

## Developing International Research Collaborations: Findings from the Evaluation of the International Research Fellowship Program

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Over a decade ago, the National Science Board (NSB) highlighted the importance of international collaboration in science and engineering (S&E) and noted that “international boundaries have become considerably less important in structuring the conduct of research and development” in S&E fields.<sup>1</sup> Further, the NSB identified the National Science Foundation (NSF) as having an important leadership role in international S&E research and education activities.<sup>2</sup> A specific area of focus for NSF was promoting “...increased participation in international S&E activities by younger U.S. scientists and engineers from diverse backgrounds, especially those in the early stage of their careers, in order to develop an internationally competitive and globally-engaged S&E workforce.”<sup>3</sup>

Through its International Research Fellowship Program (IRFP), NSF awards merit-based postdoctoral fellowships for research, lasting 9 to 24 months, to be conducted in a foreign location. Thus, IRFP aligns closely with the NSB’s call for NSF to support the international science engagement of scientists and engineers. NSF has over a dozen sources for funding postdoctoral fellowships, and policy decisions about this portfolio of programs require information about whether the specific programs are meeting their goals, and what role they play in the career development of early-career scientists.

Abt Associates conducted an evaluation of IRFP, to gather evidence about whether the IRFP program has achieved its purpose of furthering the collaborative activities and international partnerships of early career STEM researchers. The evaluation found evidence that the IRFP program is meeting its goals, which are to:

- Introduce early career scientists and engineers to opportunities for international research collaboration;
- Build research capacity and global perspective of participants; and
- Forge long-term relationships between U.S. and foreign S&E researchers.<sup>4</sup>

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<sup>1</sup> National Science Board. 2001. *Toward a More Effective Role for the U.S. Government in International Science and Engineering*. NSB-01-187. National Science Foundation, Arlington, VA.

<sup>2</sup> National Science Board. 2000. *Toward a More Effective NSF Role in International Science and Engineering, Interim Report*. NSB-00-217. National Science Foundation, Arlington, VA.

<sup>3</sup> NSB. 2000, p. 10.

<sup>4</sup> The full evaluation report is available online at <http://www.abtassociates.com/Reports/2012/Evaluation-of-NSF's-International-Research-Fellows.aspx>. Martinez, A., Carter, E., Parsad, A. & Whittaker, K. 2012. Evaluation of NSF’s International Research Fellowship Program: Final Report. Abt Associates Inc., Cambridge, MA.

This paper describes the evaluation conducted to examine the effects of IRFP on the scientific preparation and international research collaborations of IRFP fellows. The evaluation findings are relevant to decisions for both NSF's policies supporting international S&E as well as postdoctoral fellowship programs.

## Background

*Effective international S&E partnerships advance the S&E enterprise and energize U.S. innovation and economic competitiveness, but they also have great potential to improve relations among countries and regions and to build greater S&E capacity around the world.*<sup>5</sup>

The importance of international collaborations in S&E cannot be overstated, as international research partnerships are increasingly important to advancing knowledge and discoveries and for addressing problems of a global nature. Through international networks of scientists, resources can be shared and ideas can be developed, tested, and implemented across traditional boundaries (NSB, 2008).<sup>6</sup> By assuming an active role in international collaborations, the scientists can expect to reap benefits that might not otherwise be realized. For instance, Luo et al. found that when researchers from the U.S. and the U.K. engaged in collaborations, the impact of their resulting research significantly increased (as measured by citation rates), especially for U.S. corresponding authors.<sup>7</sup> Additional benefits of international collaboration may include increased access to physical resources and funding; additional opportunities to benefit from the expertise of collaborators; and access to populations, records, historical materials, and circumstances that provide natural experiments.<sup>8</sup> Finally, allowing for international collaboration also serves as a way to facilitate the expansion of U.S. markets and to promote opportunities for international economic exchange.

The promotion of international collaboration also has impacts beyond the United States. As experts note, research and development in S&E fields can be costly, and it is increasingly necessary for countries to "transcend national boundaries in order to be able to fund

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<sup>5</sup> National Science Board. 2008. *International Science and Engineering Partnerships: A Priority for U.S. Foreign Policy and Our Nation's Innovation Enterprise*. NSB-08-4. National Science Foundation, Arlington, VA, p. 1.

