Conceptual framework: what R&D does (and does not) and what we should expect from R&D policy

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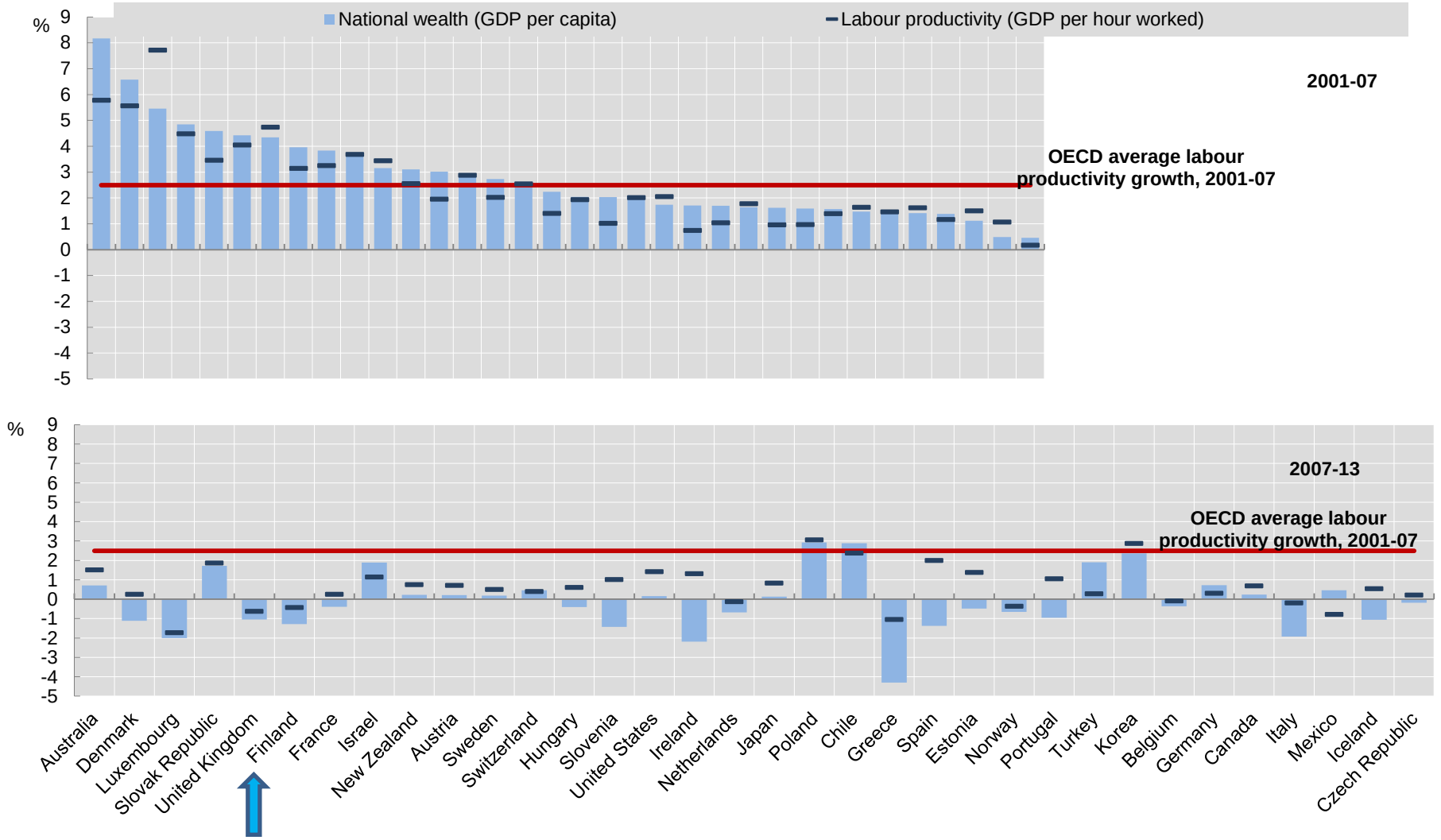
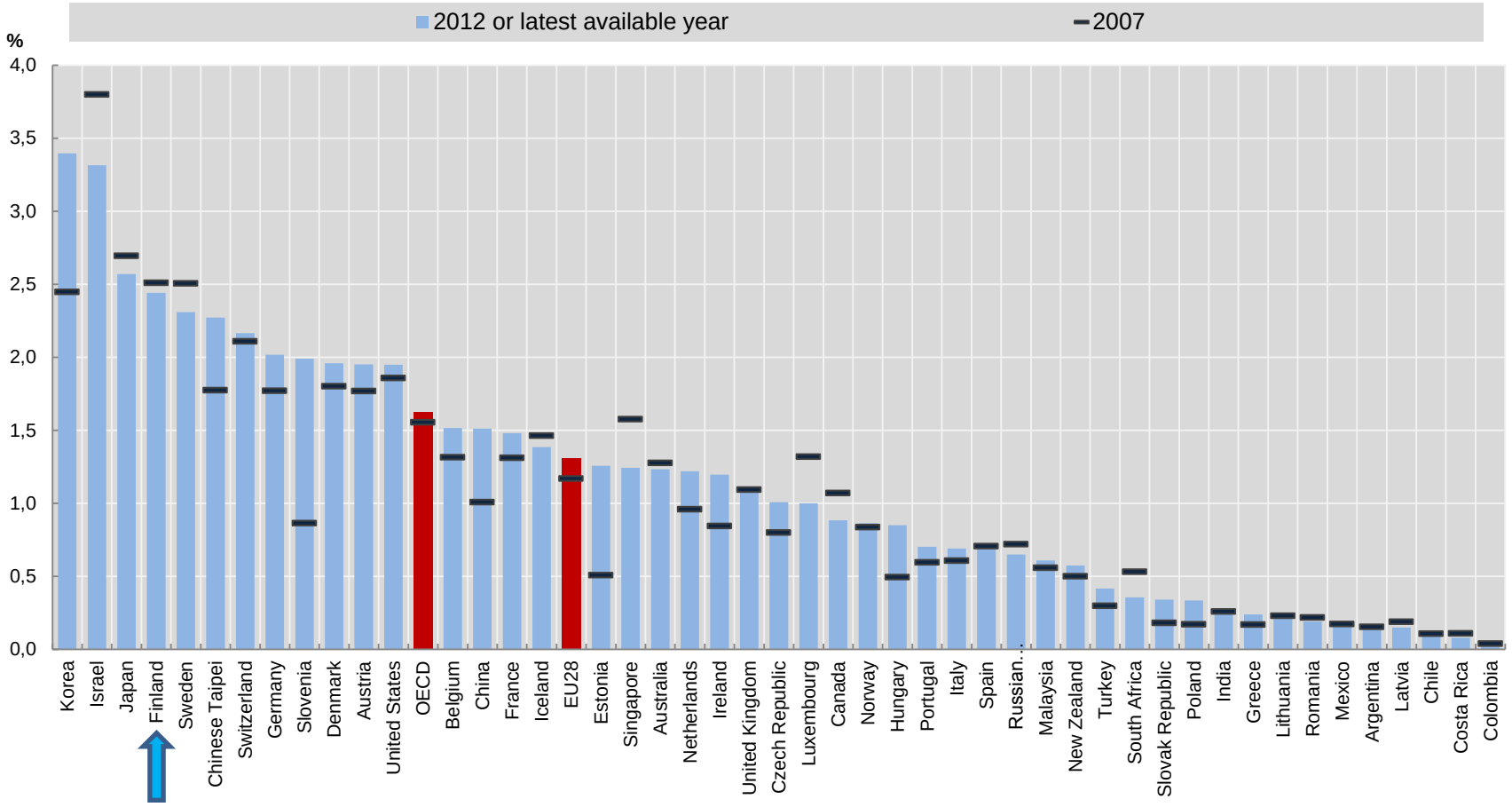
Declining productivity growth

