Competitiveness Through Basic Research Investments

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With the federal budget running a large deficit, scientists' call for more research funding must be more than just "science is good for society." As I discussed in June's article, the message must be why we can't afford to *not* increase research funding. Competitiveness meets that criterion—at least for the statistical, mathematical, and physical sciences—because it is about jobs, particularly those with good salaries and benefits at the heart of our innovation economy.

The basic thesis of the competitiveness argument is that other countries are rapidly building their science and technology (S&T) infrastructure for an innovation economy while the United States remains complacent. There are many indicators that support this thesis, and the following simple model of an innovation economy ties them together and illustrates the extent of the United States' competitiveness challenges.

One may think of our innovation economy as a pyramid, with prosperity being the apex. The foundation of the pyramid is new ideas—or discovery—out of which comes new products and the new jobs to manufacture, market, and distribute the new products. A fundamental strength of the U.S economy is how dynamic it is: We are constantly creating new jobs, with 'old' jobs being offshored, or simply dissolved. Jobs exist now that one wouldn't have imagined 10 years ago. Looking back to the turn of the 20th century, a third of all U.S. jobs were agricultural, a fraction that has since shrunk to less than 1%.

While there are many facets to keeping the generation of new jobs healthy and our economy prosperous, we must ensure that the base is vibrant; basic research is fundamental to that end. Indeed, it is widely accepted on Capitol Hill that 30%–50% of our economic growth since World War II can be attributed to technical advances.

