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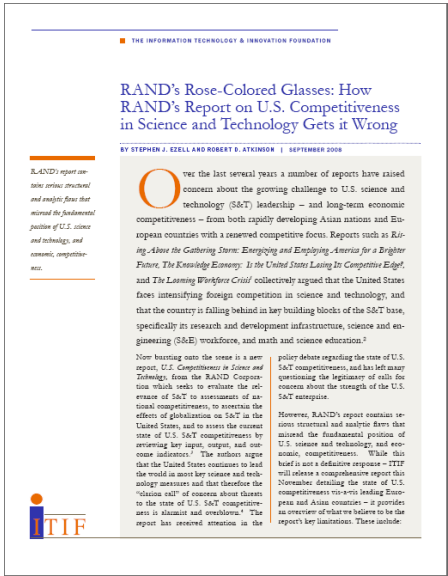
ITIF Forum: Is the United States Falling Behind in Science & Technology or Not?

September 10, 2008

Moderator: Rob Atkinson, President, ITIF
Presenter: Stephen Ezell, Senior Analyst, ITIF
Panelists: Clyde Prestowitz, President, Economic Strategy Institute
Kent Hughes, Director, Woodrow Wilson International Center for Scholars



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RAND's Rose-Colored Glasses: How RAND's Report on U.S. Competitiveness in Science and Technology Gets it Wrong

BY STEPHEN J. EZELL AND ROBERT D. ATKINSON | SEPTEMBER 2008

RAND's report contains serious structural and analytic flaws that misread the fundamental position of U.S. science and technology, and economic competitiveness.

Over the last several years a number of reports have raised concern about the growing challenge to U.S. science and technology (S&T) leadership – and long-term economic competitiveness – from both rapidly developing Asian nations and European countries with a renewed competitive focus. Reports such as *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Future*, *The Knowledge Economy: Is the United States Losing Its Competitive Edge?*, and *The Looming Workforce Crisis*[1] collectively argued that the United States faces intensifying foreign competition in science and technology, and that the country is falling behind in key building blocks of the S&T base, specifically its research and development infrastructure, science and engineering (S&E) workforce, and math and science education.[2]

Now bursting onto the scene is a new report, *U.S. Competitiveness in Science and Technology*, from the RAND Corporation which seeks to evaluate the relevance of S&T to assessments of national competitiveness, to ascertain the effects of globalization on S&T in the United States, and to assess the current state of U.S. S&T competitiveness by reviewing key input, output, and outcome indicators.[3] The authors argue that the United States continues to lead the world in most key science and technology measures and that therefore the "clarion call" of concern about threats to the state of U.S. S&T competitiveness is alarmist and overblown.[4] The report has received attention in the policy debate regarding the state of U.S. S&T competitiveness, and has left many questioning the legitimacy of calls for concern about the strength of the U.S. S&T enterprise.

However, RAND's report contains serious structural and analytic flaws that misread the fundamental position of U.S. science and technology, and economic competitiveness. While this brief is not a definitive response – ITIF will release a comprehensive report this November detailing the state of U.S. competitiveness vis-à-vis leading European and Asian countries – it provides an overview of what we believe to be the report's key limitations. These include:

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RAND's *U.S. Competitiveness in Science and Technology* Report

1. Examines whether the *Clarion Call* of concern about U.S. S&T competitiveness is warranted, assessing whether:

   A. Past calls for concern were justified.

   B. Concern about S&T competitiveness is misguided anyway, because countries don't compete; only their companies do.

2. Considers whether the globalization of innovation is likely to be an asset or a threat to U.S. S&T leadership.

3. Examines where the U.S. stands in key building blocks of the S&T base: R&D, patents, scientific publications, education, workforce.

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RAND's *U.S. Competitiveness in Science and Technology* Report

Some press coverage has interpreted RAND's report to suggest that worries of U.S. S&T competitiveness are overblown.

- Overlooks that the authors themselves discuss the need to implement or extend certain U.S. S&T policies.
- Makes no serious evaluation of the arguments presented in the report.

Economist.com WORLD UNITED STATES

Innovation

What crisis?

Jun 12th 2008 | WASHINGTON, DC
From The Economist print edition

Worries that America is losing its edge in science and technology are overblown

"THE wolves have not encircled us yet," the *Denver Post* opined in an article in 2006 entitled "Signs America's Scientific Edge is Slipping", "but there's no denying the sounds of scratching at the door."

This was a pithy summary of a mountain of reports from congressional committees, scientific panels and business groups. But a new report from the RAND Corporation's National Defence Research Institute, "US Competitiveness in Science and Technology", suggests that the panic is overblown.

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Weaknesses in RAND's *U.S. Competitiveness in Science and Technology* Report

Conceptual

1. Provides an incomplete historiography of U.S. S&T policy development.
2. Misreads the nature of global competition.

Methodological

3. Under-emphasizes some very worrying results.
4. Cites incomplete metrics.
5. Does not base analysis on the most recent data.