(source: OECD, Productivity Database)

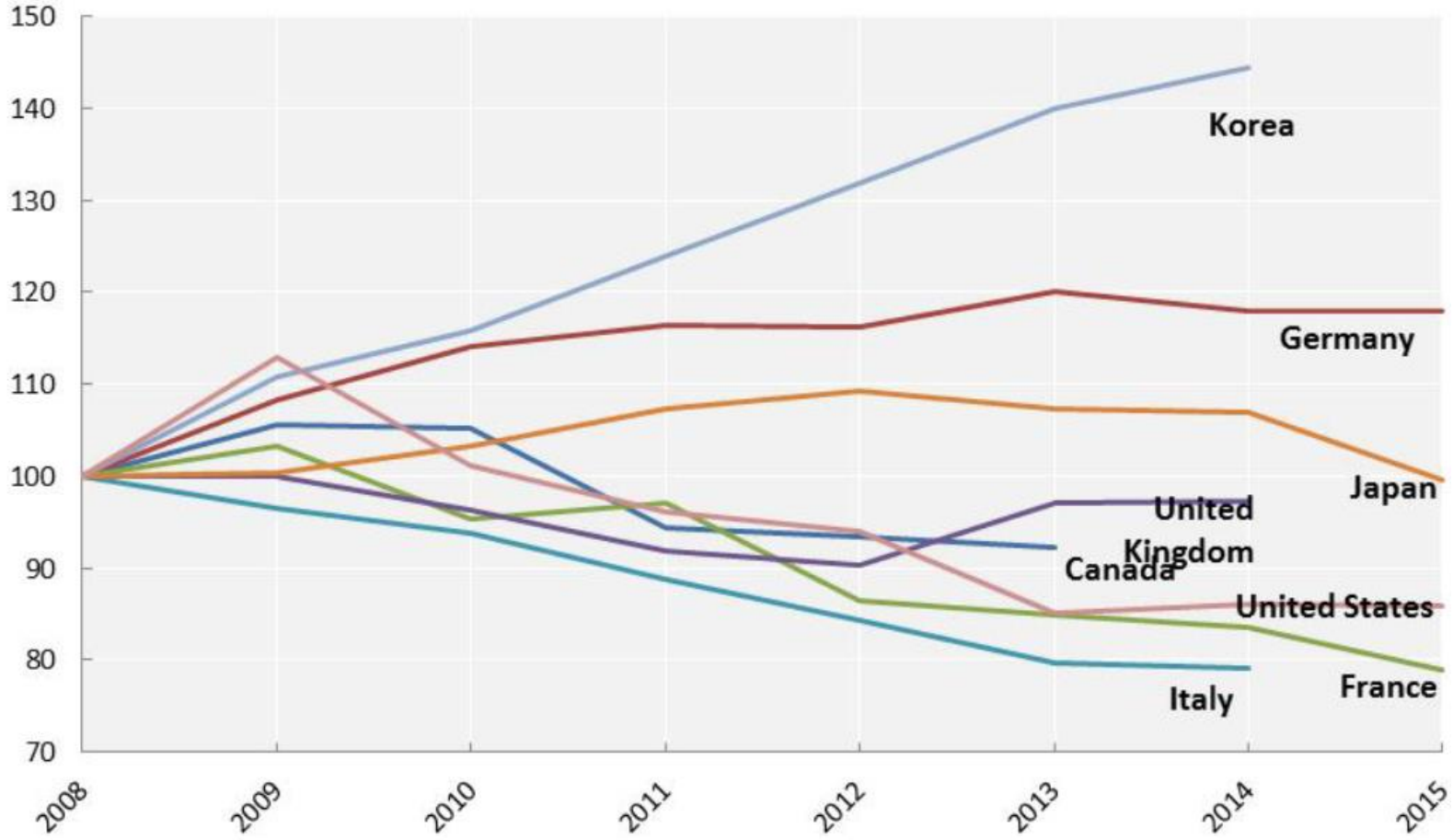


BERD as a percentage of R&D, 2007-12

(Source: OECD MSTI Database, 2014)

