

MEETING
SUMMARY

Government-University-Industry Research Roundtable | October 21-22, 2013

Research globalization is on the rise, as seen through increases in international co-authorship of articles, growth of R&D investment abroad, and other indicators. At this GUIRR meeting, participants explored how research globalization is affecting U.S. R&D within the context of ensuring national security and economic prosperity, as well as the roles the government, university, and industry sectors play in this new globalized environment.

The keynote address on October 21 was given by **Harold Varmus**, director of the National Cancer Institute (NCI), who spoke about the Institute's work to help meet the need for cancer care in developing nations. By 2030, cancer deaths worldwide are projected to increase from the current 7.5 million deaths per year to over 11 million, and that increase will occur almost entirely in lower- and middle-income countries.

The National Cancer Institute has traditionally worked with scientists abroad to study a variety of features of cancer as a global problem – looking at epidemiological patterns, for example, and trying to understand virus-initiated cancers that have particularly high incidences in certain places. When Dr. Varmus became director of the Institute three years ago, he decided to amalgamate these various efforts into one Center for Global Health. Despite deep budget reductions, the

Center set out to reach the following five goals:

- **Learn about the differing rates at which various cancers occur in different countries**, which are not well understood. Teaching people how to develop cancer registries and a National Cancer Plan for treating the cancers that occur in their countries are important first steps.
- **Pluck the low-hanging fruit – infectious agents that we know cause cancer**, such as hepatitis B and human papilloma virus. Doing this means better using existing vaccines and developing new ones, all of which depends heavily on the industrial sector. One of NCI's goals is to help solve problems with cost and dosing and make vaccines more widely distributed.
- **Identify risk factors for cancers that are also risk factors for other diseases**, which means working with colleagues who are concerned about cardiovascular disease and diabetes and addictions. Among the risk factors that are essentially behavioral, any prevention agenda would include tobacco use, obesity, nutritional factors, alcohol, etc.
- **Think more about implementation science**: the science of making operational advances that allow countries to develop appropriate screening processes and better access to treatment and prevention methods.

- **Harness the enthusiasm that exists among partners**, especially in an era of budget reductions. Scientific societies in this country, students, cancer centers, and institutions that want to be global universities can help build the scientific capacity of lower income countries, in terms of helping them build their workforce and organize their clinical activities. NCI has a total of 67 NCI-designated cancer centers in the U.S., many of which are making an effort to work around the world in a variety of research settings, including building long-term relationships with cancer centers in Africa.

One thing that gives Dr. Varmus optimism about our ability to confront cancer is the willingness of colleagues who work at cancer research funding agencies around the globe to put in place general policies that play out in international programs controlling cancer. For the past two years, Dr. Varmus has been working with Harpal Kumar from Cancer Research UK to organize an annual meeting of 15 to 20 cancer research organizations. The organizations published a report in *Science Translational Medicine* describing a series of steps they would like to see happen, and they will work to make it more likely that these steps will happen.

Following welcoming remarks from GUIRR co-chair Jack Gansler on October 22, **Jacques Banchereau**, professor and director of immunological sciences at the Jackson Laboratory for Genomic Medicine, gave the opening talk, "Research Globalization Starting From a Personal Experience." He recounted his own career as an immunologist, which began in his work for a U.S. company, Schering Plough, operating in France – his first experience with globalization. He then came to the U.S. to direct the Baylor Institute for Immunology Research in Dallas, Texas, which developed a number of candidate vaccines for cancer, HIV, and other diseases. After working for Hoffman LaRoche, Dr. Banchereau now works for the Jackson Laboratory, which specializes in genetics and is moving into genomic medicine.

Why consider globalization? We have no choice because of the way the world is evolving, said Dr. Banchereau. The cycle of change is faster than we can imagine. The British and French used to lead in science and technology, and then U.S. leadership emerged, and now China and India are emerging. Research globalization is ongoing and ubiquitous and affects everyone, both industry and academia.

In his own field, immunology, industry is facing a real problem, he said: Though the amount of money put into developing new therapies has tripled – and it now costs \$2 billion to bring a new drug to market – the number of new molecules is shrinking. Industry needs to increase its success in R&D rates by moving forward from serendipity – which yielded therapies like penicillin and aspirin – to enhanced predictability. To do this, companies will need to widen the base of target identification and work with academia, since industry on its own will never have the resources and power to do the basic research that is needed.

Globalization of research has both positives and negatives, Dr. Banchereau continued. It permits us to get talented people where they are, and resources where they are, and it permits us to share risks. However, it may lead to a loss of control, so it's important to be smart in how it's done, he said. His own approach has been to select trustworthy partners who are well-known to him, and to establish clean contracts based on increased returns for all partners.