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Provides an Incomplete Historiography of U.S. S&T Policy Development

Previous S&T and competitiveness challenges to the U.S. were in fact real.

They were met head-on with proactive reforms to U.S. S&T policies that have been instrumental in sustaining U.S. S&T pre-eminence.

1960s – USSR/Sputnik:

- Implemented National Defense Education Act (NDEA)
- Dramatically expanded federal R&D funding

1980s and early 1990s – Competitiveness Challenges from Japan and Europe met by:

- Enacting the Stevenson-Wydler Technology Innovation Act (1980)
- Passing Bayh-Dole Act
- Creating the Advanced Technology and Manufacturing Extension Programs (ATP & MEP)
- Launching SEMATECH
- Establishing the Malcolm Baldridge Quality Award
- Implementing an R&D tax credit (the world's most generous at the time)
- Etc.

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Misreads the Nature of Global Competition:

Suggests That Countries Don't Compete; Only Their Companies Do

Quotes Paul Krugman: "***The idea that nations 'compete' is incorrect; countries are not like corporations and are not to any important degree in economic competition with each other.***"

But this argument:

- Underestimates the importance that high value-added output provides to an economy, especially through spillover effects.

- Focuses mostly on the growth effect (across-the-board productivity growth), undercounting the mix effect (shifts in the mix of establishments towards more productive ones) because a pre-dominant share of high value-added sectors are in traded IT or technology jobs.

- Reflects the bias of, "Computer chips…potato chips…what's the difference?"…That what a country makes does not matter so it can be indifferent to its mix of industrial value-add.

Misreads the Nature of Global Competition:

Globalization May Well Be a Threat to U.S. S&T Competitiveness

In assessing globalization's impact on U.S. S&T, the authors favor an analysis which posits that the U.S. has a comparative advantage in S&T (esp. in R&D), so that we're likely to retain it and benefit as global demand for R&D increases.

The evidence suggests that this may be a risky proposition:

- From 1998-2003, the share of U.S. corporate R&D sites located in the U.S. declined from 59% to 52%.
- Over the same time period, the share of U.S. corporate R&D sites located in China and India increased from 8% to 18%.
- The U.S. share of worldwide domestic R&D investment decreased from 46% in 1986 to 37% in 2003.
- That R&D stays on-shore while manufacturing off-shores is no longer a safe assumption.

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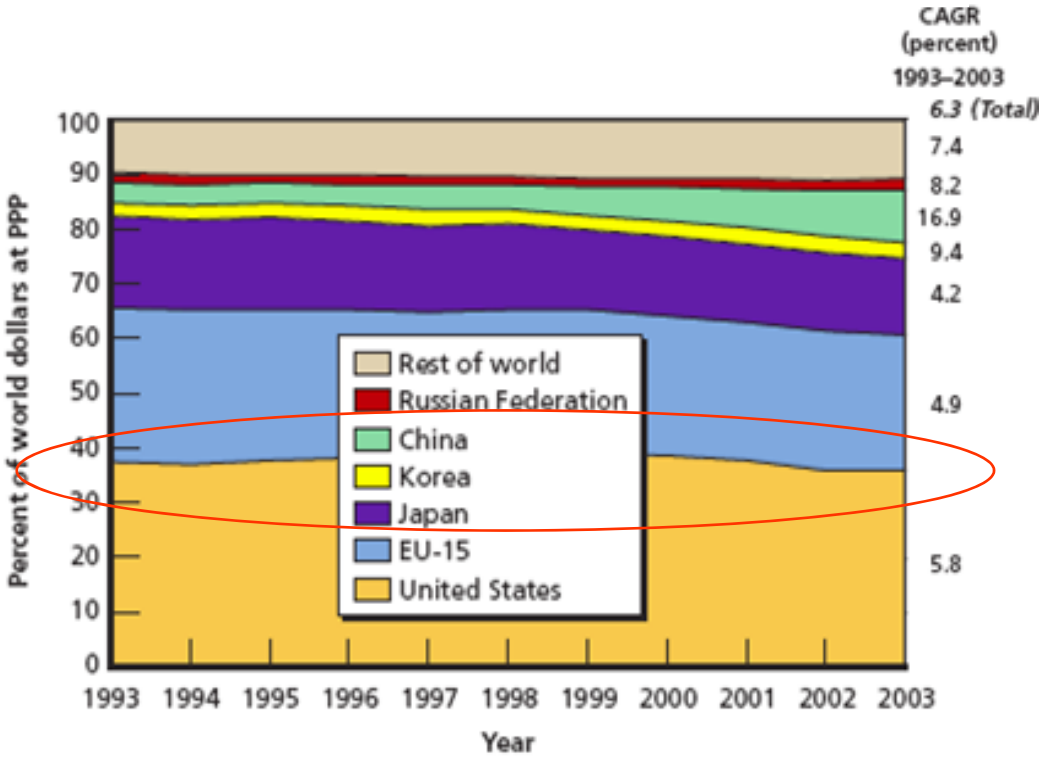
Under-emphasizes Some Very Worrying Results: U.S. R&D Expenditures

The authors argue that "***other nations/regions are not significantly outpacing the U.S. in R&D expenditures***."

