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The Effects of the Foreign Fulbright Program on Knowledge Creation in Science and Engineering

Shulamit Kahn and Megan MacGarvie

3.1 Introduction

The science and engineering workforce is becoming increasingly global. The share of science and engineering (S&E) doctoral degrees produced outside the United States has grown in recent years (National Science Foundation [NSF] *Science and Engineering Indicators* 2010), and some countries have increased their efforts to attract star scientists.[1] International migration of the highly skilled has become a hotly debated topic, with some experts pointing to "brain drain" (whereby the most talented citizens of a lower-income country are lured away by opportunities in countries like the United States) and others highlighting "brain circulation" (whereby individuals trained in the United States disseminate knowledge back to their home countries).[2] Many countries with relatively low levels of scientific activity subsidize the costs of doctoral education for their citizens in countries with cutting-edge research environments. Historically these investments have had limited success in the sense that many PhDs have not returned to their home countries. Some governments counter this tendency by requiring funded students to return home post-PhD. Alternatively, students may be encour-

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1. The Canada Research Chairs program and the Australian Research Council's Federation Fellowships offer incentives to attract researchers to these countries.

2. See Saxenian (2002).

aged to study under the US Fulbright Program, which also requires students return home post-PhD.

The Fulbright Foreign Student Program, established in 1946 and primarily sponsored by the US Department of State, is the main US government program that brings students from other countries to pursue graduate study in the United States.[3] Since its inception, it has given scholarships to more than 125,000 foreign students to do graduate work in the United States. The total budget of the Fulbright program was $374.4 million in fiscal year 2008.[4] The Department of State describes the Fulbright program as "our country's premier vehicle for intellectual engagement with the rest of the world." Students who receive a Fulbright Scholarship for study in the United States come on a J-1 student visa that requires them by law to leave the United States when they finish their education and to spend at least two years in their home country before they can return to work in the United States.

Despite the long history and apparent importance of this program, we could find no formal evaluation of this program done before 2005. In 2005, SRI International was commissioned by the Department of State to survey a group of Fulbright foreign student graduates and evaluate whether receipt of Fulbright funding had indeed fostered international understanding (SRI 2005). They did not evaluate the impact of these foreign Fulbright scholars on their home countries' intellectual environment or on their contribution to global knowledge.

More generally, little is known about whether any US graduate study sponsorship requiring foreign students to return to their home countries—be it through the Fulbright Foreign Student Program or through foreign governments' programs—has been successful in improving foreign countries' research capabilities. While the program may benefit home countries by increasing return flows of highly skilled human capital, these students may have fewer opportunities to do cutting-edge work because they are required to return to countries that have less funding for research and relatively inadequate scientific infrastructure. This may lower global knowledge creation compared to a situation without these return requirements.

Given the evidence on the importance of foreign-born scientists for research in science (Levin and Stephan 1999; Stephan and Levin 2001), as well as the United States' substantial financial commitment to the Foreign Fulbright Program, it seems reasonable to ask what impact the program has on the production of scientific knowledge in the United States itself. While the main objectives of the program are the furtherance of mutual understanding and foreign policy-related goals, we can also test the hypothesis that students supported by the Fulbright program and, therefore, required to

3. Also called the Fulbright Visiting Students Program.

4. Foreign governments contributed $74.2 million to this total, and private sources (both domestic and overseas) provided $65.9 million. The number of grants to foreign students studying in the United States was approximately twice the number of grants to US students studying overseas.

leave the United States contribute less to US-based research than otherwise similar foreign students.

Alternatively, research on knowledge flows across space has shown that connections between researchers are surprisingly persistent (Agrawal, Cockburn, and McHale 2006). With growth in the potential for brain circulation and international collaboration due to faster and cheaper international communication and travel, scientists returning to home countries may find it easy to continue to access knowledge produced in the United States and at top research institutions globally. By creating links between home countries and other countries, the Fulbright program may increase rates of international collaboration and knowledge diffusion.

One of the reasons that so little empirical attention has been given to this topic is that little data is available on what happens to foreign graduate students once they leave the United States. This chapter begins to fill this void, concentrating on foreign Fulbright PhD students in science and engineering (S&E). We have collected a data set that tracks the career progression of 488 PhD scientists of foreign origin trained at US universities. Half of the scientists in our sample received fellowship funding from the Fulbright Foreign Student Program, the other half were chosen to resemble the Fulbrights as closely as possible along observable dimensions. Our data set is unique in being the only data set of which we are aware that tracks the career progression of individual US-trained PhD scientists, whether they leave the United States or not.[5] We supplement our data with descriptive statistics on the Fulbrights from the SRI (2005) study and other Fulbright Program materials.

