Evolution of U.S. Innovation Policy

Gregory Tassey
Economic Analysis Office
National Institute of Standards and Technology

tassey@nist.gov

October 2011

Characteristics of U.S. Innovation Policy

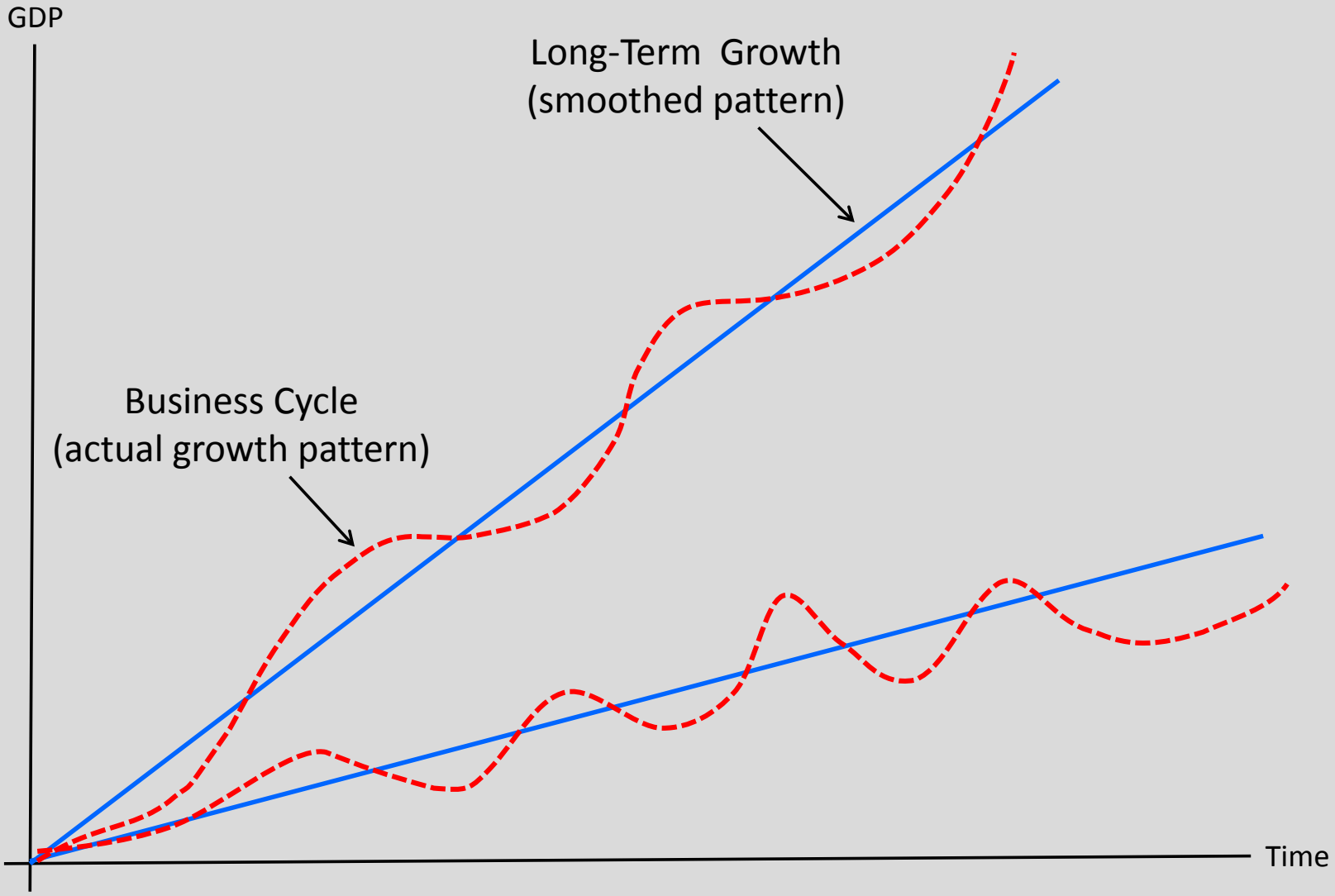
- Largely focused on public missions: defense, energy, health, security
- Mission-oriented R&D accounts for ~90 percent of federal R&D budget
- 80 percent of federal R&D budget is defense and health
- U.S. economic growth philosophy is based on "black-box" model
  - Government funds science and industry develops the technology (black-boxes)
  - Does not provide decision criteria for different policy instruments (e.g. tax incentives vs. direct funding)
- Overall, role of technology in economic growth is poorly understood and thus undervalued

Characteristics of U.S. Innovation Policy

- The positive is that "innovation policy" is finally beginning to evolve into a broader Science, Technology, Innovation, and Diffusion (STID) policy
- The "D" in STID includes important mid and late technology life cycle strategies, such as scale-up and market penetration
- In fact, the U.S. has been underinvesting in R&D and related economic assets for decades
- This underinvestment is now being manifested in a range of negative economic growth indicators