Graphic by Don Engel

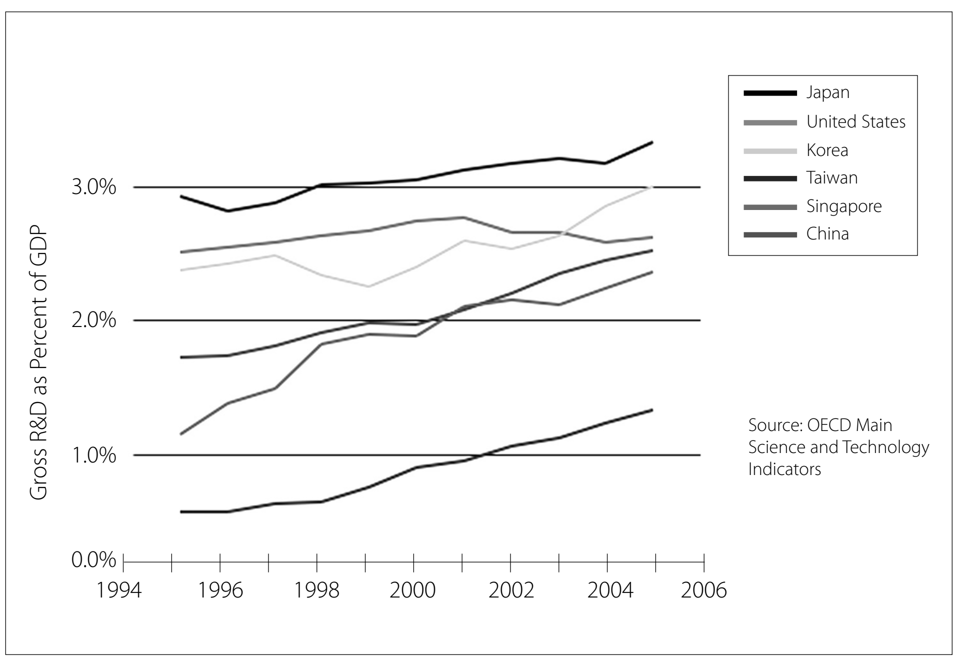
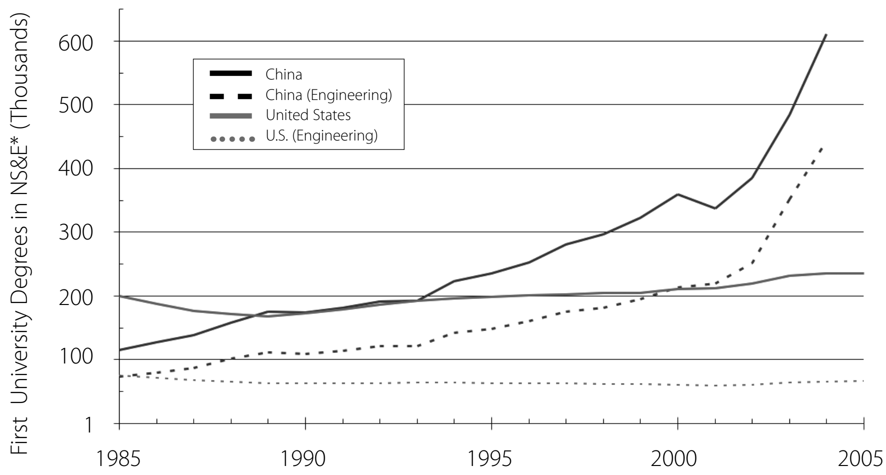
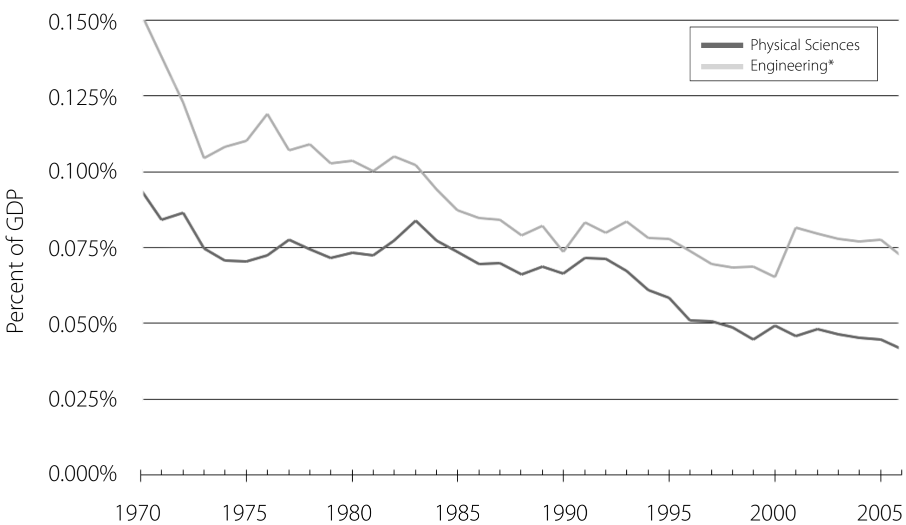


Figure 1. Asian countries building their R&D investments



*NS&E degrees include natural (physical, biological, Earth, atmospheric, and ocean sciences), agricultural, and computer sciences, statistics, mathematics, and engineering. Missing U.S. 1999 data approximated by 1998 data. Source: 2008 NSF Science and Engineering Indicators

Figure 2. Undergraduate degrees: China on rapid assent; U.S. stagnant



*The 2001 jump in engineering is due to reclassification of funding and is therefore artificial.
Source: American Asssociation for the Advancement of Science

Figure 3. Federal investment in physical sciences and engineering research in significant decline

Consider some inputs for the New Ideas base. Certainly, research funding supports the generation of new ideas. But, it also takes people. Figures 1 and 2 illustrate the rapid build-up of inputs to the New Ideas base that other countries have experienced. The first chart is the percentage of the GDP spent by the public and private sectors on research and development. The U.S. portion is flat, while selected Asian countries are on a rapid rise. A similar story is seen in the next chart for the production of scientists and engineers through undergraduate degrees for natural sciences and engineering in China and the United States. Indeed, the same trends exist for doctorate degrees in these fields.

