Longitudinal Assessment of International Investment in U.S. University Research & Development

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ABSTRACT

The global economic crisis exacerbated by U.S. sequestration has resulted in funding for research and development either remaining flat or declining slightly. By comparison, collectively, countries in Europe and Asia have expanded R&D investments. The purpose of this study was to understand the characteristics of and extent to which international sponsors are funding R&D at U.S. research institutions. This retrospective, longitudinal cohort study included R&D expenditures data from 2006 to 2012 for a convenience sample of 24 U.S. research universities selected from the 2012 report of *Higher education research and development* (National Science Foundation, National Center for Science and Engineering Statistics, 2013), broken down by total R&D expenditures, international support of R&D expenditures, countries, and sponsors of that support. A steady increase in R&D expenditures from international sources for successful universities suggests that international investment in R&D may become a significant driver of research innovation for all U.S. universities. The results of this study support the importance for having U.S. research institutions invest in research administration infrastructure to facilitate international collaborations and employ deliberate strategic directions in securing international support for R&D expenditures.

INTRODUCTION

—American institutions' preeminence is at risk as emerging countries are building their own national higher education and research enterprises. (Sedwick, 2013)

R&D comprises basic and applied research and development. More than 60% of U.S. basic research is performed in academic institutions (Grueber & Studt, 2012). Thirty of the world's top fifty research universities are in the United States (*Times Higher Education*, 2013-2014), and U.S.-based researchers were coauthors of 43% of the world's total internationally coauthored articles in 2010, well above the global percentage of U.S. article output (National Science Board, 2012). Nevertheless, global collaboration in scientific research is growing rapidly (Edler, Cunningham, & Flanagan, 2009). In 2000, only 25% of U.S. research articles had an international co-author, but in 2012 that number was 33% (Markovich, 2012). Researchers are increasingly mobile, telecommuting and traveling long distances to work with the best colleagues in their fields, to access resources and to share ideas and facilities. They are being supported internationally through cross-border funding from international organizations (corporations and foundations), multilateral initiatives between governments and research councils, multinational funding bodies, and shared scientific infrastructure (The Royal Society, 2011). This trend acknowledges that international, multidisciplinary collaborations are needed to solve global challenges such as climate change, biodiversity, food and water security, energy, and potential pandemics (The Royal Society, 2011; Smith, 2011).

In 1988, in response to a congressional request, the Resources, Community, and Economic Development Division of the United States General Accounting Office (GAO) reported on the extent to which U.S. universities received international sponsorship of R&D. The top five of the 107 institutions that reported receiving international funding were Texas A&M, Harvard, MIT, Oregon State, and the University of Wisconsin. The GAO found that only 1% ($74.3 million) of the $6.8 billion in total university R&D expenditures was sponsored by international sources (United States General Accounting Office, 1988). The GAO reported that its office has not repeated that survey (Young, 2013).

In the U.S., the largest federal supporter of basic research, applied research, and R&D at colleges and universities (after the U.S. Department of Defense) is the National Institutes of Health (NIH) (Intersociety Working Group, 2013), particularly for universities with medical schools that receive almost ten times more R&D funding (about $240 million) than those without (Grueber & Studt, 2012). Between 1998 and

2003, NIH funding increased by more than 80 percent. Since then, funding has either remained flat or slightly declined in most years (except for the Recovery Act boost) (Intersociety Working Group, 2013).

In January 2013, Moody's reported that:

> . . . even the top programs at the largest, research-intensive universities and independent research institutes will have to compete more rigorously to maintain their current sponsored funding. Federal government funding, which accounted for approximately 56% of research grants awarded to US universities in fiscal 2011, has been stagnant over the last few years, with few prospects for improvement given the growing federal budget deficit. The success rate of university grant proposals approved by NIH has already reportedly fallen significantly from a high of 30% in 2003 to just 18% in fiscal years 2011 and 2012 (Moody's Investor Services, 2013).

While the amount of R&D expenditures funded by U.S. academia was forecast to increase by 2.1% in 2013 to $12.7 billion, federal funding for academic R&D was forecast to decline by 0.8% to $41.3 billion in 2013, a decline in real terms of 2.7% (Grueber & Studt, 2012).