These data allow us to address the following questions:

1. Has the Fulbright program itself attracted a foreign student body different from the population of foreign students without this funding? Has it, for instance, made it more likely for foreign students to receive US PhDs in some S&E fields or from some countries, compared to those foreigners studying in the United States without Fulbrights?
2. Do the return requirements of the Fulbright program promote mobility of US-trained PhD scientists to foreign countries?
3. Do foreign S&E Fulbright students create more or less knowledge and have more or less impact on their fields compared to other foreign students?
4. In what ways do Fulbright students contribute to their home countries' scientific environment and the US scientific environment compared to comparable foreign students?
5. Does the Fulbright Program indeed foster US-foreign scientific collaboration?

5. One can obtain information on foreign-born scientists who remain in the United States from the NSF's SESTAT database. Also, Michael G. Finn's (2007) research provides valuable information on the stay rates of PhDs of foreign origin.

To preview our findings, we find that the distribution of Fulbright students across countries of origin is substantially different from the distribution of other graduate students. We find that the Fulbright program does encourage more mobility of US-trained PhD scientists to home countries. In terms of knowledge creation and diffusion, we find that Fulbrights from richer countries have publication and citation records similar to comparable PhDs of foreign origin without return requirements, while Fulbrights from poorer countries publish less and have fewer citations. However, the most profound effect might be on the location of article production. Fulbrights produce substantially more articles listing home country authors and substantially fewer articles listing US authors. Nevertheless, the Fulbright program does seem to have achieved its goal of increasing US-home country links by increasing collaboration between these countries.

Before presenting these results in detail, we give some background on the Fulbright Foreign Student Program itself.

3.2 Background on the Fulbright Foreign Student Program

The Fulbright Program was established by Congress in 1946 to "enable the government of the United States to increase mutual understanding between the people of the United States and the people of other countries." The Fulbright Program includes not only the Foreign Student Program, but also a US Student Program that awards scholarships to US citizens for study in foreign countries and a Scholars Program that sends scholars and professionals to research and lecture in other countries, both US citizens abroad and foreign citizens to the United States. It is funded primarily by annual appropriations of the US Department of State and the Department of Education but also receives additional support from universities, foreign governments, foundations and corporations, with some of this support in kind—including tuition waivers, housing, and stipends from some universities. The annual budget of the entire Fulbright program was over $374 million in FY2008 to 2009.

The Fulbright Foreign Student Program is the primary international exchange program for graduate students in the United States. Since its inception through 2009, the Foreign Student Program has brought more than 128,146 students to US graduate programs. In the last Annual Report available (2008 to 2009), there were 3,193 foreign students receiving Fulbright support to study in the United States. This is a small number compared to the 283,329 international students who were enrolled in graduate programs in 2008 to 2009 (IIE 2009).[6] Fulbright-supported students were, however, the vast majority of international students sponsored by the US government.

6. The IIE's Open Doors Report on International Students in the United States 2009 (http://www.iie.org/en/Research-and-Publications/Open-Doors/Open-Doors-Data-Tables/2009/International-Students).

Not all of the students on Fulbrights are in doctoral programs. In fact, according to the SRI (2005) evaluation of a sample of those who received Fulbrights between 1980 and 2000, only 36 percent reported receiving a Fulbright doctoral candidate grant, although 42 percent said that they produced a doctoral thesis as a result of the Fulbright program as of the SRI 2004 survey. More than 48 percent *had* a PhD by then.

The Institute of International Education (IIE) administers the program for Fulbrights from most areas. Two organizations share responsibility with IIE for the Fulbright Foreign Student Program for the Americas and the Middle East/Northern Africa, respectively.[7]

Foreign Fulbright students came from 139 different countries in academic year 2008 to 2009. Since the Fulbright program's inception, students have come from 178 different countries. Only 31 percent of the Fulbright foreign students in recent decades studied natural sciences or engineering (excluding social science) (SRI 2005). Because we are primarily interested in the creation and diffusion of scientific knowledge, the samples that we took were limited to this 31 percent.[8]

Fulbright recipients are required to leave the United States after completing their doctorates, since the program is intended to promote understanding of the United States abroad. It is possible to apply for a waiver of the foreign residency requirement if a student falls into one of several very restrictive and quite rare categories.[9] Also, Fulbright recipients may delay their departure for a period for educational purposes; for example, for two years

7. America-Mideast Educational and Training Services, Inc. (AMIDEAST) administers the program for most students applying from the Middle East and North Africa. Latin American Academic and Professional Programs (LASPAU) shares responsibility with IIE for the Fulbright Foreign Student Program for the Americas.