Importance of the Policy Problem

Long-Term vs. Short-Term Growth Trends

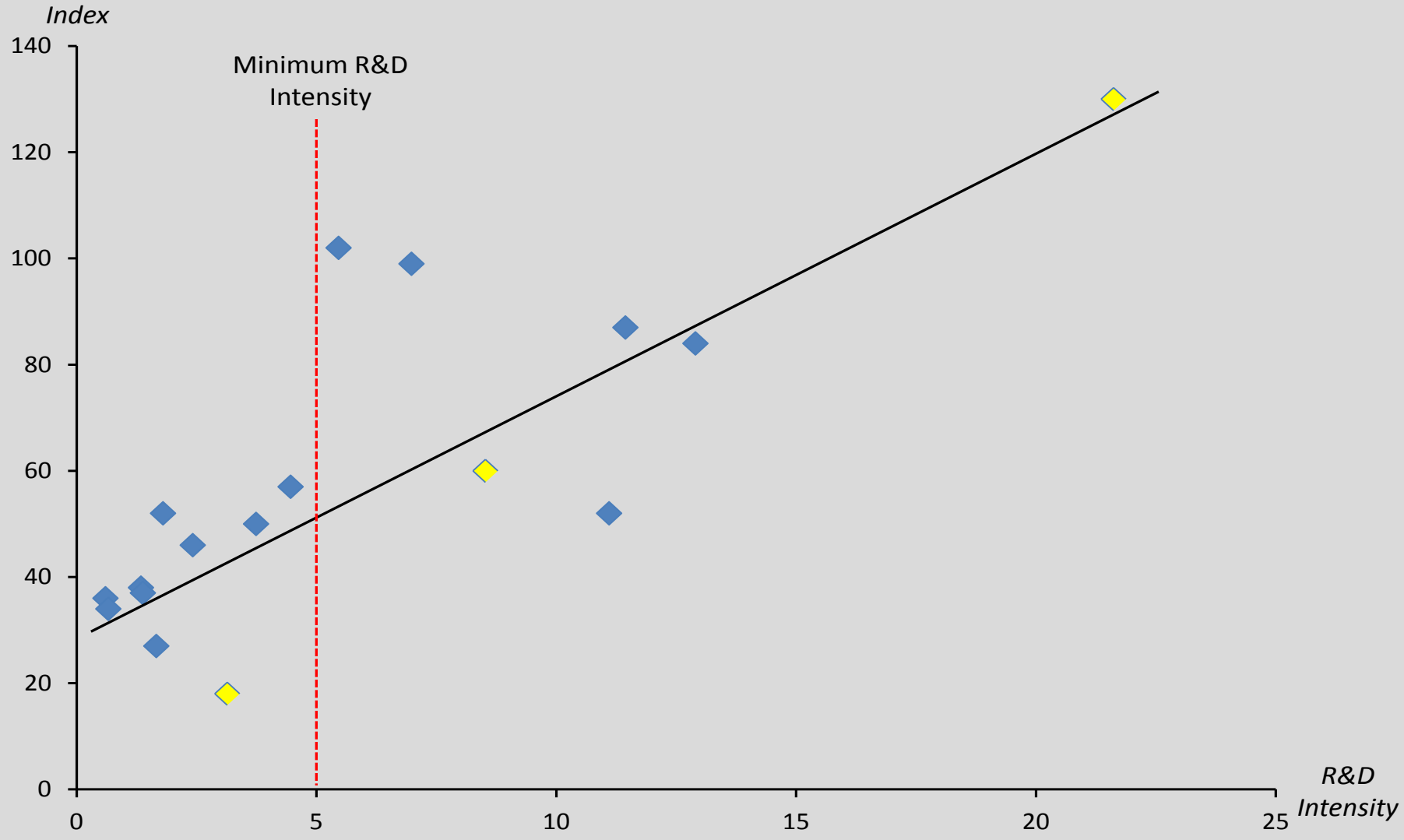


Source: Gregory Tassey, "Beyond the Business Cycle: The Need for a Technology-Based Growth Strategy," forthcoming.

Importance of the Policy Problem

Rate of Innovation vs. R&D Intensity:

Percent of Companies in an Industry Reporting Product and/or Process Innovations, 2003-2007



Source: Gregory Tassey, "Beyond the Business Cycle: The Need for a Technology-Based Growth Strategy," forthcoming. Index = sum of percent of companies in an industry reporting product innovations and percent reporting process innovations. R&D intensity data from *Science and Engineering Indicators 2010* , Appendix Table 4-14 (industry and other non-federal funds for R&D); innovation data from Mark Boroush, "NSF Releases New Statistics on Business Innovation," NSF *InfoBrief*, October 2010

Importance of the Policy Problem – Manufacturing

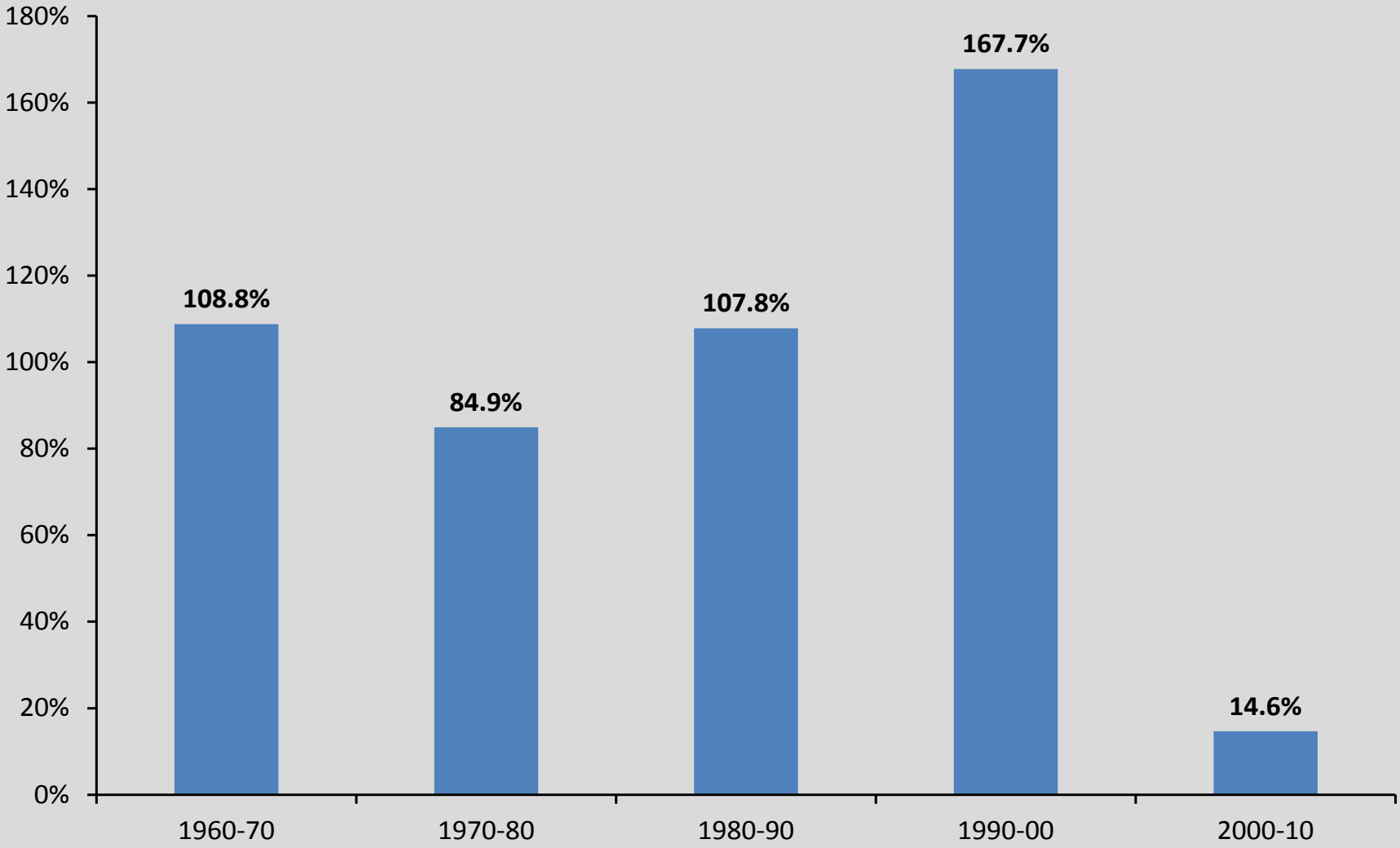
Relationship Between R&D Intensity and Real Output Growth