However:

- Whereas U.S. total R&D investment represented an *increasing share* of global R&D from 1993 to 1998, the U.S. share has been *weakening* since then.
- An initially *upward* trend has been replaced with a *downward* trend.

Figure 2.2
R&D Funding in Current Dollars at PPP (1993–2003) as Percentage of World Total



SOURCE: OECD (2006b, 2006c).

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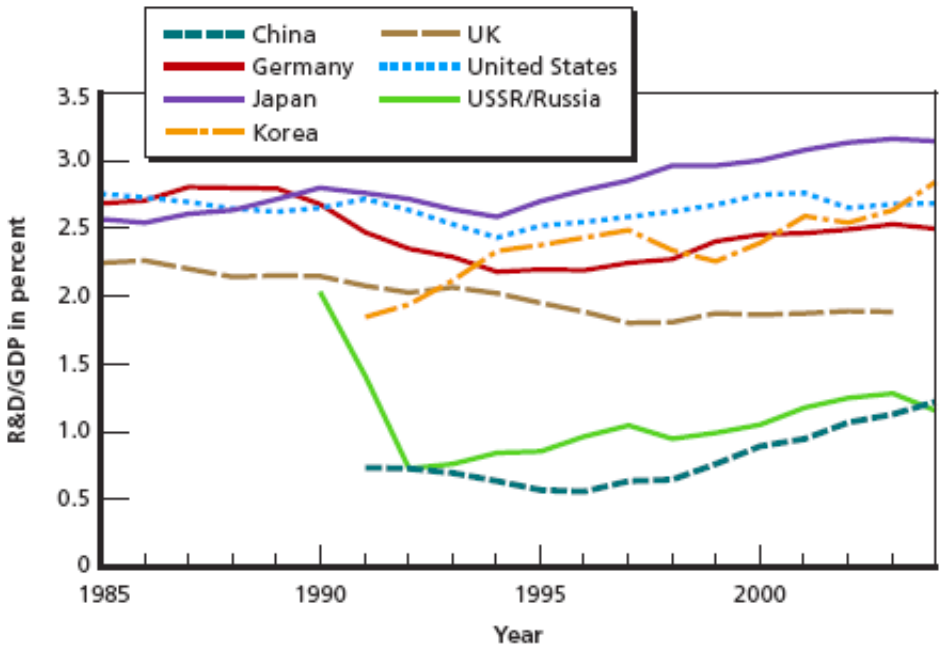
Under-emphasizes Some Very Worrying Results: U.S. R&D Intensity

The authors assert that U.S. R&D intensity is strong compared to peer countries.

Figure 2.3
R&D Intensity: Gross Domestic Expenditure on R&D as Percentage of Gross Domestic Product, 1985–2005



SOURCE: Reproduced from Eaton and Kortum (2007); OECD (2006b, 2006c). Used with permission.

However:

- While most peer countries exhibit *increasing* trends of R&D intensity, U.S. levels have *decreased* then *flattened out*.
- Japan is ahead; South Korea has passed us.
- Omits analysis of rest of world, including world leaders such as Finland, Taiwan, and Singapore.

In Fact:

- Recent OECD rankings place the U.S. only 22nd in the fraction of GDP devoted to nondefense R&D.

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Under-emphasizes Some Very Worrying Results: Importance of Decrease in Federal R&D Funding

The authors define away the slow growth of federal R&D spending, arguing that corporate R&D will likely compensate for reduced federal R&D investment:

- They note that federal R&D investment only accounts for about 30% of aggregate U.S. R&D investment (e.g. $86B of $288B in 2004).

- However, from 1999-2003, corporate-funded R&D investment as a share of GDP fell in the United States by 7%, while in Europe it grew by 3% and in Japan by 9%.

The authors concede that:

- ***"The low level of funding for the physical sciences raises the possibility that they are being underfunded***," with ramifications including that, "***the United States' premier position in condensed-matter and material physics is in jeopardy***."