<sup>6</sup> National Science Board. 2008. *International Science and Engineering Partnerships: A Priority for U.S. Foreign Policy and Our Nation's Innovation Enterprise*. NSB-08-4. National Science Foundation: Arlington, VA.

<sup>7</sup> Luo, J., Flynn, J., Solnick, R., Ecklund, E., Matthews, K., International Stem Cell Collaboration: How Disparate Policies between the United States and the United Kingdom Impact Research, PLoS One, 6(3), 2011. Available <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3050923/>

<sup>8</sup> Goodnow, J., The Benefits of Cross-Cultural Collaboration, International Collaborations in Behavioral and Social Sciences Research, Report of a Workshop, Committee on International Collaborations in Social and Behavioral Sciences Research, U.S. National Committee for the International Union of Psychological Science, National Research Council, 2006. Available [http://www.nap.edu/openbook.php?record\\_id=12053&page=24](http://www.nap.edu/openbook.php?record_id=12053&page=24)

projects.”<sup>9</sup> Additionally, important problems such as terrorist threats, climate change, and disease outbreaks exist, and therefore must be solved, on a global scale. By establishing international networks of scientists, resources can be shared and ideas can be developed, tested, and implemented across traditional boundaries.<sup>10</sup>

Finally, these partnerships can serve as an important tool in broader international diplomacy efforts. As the National Science Board explains, “science and engineering partnerships can strengthen international relationships and...promote basic scientific values such as accountability, meritocracy, transparency, and objectivity.”<sup>11</sup> Policymakers also note that the inclusion of developing nations in these collaborative efforts can promote self-sufficiency and encourage international participation in a variety of areas beyond S&E research.<sup>12</sup>

Limited research is available on the effectiveness of programs designed to promote international S&E collaboration. However, evaluations of programs similar to IRFP have found that individuals who participated in these programs reported gaining new knowledge and skills during their international collaboration. Many also reported that they would be likely to engage in international collaborations in the future, perhaps as a result of their international research experience. For instance, an evaluation of NSF’s International Research Experience Program, a program for undergraduate and graduate students that ended in 2008, found that students who engaged in an international research experience reported gaining technical, communication, and language skills; developed an appreciation for cultural differences; and felt that their research experience would “create opportunities for future international collaboration.”<sup>13</sup> An evaluation of the Research Internships in Science and Engineering (RISE) program reached similar conclusions. The RISE program provides funding for undergraduate students to complete summer internships in German higher education institutions. Researchers found that the majority of RISE student participants developed a greater understanding of German culture, the vast majority reported an increased desire to travel abroad, and about 1 in 4 alumni reported returning to Germany at some point in the future, either to visit or to pursue work/study opportunities.<sup>14</sup> Finally, an evaluation of NSF’s International Research and Education in Engineering (IREE) pilot program also found that program participants, especially

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<sup>9</sup> NSB. 2001.

<sup>10</sup> NSB. 2008.

<sup>11</sup> NSB. 2008.

<sup>12</sup> NSB. 2008

<sup>13</sup> Spencer, D. 2008. *International research experience program: International research opportunities for students at NSF science and technology centers*. Retrieved from <http://66.116.177.96/IREP%20Evaluation%20Report.pdf>

<sup>14</sup> Institute of International Education, 2009.

graduate and postdoctoral students, reported acquiring new research capabilities, and that they planned to continue collaborations with their international counterparts at the end of their program experience.<sup>15</sup>

## Methods

This study was designed to evaluate the extent to which NSF's IRFP program contributes to the engagement of postdoctoral S&E researchers in international research collaborations. Specific research questions included:

- Does the extent to which former fellows engage in international collaborations differ from those of unfunded applicants?
- Do fellows' post-award career activities and job characteristics differ from unfunded applicants?
- Do the outcomes of program participation extend beyond the direct participants?

Evaluating this merit-based program posed challenges related to identifying a comparison group that would represent the appropriate counter-factual. To control for self-selection, or the inclination to engage in research overseas and collaborations with investigators in foreign locations, the evaluation used as its primary source of comparison the unfunded applicants to IRFP. To reduce the risks associated with selection bias, the study incorporated propensity score analysis to construct groups of awardees and non-awardees that were statistically similar across a number of pre-existing characteristics, and applicants' qualifications and experiences before award decisions. We applied PSM to estimate the impacts of program participation on subsequent international engagement and professional outcomes. For each outcome, the impact of IRFP was estimated for each propensity stratum (controlling for number of years since PhD degree, underrepresented minority status, and gender, and also where applicable number of pre-award publications and field of study); then, the overall treatment effect was calculated by taking an average of the estimated treatment effects weighted by the number of treated observations (i.e., the number of awardees) within each stratum.

