

TRANSFORMATION AND OPPORTUNITY:



The Future of the U.S. Research Enterprise

Briefing to PCAST
July 18, 2012

Inventiveness and scientific curiosity are part of the American national character

- Americans are both fundamental discoverers and practical inventors. The two have always gone together.
 - U.S. industry has always invented things, not just produced them
 - Yankee watchmakers, Henry Ford's manufacturing revolution, Bell Labs, Xerox PARC, today's high-tech enterprises
 - Americans have won 330 Nobel Prizes, 40% of the world total
- Americans think that government investments in scientific research pay off in the long run (2009 Pew poll)
 - 73% for basic research, 74% for engineering and technology
 - Only small differences between Democrats and Republicans
 - Many studies by economists reach the same conclusion
 - Of 7-fold real growth since WW II, half is attributed to technological innovation
- Intangible benefits are also widely recognized
 - longer and healthier life spans
 - national and homeland security
 - resilience in an uncertain world
 - protecting the planet and feeding humanity
 - strengthening democracy and its ideals

Trends that motivate PCAST findings

- Long-term real growth in GDP
 - substantially fueled by R&D investment, as in the whole post-War period
- R&D investment has mostly grown in synch
 - about 2/3 done in industry
 - differences between 2.5% and 3% of GDP do matter, especially in the face of international competition
- Total basic research has also grown
 - but not so much in industry
 - yet it is the seed corn of the whole enterprise
- Conclusion (a dual message):
 - gov't and universities must ensure the quality and productivity of the basic research base
 - universities and industry must embrace new and better mechanisms for partnering and translation
- Universities are increasingly hubs of the innovation ecosystem



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PCAST Report: Five Key Opportunities

- **#1.** The Nation has the opportunity to **maintain its world-leading position in R&D investment**, structured as a mutually supporting partnership among industry, the Federal Government, and other governmental and private entities.
- **#2.** The Federal Government has the opportunity to enhance its role as the **enduring foundational investor in basic and early-applied research** in the United States. It can adopt policies that are most consistent with that role. Federal policy can seek to foster a sustainable R&D enterprise in which, when research is deemed worth supporting, it is supported for success.
- **#3.** Federal agencies have the opportunity to grow **portfolios that more strategically support a mix** of evolutionary vs. revolutionary research; disciplinary vs. interdisciplinary work; and project- vs. people-based awards.
- **#4.** There is the opportunity for government to create additional policy encouragements and **incentives for industry to invest in research**, both on its own and in new partnerships with universities and National Laboratories.
- **#5.** Research universities have the opportunity to strengthen and **enhance their additional role as hubs of the innovation ecosystem**. While maintaining the intellectual depth of their foundations in basic research, they can change their educational programs to better prepare their graduates to work in today's world. They can become more proactive in transferring research results into the private sector.

Actions for Key Opportunity #1

- **#1.** The Nation has the opportunity to **maintain its world-leading position in R&D investment**, structured as a mutually supporting partnership among industry, the Federal Government, and other governmental and private entities.
 - **#1.1** PCAST recommends reaffirming the President's goal that **total R&D expenditures should be 3 percent of GDP**. Congressional authorization committees should take ownership of pieces of that goal, with the Executive Branch and Congress establishing policies to enhance private industry's major share. (Section 4.1)
 - **#1.2** Recognizing its political difficulty, PCAST nevertheless urges Congress and the Executive Branch to find one or more **mechanisms for increasing the stability and predictability** of Federal research funding. Possibilities include a cross-agency multi-year program and financial plan akin to DoD's Future Years Defense Program (FYDP), or closer coupling of multiyear authorizations to actual appropriations for R&D. (Section 4.1)
 - **#1.3** The Research and Experimentation Tax Credit (usually called the **R&D tax credit**) needs to be made permanent. An increase in the rate of the alternative simplified credit from 14 percent to 20 percent would not be excessive. It also needs to be made more useful to small and medium enterprises that are R&D intensive by instituting either (i) refundable tax credits, (ii) transferable tax credits, or (iii) modifications in the definition of net operating loss to give advantage to R&D expenditures. (Section 4.2)
 - **#1.4** The Federal Government should adopt policies that **increase the productivity of researchers**, including more people-based awards, larger and longer awards for the best investigators, and administratively efficient grant mechanisms. (Section 4.3)