Industry (NAICS Code)	Average R&D Intensity, 1999-2007	Percent Change in Real Output, 2000-2007
R&D Intensive:		
Pharmaceuticals (3254)	10.5	19.1
Semiconductors (3344)	10.1	15.4
Medical Equipment (3391)	7.5	28.4
Computers (3341)	6.1	106.2
Communications Equip (3342)	13.0	-42.3
	Group Ave: 9.5	**Group Ave: 25.4**
Non-R&D Intensive:		
Basic Chemicals (3215)	2.2	25.5
Machinery (333)	3.8	2.4
Electrical Equipment (335)	2.5	-13.6
Plastics & Rubber (326)	2.3	-4.5
Fabricated Metals (332)	1.4	4.9
	Group Ave: 2.5	**Group Ave: 2.9**

Sources: NSF for R&D intensity and BLS for real output.

Underinvestment – Aggregate

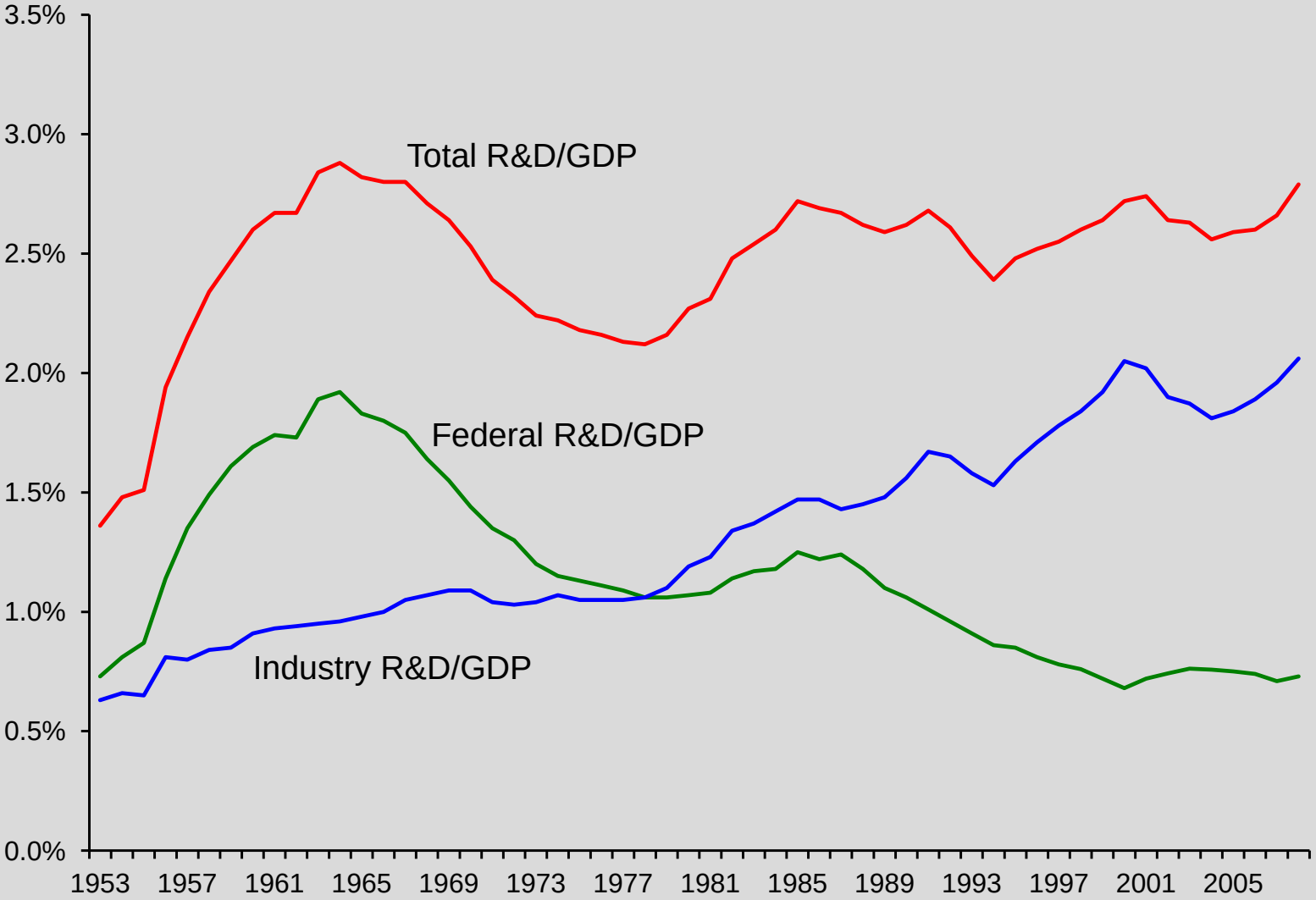
Fixed Private Investment (hardware & software)
(growth by decade in 2005 dollars)