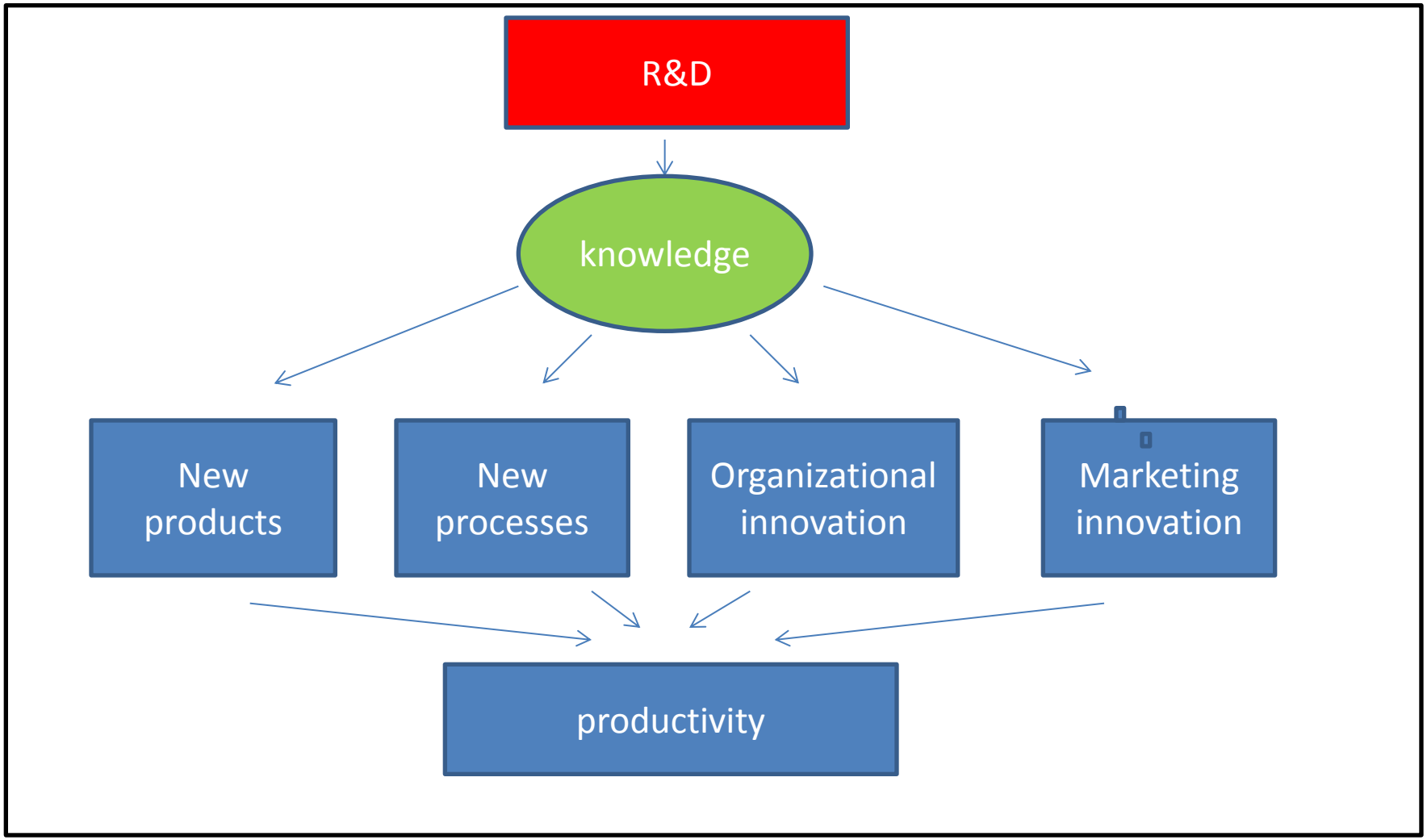


Government R&D budgets, 2008-2015



Source: OECD, Main Science and Technology Indicators Database, www.oecd.org/sti/msti.htm, January 2016.

Why does R&D increase productivity?



Returns to R&D

- R&D, especially continuous R&D, is a strong determinant of innovation output
- Micro studies estimate the private rates of return to be in the 20% to 30% range
- There are R&D externalities
- There is a lot of heterogeneity in the estimated rates of return

R&D externalities

- Positive
  - Knowledge spillovers
  - Imperfect appropriability of the returns
  - Intertemporal spillovers
  - Network externalities (complementarities)
- Negative
  - Erosion effect (decreasing returns)
  - Congestion externalities (duplication)
  - Creative destruction
  - R&D wage effect

Social rate of return to R&D

- R&D spillovers + private rate of return = social rate of return
- Social rate of return is 50% to 100% higher than the private rate of return
- Bloom, Schankerman and Van Reenen (2013) find that
  - the positive spillovers dominate the negative spillovers.
  - large firms diffuse more externalities than small firms.