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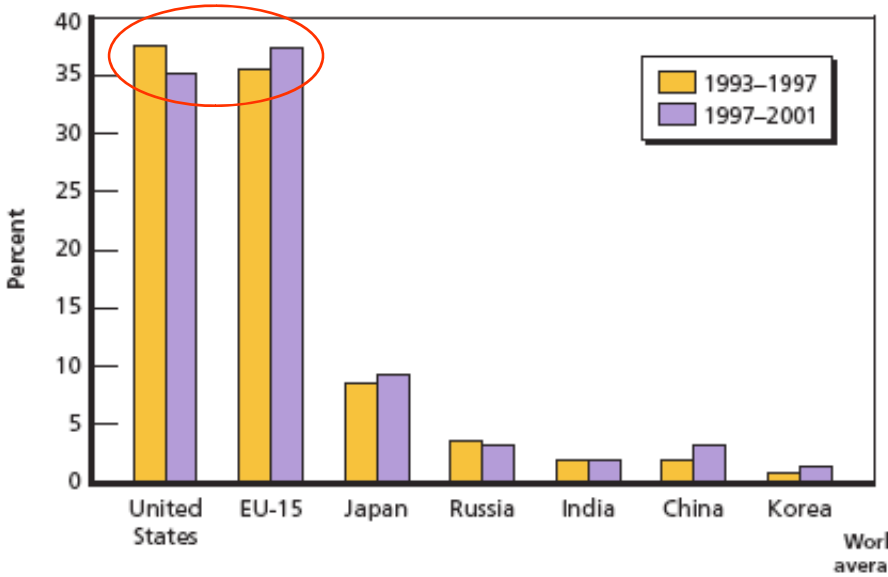
Under-emphasizes Some Very Worrying Results: U.S. Share of Scientific Publications

The U.S. Share of World S&T Publications, Share of World S&T Citations, and Share of 1% Most-Cited Publications all fell in the years 1997-2001 compared to 1993-1997.

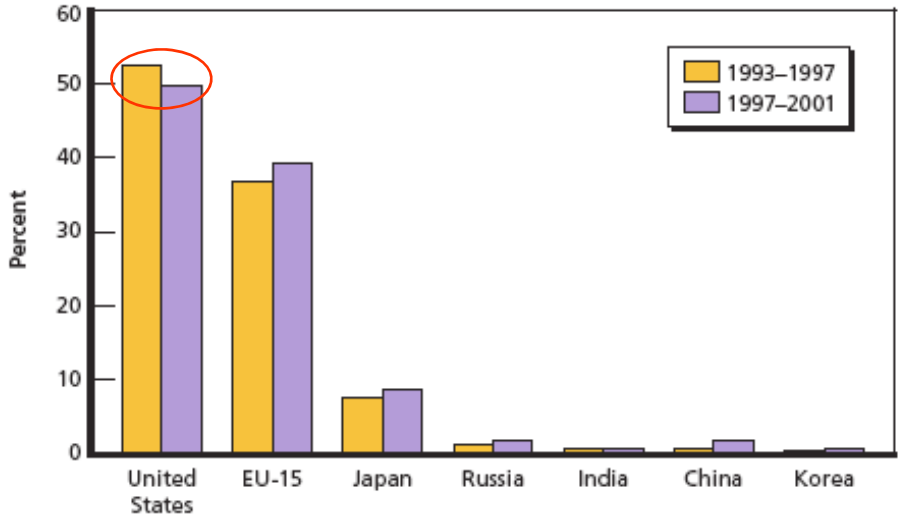
Figure 2.7
Share of World S&T Publications



	United States	EU-15	Japan	Russia	India	China	Korea	World average
CAGR (percent)	0.3	3.3	3.8	0.4	1.4	13.9	20.0	2.2

SOURCE: King (2004).

Figure 2.8
Share of World S&T Citations



SOURCE: King (2004).

- U.S. growth in overall scientific publications was basically flat from 1993-2001.
- The U.S. has ceded its leading position in World Share of S&T Publications to the EU-15.

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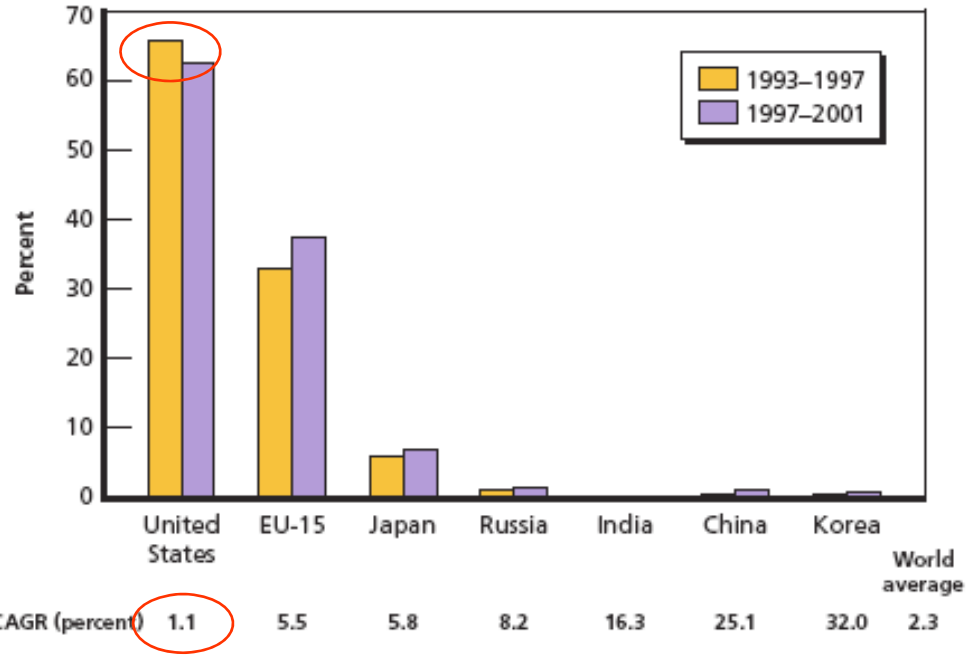
Under-emphasizes Some Very Worrying Results: U.S. Share of Scientific Publications

