Economics of Innovation
1 Economics of Science and Technology

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I. Why Study the Economics of Science &Technology?

- Why study the economics of science and technology?
  - Innovations in science and technology play an important role in economic growth.
  - Thus, it is useful to understand what factors influence the development of technology.
- In general, economists study the allocation of scarce resources.
  - In this course, the scarce resource is the *effort* utilized in the scientific process.
  - This could be money invested in R&D, labor efforts of scientists and engineers, etc.

I. Why Study the Economics of Science &Technology?

- Questions to ask:
  1. What determines how much effort is invested into the scientific process?
     - How do firms (or governments) decide how much to invest in R&D?
     - How do they decide *which* projects to invest in?
       – E.g. how much money for AIDS research vs. cancer research?
       – How do agents decide which technologies to use (adoption of technology)?

I. Why Study the Economics of Science &Technology

- Questions to ask:
  1. What determines how much effort is invested into the scientific process?
  2. How does government policy affect this process?
     - Why is intervention necessary?
       – What are the market failures?
     - How strong should intellectual property rights be?
       – E.g. do software patents help or hinder innovation? Should developing countries recognize patents on life-saving drugs?
     - How much money should the government spend on R&D?
       – How do we evaluate the effectiveness of government R&D investments?
     - Should it subsidize private R&D?
     - How do the public and private sector work together on research?

I. Why Study the Economics of Science &Technology?

- Questions to ask:
  1. What determines how much effort is invested into the scientific process?
  2. How does government policy affect this process?
  3. What effect does this research have on economic well-being?
     - As we'll see in a moment, increases in productivity greatly affect long-run economic growth. How do scientific gains translate into productivity gains?

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- Questions to ask:
  1. What determines how much effort is invested into the scientific process?
  2. How does government policy affect this process?
  3. What affect does this research have on economic well-being?
  4. How does technological change affect government policies?
     - What policies are needed to govern information technology?
     - How does globalization affect the outcomes of technological progress?
     - How can policy promote the development of clean energy technologies?

II. The Importance of Technology

- When economists look at the effects of science and technology, we look at *productivity*
  - Productivity is the amount of output per unit of input
- *Labor productivity* – output per worker
  - Labor productivity has tended to be strongly correlated with wages, and is thus a reasonable measure of changes in economic welfare.

II. The Importance of Technology

- *Total factor productivity (TFP)* – a measure of output per unit of combined inputs
  - Unlike labor productivity, this looks at the productivity of *all* inputs in the economy
  - A simple calculation focuses on capital and labor:
    - $\Delta Y = \Delta A + \Delta K + \Delta L$
  - We can measure changes in output, capital, and labor. Changes in technology are the residual.
  - TFP is simply the portion of growth that cannot be explained by changes in the inputs of the economy.

II. The Importance of Technology

- Contribution of productivity growth to U.S. GDP growth

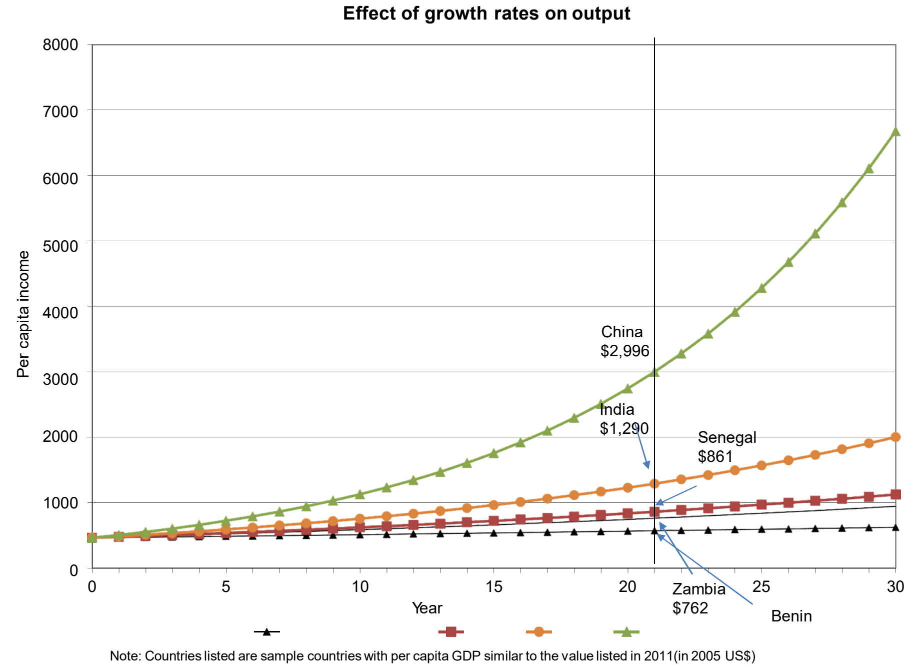
	1948-2001	1948-1973	1973-1979	1979-1990	1990-1995	1995-2000	2000-2010
Real Output	3.7	4.2	3.2	3	2.8	4.6	1.7
= growth labor*share labor	1.2	1.0	1.4	1.4	1.3	1.7	-0.1
+ growth capital * share capital	1.3	1.2	1.4	1.3	0.9	1.8	0.8
+ TFP	1.3	1.9	0.4	0.2	0.6	1.1	1.0