Heterogeneity in the social rates of return

- Knowledge spillovers may depend on the geographic proximity between emitter and receiver (tacit knowledge).
- Knowledge spillovers are higher the more similar the research, the competences.
- Market stealing effects are higher the more firms compete on the same market segments.
- Spillovers depend on absorptive capacity.
- Peri (2005) finds that regional technological leaders diffuse their knowledge faster than other regions.

Foreign R&D spillovers

- Foreign R&D spillovers can be due to:
  - international trade
  - foreign direct investments
  - international R&D collaborations
  - labor migration
- Typical findings:
  - a proportional increase in foreign R&D has a higher effect on GDP than the same proportional increase in domestic R&D, except for the G-7 countries (Coe and Helpman, 1995)
  - Small countries and countries with more R&D intensity benefit more from foreign R&D spillovers (Guellec and van Pottelsberghe de la Potterie, 2004)
  - the European countries derive most of their growth from foreign R&D, whereas the United States and Japan rely more on their own R&D (Eaton and Kortum, 1996)

Growth accounting

- Under reasonable assumptions, R&D explains 10% of MFP growth in the absence of spillovers, 20% if spillovers double the private rate of return.
- In the revision of the National Income and Product Accounts, R&D is treated as an investment.
- Fraumeni and Okubo (2005) evaluated the contribution of R&D investment to corrected GDP in the US between 2% and 7% on the expenditure side and the contribution of the returns to R&D to corrected GDP on the income side between 4% and 15%.

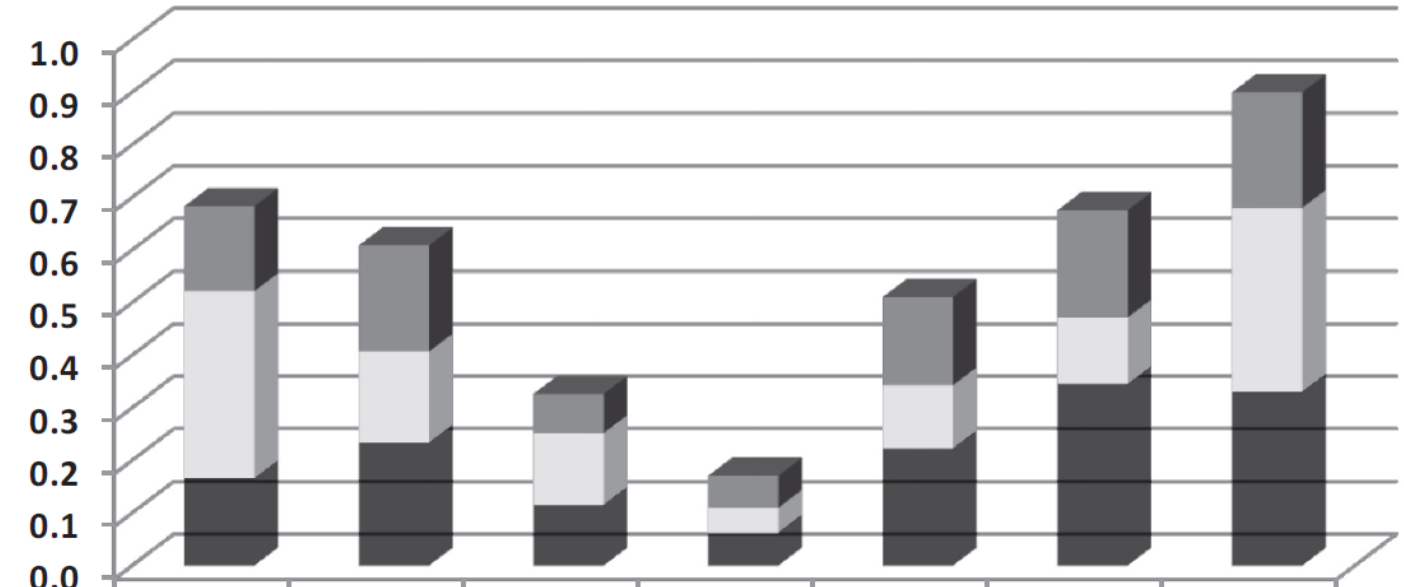
R&D and other intangibles

- Corrado, Hulten and Sichel (2009) consider three types of intangible assets:
  - computerized information (software, databases)
  - innovative property (research and development, mineral exploitation, copyright and license costs and other product development, design and research expenses)
  - economic competences (brand equity, firm-specific human capital and organizational structure)