Source: Gregory Tassey, "Beyond the Business Cycle: The Need for a Technology-Based Growth Strategy," forthcoming. Data from Bureau of Economic Analysis, NIPA Table 5.3.5 (includes both equipment and software) and Table 5.3.4 (price indexes for fixed private investment)

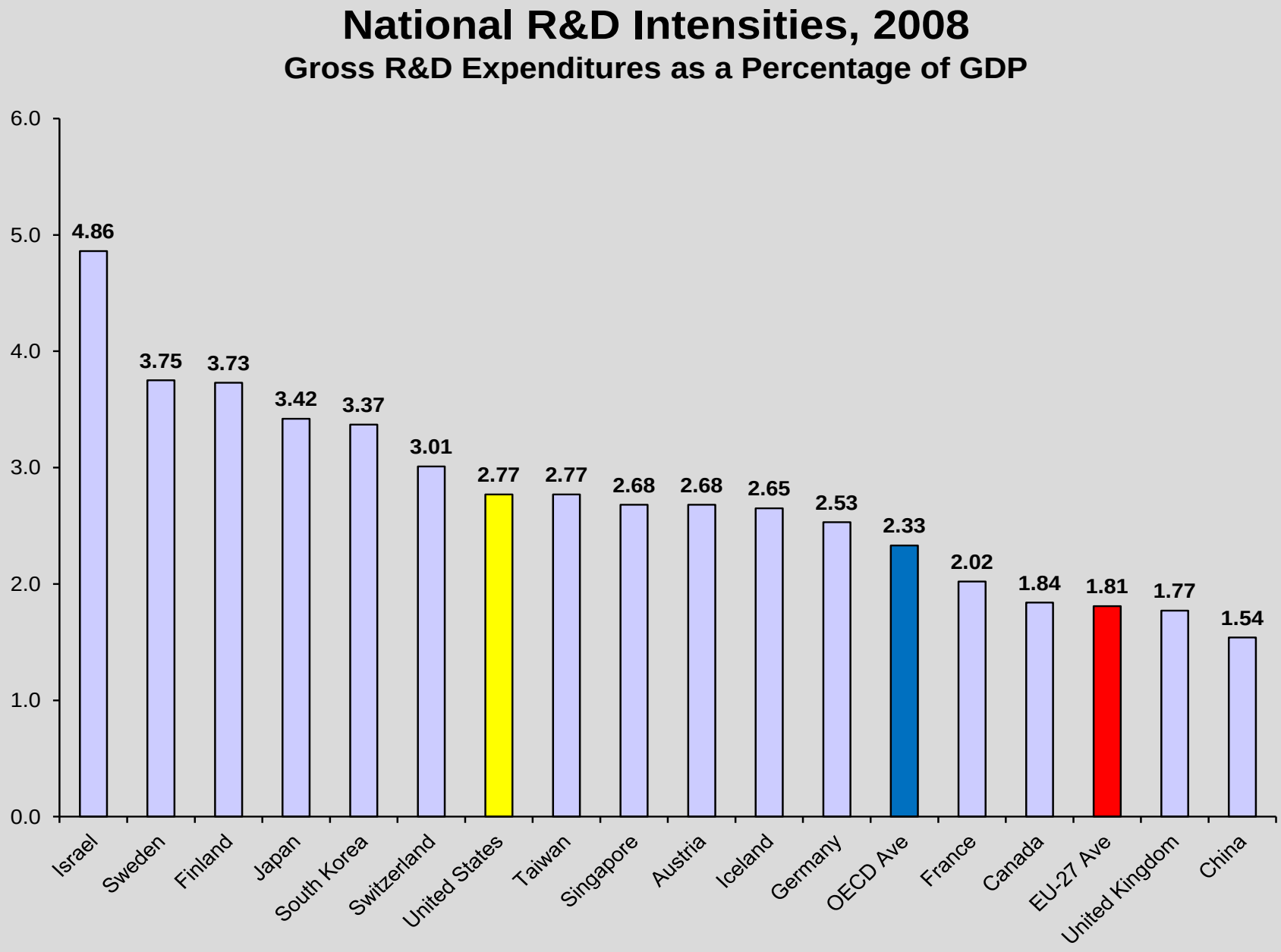
Underinvestment – Amount of R&D

U.S. R&D Intensity: Funding as a Share of GDP, 1953-2008