8. In recent years, the Fulbright program has increased funding for science and engineering students through the International Fulbright Science and Technology Award. However, because this scholarship was introduced at the end of our sample period, we do not have any PhD recipients in our sample from this program.

9. The first route is for the student to ask his country of origin to file a "no-objection" statement. While this approach may work for students whose J-1 status arose from scholarship funding from a foreign government, it is almost never considered grounds for waiving the foreign residence for Fulbrights whose funding comes from the US government (Conversation with BU ISSO January 2008). Waivers may also be obtained if an Interested Government Agency (IGA) files a request on behalf of the student, stating that the departure of the student will be detrimental to its interest and that of the public. Our conversations with experts suggest that these waivers are obtained only in rare and special circumstances. Medical doctors may also obtain a waiver if they agree to practice in a region of the United States with a shortage of health care professionals. A third reason for a waiver of the foreign-residency requirement is the threat of persecution, in which "an exchange visitor believes that he or she will be persecuted based on his/her race, religion, or political opinion if he/she were to return to his/her home country." Finally, applications for waivers may be filed on the basis of "Exceptional hardship to a United States citizen (or legal permanent resident) spouse or child of an exchange visitor." The State department warns "Please note that mere separation from family is not considered to be sufficient to establish exceptional hardship." http://travel.state.gov/visa/temp/info/info_1288.html (accessed February 17, 2008). Finally, years working for international organizations such as the UN or World Bank are considered equivalent to returning home. This loophole affects economists and others in policy-relevant fields more than the natural scientists in our study.

of a postdoctorate and/or for up to three years of occupational or practical training (OPT) on-the-job immediately following the completion of their studies.[10] Thus, in principle, a Foreign Fulbright recipient could remain in the United States for up to five years following the receipt of a PhD before having to leave the country. Moreover, after they spend two years their home country, the Fulbright-subsidized PhD can apply for a work visa and return to the United States. The two years in their home countries need not even be 730 consecutive days, but could be a combination of summers or semester-long visits abroad or both while spending the rest of the time in a United States postdoctorate or in OPT.

Nevertheless, the enforcement of these rules is sufficiently stringent that almost all foreign Fulbright PhD recipients left the United States for some period of time following the completion of their PhDs. We discuss this in section 3.5.

In the next section, we describe how Fulbright fellowships are allocated across fields, countries, and universities and how Fulbright recipients are selected.

3.3 Has the Fulbright Program Itself Attracted a Group of Foreign Students Different from Foreign Students without This Funding?

Fulbright recipients are not a random sample of all foreign students studying in the United States. The distribution of Fulbrights across countries of origin, across US universities, and across fields is not necessarily the same as the distribution of all foreign graduate students in the United States. In this subsection, we explain the source of these differences.

Countries: Foreign students apply for Fulbright Fellowships through the Fulbright Commission/Foundation or US Embassy in their home countries. If there is no Fulbright organization in the home country, students apply through the US Embassy. Fifty-one countries presently have Fulbright Commissions. Materials on the Fulbright website assure applicants that grantees are selected through "an open, merit-based competition."[11]

Fulbright Commissions in home countries are funded jointly by the United States and partner governments and include half resident Americans and half home country citizens. The commissions plan and implement educational exchanges (both foreigners to the United States and Americans to their country, both students and scholars) and recruit and nominate candidates for fellowships as well as perform other functions such as fundraising, engaging alumni, supporting American Fulbrights in their countries, and so forth. The US-based Fulbright Foreign Scholarship Board (FSB) has

10. The OPT status allows students to work in their field of study for the purposes of obtaining on-the-job training.

11. Available at: http://fulbright.state.gov/about/frequently-asked-questions, accessed Jan. 11, 2011.

input into the process and has final responsibility for the approval of selected candidates. In countries with no Fulbright Commission, the US Embassies and FSB play a greater role in selection.

