The National Innovation System

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Economics of innovation

The National Innovation System

This lesson sets out the complex interrelations concerning innovation in an economy.

- Discuss ‘science-base’ and ‘knowledge economy’
- Business does not stand alone, government and universities are integral part of innovation system
- Research and development (R&D) is investment spent both to develop new ideas and science and to transform them into commercial innovations
- We will illustrate these ideas with data from OECD and, at end, with emerging market examples

Definitions

“The national innovation system essentially consists of three sectors: industry, universities, and the government, with each sector interacting with the others, while at the same time playing its own role.” Goto (2000)

Also called Triple Helix model, there are a number of ways to discuss/define basic idea but note: national innovation system is a complex conglomerate of interacting independent parties

Roles of the three players

- Universities
  - undertake basic science and technology research
  - educate scientists and technologists needed by business and government
- Governments
  - design IPR system for business and universities
  - commission science research e.g. for defense
  - finance universities, subsidise business R&D
- Firms
  - conduct R&D to develop commercial products
  - launch innovative products
  - start up new firms to exploit new science

The central role of R&D

Next three tables illustrate breakdowns:

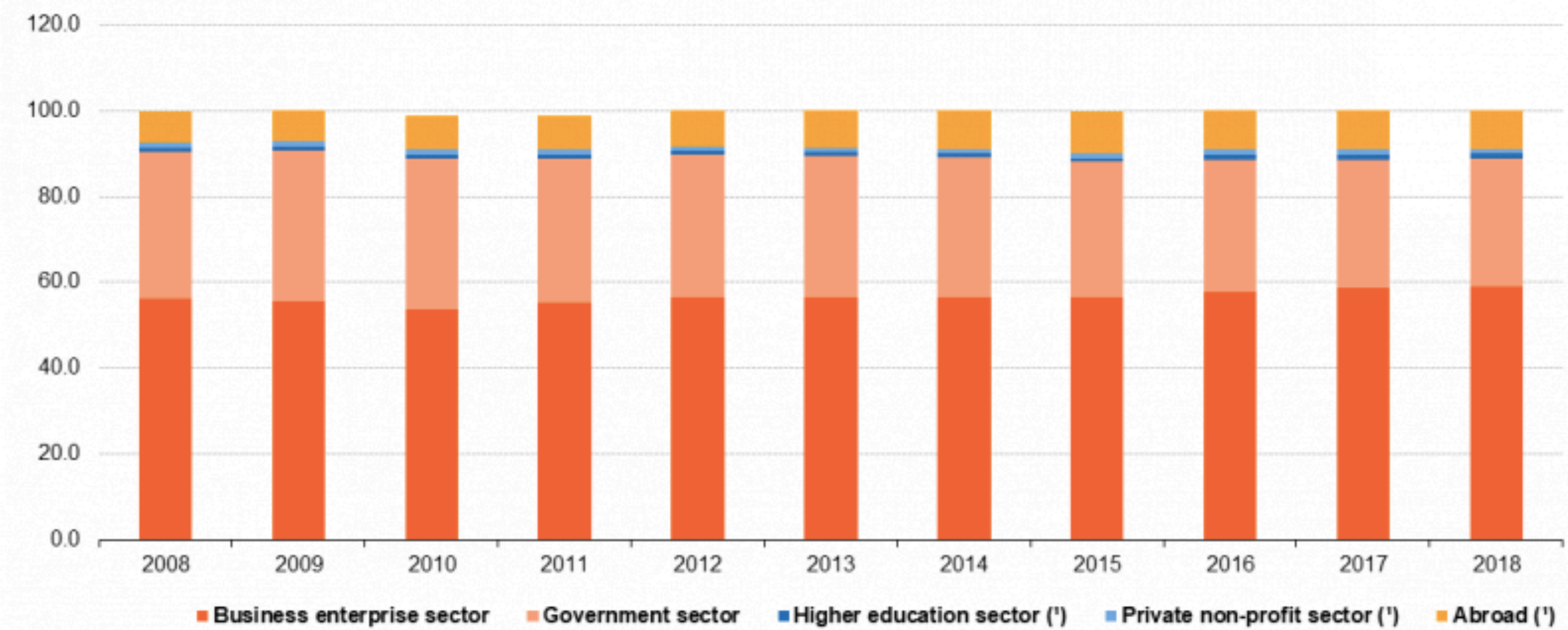
- Who funds R&D?
- Where is it conducted?
- What are main subjects for research?