Note also the anemic growth rates:

- At 1.1%, the U.S. growth rate in top 1 percent most-cited publications was half the world average and well below the performance of Japan and the EU-15 countries.

Figure 2.9
Share of World's Top 1 Percent Most-Cited S&T Publications



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Under-emphasizes Some Very Worrying Results:

U.S. Education and Academic Performance in Science & Technology, K-12

- U.S. annual expenditures for K-12 students are the second highest in the world; The results are not.

- U.S. 15-year-olds ranked 24th in mathematics literacy and 19th in science literacy out of 29 OECD countries in the 2006 Program for International Student Assessment (PISA).

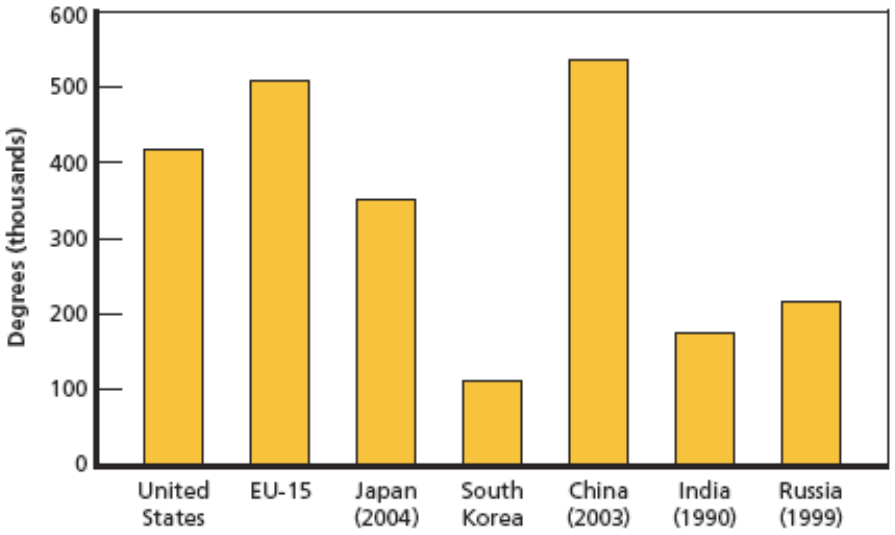
- The authors note that, "***The relatively poor performance of U.S. students has been a persistent aspect of the U.S. education system***," going back to 1964.

- In general, U.S. students are behind as they enter more advanced collegiate courses in science and technology. As the authors acknowledge, ***"U.S. students are not as well prepared for careers in science and engineering,"*** straining the long-term pipeline for development of domestic S&E talent in the U.S.

Under-emphasizes Some Very Worrying Results: Science and Engineering Graduates

- RAND's data shows that the U.S. lags most peer countries in growth rates of S&E graduates.
- The authors acknowledge, ***"Regardless of the differences in the numbers reported, various sources consistently find that the EU and China graduate more scientists than the U.S. does."***
- Sixty percent of engineering PhDs U.S. universities award go to foreigners.
- This translates directly into increased reliance on foreign-born S&E talent in the workforce.

Figure 2.5
First University Degrees in S&E, 2002



SOURCE: National Science Board (2006a; Table 2-37; CAGR from Table 2-38).