Contributions to the growth of output/hour, 1995-2007 (from Corrado, Haskel, Jona-Lasinio and Iommi (2013)

	Labour productivity growth	Contribution of components:				
		Total capital deepening	Tangibles	Intangibles	Labour composition	MFP
	(1)	(2)	(3)	(4)	(5)	(6)
Austria	2.4	0.8	0.3	0.5	0.2	1.4
Belgium	1.8	0.7	0.2	0.5	0.1	1.0
Czech Rep.	4.2	2.4	1.9	0.5	0.3	1.5
Denmark	1.4	1.2	0.7	0.5	0.2	–0.1
Finland	3.8	0.9	0.2	0.7	0.2	2.7
France	1.9	1.0	0.4	0.6	0.4	0.5
Germany	1.7	1.0	0.7	0.3	0.0	0.8
Ireland	3.8	1.4	0.8	0.6	0.1	2.2
Italy	0.6	0.7	0.5	0.2	0.2	–0.4
Netherlands	2.3	0.9	0.4	0.5	0.4	1.0
Slovenia	5.3	1.7	1.2	0.5	0.7	2.9
Spain	0.8	1.0	0.7	0.3	0.5	–0.6
Sweden	3.7	1.9	1.1	0.8	0.3	1.5
UK	2.9	1.5	0.8	0.7	0.4	1.1
Japan	2.1	0.9	0.7	0.2	0.8	0.5
United States	2.8	1.5	0.7	0.8	0.2	1.1

Contributions of sub-components of intangibles to labor productivity growth, 1995-2007 (Corrado et al., 2017)



	Finland	France	Germany	Italy	Netherlands	UK	US
SFT	0.16	0.20	0.07	0.06	0.17	0.20	0.22
IP	0.36	0.17	0.14	0.05	0.12	0.13	0.35
EC	0.17	0.23	0.12	0.06	0.22	0.34	0.33

Notes: SFT = software, IP = innovative property, EC = economic competencies (see Table 1 for definitions of each category).

