The Global Research Landscape: Implications for Higher Education

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Over the past year, I've been speaking about the profound shifts in American higher education. Having lived and learned on three continents, I believe the American system of higher education is the best in the world. It is uniquely meritocratic, competitive, and diverse. But our system is at a critical inflection point, driven by several disruptive forces, accelerated by technological innovations, intensified by a stagnant economy, and challenged by globalization. This has implications for the American research enterprise, which is largely centered in academic institutions.

Nonetheless, it is still an exciting time for research universities. We are facing significant and complex global challenges in health and sustainability, among other areas. At the same time, our technology is increasingly sophisticated: mobile phones, satellites, and the Internet itself are bringing in massive quantities of data that allow us to ask, and hopefully answer, questions we couldn't even fathom before. The needs and opportunities are enormous.

The United States remains a research powerhouse. We have a predominant share of the world's best universities; we produce nearly a quarter of its scientific publications; we are home to a disproportionate share of its innovators; and, as a nation, we still make significant investments in research. Last year, total R&D funding here in the U.S. was around $427 billion. This represents one-third of total R&D globally.

But our leadership is in jeopardy.

The Domestic Scene

Since 2004, total federal research dollars have remained relatively flat. When we look at total R&D expenditures relative to GDP across the globe, the picture is even worse. While we remain among the top countries by this metric, Japan and South Korea are far ahead of us, and others are catching up. We also need to brace ourselves for the possibility of further federal cuts, and face the fact that the pace is accelerating and more is demanded of us in terms of research output and impact.

At the state level, the situation is dire. Between 2002 and 2010, state appropriations to higher education were cut by an average of 25 percent. Public universities conduct nearly two-thirds of the nation's academic research and educate about 70 percent of our scientists, engineers, doctors and other professionals. So dismantling the public system will have serious direct consequences.

There are indirect consequences as well. External resources have never provided full funding for university-based research, and universities have always subsidized the investment in the human capital, facilities, and infrastructure required for a robust research enterprise. As external support declines, we must increase internal subsidies to stay even.

This puts enormous pressure on tuition, one of the few sources of unrestricted institutional revenue. But with the cost of higher education a hot-button issue, we can no longer increase tuition to subsidize research. If this situation continues, only well-endowed universities—a relatively small segment of the system—will be able to provide internal funding. We may be facing a situation in which a disproportionate share of research is concentrated in the hands of a few mega-institutions.

Is this a bad result? Some within the academy have questioned whether there are too many research universities receiving government dollars, suggesting that a concentration of funding might be beneficial. But the diversity of our institutions—and competition among them—makes the system great. If we lose this, we lose a critical resource of creativity and innovation.

The Global Context

While our nation is disinvesting in education and research, new global players are entering the scene. China, India, and others are committing to university education and research, creating intense global competition for talent, research dollars, and output.

In the past decade, China alone has doubled its number of institutions of higher education from 1,000 to 2,000. In the same time period, the number of degrees awarded in engineering and natural sciences increased by 42 percent annually in China, compared to a mere 3 percent increase here in the U.S. About half of the U.S. degrees are going to international students. Unfortunately, most of these students will return home—the result of immigration policies that deprive us of the benefits of U.S.-educated talent.

From the competitive standpoint, our STEM pipeline suffers not only from issues in our universities but also in our K-12 classrooms. Our students lag behind other countries, and this is an issue of serious national concern. I address it today only to say that universities, and especially research universities, have an important role to play.

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In addition to developing their own research talent, new global players are competing for worldwide talent. Singapore, Saudi Arabia, and other countries are trolling for researchers, making them extremely attractive offers for salary and living expenses. In addition, given the significant investments in research infrastructure, they can offer state-of-the-art facilities that may be better than those at home.

Another challenge comes from increased industry offshoring: U.S.-based companies now have 23 percent of their industrial R&D located overseas. Taking a wider lens, eight of the 10 companies with the largest R&D budgets globally have established facilities in India, China, or both. This is a significant shift.

New forms of global outsourcing are tapping talent through the Internet. One example is InnoCentive, an online service that invites businesses and others to pose scientific and engineering problems and offer rewards for the best solution. Another variant is Fold-It, a protein folding computer game, which allowed a team with little scientific background to solve a problem that had eluded experts for years.

Finally, globalization raises questions about our approach to cost. In the U.S., we are just beginning to pay attention to cost. But in India and elsewhere in the emerging world, research and innovation have always been coupled with cost. In a "reverse innovation" approach, products like imaging machines are being engineered at low cost, first brought to market in the emerging world and then introduced here.

Implications and Opportunities

How can we address these challenges? New and strengthened partnerships—with global researchers, with domestic businesses, and with each other—are key. We also need to revisit some of our internal policies.

Industry Partnerships

Partnerships with business and industry are critical to maintaining a strong research enterprise, and most institutions are moving in this direction. But we do have something of a chicken-and-egg problem: We need business and industry partners to help support research, but we need government and other private funding to help maintain a robust infrastructure—of facilities and talent—to attract industry. We are competing with global institutions for these partners, so carefully crafted tax benefits or other incentives for private investment in university research may be appropriate.

As universities form agreements with industry, and as these relationships evolve, we must reach an appropriate balance between collaboration and control. We must question whether the industry agenda will inhibit innovation and experimentation or important fundamental research. Do intellectual property issues and nondisclosure provisions stifle the type of collaboration and information sharing required in an academic environment?

Global Partnerships

Global partnerships with other research institutions and with businesses are essential if we are to remain a key player.