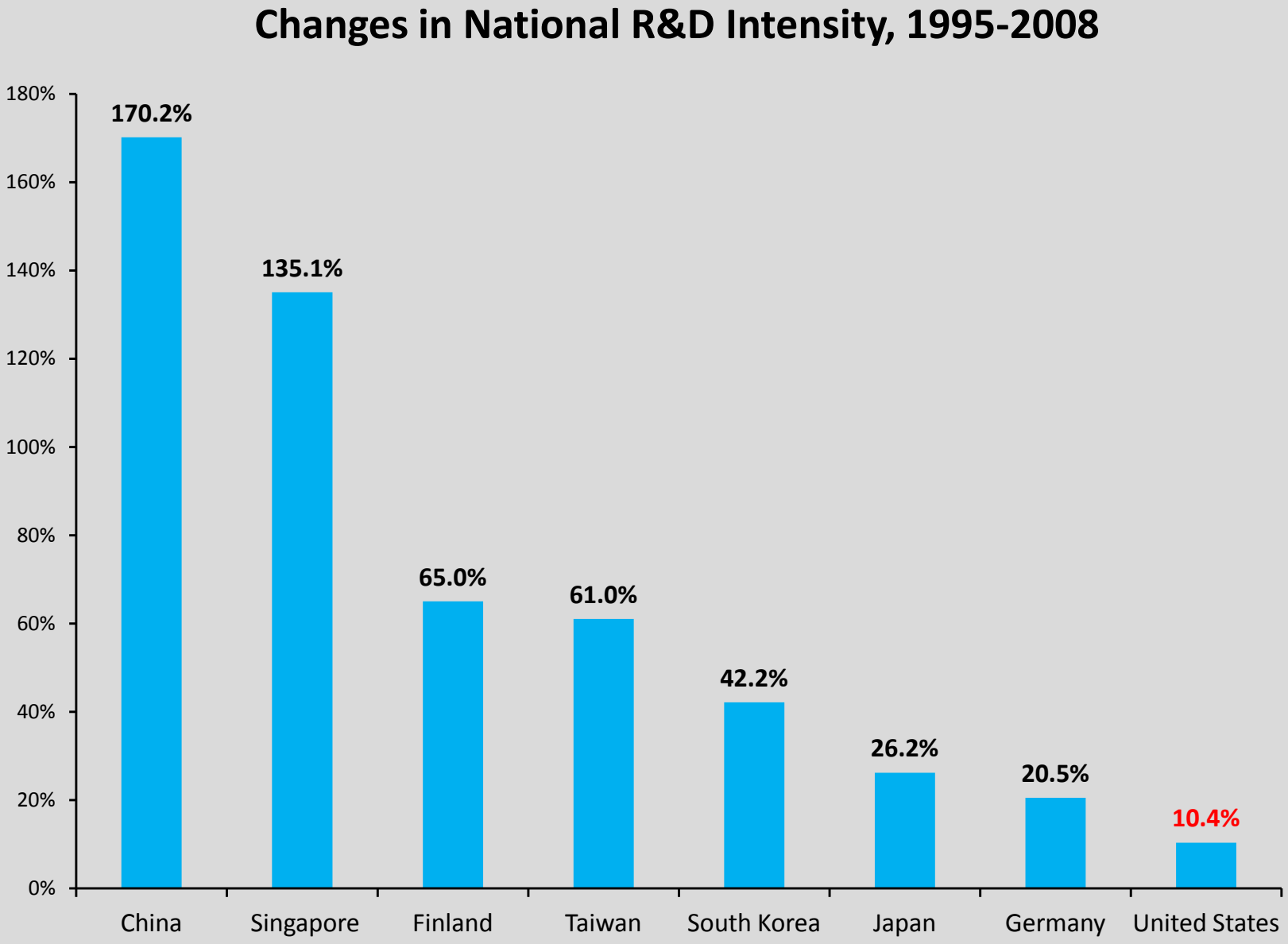
Gregory Tassey, "Rationales and Mechanisms for Revitalizing U.S. Manufacturing R&D Strategies," *Journal of Technology Transfer 35* (2010): 283-333. Data from the National Science Foundation.

Underinvestment – Amount of R&D



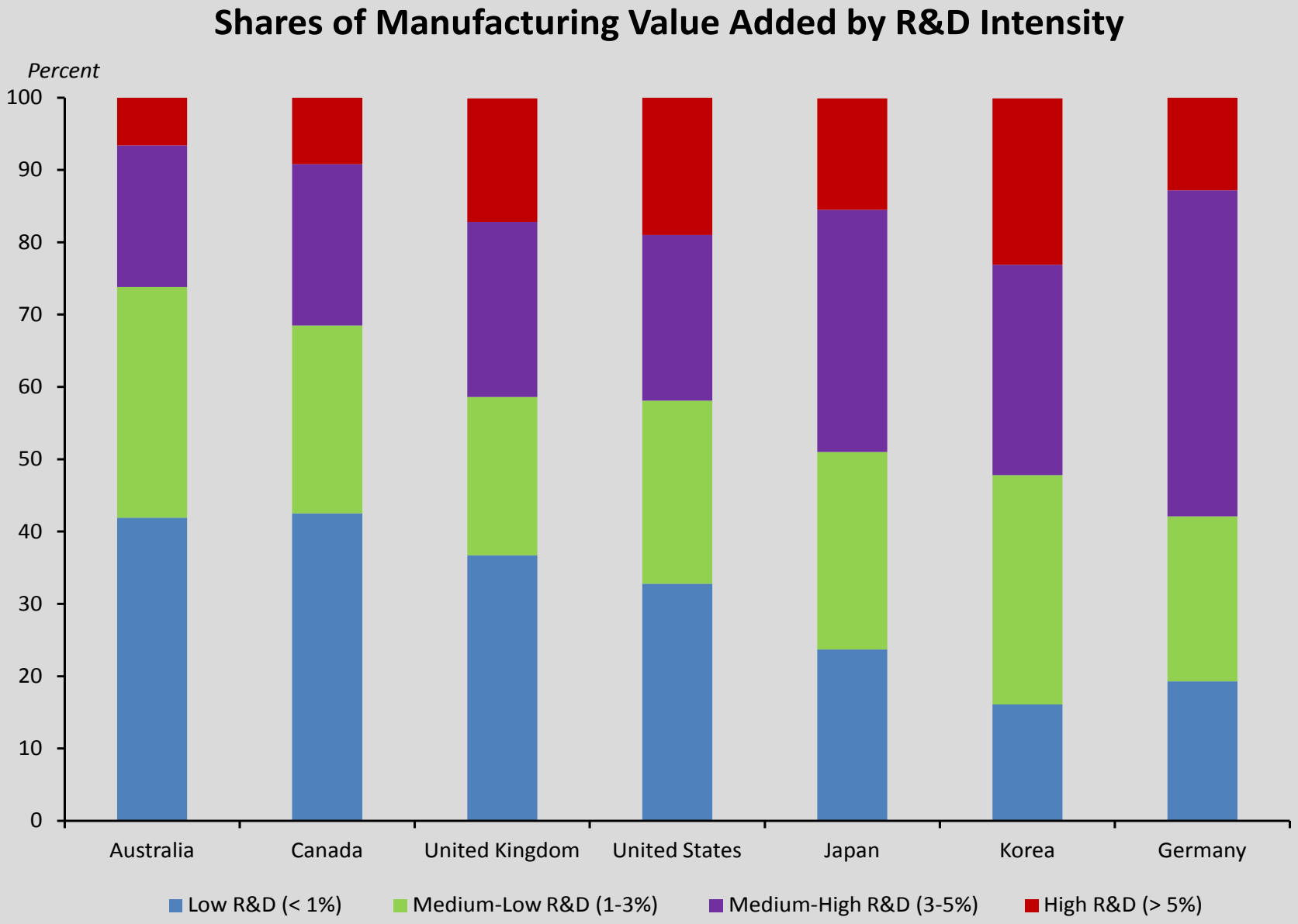
Source: OECD, *Main Science and Technology Indicators*, 2010.