While we do not have information on the precise kinds of considerations the commissions, embassies, or the FSB presently or in the past have taken into account in their choices among candidates, we can infer some from the facts. The most recent Fulbright Annual Report lists the number of Fulbright scholars from each country for the most recent year (AY2008 to 2009) and over the entire sixty-three years since its inception. These numbers and their comparisons indicate some clear priorities. First, there is wide variation in the number from each country, ranging from 1 (from Equatorial Guinea and others) to 21,819 from Germany over the entire 63-year period.[12] The variation is clearly not random. Germany was a full 17 percent of the total number of students over the 63 years, but only 8 percent in AY2008 to 2009, and other countries in Europe also saw their proportion of the total fall proportionately. On average, Europe sent 60 percent of the foreign Fulbright students from 1946 to 2009, but by the end of that period it was sending half of that percentage.

Why so many from some countries and not from others? First, it is clear that the changing patterns by country over time reflect political relationships between the United States and the sending country. Post–World War II, US foreign policy was heavily concentrated on rebuilding Europe and strengthening ties with Western European countries. Hence, while recently Fulbrights from Europe were 30 percent of the total, over the entire 62 years (including the post–World War II years), they were 60 percent. Soviet bloc countries did not send Fulbrights at all during the period of the United Soviet Socialist Republic (USSR). Africa has become more important over time so that, in the most recent year, 7.6 percent of Fulbright foreign students came from Africa, while the 62-year average was only 4.5 percent. The same trend is evident for the Middle East. In South America, Chile, and Brazil both had notable growth percentage-wise.

Second, the United States and foreign governments share the cost of the program to varying degrees, and countries willing to put considerable resources into funding Fulbright students send more students. In 1990, Germany contributed 71.4 percent of the budget of the German binational commission, while Japan contributed 62 percent of the budget for its program. Most other higher-income countries appear to have contributed in the range of 40 to 50 percent of the budget for their country.[13] Poorer countries contribute far smaller shares of the budget, generally less than 10 percent.[14]

12. The second largest was France at 6,469.

13. The UK contributes 40 percent, France 39 percent, South Korea 39 percent, the Netherlands 55 percent, and so forth.

14. Pakistan contributed approximately 1 percent of the budget in 1990, Colombia 2 percent, and Egypt 1.6 percent. (Annual Report of the Foreign Scholarship Board [FSB], 1991.)

Interestingly, Pakistan has recently become the single largest Fulbright program, thanks to a $90 million initiative funded by the US Agency for International Development (USAID) and the Pakistani Higher Education Commission that began in 2005.[15] A similar initiative was recently launched to increase Fulbright funding for science and engineering students from Indonesia. These initiatives, reflective of current US foreign policy goals, illustrate the extent to which the geographic emphasis of the Fulbright program can vary over time.

We also find evidence that countries with commissions send more Fulbright students than countries without commissions. Two thirds (66 percent to 71 percent) of Fulbright foreign students were from countries with Fulbright commissions, yet those countries with commissions held only 16 percent of the population of all countries that had ever sent Fulbrights.[16] Of course, those countries with commissions will tend to have closer political ties to the United States as well, so it is difficult to separate the contributions of commissions. Nevertheless, the existence of an ongoing body committed to maintaining Fulbright exchanges is bound to increase those exchanges. In addition, commissions help raise funds from nongovernmental sources to support grants.

Even in countries without commissions, there is a great deal of historicity in the patterns of foreign Fulbright students by country. One reason may be that some individual professors and universities are particularly enthusiastic about the Fulbright program and are likely to encourage students to apply. In the SRI (2005) survey, a full 60 percent said that they had received encouragement from their home university or professors to apply for a Fulbright scholarship.

Our data set includes people sponsored by the Fulbright program during the 1990s, in order to allow time to track post-PhD career progressions. In our data set, the Fulbrights come from 79 different countries—similar to the number of countries in the program overall in 2008 to 2009 with 10 or more students (FSB Annual Report 2009). The distribution by country is given in table 3.1. Our sample coincides with a period during which many Fulbright doctoral students in science and engineering came from Mexico. A full 38 percent of our sample comes from Mexico, although only 3 percent of all Fulbright foreign students were from Mexico in 2008 to 2009 and only 2.4 percent were from Mexico on average over the 62 years. This also reflects variation across countries in the use of the Fulbright program to fund students in doctoral rather than master's or other programs or in their tendency

15. "The USAID, HEC Expand Fulbright Scholarship Program; Initiative Called 'Investment In Pakistan's Future'" (press release of the US Embassy in Islamabad, April 6, 2005).