Heterogeneity

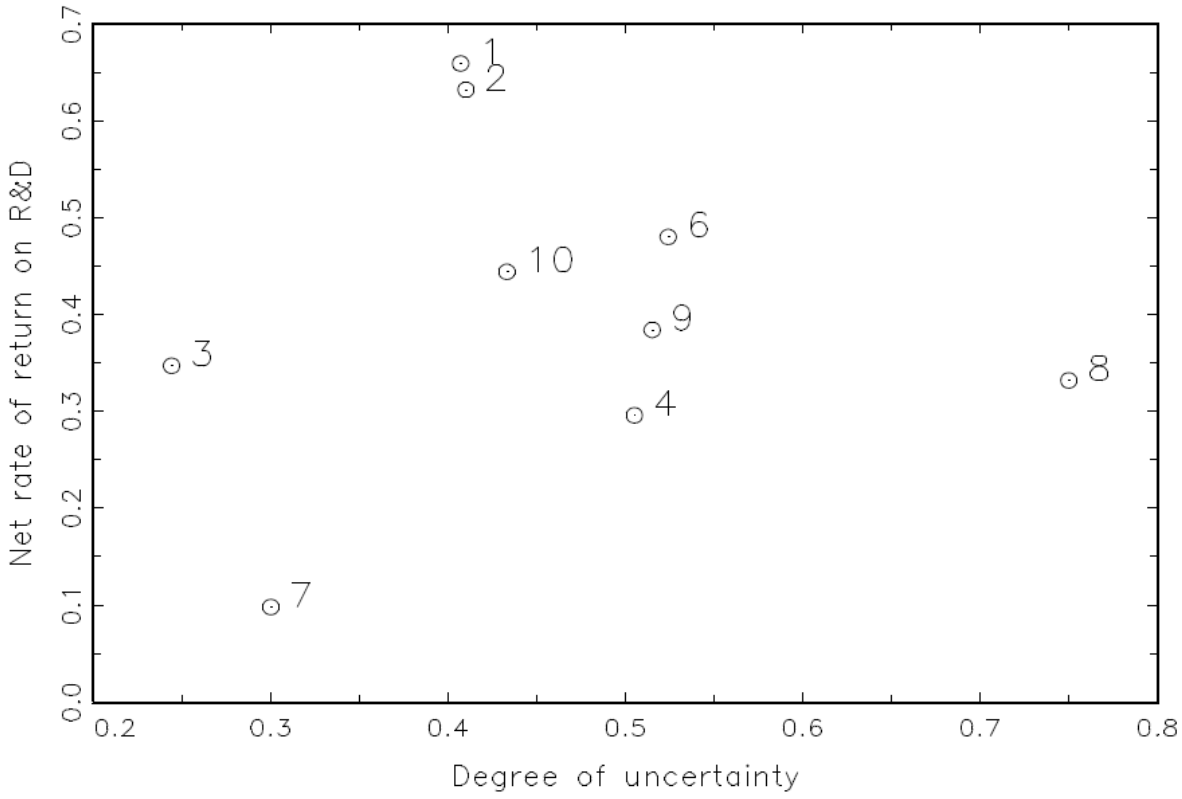
Distance to the frontier

- The further from the frontier, the more R&D serves to develop absorptive capacity
- The further the distance from the best practice, the more there is to gain from backwardness by doing R&D, but there may be a point where the lack of human capital and public-private sector interactions reduce the returns from R&D.

(Kumbhakar, Ortega-Argilés, Potters, Vivarelli and Voigt, 2012; Griffith, Redding and Van Reenen,2014; Goñi and Maloney,2014; Kokko, Gustavsson Tingvall and Videnord, 2015)

Uncertainty

- Doraszelski and Jaumandreu (2013) find on Spanish data that the rate of return is higher in industries where the uncertainty is higher.



High-tech/low-tech

- Given the lower probability of doing R&D and the lower payoff in terms of productivity, in low-tech industries the difference in expected value between firms that do and those that do not do R&D is 2.8% against 6.7% in high-tech industries

  (Peters, Roberts, Vuong and Fryges, 2013)

Basic research

- Countries with more public research done in universities have higher returns on their public R&D

  (Guellec and van Pottelsberghe de la Potterie, 2004)

- Higher returns on basic R&D

  (Mansfield, 1980, Griliches, 1986)

- Higher returns on R&D done in collaboration with universities or public research organizations

  (Link and Rees, 1990; Belderbos, Carree, Lokshin, 2004)

Publicly-funded R&D

- Lower returns than on business-funded R&D
- Reasons:
  - Maybe less performing, efficiency-driven
  - Maybe more in areas of social necessity where other objectives are important
  - Maybe in fields where it takes time to see benefits
  - Maybe crowding out of private research

R&D composition

- Returns may vary across countries because of different compositions in
  - Basic R&D
  - Public R&D
  - High-tech/low-tech sectoral composition
  - Absorptive capacity
  - Innovation policies

Innovation policies

- Tax incentives
- Direct support
- Framework conditions

R&D policies: tax incentives

- Do they stimulate R&D? YES
- Leave the choice of R&D projects up to the private sector
- Deadweight loss associated to level-based R&D tax incentives
- Incremental R&D tax incentives are more efficient but less effective

R&D policies: direct support

- Can be channeled to where social return is high
- Mixed evidence of additionality versus crowding out
  (David, Hall and Toole, 2000; Zuñiga-Vicente, Alonso-Borrego, Forcadell and Galán, 2014)
- Takalo, Tanayama and Toivanen (2013) on Finland have found that the expected returns on subsidized R&D are heterogeneous, the social rates of return are around 30% to 50%, 60% of the social return is internalized by firms, and that firms do not apply for the most profitable projects
- Subsidized R&D can produce behavioral externalities: speed up R&D, do more basic research, yield more radical innovations

R&D policies: framework conditions

- Trade openness, IPR protection, the level of education, transparency of public policy, stable macroeconomic policies, bankruptcy laws, availability of venture capital, procurement, ease to start a business, low income taxation, business-industry-government collaborations, efficiency and flexibility of the labor market stimulate R&D.

  (Jaumotte and Pain, 2005a, 2005b; Andrews and Criscuolo, 2013)
- Griffith and Macartney (2014):employment protection legislation spurs incremental innovations but discourages radical innovations by multinational firms.