To maintain its preeminence in science and technology, the U.S. needs a new generation of strong individuals, openness of inquiry, communication, and collaboration, Dr. Banchereau said; it also needs both strong education and strong basic research in universities. Congress received a report in 2000 that says every dollar that goes to NIH is the best investment, yielding a 20 to 40 percent return per year – a fact that is often forgotten but should not be, he said. Strength lies in government-industry-academic partnerships, and establishing that synergy will be critical. A major challenge, meanwhile, is the decreasing number of national scientific trainees: young scientists from abroad who study here are going back to their home countries in increasing numbers, and young Americans are not motivated to go into science, in part because of challenges such as long training and low income.

The meeting's first panel explored "Drivers and Obstacles" to research globalization. Moderator **Elizabeth Lyons**, a senior advisor at the State Department, opened the panel by observing that maintaining U.S. global leadership in science is essential not only to our national security, but also to our economy, environment, health, and global soft power and development, which are some of the drivers. How can we use international research collaborations as an adaptive mechanism to try and leverage funding and expertise and equipment around the world, and at the same time deal with those drivers?



SOURCE: Presentation by Dr. Carolyn S. Wagner, The Ohio State University, October 22, 2013

Panelist **Caroline Wagner**, Ambassador Milton A. and Roslyn Z. Wolf Chair in International Affairs at Ohio State University, began by noting that in 1990, only six countries accounted for 90 percent of global R&D spending. Now R&D in developing countries is increasing, and international collaborations have increased; almost 40 percent of co-authored scientific papers are co-authored internationally. From 1980 to 2010, U.S. quality as reflected in citations has flattened, and some European countries now have surpassed the U.S. in citations. The other story is the rise of China, which will soon surpass the U.S. in the quantity of papers, though not yet in quality indicators. China is also the U.S.'s largest collaborative partner in science. One of the most interesting stories is the growth in the number of developing countries that are now part of the global network of science, Dr. Wagner said.

Looking at this global network of science, it is clear that 1) smart people are everywhere; and 2) the idea that the U.S. science system stays ahead or behind doesn't make sense anymore in this globalized system. This is a network, one in which 90 percent of the collaborations start face to face. Dr. Wagner said that her research indicates that we need to shift 180 degrees and recognize that now we are in a time of abundance – unlike the 1980s, for example, when there were really only one or two global scientific powers. Instead of focusing on the push side – where we just push money and smart people into the system – we need to work on the pull side: taking all of this global knowledge, reintegrating it, and applying it on a local level. In other words, we need to shift from a national focus to one that is both global and

local, and look at ways to keep those research networks robust and strong.

Panelist **Patricia Falcone** discussed international collaborations in the context of her work as associate director of the National Security and International Affairs Division at the White House Office of Science and Technology Policy (OSTP). OSTP's role is "science and technology for policy, and policy for science and technology" – in other words, making sure the science and technology used to inform White House and agency decisions is accurate, and examining what policies are needed about the conduct of science and technology, including some policies relevant to international engagement. The U.S. government has close to 50 official state-to-state science and technology agreements, which are always positive parts of our relationships with other nations, even relationships that are conflict-laden.

From the government perspective there are a number of drivers of international collaborations, said Dr. Falcone, including shared priorities we have with other nations, such as pandemic flu, safe use of nuclear power, and energy supply, as well as cross-border issues such as ocean science and climate change. Another driver is the need for cost-sharing; the U.S. has agreements to share costs on very large facilities, such as colliders, satellites, and telescopes, for example. In addition, we can learn from other nations on best practices for managing S&T and innovation.

OSTP is also trying to address some obstacles to collaboration, including making sure that scientific colleagues can get visas to attend meetings; encouraging those who are educated in the U.S. in

S&T to stay here and enabling them to do so; and identifying shared priorities with other nations, which is often easier said than done. Other obstacles include the U.S. budget process, since lapses in appropriations for international collaborations can be a challenge; bureaucracies, because responsibilities related to one issue may be divided among many issues; and sharing samples for research on emerging viruses. OSTP is continuing to make progress on these obstacles, which are things that all entities need to work on, said Dr. Falcone.

John Evans, vice president for international engineering and technology at Lockheed Martin, spoke about the company's efforts to branch out into more international markets and the important role global partnerships in R&D play in that effort. The company has partnerships for innovation with India, Saudi Arabia, Turkey, and South Korea, for example. The company's metric for evaluating these partnerships is whether they enable Lockheed Martin to help solve partners' problems in ways that improve the company's financial position.