The global competitors I mentioned earlier are also our collaborators, offering unique perspectives on international issues, and an opportunity to expand the scope and impact of our work. Not surprisingly, global partnerships are ongoing and growing. The percentage of internationally co-authored articles almost trebled between 1998 and 2008 and continues to climb, encouraged and facilitated by government funders and our own State Department, which just last year held a productive U.S.-India summit to foster collaborations.

But global partnerships present their own challenges. We need careful management and constant renegotiation to maintain an acceptable balance between competition and collaboration. Intellectual property issues, for example, can be particularly difficult to negotiate. In a number of countries, IP policies are more generous to faculty than in the U.S. For instance, Chinese universities give around 50 percent interest to faculty; Canadian faculty often receive 100 percent. Some countries may have weak IP enforcement mechanisms. Issues like these must be addressed at the outset of any collaboration.

Successful global partnerships require global competencies, and research universities have a critical role to play, educating the next generation of engineers and scientists so that they can communicate, collaborate, and compete across cultures. Global experiential learning is becoming more common in the U.S. but is still rare. At Northeastern, we have been expanding our co-op model globally and now have students in more than 69 countries.

Within the Academy

We also need to partner better with each other. Diversity and competition among institutions are the hallmarks of our system of higher education. But as we think about addressing funding challenges and complicated research questions, collaboration becomes increasingly important.

With exponential increases in the cost of instrumentation, we must consider shared facilities and infrastructure. Not every researcher needs a dedicated confocal microscope, and not every institution needs its own 900-megahertz NMR spectrometer.

Here in Massachusetts, Northeastern is addressing this issue by joining with four other academic institutions to launch the Massachusetts Green High-Performance Computing Center. This facility will provide state-of-the-art, energy-efficient computational infrastructure to focus on collaborative research in areas such as clean energy and the environment.

Changes to the Academy

Internal institutional policies can also impact our success in a highly competitive global environment, and we need to review these thoughtfully.

First, we need to promote an entrepreneurial ecosystem within academia. Some institutions are revisiting their faculty evaluation policies, looking to entrepreneurial activity in promotions, tenure, and post-tenure review. The University of Maryland recently announced a new policy that takes into account work leading to patents and other intellectual property. About two dozen institutions now formally recognize such activity for tenure.

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Finding new ways of promoting interdisciplinarity is also key. Interdisciplinarity is a familiar word on university campuses, and it's clear that collaborations across disciplines are essential to addressing big global challenges. The most exciting ideas are happening at the intersection of fields. NSF and other agencies are promoting interdisciplinarity with new programs.

But universities are tradition-bound and change isn't easy. We need to rethink some of our traditional structures, finding approaches that break down silos and reshape institutional culture. This may require a new approach to hiring that brings departments together, and in some cases, even reorganizes them to create faculty clusters around big issues such as sustainability or health.

Evaluation criteria and the notion of peer review should also be re-examined. Consider how an institution should evaluate a faculty member in the biology department who publishes in an architectural journal focusing on sustainable design. We don't easily recognize this kind of contribution in academia.

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Equally important, we should also rethink many of our graduate programs. To remain competitive, we must establish new interdisciplinary programs that capture emerging fields such as network science. We need programs that are translational, blending fundamental and applied research, and these programs should not be ranked by traditional measures. In particular, the rankings should not penalize the programs that place students in industry.

Finally, shared facilities and building design can also promote work across disciplines. Most new research buildings in academia and industry include spaces and shared core facilities that foster disciplinary cross-pollination. Open configurable workspaces that accommodate evolving collaborations are also becoming common.

The Unique Role of Universities

I began by mentioning some of the significant and complex issues facing our nation and the world. Our research universities have made enormous contributions to solving these challenges in the past, and I believe we are uniquely positioned to continue doing so in the future. Even with concerns about cost, universities can work with longer timeframes than government or industry, bridging the divide between basic and applied research. Even with an eye to outcomes, universities have a greater tolerance for risk, experimentation, and creativity. Universities foster these qualities as habits of mind.

Additionally, the breadth and depth of university-based expertise is unparalleled. Not only can we bring together engineers, biologists, and behavioral scientists to address environmental issues, but we can also add philosophers and policy experts to the mix.

And interactions with students matter. Students force us to clarify what we take for granted, overcoming the so-called "expert blind spot." The intellectual challenges that come from teaching energize us and inform our own work. Students keep us on our toes and help us keep our eyes on the future. They are also a great source of innovation in their own right, and we should cherish this competitive advantage.

A Social Compact

I'd like to conclude with a quote from Vannevar Bush, considered the godfather of the NSF. In 1945, he wrote: "Scientific progress is one essential key to our security as a nation, to our better health, to more jobs, to a higher standard of living, and to our cultural progress."

This comment puts our current set of challenges in a powerful context.

The stakes are high. Every aspect of the human experience is touched by scientific discovery and knowledge creation. As a result, I encourage you to see this period of turbulence and change as a time of opportunity—the moment in which you can exercise a disproportionate impact on your field and society as a whole.

The powerhouse that is the American research enterprise—designed in large part by Vannevar Bush—is based on a social compact to benefit the greater good. It has fueled American economic progress and social mobility for more than five decades. As we face new competition on the global stage, we must reaffirm and reinvest in this compact.

In partnership with government and industry, universities are uniquely positioned to lead this effort. We should seize this opportunity—not for ourselves or for our institutions, but because of the responsibility we have as educators and researchers to create a better world.

Thank you.