If one looks at only federal funding for statistical, mathematical, and physical science and engineering research as a ratio of the GDP, one sees that the United States now invests only half the proportion it did in 1970 (see Figure 3). If one accepts the simple model for the innovation economy where basic research funding is a fundamental component, then we should grow our basic research funding in some proportion to our economic growth.

There are two simple measures of outputs of the New Ideas base, science and engineering (S&E) articles and U.S. patent applications, where, again, one sees a similar trend of flat or modestly increasing U.S. values versus rapid increases for Asian countries (see Figure 4 and 5). The patents data show a more hopeful picture than some of the other charts in that the U.S. number is rising, and, in fact, the United States has maintained a steady majority for the past 20 years. But, one must keep in mind that these are U.S. patent applications and therefore not a good world measure. Further, one can be sure a significant proportion of the U.S. applicants are foreign born.

Moving up the pyramid to New Products, there are many indicators of the growing production of high-tech products by other countries. My June article had charts showing that our advanced technology product trade balance has suffered a $100 billion swing to a $55 billion deficit in 2007, and our world share of high-tech exports has shrunk from 29% in 1980 to 12% in 2005. Indeed, walking in to a consumer electronics store also confirms this trend—cell phones from China and Finland, flat-screen TVs from Korea, digital cameras from Japan …

At the New Jobs pyramid level, the terms "off-shore outsourcing" and "high-tech" started appearing frequently in the news four to five years ago with such blue-chip companies as IBM, Honeywell, Intel, and Xerox. Some might say the United States can never compete with the low salaries in other countries, but one prominent study indicates the availability of talent is the single biggest factor for companies considering the location of its next R&D or high-tech production facility. Further, my high-tech industry counterparts tell me it is not a question of whether their company will survive in the fiercely competitive global market, but whether they will survive in the United States.

Statistics plays an important role in the innovation economy pyramid at many levels. The 2004 report "Statistics: Challenges and Opportunities for the Twenty-First Century" documents many of these. Total quality management, Six Sigma, and Edward Deming's 14 points ensure the competitiveness of companies whose domain is the middle of the innovation economy pyramid. The use of false discovery rate in fields as diverse as cosmology and medical statistics and the diversity of fields that use Brad Efron's bootstrap methods speak to the invaluable contributions to our research base and importance of statistics to the science infrastructure.

The competitiveness argument is sometimes perceived as casting progress by other countries in a negative light, but that is not the intention. The countries that have striven to improve their S&T infrastructure are deservedly reaping the benefits. We should support those countries efforts to build their economic base. We should also ensure the United States remains as economically competitive as possible.

Lastly, as an advocate for more basic research funding, I'm sometimes accused of exacerbating our federal deficits by advocating for more federal spending. In fact, Capitol Hill and administration staffers frequently ask from what budgets the money to fund the increases we are requesting should come. While it would be tempting to start naming programs, we would be foolish to offer up programs to cut (as any one we target would inevitably be bigger and more powerful than we). It is our job to advocate our interests and Congress' job to determine overall priorities.

While I've focused support material for basic research funding in this article, I'm also interested in arguments in support of the statistics work done across our federal government system. Please email *pierson@amstat.org* with your suggestions. ■