Reflecting on a topic he had explored during his previous work at the Defense Advanced Research Projects Agency (DARPA), Dr. Evans observed that there is currently a market failure in that people and companies are unable to capture the value they create by doing basic research – which raises the question of whether policies could help them capture that value. One disincentive is that in R&D it takes a long time for an idea to progress from basic inception to market; this time lag creates the opportunity for leakage of ideas, which means the company that creates the idea may not be able to enjoy the returns. Also, in conducting basic research a person or company may not know the ultimate application of whatever idea they come up with, and the odds of it being applicable to the particular market they are in are low. Both of these disincentives may make companies reluctant to invest in basic research.

Another way to think about leakage is as “open source,” observed Dr. Wagner, who noted that there is a big push in science to have people share their data so others can reproduce their findings. The European science community has been working hard to make sure information diffuses in ways that still honor the incentives. The question is, how can we incentivize the uptake and integration of knowledge and at the same time incentivize the investment in research?

Participant and NAE President Dan Mote observed that the U.S. lacks a real policy on globalization. The term doesn't pass the lips of anyone in industry, for example, and the public thinks globalization means the loss of jobs and intellectual property. Because we have no policy, we're stuck between two eras – between the defensive policy of the Cold War and the acceleration of partnerships currently underway. Dr. Wagner responded that the U.S. is the last steamer to turn into the global stream, in part because we're so huge; smaller economies have shifted long ago toward the local-global focus and away from the national one. In the U.S., states are far ahead of the federal government in terms of creative funding and international partnerships around R&D. Dr. Falcone noted that there is always going to be tension around globalization, because although it is a fact of the environment, we do have a set of national responsibilities that are not part of the global commons and which can't be if we want to preserve national strength.

Another participant observed that while the U.S. is not the absolute center of the system anymore, it does still seem to be a uniquely important part of the global scientific enterprise. Are there ways in which our quality and productivity metrics may be underestimating enduring American strength? Dr. Wagner replied that during her previous work at Rand, interviews with chief technology officers at U.S. companies revealed that U.S. industry has a particular strength in its ability to integrate knowledge. To the extent that our education system can keep encouraging cultural capabilities like integration and creativity, we will maintain our scientific strength, she said. Another participant posed the question of whether, instead of investing our R&D across all disciplines as the U.S. has historically done, shouldn't we be thinking about “smart specialization”? Dr. Evans replied that specialization by field/industry may be an answer, or specializing in a particular phase of the R&D process – for example, if we're good at integration or creating value, we could specialize in those areas.

The second panel discussion on “The Influence of Public Policy” was introduced and moderated by the National Research Council's **Patricia Wrightson**, who reiterated Dr. Mote's point that the U.S. is understandably stuck between two centuries. The country is trying to deal with security issues in an inertial way leftover from the Cold War, while also responding to 9/11 and current globalization, and its policies have not navigated these shoals particularly well, she said. One of the

topics the panel will explore is whether it is possible for policy and practice to do better.

Daryl Pelc, vice president of engineering and technology for Boeing Phantomworks, an advanced design and prototyping division within Boeing Defense Space and Security, explained that Boeing deals with issues like leakage by making sure that its R&D spending is aligned with the company's long-range business plan. Boeing has identified about 10 strategic universities where it invests the majority of its R&D spending, but it has relationships with about 140 universities, both nationally and internationally. The company is increasingly going global in terms of the balance of its revenue stream: about 70 percent of Boeing's commercial airplanes are sold internationally. On the defense side, with U.S. defense budgets trending down, the company's objective is to get 30 percent of its revenue from international opportunities. In these global partnerships, the company is focusing on some countries where it wants to have a sustained presence -- India, Brazil, Australia, and some Middle Eastern countries -- and has established research centers in some of these countries.

Regarding policy issues, Mr. Pelc said that there is a need to make International Traffic in Arms Regulations (ITAR) work as smoothly and efficiently as possible. Another issue is how to enable international students to stay here after their studies end and how to establish incentives for U.S. students to study internationally and bring that expertise back. The U.S. should also create incentives and policies to improve our STEM pipeline, reaching into the K-5 level to give students a strong math foundation.

The next panelist, **Lee Branstetter**, associate professor of economics and public policy at Carnegie Mellon University, explained that while America's multinationals have been conducting R&D abroad for a long time, they are increasingly active in emerging markets whose institutional contexts present a unique set of opportunities and challenges. For example, one challenge is that some emerging host countries bring multinationals in and then use "carrots and sticks" to migrate some of these firms' advanced first-world technology into the hands of indigenous national high-tech companies.