In 2014, global research and development spending was forecast to grow by 3.8% to $1.6 trillion in 2014, according to Battelle and R&D Magazine's annual forecast. "After a flat year of R&D spending in 2013, the United States is projected to show modest growth in 2014 while China's total investment in R&D is expected to continue its upward trajectory and surpass that of the United States by 2022" (Battelle, 2013). Despite the setbacks that threaten the economic stability of individual European countries, the countries continue to invest in R&D in their own countries and collectively (Grueber & Studt, 2012). Leaders of the European Union recently agreed on budget caps for 2014–2020 (70.2 billion euros), including research spending through the continent-wide R&D program, Horizon 2020, the new 8th Framework Programme [sic] (FP8). This is a 23.4% boost compared to the previous FP7 that spanned the years from 2007 to 2013 (Rabesandratana & Vogel, 2013).

The intent of this retrospective, longitudinal cohort study was to understand the extent to which non-U.S. funding agencies are supporting U.S. research institutions in a climate of flat U.S. funding. By examining 24 institutions with the potential to receive substantial research funding from international sources, a picture of the role of international support of U.S. research universities might emerge to reveal what is happening more broadly in U.S. research institutions. It is hypothesized that no difference in the median rate of success within similar areas of research excellence exists among these institutions in attracting international research support of R&D.

METHODS

The purpose of this study was to assess and describe the characteristics of international funding of research and development at U.S. research universities and reveal possible funding trends from international sources that may have resulted due to recent flat funding in the U.S. The author was interested to see if the national picture had changed from that reported in the 1988 GAO survey. The project had three aims: (1) to define what institutions require to be successful in attracting R&D expenditures supported by international sources; (2) using the measures defined by Aim 1, to measure the success rates of those universities; and (3) to compare success rates for those universities.

The convenience sample for this study included institutions whose area of research excellence is "medical sciences" (as defined by the National Science Foundation) who reported in the FY2011 NSF "Higher Education Research and Development Survey" high levels of international R&D support. Additionally, those institutions known as "The Big 11" (Fuller & O'Leary, 2012) were included in the sample. These institutions promote more effective policies and procedures relative to the administration of sponsored programs to assure the achievement of the maximum potential in academic programs, and therefore were considered to be more likely to participate in the survey. Collectively, these 24 U.S. research universities comprised the sample population for the study.

A survey instrument was developed and distributed by email to the 24 institutions, with two follow-up reminder emails. For each institution, the following variables were measured for the period from 2006 to 2012 (overlapping pre- and post-economic recession years): total R&D expenditures, total international support of R&D expenditures, total international support of R&D expended in medical schools, types of agreements, percentage of international support of R&D expenditures by country, and international sponsors of R&D expenditure. Based on the variables to be measured, the institutional review boards of Yale University (IRB Protocol 1310012932, 10/28/13) and Rush University (11/25/2013) deemed the project exempt from approval. Additionally, total R&D expenditures and total R&D expenditures from international sources was extracted for the years 2010 to 2012 from the 2014 FFRDC Research and Development Survey (National Science Foundation, 2014).

The invitation to participate in the survey generated ten responses (42% of the sample, n=24), with varying degrees of completion. Two institutions indicated that competing priorities allowed them to report only high-level data, and one institution responded that it was unable to participate. Several institutions indicated that their

reporting systems were unable to easily identify the breakdown of personnel supported through international support of R&D expenditures. One institution had changed its reporting system in 2010, and although it had received international support prior to 2010, was unable to report data prior to 2010. For all institutions, total R&D expenditures and international R&D expenditures were extracted from the 2012 *Higher Education Research and Development* report published by the National Science Foundation (National Science Foundation, 2014) for the years 2010–2012. Note that NSF did not begin to collect data on R&D expenditures supported by international sponsors until 2010.