16. The two-thirds applies both to 2008 and 2009 and to the entire sixty-two years from numbers in the Fulbright Annual Report. The 16.1 and 71.5 is from the population numbers for 1993 to 1997 for Fulbright. Note that these are countries with commissions at the end of this period. Some of these countries did not have commissions earlier on.

Table 3.1 Distribution of controls and Fulbrights by country of origin

Country of origin	Controls	Fulbrights	Total	Country of origin	Controls	Fulbrights	Total
Argentina	3	4	7	Kenya	0	2	2
Armenia	1	0	1	Korea	8	0	8
Australia	0	4	4	Lesotho	0	1	1
Austria	3	3	6	Lithuania	0	1	1
Bangladesh	2	0	2	Macedonia	1	0	1
Belgium	1	3	4	Malawi	1	1	2
Bolivia	0	1	1	Malaysia	1	0	1
Botswana	0	1	1	Mexico	9	93	102
Brazil	11	0	11	Morocco	0	2	2
Bulgaria	1	0	1	Netherlands	4	5	9
Canada	8	0	8	Nigeria	2	0	2
Chile	3	0	3	Norway	2	6	8
China	18	0	18	Pakistan	2	0	2
Colombia	4	8	12	Panama	1	1	2
Costa Rica	0	3	3	Peru	2	2	4
Cote D'Ivoire	0	2	2	Philippines	3	2	5
Croatia	1	1	2	Poland	1	1	2
Cyprus	1	0	1	Portugal	2	19	21
Czech Republic	3	1	4	Romania	5	1	6
Denmark	2	4	6	Russia	9	0	9
Ecuador	1	0	1	Singapore	1	0	1
Egypt	2	0	2	Solomon Islands	0	1	1
Ethiopia	2	2	4	South Africa	0	7	7
Finland	2	5	7	Spain	6	7	13
France	2	0	2	Sri Lanka	1	0	1
Germany	10	0	10	Swaziland	1	0	1
Ghana	0	2	2	Sweden	2	3	5
Greece	4	7	11	Switzerland	3	1	4
Guatemala	1	1	2	Taiwan	7	0	7
Haiti	0	1	1	Tanzania	1	1	2
Hungary	3	1	4	Thailand	5	5	10
Iceland	2	7	9	Togo	0	2	2
India	25	0	25	Trinidad & Tobago	1	1	2
Indonesia	4	0	4	Turkey	11	1	12
Iran	1	0	1	UK	2	4	6
Iraq	1	0	1	Uganda	1	2	3
Ireland	2	1	3	Ukraine	5	0	5
Israel	3	6	9	Venezuela	2	1	3
Italy	5	3	8	Yugoslavia	3	0	3
Japan	5	0	5	Zimbabwe	1	0	1
Jordan	1	0	1	Total	244	244	488

to send students studying S&E rather than other fields. For example, despite the fact that Germany had the largest budget for Fulbright students in 1993, all but a handful of the German Fulbrights entering PhD programs in the United States in 1994 were enrolled in nondegree programs, presumably temporary exchange programs. Of the nineteen Spanish Fulbrights entering

programs in 1994, only one was pursuing a doctorate in S&E, with the others enrolled in master's or nondegree programs, mostly in nonscientific fields. By contrast, of the ninety Mexican Fulbrights arriving in 1994, sixty-four enrolled in S&E doctorates.

Universities: The Institute of International Education (IIE), headquartered in New York City, facilitates the placement of many Fulbright nominees at academic institutions and communicates with Fulbrights during their stay in the United States. In some countries (e.g., Canada, France, Germany, and Australia, and formerly the UK), students apply directly to universities, in many cases applying for Fulbright funding once they have been accepted. For students from most other countries, the IIE works with the binational commission and the student to obtain a place at a university once the student has been awarded a Fulbright. The IIE also acts as a liaison with the university and often helps students obtain additional financial support from the university. In many countries, Fulbright commissions guide the Fellows toward particular US universities and are sometimes influenced by the availability of supplementary fellowship funding from the university or the lower tuition costs of public universities or both.[17] Finally, the Fulbright Foreign Scholarship Board's policies encourage geographic diversity, stating that "Every effort will be made to affiliate grantees at institutions in all geographic areas of the United States, and at all types and sizes of institutions, provided that such affiliation is not detrimental to the goal of providing the best possible academic experience for the grantee."[18]

The SRI (2005) survey gives us a sense of how many Fulbright foreign students end up being assigned and how many choose their institutions. Of their sample of Fulbright foreign students in 1980 and 2000, 47 percent said they knew which university they wanted to attend before applying for the Fulbright, and 29 percent were either assigned to the university or were given a choice between two universities. The remaining 24 percent did not know which school they wanted to attend before applying to the Fulbright, but were not assigned.