Multinationals would not object to some of these "indigenous innovation" policies, like tax incentives to relocate into these emerging economies. Once companies are there, however, they may face policies that try to force them to localize the

production of strategically significant parts and components even if the local supply base is not the most efficient place to do so. These multinationals may find that government-owned clients in these countries may give them large purchase orders only if they are willing to transfer sensitive technology to indigenous entities over which they have little control. Once they have a sizable operation in these host countries, these operations are subject to efforts to extract these technologies through legal and quasi-legal means.

While forced technology transfer is illegal according to the World Trade Organization (WTO), it is fairly easy to structure this pressure in a way that makes it hard to build a WTO case against it. One strategic response would be to use the International Trade Commission's ability to do fact-finding missions, which could give policymakers an overall sense of how serious these risks are, said Dr. Branstetter. If there is a real issue there, this investigation could provide an evidentiary base for a WTO case.

Christopher Stagg, an associate with Williams Mullin, offered an overview of export controls and areas where they are creating tension, based on his three years as a regulator of export controls at the State Department. Like most other countries, the U.S. has a robust system of controlling sensitive goods, services and information for a variety of reasons, such as national security and regional stability. The overall concept is that everyone is free to do what they want, but if it interferes with a national security or foreign policy priority, the U.S. government wants the ability to say "no" to a particular transaction. The two main export control regimes are the ITAR, administered by the State Department, and the export administration regulations, which are administered by the Department of Commerce.

Mr. Stagg explained a part of ITAR that has the effect of discouraging partnerships with foreign countries. If an ITAR-controlled item is used in an end product, that product also becomes ITAR controlled -- even if it is not a defense-related product. For example, if a bolt is modified in a nominal way to make it fit into an Abrams battle tank, it would be ITAR-controlled because it was designed for a military product. If the bolt also happens to work in a regular conference table, then that table also is on the U.S. munitions list and becomes an ITAR-controlled item. This is true even if the end item is foreign; for example, if a French satellite is 99 percent French-built but contains one U.S.-made, ITAR-controlled product, the entire satellite is ITAR-controlled. So this policy

creates an ITAR “taint” that discourages potential foreign partners from dealing with U.S. companies. A second area of tension is fundamental research, which is defined and regulated differently depending on whether it is conducted by a university or a private company.

The objective of export control reform is to move less-sensitive items, like the bolt mentioned in the example above, from the ITAR to the Department of Commerce list, said Mr. Stagg. Industry should continue to engage the government and push on the issues of fundamental research and technical data in the public domain: what are the national security reasons for controlling something on the ITAR when we all agree that to do so would be more of a detriment than a benefit?

Asked by a participant where export controls are headed, Mr. Pelc replied that the trend is all positive: there is recognition that things are too onerous and that the investment and cycle times could be improved. Another participant asked whether the globalization “drawbridge” should be closed up more tightly or let down, in terms of how the U.S. relates to the rest of the world. All three panelists thought that the drawbridge should come down; Dr. Branstetter added that if we can lower the drawbridge intelligently and carefully, we can avoid a scenario where something bad happens and we close the drawbridge in a reactionary way.

The final panel of the day on “Future Trends” was introduced and moderated by **Kent Hughes**, public policy scholar at the Woodrow Wilson International Center for Scholars. The question, he said, is not whether we are globalizing research but rather how much and how fast. The first panelist, **Gray Handley**, associate director for international research affairs at NIH’s National Institute of Allergy and Infectious Diseases, described his institute’s international efforts. Ten to 12 percent of NIAID’s budget is spent overseas, and much of that funding has been devoted to building research capacity, allowing the institute to study diseases where they occur. Because NIH’s legislation does not restrict who the institution can fund, it can give direct grants to foreign investigators who come to the institution with meritorious proposals.

Among the trends NIH is seeing is a rapidly rising interest across the country among young Ph.D.’s and M.D.’s in working globally and doing research in global health. Many U.S. schools of public health are opening up full-blown departments in other countries. At the same time, NIH is seeing increasing interest among foreign scientists who want to come to the U.S., but they are being pulled

back to their home countries. Senior investigators too are being pulled by China, India, and other nations, who sometimes offer fully staffed labs abroad where the principal investigators can work a couple of months each year. So there is a flow of skilled individuals in both directions. NIH is also participating in an increasing number of jointly funded activities with a few key countries and is encouraging greater partnerships between U.S. and biomedical researchers abroad through grant criteria.

