Knowledge for Development: A Survey of Core Questions, Tentative Answers

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A statement of bias… or Where is this talk coming from?

- Trained as an ecologist, with work experience in natural resources, agricultural development, energy, environment policy… sustainability.
- Initiative on Science and Technology for Sustainability: dialogs between scientists/ engineers and development practitioners;
- Research program comparing experience with knowledge systems around the world in health, agriculture, energy, manufacturing, defense…

The main points…

- Knowledge (including science, technology and the fruits of practical experience) is one of, if not the, major drivers of development;
- Most efforts to enhance the contribution of knowledge to development fail. But a few succeed, offering lessons about need for…

Lessons on the need for…

- Treating knowledge mobilization as a *systems* problem, not a delivery pipeline;
- Ongoing *dialogue* between producers and users, instead of granting primacy to either;
- Emphasizing *end-user capacity* to redesign and reinvent, not "one size fits none";
- *Institutions* to target financing, create and nurture human capital.

Knowledge matters for development

- Growing (recurrent) recognition that development "is built not merely through the accumulation of physical capital and human skill, but on a foundation of information, learning and adaptation…"
  - World Bank, 1999. *World Development Report: Knowledge for development.*

Knowledge matters… (cont.)

- "The 20th century's unprecedented gains in advancing human development and eradicating poverty came largely from technological breakthroughs (eg. antibiotics, vaccines, high-yield crops)… Technology is a tool, not just a reward, for growth and development…"
  - UNDP. 2001: *Human development report: Making new technologies work for human development*.

But its potential contribution is seldom realized…. Why?

- Underinvestment
- Uneven distribution
- Ineffective application

Why? The world almost certainly underinvests in knowledge…

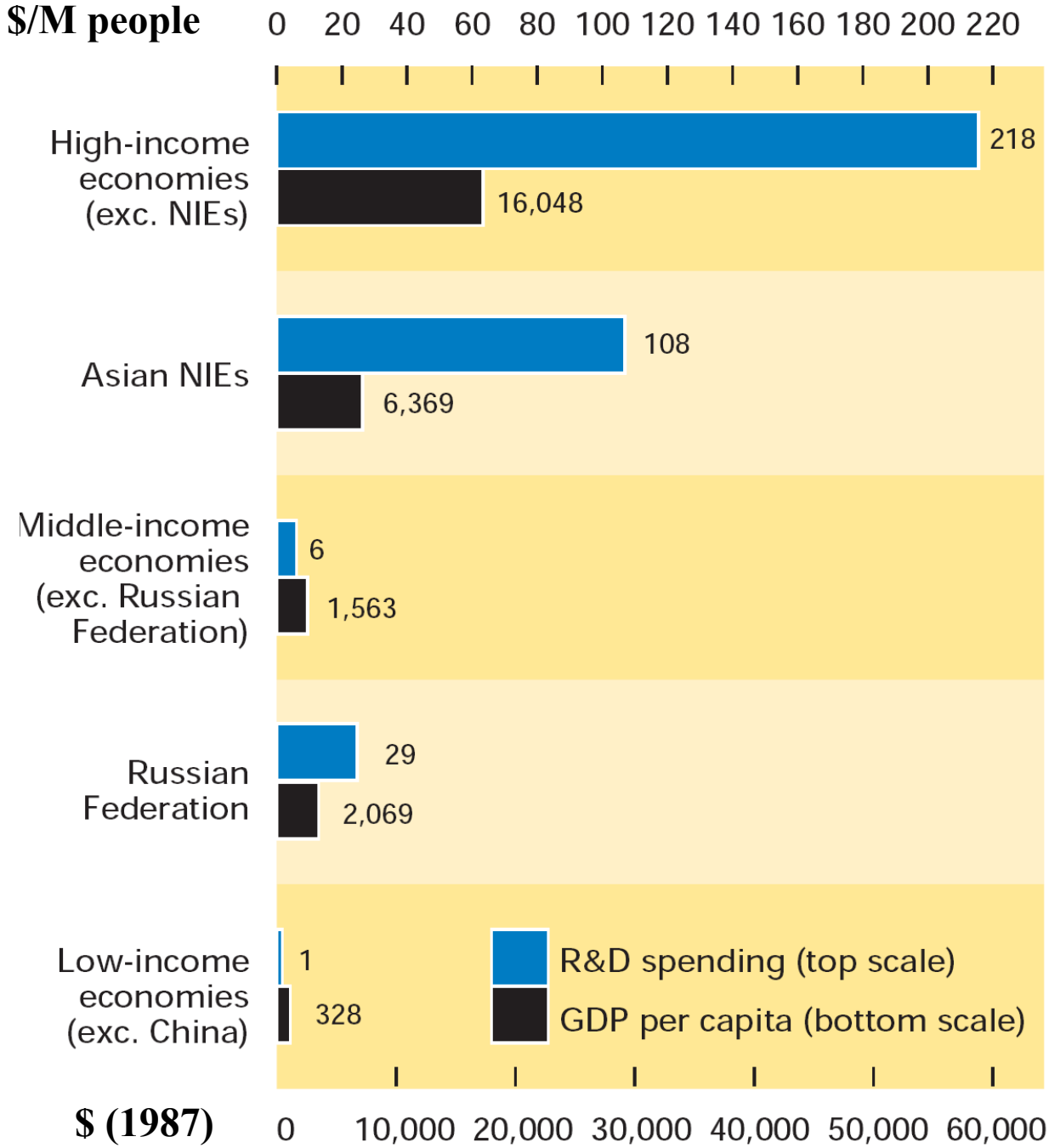
- Technology ("the growth of knowledge") is dominant engine economic growth (Solow)
- Marginal social rates of return to R&D v high…
  - Eg. In Ag, 40% to private, 70% to public R&D (Ruttan)
- But private investments lag, in part because of large public spillovers, property rights issues…
- Public investments static or falling due to perceived irrelevance, ineffectiveness of results (ICSU/TWAS/ISTS)

