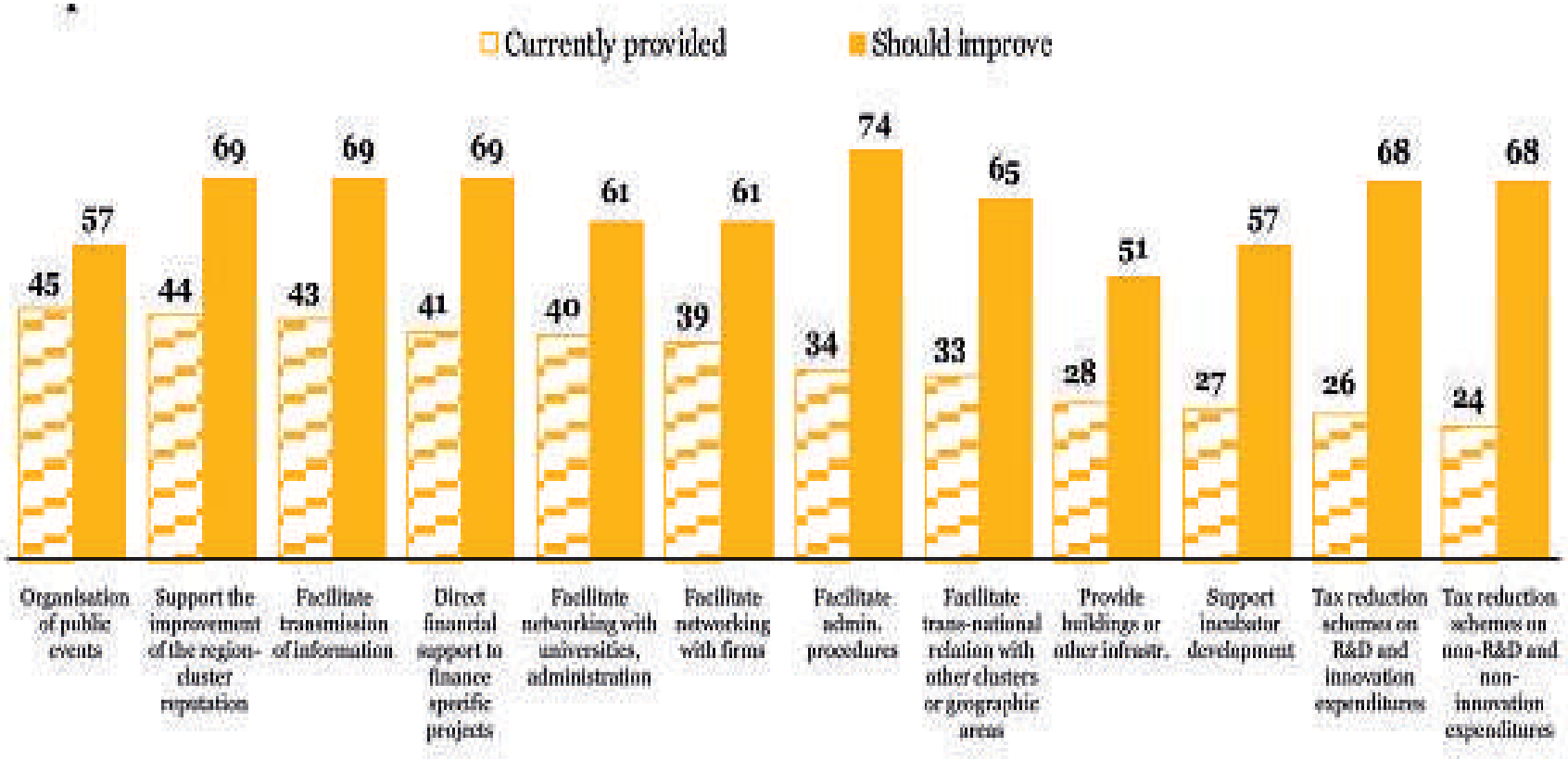
# Support activities of public authorities:

# Assessment of current levels and desire for improvement




Source: European Commission (2006) Innobarometer 2006 on clusters



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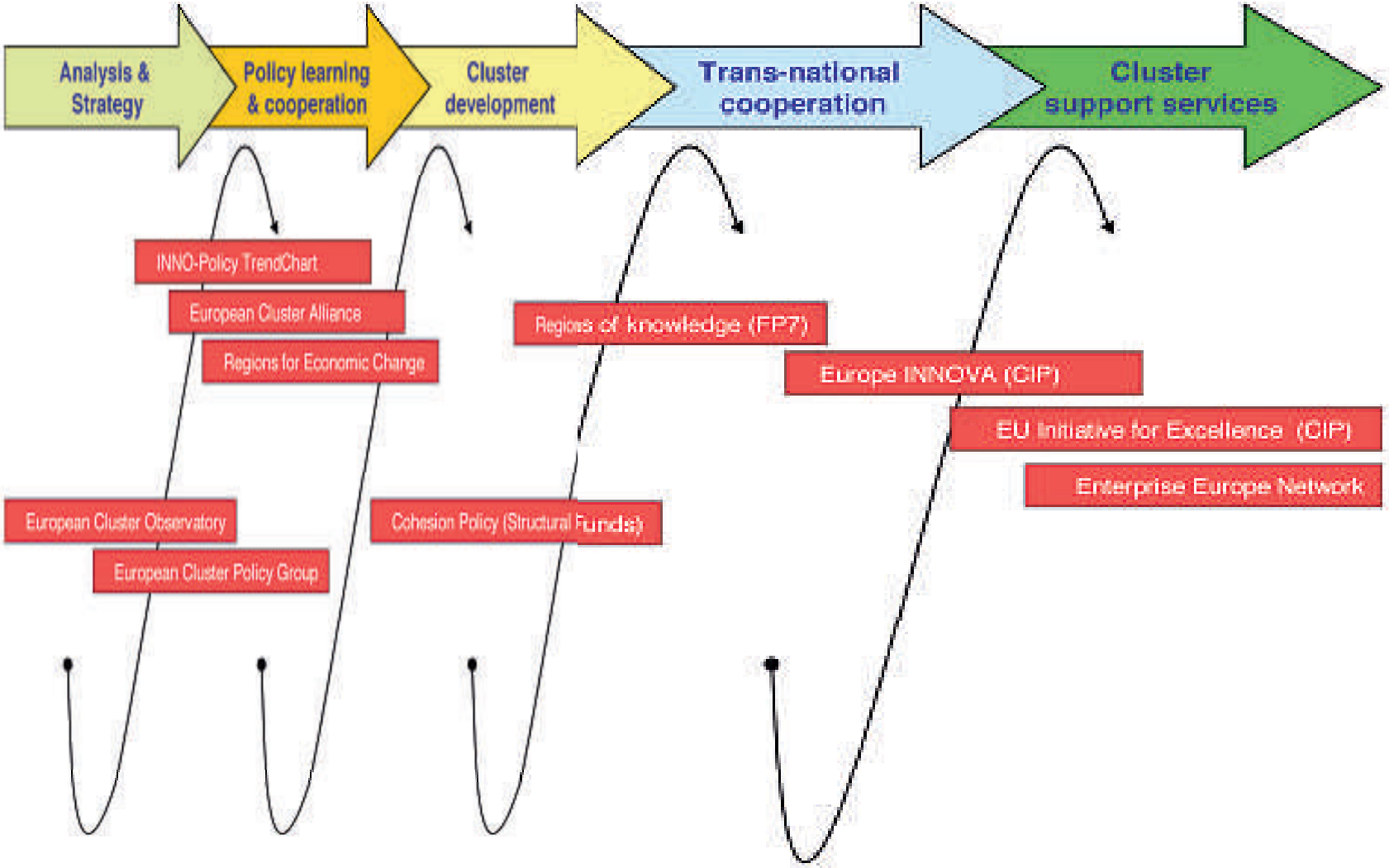
# Current and planned EU initiatives in support of clusters



# Case studies of clusters by the European Cluster Observatory