Currently, there is a real struggle in biomedicine; the pharmaceutical industry that was once run by scientists is now run by businessmen, and they are less interested in investing in science, said Mr. Handley. This increases the burden on NIH for more downstream research, and NIH doesn’t have the budget for it. Also troubling is the increasing tide of questions from Congress about why we’re investing in fundamental science. And there is worry that as money gets tighter for the NIH, concerns will be raised about NIH awarding funding to foreign institutions. If foreign awards go away, that will fundamentally change the way NIH manages biomedicine and will undermine the remarkable progress that has made over the past 40 years, said Mr. Hadley. The reason we were able to move so far so fast – for example, developing HIV drugs within five years – is that we lowered the international drawbridge long ago.

Alan Shaffer, acting assistant secretary of defense for research and engineering at the U.S. Department of Defense, explained that DoD has an interesting dichotomy. The agency has to be globally engaged, he said, but at the end of the day “my job is to deliver capabilities that keep the young men and women we deploy in support of national security safe.” In January 2012, the President rolled out the Defense Strategic Guidance – a short, remarkable document predicated on five points, three of which are germane to the meeting’s discussion. The first point in the strategy is to shift DoD’s emphasis away from a European-centric view, rebalancing it toward the Asia Pacific region. The second point is the need to build partnerships around the world, and one of the best ways to do this is through collaborative research projects. DoD has been partnering with European nations, Japan, and South Korea, and is now opening up research partnerships with Thailand and Vietnam.

The third relevant point in the document is that our military has to continue to be technologically advanced in order to protect us. We don’t do that by just looking inward, said Mr. Shaffer; we look for

opportunities to invest in basic research around the world and for the best possible science and technology opportunities. In addition to developing its capacity to forecast these emerging areas of technology, DoD also wants to bring in researchers from around the world. A DoD proposal to fund non-U.S. citizens to come here to work in DoD labs didn't make it out of Congress, or even out of committee, but we need to get there, said Mr. Shaffer. Science is globalizing, and though we still need to protect the really critical pieces, we also need to be much more open to operate in a global environment.

Erica Fuchs, associate professor in the department of engineering and public policy at Carnegie Mellon, focused her remarks on the global shift in the distribution of manufacturing and what that means for innovation. The U.S.'s manufacturing value-added has continued to slowly rise, but what has changed is our percentage of the global pie. The pie is growing faster than our own slice of it, so over time our share is declining.

Dr. Fuchs discussed case studies showing that while manufacturing location matters for the economic viability of new technologies and a firm's ability to produce them, moving manufacturing abroad doesn't necessarily mean that a firm will abandon innovation. Some researchers would say that it allows a firm to take the money saved by moving manufacturing abroad and invest it in innovation at home. In research Dr. Fuchs conducted with a student, she found that optoelectronics firms that move assembly overseas saw an increase in innovation in incremental

manufacturing and no change in their production of advanced technologies. Moving fabrication overseas along with assembly, however, did decrease a firm's innovation in emerging technologies.

While manufacturing offshore changes the path of technology development in the optoelectronics industry, that doesn't have to be the case globally, said Dr. Fuchs. For example, in the global automotive industry, it is possible to imagine circumstances where a company could leverage national differences in production and consumer preferences to increase its innovation globally.

Following the presentations, Dr. Hughes raised a question about distribution of the benefits of globalization, noting that one report suggests that almost all benefits of productivity growth have gone to the top five percent of the population, and most of it to the top one percent. Regular taxpayers may think that, although they are the ones who need to adjust to this new reality, they are not seeing any of the benefits. What do we do about that "sharing the wealth" question? Mr. Hadley responded that it depends on the kind of wealth; in terms of biomedicine and vaccines, as long as they are coupled with improved accessibility, the benefits of that research are clear. It's trickier when talking about profit. Dr. Fuchs replied that she does think there is a global benefit to innovation; the question is whether innovation – whether in health technologies or IT or another field – is being underinvested in, compared to its societal benefits. And if workers are losing out, the question is how the nation can train a workforce that can adapt to a change in what we're producing every five years.



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The summary was reviewed in draft form by Tilak Agerwala, IBM Research and Karina Edmonds, California Institute of Technology, to ensure that it meets institutional standards for quality and objectivity. The review comments and draft manuscript remain confidential to protect the integrity of the process.

About the Government-University-Industry Research Roundtable (GUIRR)

GUIRR's formal mission is to convene senior-most representatives from government, universities, and industry to define and explore critical issues related to the national and global science and technology agenda that are of shared interest; to frame the next critical question stemming from current debate and analysis; and to incubate activities of on-going value to the stakeholders. The forum is designed to facilitate candid dialogue among participants, to foster self-implementing activities, and, where appropriate, to carry awareness of consequences to the wider public.



For more information about GUIRR visit our web site at <http://www.nas.edu/guirr>
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