Why? Mutual misperceptions…

- Researchers are dissatisfied "because they are not listened to" while decision makers are dissatisfied "because they do not hear much they want to listen to…"
  - Lindblom and Cohen, 1979, *Usable knowledge*
- Decision makers see the R&D community as problem-raisers, uninterested in solutions
  - ICSU/TWAS/ISTS, 2002, *S&T for SD*

Why? Inequalities in the capacity to create knowledge

(4x greater than inequalities in income)



(Source: WB, 1999)

Why? Ineffective application of what is known…

- Even the knowledge that exists is seldom integrated into systems that can actually support development and decision making on the ground
  - Misplaced priorities
  - Missing pieces in the production-consumption chain

How to better harness science & technology to support development?

- "Long lists" of policy measures being advocated
  - "Send more money…" (Sachs)
  - Fix intellectual property rights (including TRIPS)
  - Build capacity (Johannesburg Summit)
  - Do more research (World Acads of Science)
  - Better monitoring and reporting (World Bank)
  - Reform institution X (UNEP, CGIAR, UNDP, WB…)
- Probably all useful… but somewhat random and not obviously complementary or prioritized

Knowledge systems…

- Need to understand the "knowledge systems" that support decisions through…
  - set priorities, mobilize funds, do the R&D, review publications/promotions, facilitate practical application and reinvention…
- Recognize these not designed from scratch, but evolve through time…
- Example of a "knowledge system"…
  - The international agricultural research system

S&T in the Agricultural R&D System

Specific Example	*Agriculture System*	*General "Layer"*
Farming	Locational learning	User adoption
Managem't advice	Extension	Information system
Plant varieties	Agroindustrial dev	Commercialization
Plant breeding	Technology devel	Invention
Plant genetics	Agricultural res	Applied research
Botany, Biochem	BioSciences res	Basic research

Ruttan, from Huffman and Evenson, 1993

Components of US Military R&D systems

- 6.1 Basic Research
- 6.2 Applied Research
- 6.3 Advanced Technology Development
- 6.4 Demonstration and Validation
- 6.5 Engineering & Manufacturing Development
- 6.6 RDT&E Management Support
- 6.7 Operational Systems development

Examples of other (relatively) effective knowledge systems

- *Agriculture*: CGIAR commodity programs
- *Environment*: ENSO applications programs
- *Health*: WHO malaria campaigns
- *Manufacturing*: flat-panel displays
- *Military*: WWII torpedo systems…
- …

Learning from experience with knowledge systems?