A secondary set of comparative analyses between IRFP applicants (and fellows) to a nationally representative sample of S&E doctorates from the Survey of Doctoral Recipients (SDR) helped to situate the outcomes of IRFP program participants and applicants within the national S&E context. Comparisons between SDR respondents and IRFP fellows were limited to SDR respondents who had completed a doctoral degree by the reference date specific to that SDR

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<sup>15</sup> Flattau, P.E., Lal, B., Laskey, A., & Ford, J. J. 2009. *Portfolio Evaluation of the National Science Foundation's Grants Program on "International Research and Education in Engineering" (IREE)*. Washington, DC: Institute for Defense Analyses, Science & Technology Policy Institute.

wave (April 1, 2006 in SDR 2006; October 1, 2008 in SDR 2008); and to IRFP fellows who had applied for IRFP prior to 2008 (N=379) and who had completed their IRFP fellowship by October 1, 2010. In addition, analyses controlled for gender, whether or not an individual was a member of an ethnic or minority group traditionally underrepresented in STEM fields (URM), field of study for the first doctorate, and the number of years between receipt of first doctorate and the reporting year of outcomes.

Data for the evaluation were drawn from extant sources, and surveys were administered to collect information from program applicants (both those who received IRFP fellowships and those who did not) and IRFP foreign hosts. Extant data came from NSF's administrative records on applicants and from the Survey of Doctoral Recipients (SDR). The core data for the evaluation were gathered through online surveys completed—from January through March, 2011—by IRFP applicants and hosts.

The target populations for the study included all individuals who had applied to the IRFP program from its inception in 1992 through 2009, as well as the research scientists who served as foreign hosts during this period. Responses were received from 457 IRFP fellows and 582 unfunded applicants; responses rates were 81 percent and 55 percent, respectively, and estimates were adjusted for non-response. Surveys were received from 328 hosts, for a 61 percent response rate.

## Findings

The fellowships provided opportunities for collaborations and advances in research. A majority of fellows credited their IRFP fellowship with allowing them to make substantial advancements in their research, and hosts and fellows agreed they worked collaboratively on important aspects of research projects. About two-thirds of fellows commented that their IRFP fellowship provided them with the chance to become familiar with the scientific enterprise in their host site (65 percent) and to make substantial advancements in their research (64 percent).

The evaluation investigated the impact of the program on international collaborations, comparing the extent to which former fellows' engagement in international collaborations differs from that of unfunded applicants (Exhibit 1). Findings indicate that compared to a matched group of unfunded IRPF applicants, IRFP fellows on average were more likely to establish productive international research collaborations. Specifically, statistically significant differences emerged, whereby fellows held a greater number of international postdoctoral fellowships;<sup>16</sup> produced a greater number of publications with a foreign co-author; and produced a higher percentage of publications with a foreign co-author.

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<sup>16</sup> The number of international postdoctoral fellowships is a measure of internationalization and not a measure of employment.

IRFP fellows had held an average of 1.1 international postdoctoral fellowships, whereas unfunded IRFP applicants had held an average of 0.63 international postdocs.<sup>17</sup> That the average number for fellows is close to one suggests that the IRFP was likely the only international postdoc they had ever held. The non-zero average for unfunded applicants means that some unfunded applicants did go on (after an unsuccessful application to IRFP) to hold at least one international postdoc. However, the statistically significant difference in the number of international postdocs reveals that some proportion of unfunded applicants never went on to a different (non-IRFP) international postdoc.

On average, IRFP awardees produced 12.8 publications with a foreign co-author, 6 more publications than unfunded applicants. Moreover, a statistically significantly higher percentage of IRFP awardees' publications were internationally coauthored than were those of unfunded applicants (37 and 27 percent, respectively). In terms of the number and rate of internationally co-authored publications, the IRFP program facilitates productive international research collaborations.