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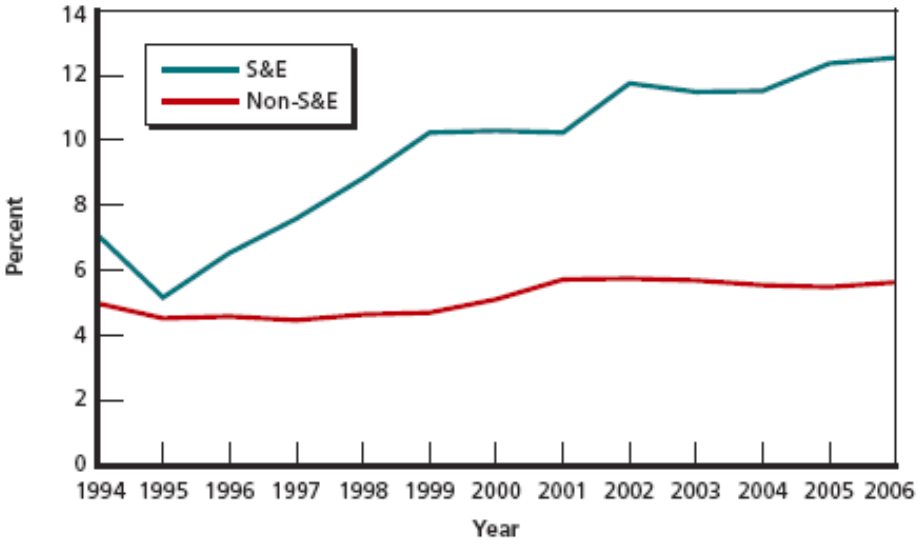
Under-emphasizes Some Very Worrying Results: U.S. Science and Engineering Workforce

- The percentage of non-U.S. citizens in the S&E workforce doubled from 6% to 12% between 1994 and 2006. 20% of the younger S&E cohort (ages 21-35) are foreign born.
- Authors: ***"The U.S. is likely to be worse off if foreign access to U.S. graduate education and S&E jobs is limited."***
- Thus, the U.S. has become increasingly dependent on a foreign-born S&T workforce at precisely the same time it has severely restricted the immigration of talented foreign labor into the workforce.

Figure 3.20

Percentage of Non-U.S. Citizens (Bachelor's Degree or Higher)



SOURCE: RAND analysis of Current Population Survey data (for details, see the appendix).

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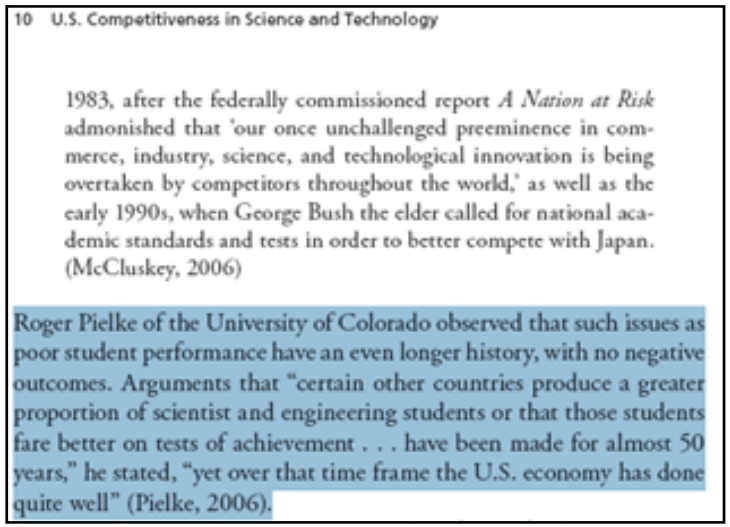
What Does Poor U.S. Academic Performance in Math and Science Imply for U.S. Competitiveness?

The authors note that some have questioned the relevance and impact of sustained poor student performance and lagging production of S&T professionals on U.S. economic performance:

Such issues as poor student performance have an even longer history, with no negative outcomes. Arguments that 'certain other countries produce a greater proportion of scientists and engineering students or that those students fare better on tests of achievement...have been made for almost 50 years, yet over that time frame the economy has done quite well.'

The U.S. economy has performed quite well over the past fifty years, for many reasons, one of the largest being U.S. dominance of the global economic landscape Post WWII.

But widening income inequality gaps, unemployment at the highest rate in five years, persistent deficits on the order of $700B annually over the past three years, a trade deficit of $53B in advanced high technology products, and ceding a century-long position as the world's largest manufacturer, suggests that there is at least opportunity to deploy policies that could help improve the performance of the U.S. economy.



10 U.S. Competitiveness in Science and Technology

1983, after the federally commissioned report *A Nation at Risk* admonished that 'our once unchallenged preeminence in commerce, industry, science, and technological innovation is being overtaken by competitors throughout the world,' as well as the early 1990s, when George Bush the elder called for national academic standards and tests in order to better compete with Japan. (McCluskey, 2006)

Roger Pielke of the University of Colorado observed that such issues as poor student performance have an even longer history, with no negative outcomes. Arguments that "certain other countries produce a greater proportion of scientist and engineering students or that those students fare better on tests of achievement . . . have been made for almost 50 years," he stated, "yet over that time frame the U.S. economy has done quite well" (Pielke, 2006).