Actions for Key Opportunity #2

- **#2.** The Federal Government has the opportunity to enhance its role as the **enduring foundational investor in basic and early-applied research** in the United States. It can adopt policies that are most consistent with that role. Federal policy can seek to foster a sustainable R&D enterprise in which, when research is deemed worth supporting, it is supported for success.
 - **#2.1** The Federal Government should identify and achieve regulatory policy reforms, particularly as relating to the regulatory burdens on research universities. (Section 4.4)
 - PCAST substantially concurs with the AAU-APLU-COGR consensus list
 - **#2.2** The Federal Agencies should appropriately circumscribe the use of cost sharing. (Section 4.4)
 - Apply 2009 NSF cost-sharing reforms government-wide.

Actions for Key Opportunity #3

- **#3.** Federal agencies have the opportunity to grow **portfolios that more strategically support a mix** of evolutionary vs. revolutionary research; disciplinary vs. interdisciplinary work; and project- vs. people-based awards.
 - **#3.1** Each agency should have a strategic plan that explicitly addresses the different kinds of research activities that can contribute to its mission, specifically addressing the dimensions of **evolutionary vs. revolutionary research; disciplinary vs. interdisciplinary work; and project- vs. people-based awards.** (Section 4.5)
 - **#3.2** Each agency should **diversify its mechanisms for merit review** so as to be optimal for the portfolio in its strategic plan. (Section 4.5)
 - **#3.3** Each agency should adopt policies that increase the **agility** of funding new fields, unexpected opportunities, and the creativity of new researchers. (Section 4.5)
 - Increase funding for fellowships (including portable) and training grants
 - Fund more early career opportunities

Actions for Key Opportunity #4

- **#4.** There is the opportunity for government to create additional policy encouragements and **incentives for industry to invest in research**, both on its own and in new partnerships with universities and National Laboratories.
 - **#4.1** Improve **STEM education** so as to produce more and better home-grown researchers and technology entrepreneurs. (Section 5.1)
 - Two previous PCAST reports on STEM education recommend policy directions
 - **#4.2** Attract and retain, both for universities and industry, the world's **best researchers from abroad**. (Section 5.1)
 - Visa reform for high ability STEM graduates
 - **#4.3** Support the President's **Export Control Reform** initiative and further measures. (Section 5.2)
 - Reduce “deemed export” burdens on universities
 - Unleash U.S. firms to compete internationally
 - **#4.4** Enable **streamlined interactions between U.S. National Laboratories and industry**. (Section 5.3)
 - Actions needed by both laboratory leadership and sponsoring agencies

Actions for Key Opportunity #5

- **#5.** Research universities have the opportunity to strengthen and **enhance their additional role as hubs of the innovation ecosystem.** While maintaining the intellectual depth of their foundations in basic research, they can change their educational programs to better prepare their graduates to work in today's world. They can become more proactive in transferring research results into the private sector.
 - **#5.1** Maintain strong commitment to the **scope and intellectual depth of fundamental university research.** (Section 6.1)
 - Fundamental research provides the foundation for world-changing new industries
 - **#5.2 Augment the educational mission** to today's world. (Section 6.2)
 - Train for entrepreneurship and technology transfer
 - Prepare for national needs and grand challenges
 - Increase undergraduate research experiences
 - **#5.3** Embrace more fully the **additional role of universities as hubs** of the innovation ecosystem. (Section 6.3)
 - Technology licensing best practices
 - Proof of concept centers
 - Leadership in public-private partnerships
 - **#5.4** Confront difficult **career development and workforce issues**, including length of time to Ph.D. and the reliance of the S&T enterprise on the labor of early career training positions. (Section 6.4)

Recommendations “heritage” (1)

“Never recommend anything that hasn’t already been recommended.”