### Exhibit 1: Fellows' and Unfunded Applicants' Engagement in International Collaboration

Outcomes	Awardee Adjusted Mean	Unfunded Adjusted Mean	Impact Estimate	Impact Standard Error	P value
<b>Work with individuals outside the U.S.</b>					
Number of international postdoctoral fellowships	1.10	0.63	0.47***	0.08	0.000
Any employment outside the U.S. between 2 years after IRFP application and October 1, 2010	0.45	0.56	-0.11	0.07	0.131
Duration of any employment outside the U.S. during the reference period	4.10	3.14	0.96	0.75	0.201
In current job (as of October 1, 2010), works with individuals located in other countries	0.64	0.57	0.07	0.06	0.200
In current job, work with individuals in other countries includes joint publications and/or jointly-developed products	0.54	0.50	0.04	0.06	0.461
<b>Publications with foreign collaborator</b>					
Number of publications co-authored with a foreign collaborator	12.76	6.69	6.07**	1.99	0.002
Percent of publications co-authored with a foreign collaborator	37.17	26.50	10.67**	3.69	0.004
<b>Fostering international collaboration</b>					
Has mentored others from the U.S. traveling to another country to conduct research <sup>a</sup>	0.59	0.58	0.01	0.07	0.886
Engages in one or more activities to foster international collaboration <sup>a</sup>	0.72	0.64	0.09	0.07	0.204

\*p<.05, \*\*p<.01, \*\*\*p<.001

<sup>a</sup>These activities included one or more of the following: Established a program to foster international collaborations; hosted researchers or professional colleagues from another country at my institution; led a delegation of colleagues to visit a research laboratory, university, or business in another country; established or served in a leadership role for an international

<sup>17</sup> This figure includes the IRFP postdoctoral fellowship.

association for professionals in my line of work.

SOURCE: IRFP Applicant Survey—Items C9, D1a, D1b, D4, D4a, D6, D7, D7a, D8, D10.

The evaluation also explored whether the IRFP experience in a foreign country represented a detour with potentially negative consequences for fellows’ career paths, primarily to determine whether any observed benefits of IRFP resulted in trade-offs in terms of other professional accomplishments (Exhibit 2). Importantly, fellows’ international efforts did not come at the expense of research productivity or professional advancement. There were no statistically significant differences between IRFP fellows and unfunded applicants on career other outcomes. These findings are important for the IRFP program given criticism that time spent abroad may put individuals at a disadvantage relative to their peers who do not engage in these activities.<sup>18</sup>

**Exhibit 2: Fellows’ and Unfunded Applicants’ Career Outcomes**

Outcome	Awardee Adjusted Mean	Unfunded Adjusted Mean	Impact Estimate	Impact Standard Error	P value
Held two or more total postdoctoral appointments	0.60	0.51	0.09	0.06	0.111
Number of post-application publications	34.00	27.40	6.60	3.78	0.081
Currently holds a research faculty, scientist, associate or fellow position (solely or along with another type of academic position, e.g., teaching faculty, department chair, etc.)	0.62	0.62	-0.00	0.07	0.422
Currently has a faculty rank of Assistant, Associate or Full Professor	0.85	0.90	-0.06	0.05	0.424
Currently has tenure	0.55	0.49	0.06	0.08	0.444

\*p<.05, \*\*p<.01, \*\*\*p<.001

SOURCE: IRFP Applicant Survey—Items C9 and D1a, D1c, D2, D2a, D2c, D2d, and D6.