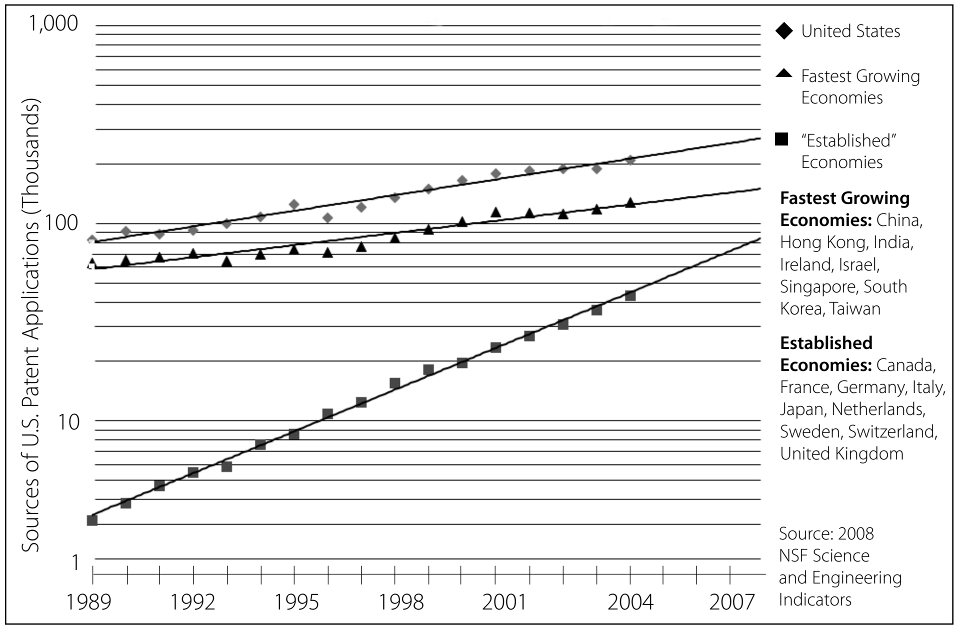


Figure 4. U.S. patent applications: fastest-growing economies gaining on U.S. rapidly

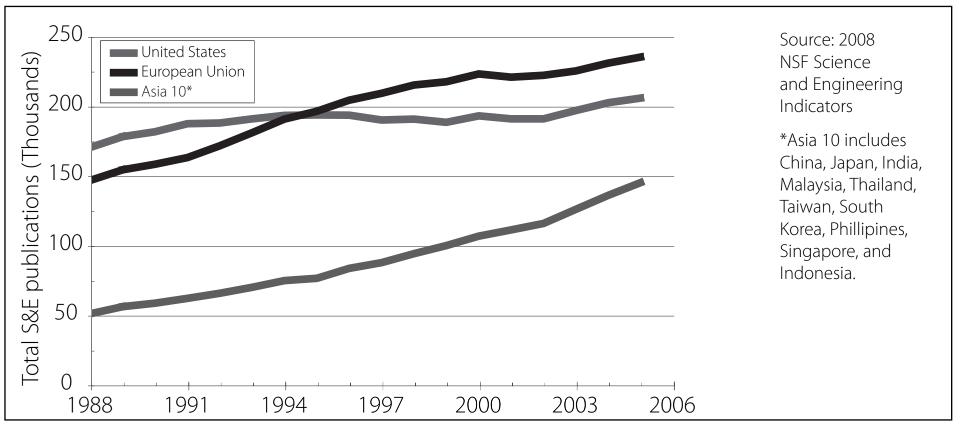


Figure 5. S&E publications: passed by Europe; Asia rapidly closing

ASA Science Policy Actions

- Signed letters in support of funding for NSF, NIH, 2010 Census, and NCHS
- Joined groups in submitting comments on proposed changes to the Family Educational Rights and Privacy Act (FERPA)
- Endorsed H.R. 6314, "Fulfilling the Potential of Women in Academic and Engineering Act of 2008"
- Organized briefing for congressional "Blue Dog" science staffers with help of Task Force on the American Innovation

How You Can Help

If you can provide specific examples of how statistics has contributed to society, in topics ranging from the environment and health care to economic growth and defense, please send them to me at *pierson@amstat.org*. They will be considered for inclusion in one-page documents to be used on Capitol Hill for explaining what statistics is and how it contributes in a practical manner. As an example, I've read about William Gossett's contributions to Guinness Brewing and the contributions of statisticians to agricultural productivity. There is also statisticians' development of double-blind, randomized, controlled experiments and adaptive trial designs and their contribution to biomedical research and other applications.

For details about the ASA's involvement in science policy, see *www.amstat.org/scipolicy/index.cfm.*

Correction

In the July issue of *Amstat News*, Jeanne Griffith's name was misspelled in the Government News article. We regret the error.