Moreover, in an increasingly knowledge-based economy, the strength of educational systems becomes a key determining factor in national S&T competitiveness.

Maintaining status quo policies on the notion that "we've faired quite well so far" can simply no longer be an adequate basis for policy making.

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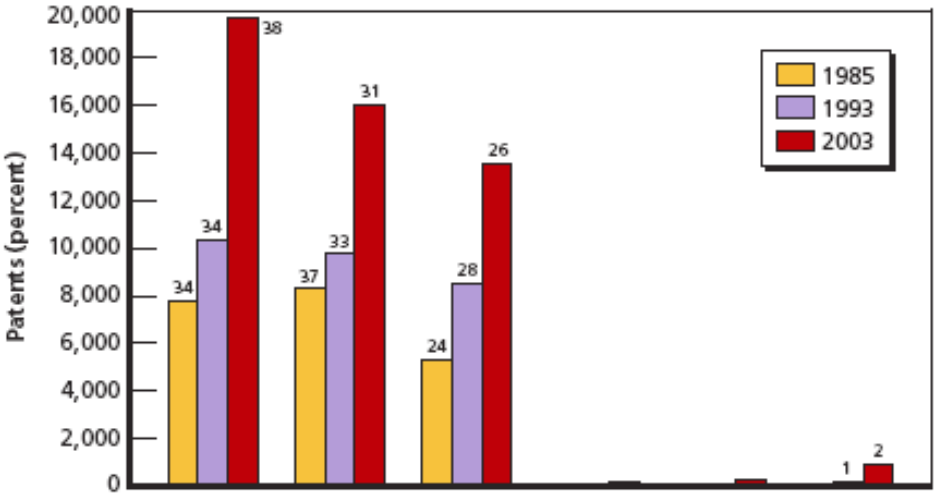
Cites Incomplete Metrics: U.S. Patent Activity

- The authors assert that the United States accounts for 38% of industrialized nations' (OECD countries') triadic patents in 2003, a proxy of U.S. strength in S&T.
- But many are business method patents. The authors permit that, "***The large increase in triadic patents [from 1993-2003] could reflect increased use of patents as part of legal and business strategies.***"
- So tenuous were many of these patents that patent litigation in the U.S. rose by 120% from 1990 to 2005. This actually imposes a significant tax on the U.S. innovation system, and has contributed to U.S. companies spending three times more on total litigation than on R&D in 2006.
- Nearly 60% of the patents filed with the U.S. PTO in the field of information technology now originate from Asia.

Figure 2.6
Triadic Patents in 1985, 1993, and 2003, by Nation/Region



CAGR (percent)	United States	EU-15	Japan	Russia	China	Korea	OECD
1985–2003	5.3	3.7	5.3	6.2	10.6	29.5	4.8
1993–2003	6.6	5.1	4.9	7.7	28.5	17.9	5.7

SOURCE: OECD (2006b, 2006c); see also Eaton and Kortum (2007).
NOTES: Numbers above bars denote percentages of OECD triadic patents; triadic patent families are a set of inventions that are patented broadly in the United States, Europe, and Japan.
RAND MG674-2.6