Underinvestment – Amount of R&D



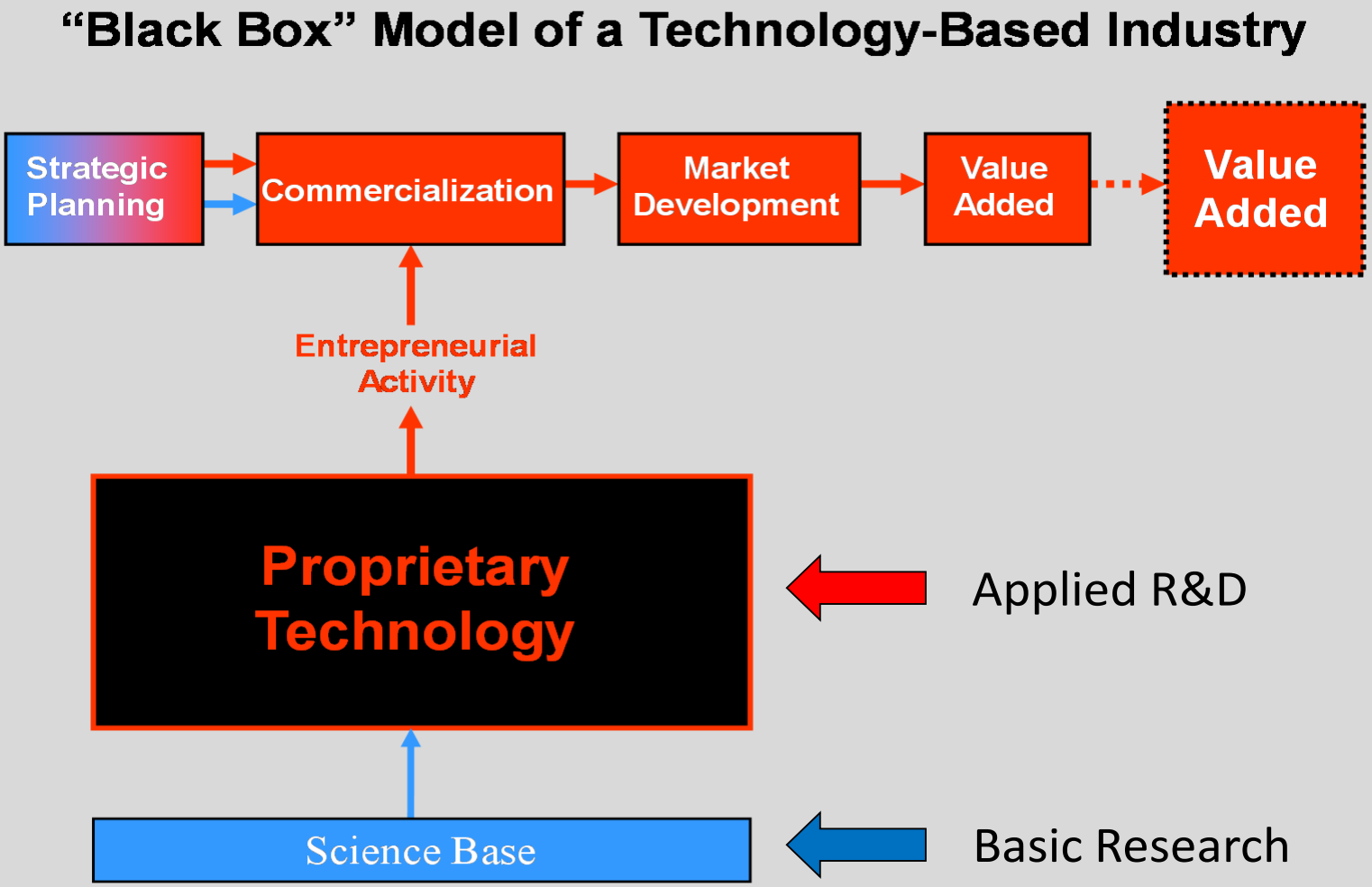
Source: Gregory Tassey, "Beyond the Business Cycle: The Need for a Technology-Based Growth Strategy," forthcoming. Data from OECD, *Main Science and Technology Indicators*, 2010/1.