Table 1 - Funding of R&D by government and firms

Country	R&D/GDP in 2004	R&D/GDP funded by GOV in 2005	GOV R&D / Total R&D x 100%	% of R&D funded by BES in 2003
EU25	1.86	0.74	39.8	54.3
EU15	1.92	0.76	39.6	54.6
Germany	2.49	0.76	30.5	67.1
France	2.16	0.94	43.5	50.8
UK	1.79	0.73	40.8	43.9
Japan	3.20	0.71	22.2	74.5
USA	2.66	1.06	39.8	61.4

Source. Eurostat (2007).
Notes. “GOV” is the government sector and “BES” is the business enterprise sector.

Gross domestic expenditure on R&D by source of funds, EU 27, 2008-2018 (% share of total)



(¹) 2017 instead of 2018

Source: Eurostat (online data code: rd_e_fundgerd)

Table 2 - The conduct of R&D by business, government and universities in 2003

Country	R&D/GDP conducted by BES	R&D/GDP conducted by GOV	R&D/GDP conducted by HES	Sum of columns 1 to 3	Total R&D/GDP
EU25	1.22	0.25	0.41	1.88	1.90
EU15	1.26	0.25	0.42	1.93	1.95
Germany	1.76	0.34	0.43	2.53	2.52
France	1.37	0.36	0.42	2.15	2.18
UK	1.24	0.18	0.40	1.82	1.88
Japan	2.40	0.30	0.44	3.14	3.20
USA	1.86	0.33	0.37	2.56	2.67

Source. Table 2.8 of Eurostat (2007).
Notes. "BES" is the business enterprise sector; "GOV" is the government sector; "HES" is the higher education sector. Figures are for 2003.
The United Kingdom, Japan, and the United States have significant "other institutions" conducting R&D (e.g., private nonprofit), hence the sum of BES, GOV, and HES can be less than total R&D/GDP.

