

R&D and growth: Introduction

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7.4.2021

R&D

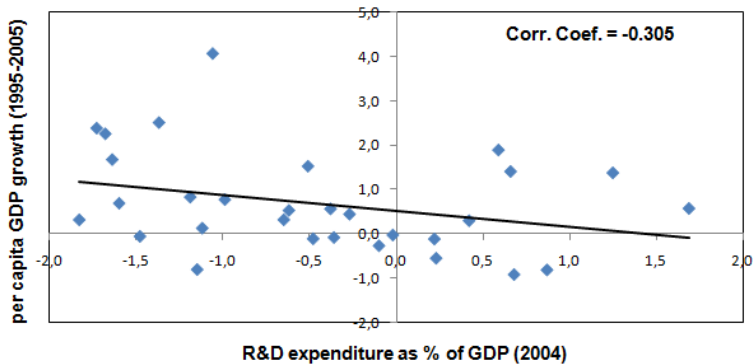
- ▶ Expenditures on research and development over GDP: around 2% <https://data.worldbank.org/indicator/GB.XPD.RSDV.GD.ZS>
- ▶ Compare with the weight of government expenditures in education over GDP: around 5% <https://data.worldbank.org/indicator/SE.XPD.TOTL.GD.ZS>
- ▶ It commands sizeable resources
- ▶ How do we define R&D and how do we relate it to economic growth ?

R&D

- ▶ a measurable output of R&D are patents
<https://data.worldbank.org/indicator/IP.PAT.NRES>
- ▶ (maybe) another is: scientific papers published
<https://ourworldindata.org/grapher/scientific-publications-per-million>

R&D and growth

- ▶ there are some puzzles



(see Gil et al. (2013))

R&D. ideas, competition and growth

- ▶ Technology and technical progress:
technical progress = systematic increase in TFP
- ▶ Exogenous and endogenous technical progress:
endogenous t.p = increase in TFP a purposeful activity
- ▶ Types of endogenous technical progress:
learning-by-doing, and ideas
- ▶ Ideas:
fundamental research = ideas for the purpose of knowledge,
curiosity
R&D = ideas for profit

R&D. ideas, competition and growth

The problem with ideas: rivalry and excludability

- ▶ can be used by several people simultaneously (non-rivalry)
- ▶ once an idea is found it can be used by others (non-excludability)
- ▶ because coming up with ideas takes costs (effort, time, resources) this generates a problem of free-riding
- ▶ this is particularly serious for R&D ideas that can have market value
- ▶ fundamental research has some characteristics of excludability and lack of market value

R&D. ideas, competition and growth

- ▶ Because of non-rivalry and non-excludability:
there is a potential free-riding problem (difference between private benefits and costs for the developers of R&D)
- ▶ As R&D has costs, it can only take place under two environments:
 - ▶ market economy in which there is imperfect competition (patents or other type of rent generating mechanism)
 - ▶ in a centralized economy, where R&D costs can be internalized
- ▶ **R&D and growth:** there is a trade-off:
 - ▶ imperfect competition generates a reduction in the growth of productivity
 - ▶ but R&D generates growth
- ▶ This creates a role for policy: internalizing the externalities

R&D models in the literature

- ▶ Process innovation (intermediate products) versus product innovation (final goods)
- ▶ Horizontal innovation (new industries) versus vertical innovation (existing industry)
- ▶ Product based or task-based
- ▶ Quantity expansion versus quality enhancement
- ▶ Neutral versus biased technical change (complementary or substitutable with other inputs)
- ▶ Who does the innovation: an incumbent or an entrant
- ▶ Innovation: fundamental or applied, new or imported or imitated
- ▶ Technology of R&D: lab-equipment versus knowledge-driven

References

- ▶ (Barro and Sala-i-Martin, 2004, ch. 6), (Acemoglu, 2009, ch. 13), (Aghion and Howitt, 2009, ch. 3)

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Philippe Aghion and Peter Howitt. *The Economics of Growth*. MIT Press, 2009.

Robert J. Barro and Xavier Sala-i-Martin. *Economic Growth*. MIT Press, 2nd edition, 2004.

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