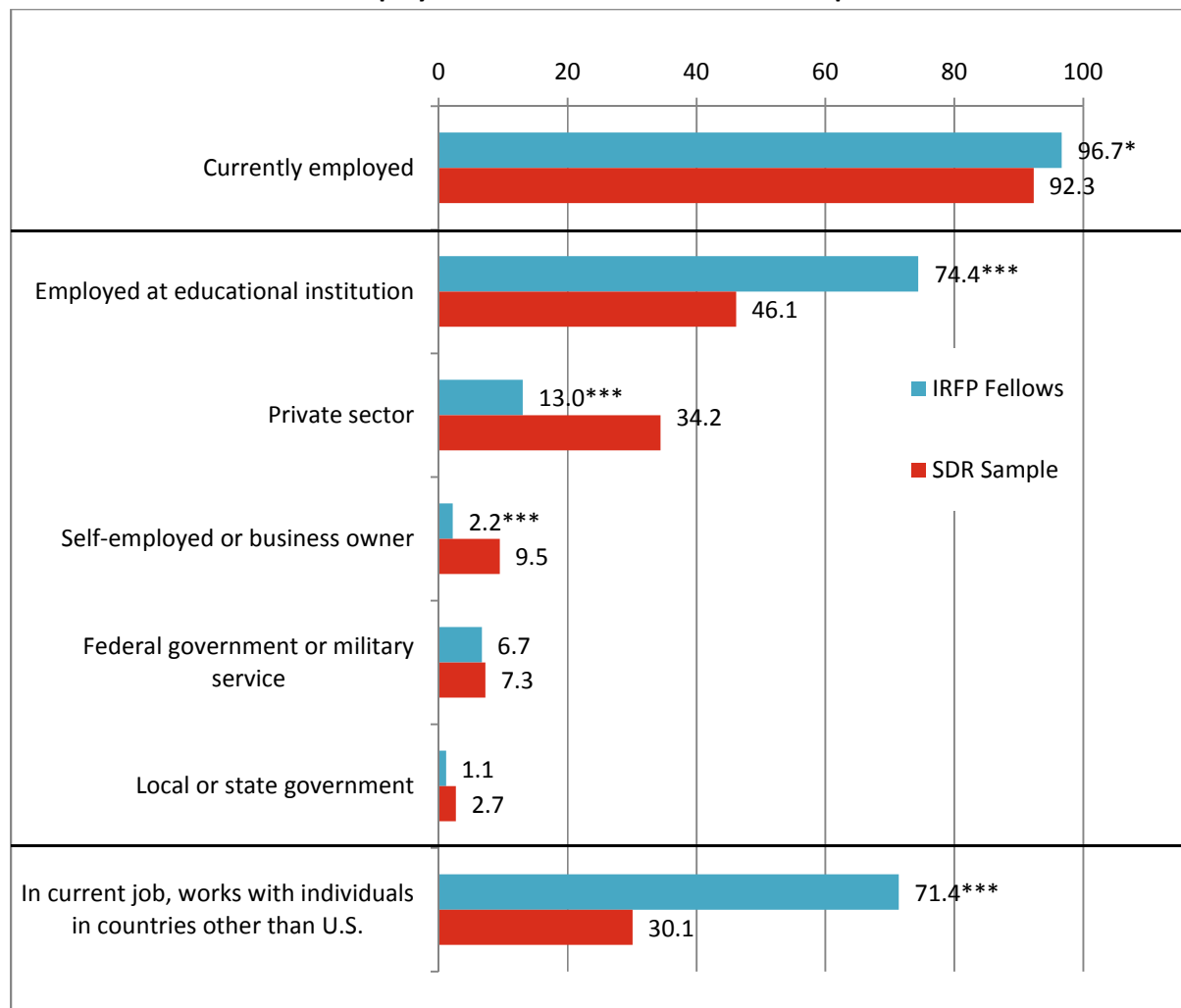
To situate IRFP fellows within a broader context, comparisons were made between fellows and respondents to the Survey of Doctoral Recipients (SDR), a longitudinal survey of a nationally representative sample of science, engineering, and health (SEH) doctorate recipients. The comparison of estimates on career outcomes of IRFP fellows to the national estimates indicate that IRFP fellows’ outcomes compare well against national SEH PhD holders on employment, publications, and international collaborations, suggesting that IRFP attracts a talented pool of applicants (Exhibit 3).

Specifically, IRFP fellows were more likely to work in their current job with individuals in countries other than the U.S. (71 percent) than the typical SEH doctoral recipient (30 percent), a large and statistically significant difference. Virtually all former fellows and virtually all SEH doctoral recipients in the U.S. were employed (97 percent and 92 percent respectively), but

<sup>18</sup> NSB. 2001.

IRFP fellows were more likely than the typical SEH doctorate to be working during a specified reference week, a statistically significant difference of 4.3 percentage points.

**Exhibit 3: Characteristics of Employment of IRFP Fellows and SDR Respondents**



\*p<.05, \*\*p<.01, \*\*\*p<.001

SOURCES: IRFP Applicant Survey—Items C9, D1c, D3, and D4. SDR 2008—Items A1, A11, and A12 and SDR 2006—Item A27.