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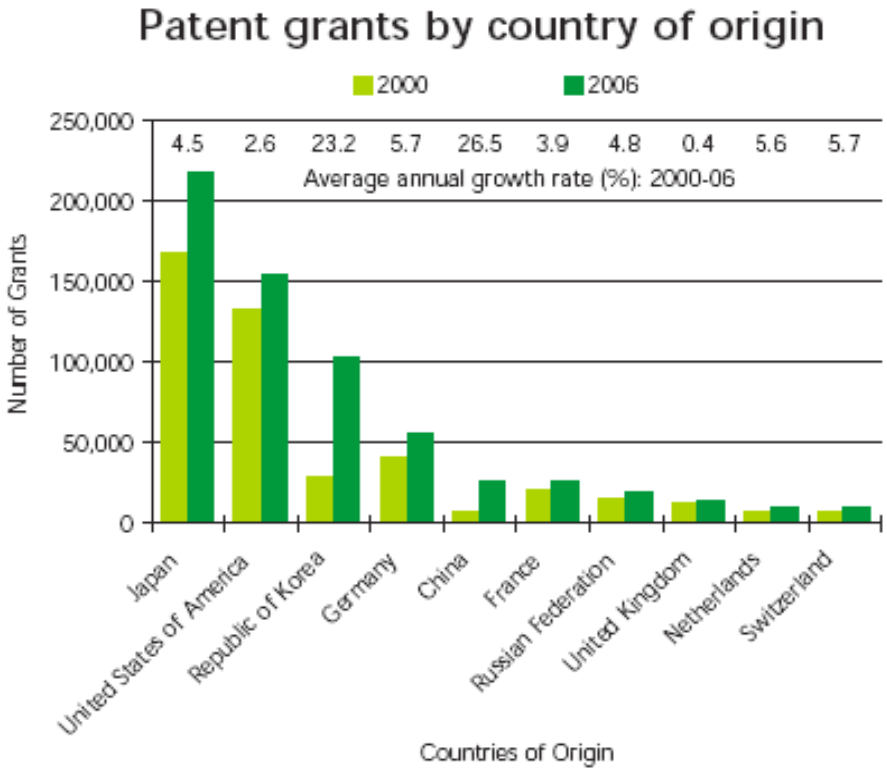
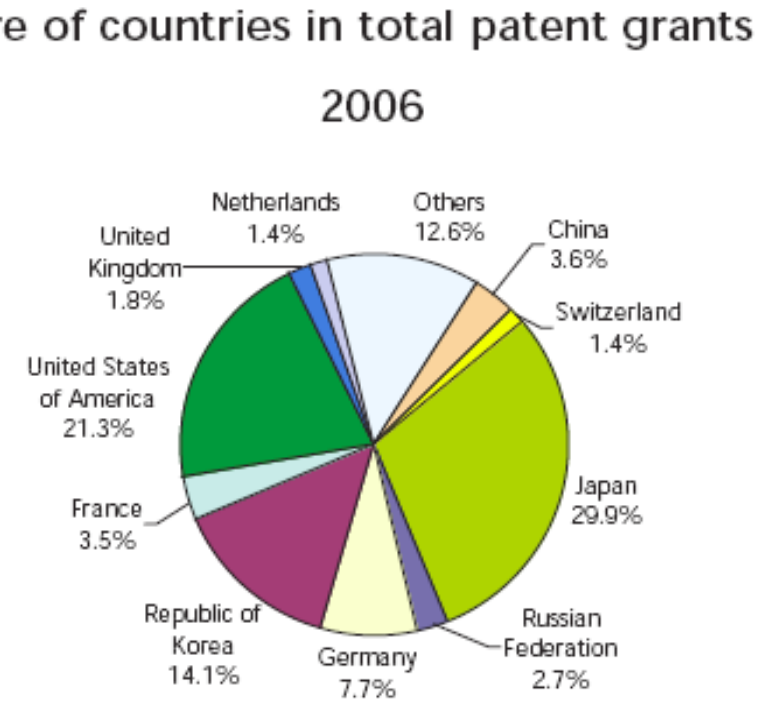
Cites Incomplete Metrics: U.S. Patent Activity (ctd.)

Other metric of patent activity would not necessarily place the United States in the lead.





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Source: World Patent Report 2008, A Statistical Review. See http://www.wipo.int/export/sites/www/ipstats/en/statistics/patents/pdf/wipo_pub_931.pdf , page 22.

Cites Incomplete Metrics

The authors fail to include a number of key metrics that would present a differing picture of U.S. economic competiveness as a consequence of U.S. performance in S&T, including that:

- The United States persists in running a current account deficit of $700B.
- The United States runs a $53B annual deficit in advanced technology products.
- The United States in 2009 will cede its status as the world's largest manufacturer, a position it has held for over a century.[1]

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[1]Source: "China to overtake U.S. as largest manufacturer," *The Financial Times* 10 Aug 2008 <www.ft.com/cms/s/0/2aa7a12e-6709-11dd-808f-0000779fd18c.html?nclick_check=1>

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Data Presented Does Not Adequately Reflect Current Reality

The authors' use of time-series data sets – generally reflecting the years 1993-2003 – are not adequately reflective of the competitive challenge that has emerged since 2000 and do not satisfactorily depict the competitive landscape as it exists in mid-2008.

- The ability to perform and the reality of intensive R&D offshoring really arose post-2000.
- Many countries have implemented competitiveness and innovation programs post-2005.

E.g. In January 2006, China launched its 15-year "Medium- to Long-term Plan for the Development of Science and Technology."

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Conclusions

- The United States does continue to lead the world in S&T competitiveness.
  But that's not the central question, which is: Are current U.S. policies and approaches sufficient to sustain that lead amidst stiffening international competition?

- While the sky is not falling, the U.S. lead in many key building blocks of the S&T base is clearly slipping – and in several cases has disappeared altogether.

- Previous challenges to U.S. S&T pre-eminence – from Russia in the 1960s and Japan and Europe in the 1980s – were in fact real, and met head-on with proactive science and technology policies that were instrumental in maintaining the United States' leading position.

- The current challenge is also real – and evidence is showing up in the form of trade deficits, loss of manufacturing leadership, and reduced levels of economic growth.

- Calls for concern about U.S. S&T competitiveness are valid, and the impetus to put in place robust national competitiveness and innovation strategies is not only warranted, but required.

- The U.S. government should take an active role in safeguarding U.S. leadership in S&T, and keeping it at least *on par*, if not *ahead*, of other advanced and rapidly developing countries.