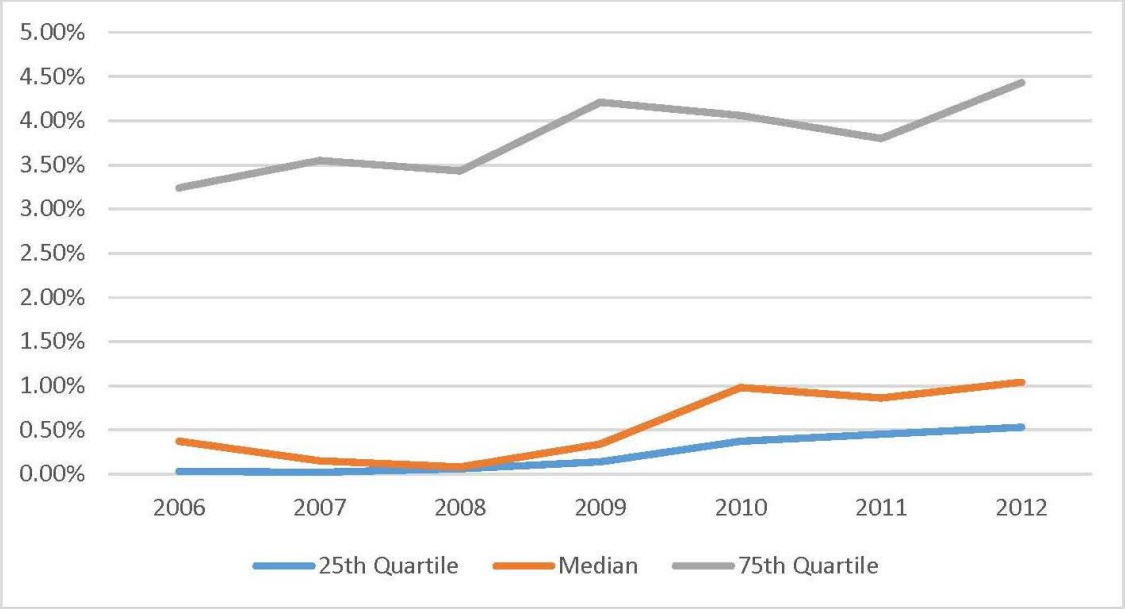
Participants were asked to report R&D expenditures funded by international sources by country/region, and to list up to ten agencies that funded the largest R&D expenditures. 74 unique sponsors were reported, with only two sponsors reported by more than one respondent. The 74 sponsors represent industries such as pharmaceuticals and biomedical devices, motor vehicle corporations, universities, governments, engineering, and education and science foundations.

For each institution, the ratio of R&D expenditures from international sources and total R&D expenditures was calculated for each year (where data were provided). For each year, median ratios and quartiles (25%, 75%) were calculated. Actual R&D expenditures from international sources were calculated on the logarithmic scale.

RESULTS

Only one responding institution reported having an office dedicated to international research administration with a single FTE supporting that office. Another institution, though not having a dedicated office, reported that the vice provost for international affairs seeks to promote and develop its international activities across its schools, foster coordination between them, oversee and review large-scale international endeavors, and set policies to establish best practices. The administration of those programs remains the responsibility of those schools, departments, research centers, or other units.

As shown in Figure 1, a steady increase in median ratios of R&D expenditures from international sources and total R&D expenditures for years 2006–2012 approaches 1%, with the 25% quartile steadily increasing from 0.03% in 2006 to 0.37% in 2010 to 0.53% in 2012, and the 75% quartile growing from 3.25% in 2006 to 4.06% in 2010 to 4.43% in 2012. Note that data are limited for the years 2006 and 2007.



For the 1,000+ institutions that respond to the annual NSF survey, the median for 2012 is 1%. However, those universities most successful at attracting international R&D support have rates closer to 3%, and these rates are increasing every year. Even when the total R&D expenditures decrease in any year, international R&D expenditures are increasing.

Figure 1. Medians and Quartiles (25th, 75th) for Ratio of International R&D Expenditures and Total R&D Expenditures, 2006–2012

The picture is even more illuminating when examining actual dollars for the "Big 11" institutions (Figure 2).