Underinvestment – Amount of R&D



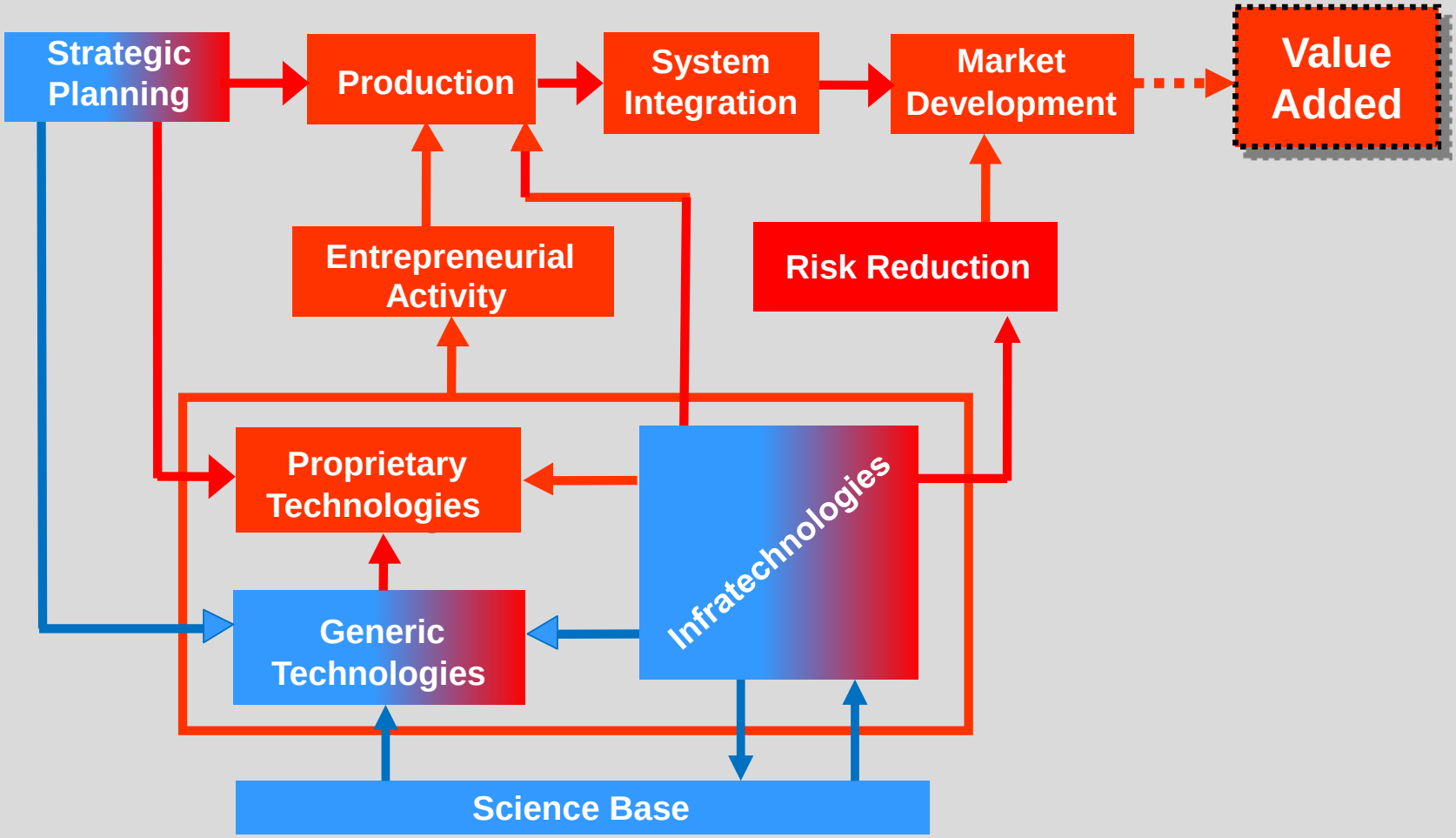
Stephen Ezell and Robert Atkinson (2011), *International Benchmarking of Countries' Policies and Programs Supporting SME Manufacturers*. Washington: DC: Information Technology and Innovation Foundation, September. Data from OECD, "Industry and Services STAN Database: "Value-added shares relative to manufacturing," http://stats.oecd.org/index.aspx?r=228903

Identifying Underinvestment – Technology-Element Growth Model



Gregory Tassey, *The Technology Imperative*, 2007; and, "The Disaggregated Technology Production Function: A New Model of Corporate and University Research*", Research Policy*, 2005.

Economic Model of a Technology-Based Industry



Gregory Tassey, *The Technology Imperative*, 2007; and, "The Disaggregated Technology Production Function: A New Model of Corporate and University Research", *Research Policy*, 2005.