- What distinguishes more from less effective knowledge systems? What can be learned about improving performance from comparisons?
- We don’t know…
  - Little systematic research within problem areas
  - No comparison across problem areas (“Island empires”)
  - Yet some core challenges beginning to emerge…

Dialogue among producers and users

- Donor driven priorities distort efforts to mobilize useful knowledge on locally important questions…
- But “the customer is always wrong”.
- Need for continuing dialogue between producers and users at all levels
  - “boundary organizations” to facilitate

End-user capacity to reinvent

- Failure of the pipeline model:
  - “one size fits none”
- Examples from
  - “green revolution” agriculture
  - Mexican oil industry
  - the (relative) failure of health systems

Institutional needs

- Create and nurture human capital
  - career tracks
  - partnerships across universities, governments, private sector
- Sustain knowledge systems through time, to enable learning, cost reductions….

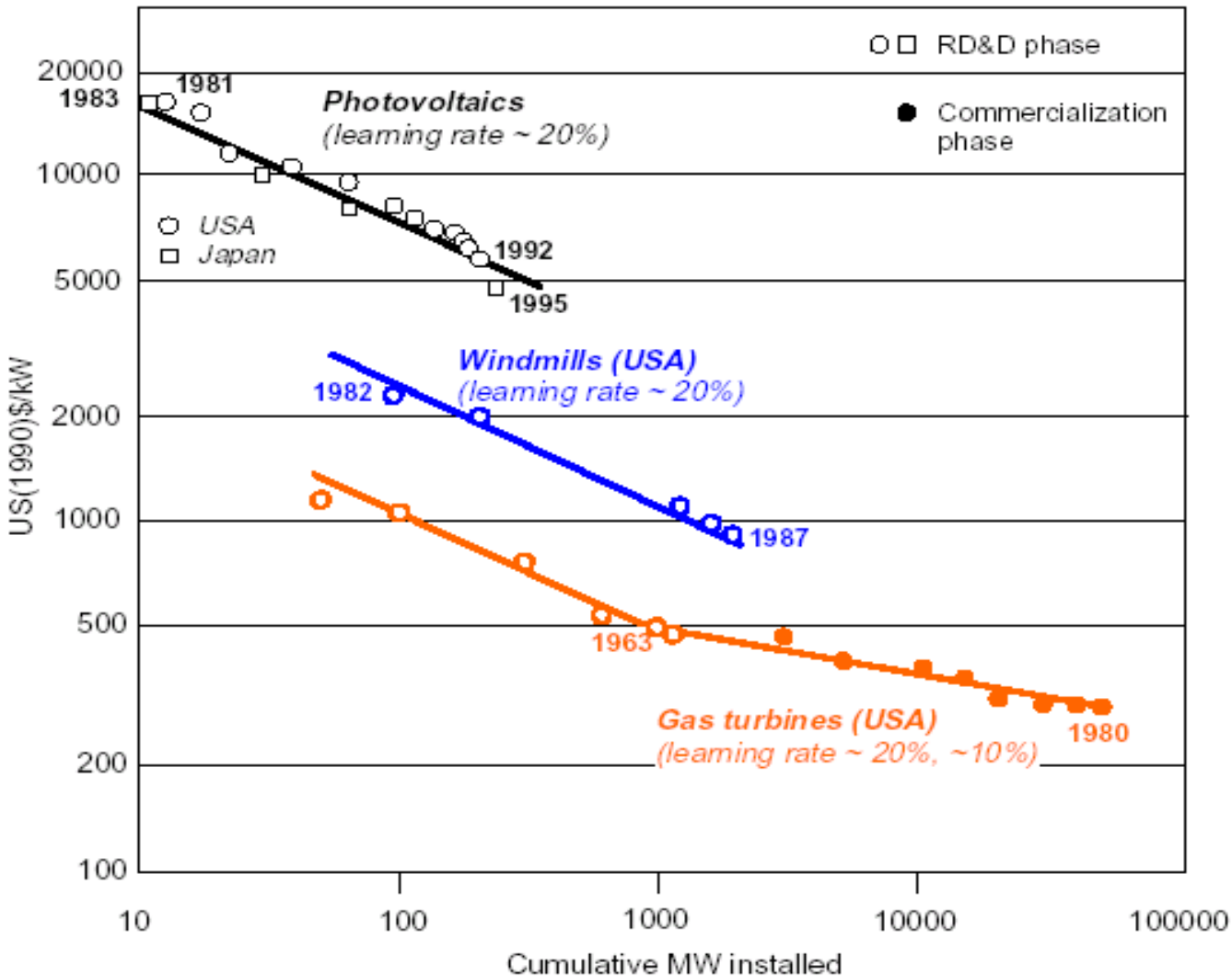
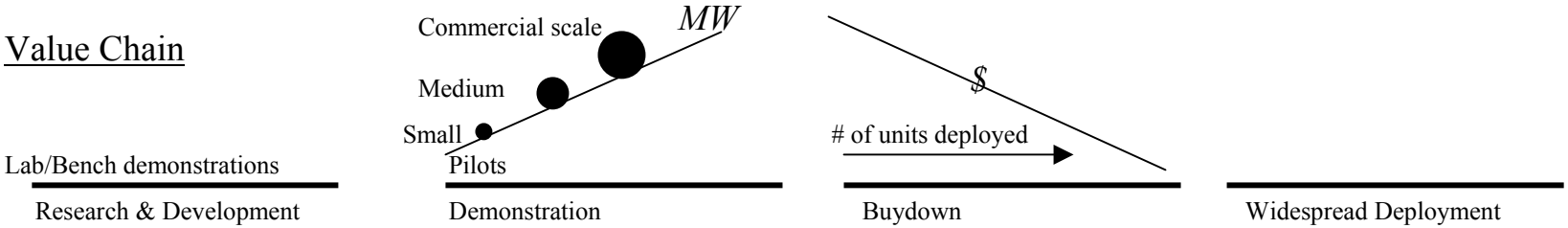