-- advice from a knowledgeable bureaucrat

- From the American Academy of Arts and Science’s 2007 *Advancing Research in Science and Engineering (ARISE)*:
 - Create or strengthen existing **large, multiyear awards for early-career faculty**.
 - Provide **seed funding for early-career faculty** to enable them to explore new ideas for which no results have yet been achieved.
 - Consider targeted programs, grant mechanisms, and policies— and adapt existing grant programs—to **foster transformative research**; establish metrics with which to evaluate their success.
 - **Strengthen the application and review processes**. High-risk research proposals face even greater challenges in a stressed peer-review system not equipped to appreciate them
 - Establish new research programs only if they have enough critical mass to **avoid fruitless grant-writing efforts**. Grant programs that fund a very small percentage of applications are inefficient uses of money, time, and effort.

Recommendations “heritage” (2)

- From the National Research Council’s 2012 *Research Universities and the Future of America*:
 - The federal government should **review and modify those research policies** and practices governing university research and graduate education that have become burdensome and inefficient, such as research **cost reimbursement, unnecessary regulation**, and awkward variation and coordination among federal agencies.
 - As a core component of a national plan to raise total national R&D funded by all sources to **3 percent of GDP**, Congress and the Administration should provide full funding of the amount authorized by the America COMPETES Act that would double the level of basic research conducted by NSF, NIST, and DOE Science as well as sustain our nation’s investment in other key areas of basic research, including biomedical research. Within this investment, as recommend by *Rising Above the Gathering Storm*, a portion of the increase should be directed to **high-risk, innovative, and unconventional research**.
 - The **relationship between business and higher education should evolve** into more of a peer-to-peer nature, stressing collaboration in areas of joint interest rather than the traditional customer-supplier relationship in which business procures graduates and intellectual property from universities.
 - Within the context of also **making the R&D tax credit permanent**, implement new tax policies that incentivize business to develop partnerships with universities (and others as warranted) for research that results in new US-located economic activities.
 - **Collaboration among research the nation’s national laboratories, business, and universities** should also be encouraged, since the latter’s capacity for large scale, sustained research projects both supports and depends critically on both the participation of university faculty and graduate students as well as the marketplace

Recommendations “heritage” (3)

- From AAU/APLU/COGR’s *Recommendations to the National Research Council on Regulatory and Financial Reform of Federal Research Policy*:
 - **Prohibit voluntary committed cost** sharing across the Federal government and create a mandatory cost sharing exemption for research universities.
 - Harmonize regulations and information systems between agencies and statutes where reasonable and **eliminate unnecessary duplication** and redundancy.
 - **Eliminate regulations which do not add value** or enhance accountability. At least two requirements, Effort Reporting and Cost Accounting Standards, neither add value nor enhance accountability.
 - Reinforce the original intent of the **Single Audit Act**.
- From Business Roundtable’s 2011 report *Action for America*:
 - Create a new **STEM green card** for foreign students who graduate from U.S. universities with advanced degrees in STEM fields.
 - Increase the standard **H-1B visa cap** and remove the cap for advanced degree holders so that all foreign nationals who receive a master’s degree or higher from a U.S. university can be eligible for an H-1B visa.
 - Make every feature of the reformed U.S. corporate **tax code permanent**, establishing the high-priority objective of eliminating corporate tax policy uncertainty.

Recommendations “heritage” (4)

- From the 2012 Report of the Biomedical Research Workforce working group of the NIH Advisory Committee to the Director:
 - To ensure that all graduate students supported by the NIH receive excellent training, NIH should **increase the proportion of graduate students supported by training grants and fellowships** compared to those supported by research project grants, without increasing the overall number of graduate student positions.
 - NIH should create a program to supplement training grants through competitive review to allow institutions to provide additional training and career development experiences to **equip students for various career options**, and test ways to shorten the PhD training period.
 - NIH should revise the **peer review criteria for training grants** to include consideration of outcomes of all students in the relevant PhD programs at those institutions, not only those supported by the training grant. Study sections reviewing graduate training programs should be educated to value a range of career outcomes. This recommendation could be phased in relatively quickly.
 - To **encourage timely completion of graduate degrees**, NIH should cap the number of years a graduate student can be supported by NIH funds (any combination of training grants, fellowships, and research project grants), with an institutional average of 5 years and no one individual allowed to receive support for more than 6 years. ... NIH should continue to **assess the pre-doctoral stipend level** annually.