Application of the Technology-Element Model: Biotechnology

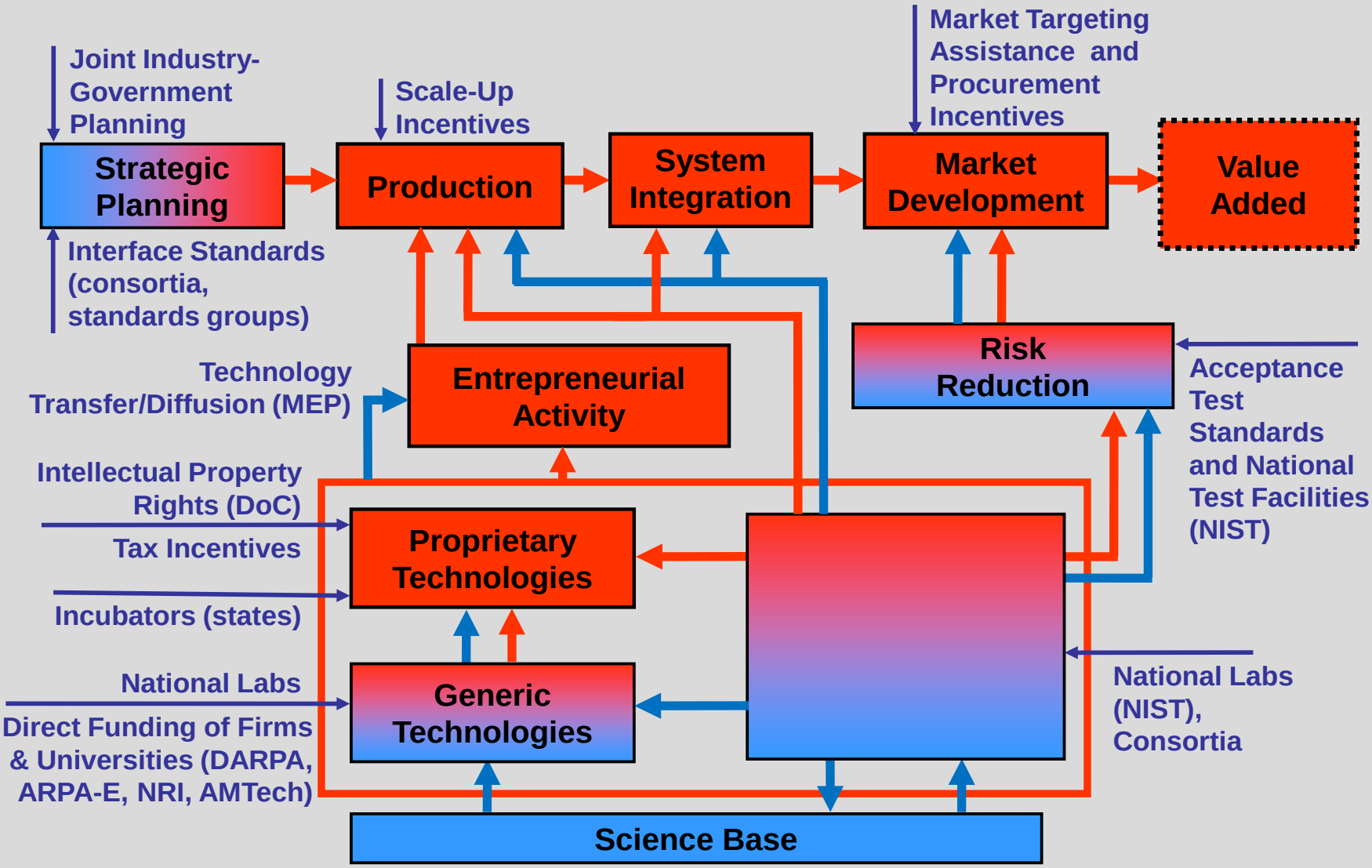
Science Base	Infratechnologies	Generic Technologies: Product	Generic Technologies: Process	Commercial Products
▪ genomics ▪ immunology ▪ microbiology/ virology ▪ molecular and cellular biology ▪ nanoscience ▪ neuroscience ▪ pharmacology ▪ physiology ▪ proteomics	▪ bioinformatics ▪ bioimaging ▪ biomarkers ▪ combinatorial chemistry ▪ DNA sequencing and profiling ▪ electrophoresis ▪ fluorescence ▪ gene expression analysis ▪ magnetic resonance spectrometry ▪ mass spectrometry ▪ nucleic acid diagnostics ▪ protein structure modeling & analysis techniques	▪ antiangiogenesis ▪ antisense ▪ apoptosis ▪ bioelectronics ▪ biomaterials ▪ biosensors ▪ functional genomics ▪ gene delivery systems ▪ gene testing ▪ gene therapy ▪ gene expression systems ▪ monoclonal antibodies ▪ pharmacogenomics ▪ stem-cell ▪ tissue engineering	▪ cell encapsulation ▪ cell culture ▪ microarrays ▪ fermentation ▪ gene transfer ▪ immunoassays ▪ implantable delivery systems ▪ nucleic acid amplification ▪ recombinant DNA/genetic engineering ▪ separation technologies ▪ transgenic animals	▪ coagulation inhibitors ▪ DNA probes ▪ inflammation inhibitors ▪ hormone restorations ▪ nanodevices ▪ neuroactive steroids ▪ neuro-transmitter inhibitors ▪ protease inhibitors ▪ vaccines



Gregory Tassey, *The Technology Imperative*, Edward Elgar, 2007

Policy Response

Managing the Entire Technology Life Cycle: Science, Technology, Innovation, Diffusion (STID) Policy Roles



Gregory Tassey, "Rationales and Mechanisms for Revitalizing U.S. Manufacturing R&D Strategies," *Journal of Technology Transfer 35* (2010): 283-333.

Emerging Targets of R&D Policy:

Amount of R&D

- Create financial incentives for private companies to increase investments in R&D and increase the R&D intensity of the manufacturing sector
- Increase Federal investment in research aimed at objectives relevant to private-sector R&D targets in addition to those related to agency missions

Composition of R&D

- Create incentives for private-sector investment in early phases of R&D cycle
- Create public-private partnerships to meet industry's long-term research needs through support for innovation clusters
- Fund research aimed at manufacturability to overcome scaling issues and target the "other" 90% of manufacturing value added (outside of NAICS 3345 and 3364)
- Eliminate barriers to investment in new and innovative technology-based firms (high technical risk, appropriability, and process-capability barriers)

Efficiency of R&D

- Improve R&D timing and content through road mapping and portfolio management techniques
- Increase rates of return and shorten the R&D cycle through technology clusters and other forms of collaboration
- Build in technology transfer through cluster design and IP management