https://stats.oecd.org/Index.aspx?DataSetCode=MFP

II. The Importance of Technology

- Small differences in growth rates lead to large long-term results
- Consider China in 1990
  - Per capita GDP: $463 (2005 US$)
    - Similar countries in 1990: Benin ($453), Guinea-Bissau ($497), Kenya ($550), India ($403)
  - China's growth rate 1990-2011: 9.3%

RULE of 70
The rule of 70 states that in order to estimate the number of years for a variable to double, take the number 70 and divide it by the growth rate of the variable.
This rule is commonly used with an annual compound interest rate to quickly determine how long it would take to double your money.



II. The Importance of Technology

Compare to other growth rates

• **World:**	**2.4%**
• East Asia & Pacific:	7.5%
– China	9.3%
– India	4.9%
– Korea	4.1%
– Singapore	3.5%
– Vietnam	6.0%
• Latin America & Caribbean	1.7%
– Argentina	2.3%
– Brazil	1.6%
– Mexico	1.3%
• Selected high income countries	
– US	1.7%
– Japan	0.7%
– Germany	1.3%

and Italy?
Let us try to find the data and compute it…

III. Policy Relevance

- Technological change has three parts
  - *Invention*: the initial development of an idea. Could be represented, for example, by a patent
  - *Innovation*: adopting the invention for commercial use
  - *Diffusion*: the spread of the new innovation throughout the economy
- Different policies affect different parts of the process

III. Policy Relevance

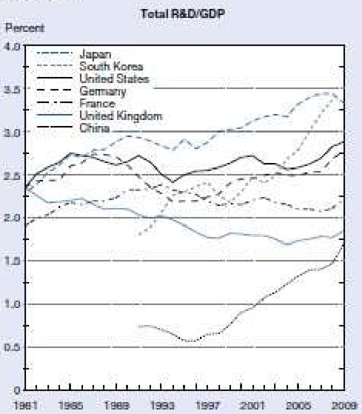
- R&D spending in selected countries

	Total R&D	**% GDP**	**% Govt**	**% Industry**	**% Higher Ed**
US	$402 b	2.88	11.7	70.3	13.5
Japan	$138 b	3.33	9.2	75.8	13.4
France	$48 b	2.21	16.3	61.9	20.6
Germany	$83 b	2.78	14.9	67.5	17.6
Canada	$25 b	1.92	10.1	51.7	37.6
South Korea (2008)	$44 b	3.36	12.1	75.4	12.1
China	$154 b	1.70	18.7	73.2	8.1
Brazil (2008; % from 2004)	$21.6 b	1.08	21.3	40.2	38.4

2009 data unless indicated. Source: *US Science & Engineering Indicators, 2012*

and Italy?

Figure 4-16
Gross expenditures on R&D as share of gross domestic product, for selected countries: 1981–2009



GDP = gross domestic product

NOTES: Top seven R&D performing countries. Data not available for all countries for all years. Figures for the United States reflect international standards for calculating gross expenditures on R&D, which differ slightly from the NSF protocol for tallying U.S. total R&D. Data for Japan, for 1996 onward, may not be consistent with earlier data due to changes in methodology.

SOURCE: Organisation for Economic Co-operation and Development, Main Science and Technology Indicators (2011/1). See appendix table 4-43.

Science and Engineering Indicators 2012