Gross domestic expenditure on R&D, 2008-2018

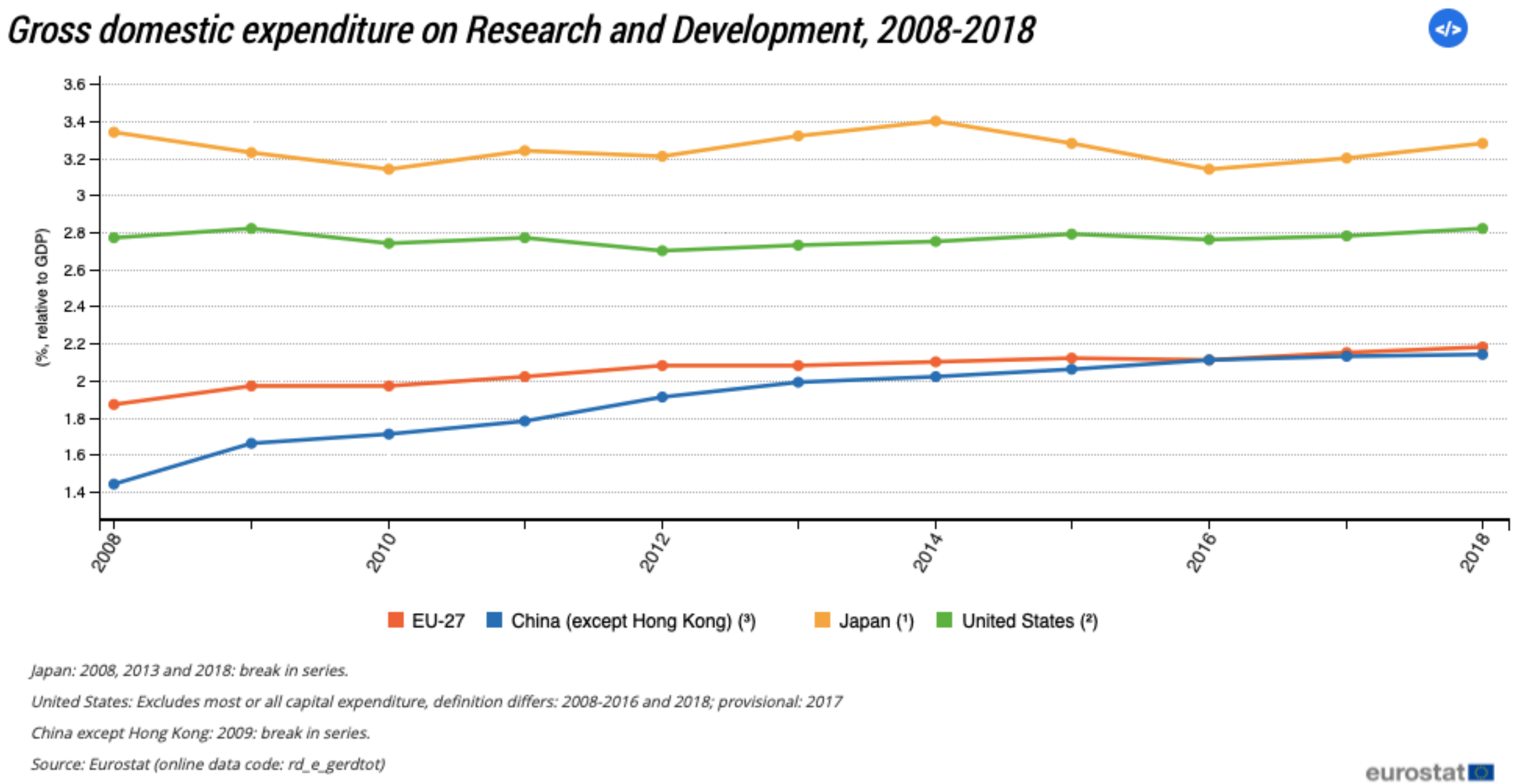


Table 3 - Percentage allocation of government R&D support by objective in 2005

Country	Land	Health	Energy	Industry	University	Defence	All Other
EU25	9.6	7.3	2.8	10.9	32.0	13.6	24.0
EU15	9.3	7.3	2.7	10.9	32.4	13.8	23.8
Germany	8.9	4.4	2.9	12.4	40.3	5.8	26.0
France	6.5	6.1	4.5	6.2	24.8	22.3	29.5
UK	8.5	14.7	0.4	1.7	21.7	31.0	22.0
Japan	10.3	3.9	17.1	7.1	33.5	5.1	23.0
USA	4.5	22.8	1.1	0.4	..	56.6	14.6

The Government-University Axis

Knowledge is a public good (non-rival), hence market mechanism alone cannot generate optimal amount

- ❖ Government funding of university research, and government research labs, are main solutions in modern economies
- ❖ Discussion of historical origins (including your own university/college role in science)
- ❖ Funding mechanisms – is there an optimal one?

Changing provision of basic science for knowledge economy

Historical system:

- Provision of basic science as a public good
- Discoveries were placed in the public domain without any private ownership
- Motivation of scientists was respect of scientific community or ‘peer review’
- Use of science base open to all types of business

Recent changes:

- Government finance for research is conditional on the research having more immediate application in industrial and commercial products

The University-Business Axis

- University-business links - many dimensions:
  - IPRs held by university
  - Research joint ventures
  - Spin-outs/start-ups
  - Personnel pooling
- Growth of university IPRs
  - US Bayh-Dole Act 1980 stimulated change
  - Before - government owned any patents on federally funded science and then issued non-exclusive licences
  - After – university/scientists own IPRs and can licence exclusively to key firms
  - Often achieved via technology transfer offices (TTOs)
  - Many EU countries have followed these changes

University-Business Linkages

Collaboration in Research

- Joint, contract, and commissioned research,
- Consultancy by academics

Spin-outs, Start-ups, Science Parks

- Formation of spin-outs and joint ventures
- Formation of university incubators
- Growth of science parks near to university

Personnel Linkages

- Formal and informal social and professional networks
- Continuing professional development and education, including public university lectures and workshops
- Academic-scientist exchanges with firms
- Recruitment of students from universities by firms

Consequences of the New University–Business Relationship

- The changing nature of university–business relations raises a number of important questions.
- Does increased commercialization shift research away from fundamental research toward applied, developmental research? If so, is such a shift detrimental to economic growth in the long run?
- Does exclusive patenting and licensing of university research reduce the diversity of commercialization attempts?
- Do the transaction costs associated with patenting and licensing dissuade some firms, especially smaller ones, from attempting commercialization?
- Do some universities fail to account for the true cost of TTOs and finding licensees?
- What are the implications for science education of turning many professors into company advisors or managers?
- Has the growth in university patenting and associated licensing biased effort away from fundamental research?

The Government-Business Axis

Key areas of innovation policy:

1. IPRs
2. Tax policy
3. Competition policy
4. Government-business targeted funding
5. Standard setting
6. Procurement policies

National Innovation Systems in Emerging Markets

- South Korea and Taiwan:

  - 50 years ago both were poor countries

  - Their governments promoted research and technology setting up important university research institutes

  - Firms were encouraged to do R&D

  - Initial approach was reverse engineering and technology transfer from the rich world

  - Later graduated to developing world class innovations

- China and India:

  - Began with large populations but small % highly educated

  - China has encouraged FDI and technology transfer

  - India less open, but in 1990s expanded higher education

  - Indian firms have focused on pharmaceuticals and software

Patenting, national innovation systems and performance

- Emerging countries have taken different routes for acquiring and developing technologies
- Catching up through technology transfer precedes the stage of becoming innovators
- Big differences in US patent applications by emerging economies in last 20 years (next slide)
- Korea and Taiwan show rapid growth since 1990
- China is also beginning to emerge as an innovating country after 2000
- India slower growth in IPRs due to narrow range
- Brazil, Mexico and Russia very low figures