Once IRFP fellows returned to the U.S., they have had the opportunity to share with colleagues any new skills, data, or methods acquired during their IRFP fellowship, and they have the opportunity to foster new international collaborations among their colleagues. More than three-quarters of former IRFP fellows shared resources or tools acquired during their postdoc abroad and taught colleagues, students or peers methods learned during this time (Exhibit 4). More than half of former IRFP fellows reported that the methods or ideas that they had learned benefited others at their institution (64 percent). Forty-one percent reported that samples or tools from their fellowship benefited others in their institution. Smaller proportions of fellows reported that their enthusiasm may have spread to others: 23 percent reported that their peers



became interested in international collaboration and 15 percent reported that members of their research group in the U.S. began an international collaboration.

**Exhibit 4: Extension of Fellowship Experience to Others as Reported by IRFP Fellows**

Activities Undertaken by Former IRFP Fellows' to Share Benefits of Their Fellowship	Percent who Engaged in Activity
Taught colleagues, students, or peers research methods that you learned during your IRFP fellowship	78.1
Shared with your colleagues resources or tools that you collected developed during your IRFP fellowship	75.4
Benefits of IRFP for Colleagues of former IRFP Fellows	Percent
Research methods or ideas that I learned benefited others in my institution	64.1
Sample that I collected or tools that I developed benefited others in my institution	40.8
My peers became interested in international collaboration	23.3
Others in my research group (in the U.S.) began an international research collaboration	15.4
Researchers that I met during my fellowship joined my research group in the U.S.	8.6
Other	7.1
None of the above	19.4

*SOURCE: IRFP Applicant Survey–Item D9, F4.*

Finally the study evaluation also explored whether the collaborations initiated during the fellowship extended beyond the fellowship period. Of the former fellows (1992–2009) who had completed their IRFP postdoctoral fellowship, 46 percent had since collaborated on research with their former host, and an additional 46 percent had communicated with their host after the fellowship period. During the continued collaborations, former fellows and hosts co-authored papers (82 percent), exchanged ideas, data, results or tools (80 percent) and visited each other at their respective institutions (44 percent). In some cases, continued collaboration extended to co-advising students (25 percent).

**Discussion**

The evaluation findings are informative for policy decisions. The evaluation found evidence that the IRFP program is meeting its goals, which are to: introduce early career scientists and engineers to opportunities for international research collaboration; build research capacity and global perspective of participants; and forge long-term relationships between U.S. and foreign S&E researchers. Specifically, statistically significant differences were found in the number of international postdoctoral fellowships held, the number of publications with a foreign co-author and the percentage of publications with a foreign co-author. Importantly, this international focus did not come at the expense of research productivity or professional advancement. Fellows and their peers were equally likely to hold multiple postdoctoral appointments, and were equally productive researchers, equally likely to hold a faculty rank of assistant, associate, or full professor, and equally likely to be tenured.

A unique feature of IRFP is its focus on providing international research experiences for postdoctoral fellows. Individuals who participate in IRFP develop their knowledge and research skills, broaden their perspectives, and contribute to the global understanding and research enterprise more broadly. A majority of fellows credited IRFP with opening up new areas for investigation and familiarizing them with the scientific enterprise in their host site. Three-quarters of fellows also observed that IRFP qualified them for a broader range of career options, and two-thirds felt it contributed to making them more competitive for jobs.

The evaluation provides evidence that these experiences lead to greater levels of international research engagement among fellows. Fellows ranked consistently higher than unfunded applicants on several facets of international research, including the number of international postdoctoral fellowships, the number of publications with a foreign co-author, and the percentage of publications with a foreign co-author. The fellows' research productivity is consistently higher across all three measures.

Importantly, this international focus did not come at the expense of research productivity or career advancement. Specifically, fellows and their peers were equally likely to hold multiple postdoctoral appointments, and were equally productive researchers, equally likely to hold a faculty rank of assistant, associate, or full professor, and equally likely to be tenured.

Further, the program demonstrates potential to reach beyond the immediate participants. More than three-quarters of former IRFP fellows shared resources or tools acquired during their international postdoctoral fellowship and taught colleagues, students or peers methods learned during this time.

Further, the relationships developed during IRFP seed subsequent professional collaborations and activities. Many IRFP fellows developed professional relationships that endured beyond the fellowship period, through subsequent collaborations with their hosts and/or additional communications. The continuing collaborations reported by a large proportion of former fellows and hosts included co-authored papers and exchanged ideas, data, results or tools. They also visited each other at their respective institutions, and co-advised students. Also, there is evidence that the collaborations may be seeding networks, as fellows interact with hosts' research groups, and as hosts establish collaborations with other U.S researchers as a result of their participation in the IRFP program.

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