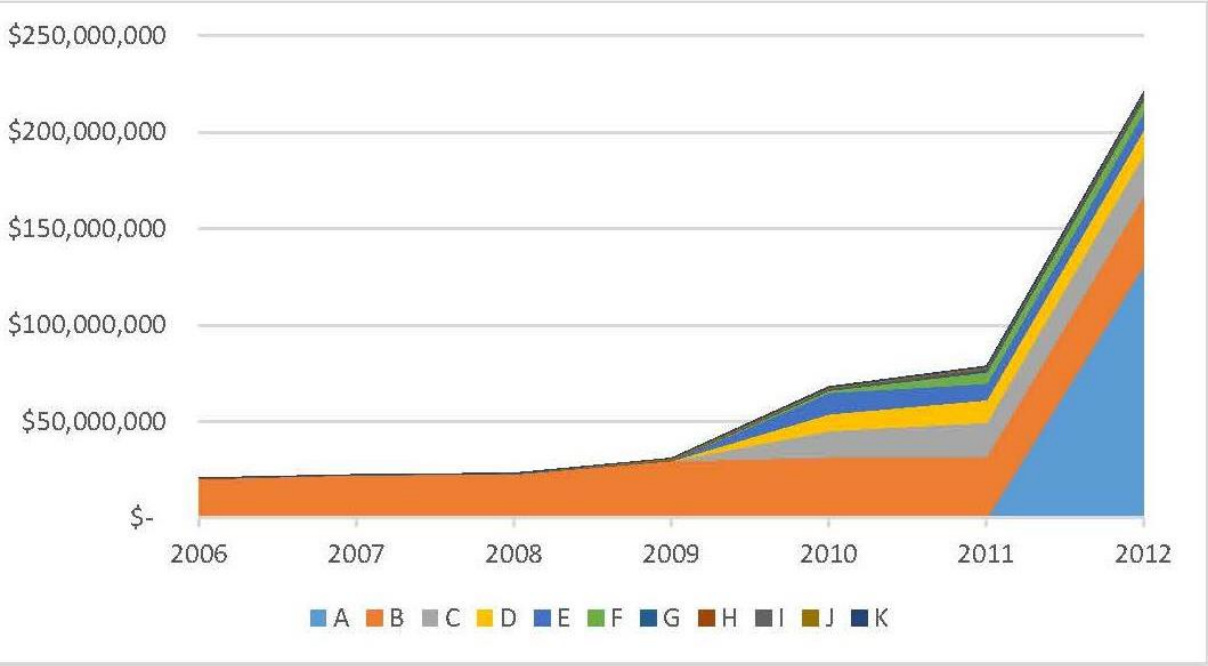


Figure 2. R&D Expenditures from International Sources for "Big 11" Institutions

One institution is a clear outlier, increasing in the order of $30 million for each of the three years for which data were reported. Given the substantial amount of funding at these institutions, the increases cannot be explained simply by a single new grant or contract or the ending of an existing grant or contract, which probably explains fluctuations in annual R&D expenditures at smaller institutions.

Results (Figure 3) indicated a strong commitment for U.S. institutions from European Union and Middle East countries. These are predominantly awarded as grants (59.5%) rather than contracts (40.5%). The median percentage of R&D expenditures from international sources that was expended for R&D projects in medical schools was 10.07%. Responses to questions concerning personnel supported by international R&D expenditures were too few to provide meaningful results.