Figure 3.6: Learning Curve Relationships for Photovoltaics, Wind Generators, and Gas Turbines. All three have similar learning curves; however, after 1963 the gas turbine learning curve increased substantially, indicating attenuated experience effects. Note that gas turbines also have fuel costs and associated capital investment that are not shown here. Source: IIASA/WEC (1995).

Institutional needs

- Create and nurture human capital
  - career tracks
  - partnerships across universities, governments, private sector
- Sustain knowledge systems through time, to enable learning, cost reductions….
- Target financing at key points in chain of production to use….

Value Chain



Barriers, Risks, and Externalities

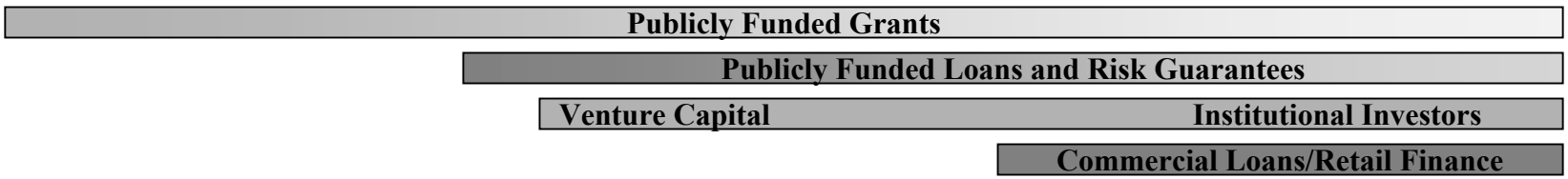
- Difficulty of co-opting benefits of R & D
- Long time horizons
- High risks

- Difficulty of co-opting benefits of demonstration
- Funding cycles

- Financing of incremental cost
- cost uncertainty
- technological and other risk

- Transaction costs
- Cost of feasibility studies
- Lack of security or collatoral; lack of retail finance

Financial Mechanisms



Existing Participants, Institutions, and Mechanisms

For further information…

- On the general challenge of harnessing science and technology for sustainability
  - http://sustainabilityscience.org
- On knowledge systems research seminar at Harvard University
  - http://www.ksg.harvard.edu/sed/k4dev_sem.htm

Items for discussion…

- Treating knowledge mobilization as a *systems* problem, not a delivery pipeline;
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END