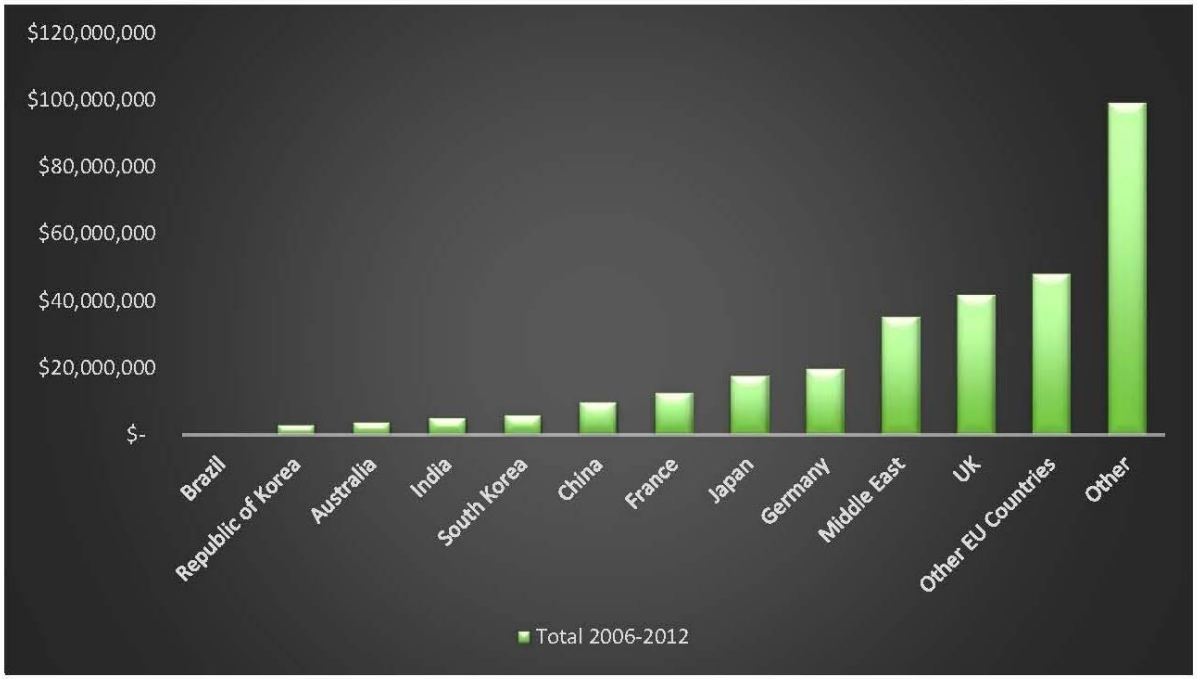


Figure 3. Total R&D Expenditures Funded by International Sources, by Country/Region, for 2006–2012

CONCLUSION

Overall, for all higher education institutions in the United States that report data in the annual NSF Higher Education Research and Development Survey, R&D from international sources still represents only about 1% of all R&D expenditures (National Science Foundation, National Center for Science and Engineering Statistics, 2015). The author had hypothesized that no difference would be found in the success rates of institutions within similar areas of research excellence in attracting international research support of R&D. This hypothesis was not supported since institutions did report varying levels of success (Figure 2). International funders are investing in U.S. universities, and many institutions are successfully attracting those funds at significant levels. Additionally, this study revealed that for successful institutions, international support for R&D expenditures is increasing over time even while total R&D expenditures fluctuate. A limitation to focusing on this population is a possible bias in the outcomes because the results may not be generalizable to the population. Given the increased interest in international collaboration, flat funding trend in the U.S., and the rise in R&D investment outside the U.S., U.S. universities would be wise to seek non-U.S. sources of support in order to increase R&D funding.

Recommendations for Further Study

This study's results suggest further research questions to be explored: In what ways do strategic directions of international sponsors diverge from or dovetail with focused areas of interest/ development of U.S. sponsors? Does the pattern of divergence/dovetailing give each institution a particular international funding "footprint" that is legible in the proportion of international sources of funding? Do U.S. institutions strategically develop such a footprint in order to internationally diversify funding sources? Do smaller, newer institutions/programs have a degree of tactical or strategic flexibility that older more established institutions/programs cannot match in this regard? What are the factors influencing the likelihood of a given country to fund a project (e.g. where the country is located, salient policies for that country, national income, a "good ole' boy" system)? Are international sponsors using U.S. expertise to bolster and grow their own domestic research institutions through funding strategic networking and partnership opportunities with U.S. institutions? If so, how do U.S. institutions leverage those opportunities to strategically pursue their own research growth and development agenda, and grow Ph.D. and postdoctoral applications from non-U.S. scholars? Do U.S. institutions need to develop an international partnership strategy that takes these opportunities into account, or is the question irrelevant at the institutional level?

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