In the data set used in this chapter, 156 students or 32 percent of the sample obtained degrees from universities in the Northeast, and 122 (25 percent) obtained degrees from Midwestern universities. There were 90 degrees (18 percent) that came from Southern universities, and the remaining 120 students or 25 percent of the sample received degrees from Western universities. A large share of the universities in our sample are publicly funded.

Fields: Within the S&E area, table 3.2 gives the distribution by fields in our sample, using the NSF major field classifications further aggregated into

17. Conversation with IIE representative, June 2009.

18. Available at: http://fulbright.state.gov/fulbright/become/programwork/program-structure-and-rules.

Table 3.2 **Distribution of controls and Fulbrights, by first-listed field of study**

	Controls	Fulbrights	Total
Agricultural sciences	30	34	64
Biological sciences	47	53	100
Engineering & computer sciences	86	82	168
Earth/air/ocean sciences	21	17	38
Mathematics & statistics	21	22	43
Physical sciences	27	23	50
Environment science	12	13	25
Total	244	244	488

seven categories because of the small size of our sample. The distribution across fields is slightly different for Fulbrights and controls because this is the first field listed in the person's (ProQuest) dissertation record. Occasionally, people listed two or more fields and we sometimes had to match Fulbrights and controls on their second field. The two distributions are not significantly different from each other (the *P*-value of a Chi-square test is 0.965). We also matched the field division to the overall distribution across S&E fields among Fulbright foreign students 1980 to 2000 (SRI 2005) and found that this was also remarkably similar ($P = .9999$). Of all PhDs in science granted in 1996 (the year closest to our median year of degree for which data were available), 45 percent were in math, computer science, or engineering, while the equivalent figure in our data set is 43 percent.[19] Of all US PhDs in 1996, 55 percent were in the natural sciences, in contrast to 57 percent of our sample.

3.4 Data Set

In order to understand whether and how Fulbrights PhD scientists' careers unfold differently from the careers of other foreign students who received their PhDs in the United States, we have collected a sample of 244 Fulbright scholars who were receiving a Fulbright foreign student fellowship to study in a PhD program in a science or engineering field between 1993 and 2005. To create this sample, we took all Fulbright scholars who completed a PhD at the institution listed in the *Foreign Fulbright Fellows: Directory of Students* for whom we could identify a location for at least half of the post-PhD period and for whom we could identify a match. We wanted to match each of these Fulbrights with a non-Fulbright foreign student who was as similar as possible to the Fulbright in terms of research potential. The characteristics

19. Data on the distribution of doctorates across fields in 1996 comes from *NSF Science and Engineering Indicators 2000.*

that we a priori believed to be most relevant for future research output while being easily identifiable include institution, advisor/field, date of graduation and, where possible, region of origin. Therefore, we used the ProQuest Dissertations and Theses database to obtain information on the year of graduation and advisor and to identify a "control" student of foreign origin who did *not* have post-PhD location restrictions, whose location could also be found on the web for at least half of their post-PhD years, and who was similar along the previous dimensions, that is, he or she graduated from the *same* program in the *same* year and, whenever such a student existed, with the same advisor and from the same region.[20] Since students who receive substantial funding from their home country's government often are required to return for some period, we searched PhD acknowledgements for evidence of foreign governmental funding and did not include the student as a control if we found any.

When several potential control students were identified for a single Fulbright fellow, we chose the student who came from the same or similar countries as those represented in the Fulbright sample. Table 3.1 lists the countries of origin of our Fulbright and control samples. It is clear that the distribution of students across countries in the treatment and control groups, while similar, is not identical. There are several reasons for this. First, the distribution of Fulbrights across countries is affected by all of those factors we discussed earlier—most notably the past and present government policies and the presence of commissions or specific individual or institutional boosters. Second, because many students from certain countries receive government funding, we were less likely to select controls from those countries. There are two cases where the differences in the numbers of Fulbrights and controls are substantial enough to be noted. There are no Fulbrights in our sample from China or India so we tried to avoid sampling controls from these countries, but when a suitable control could not be found from another country we allowed control students of Chinese and Indian origin in the sample. Also, in our sample there are many Fulbrights from Mexico but few controls since most of the Mexican students in the United States without Fulbright fellowships are subsidized by their governments. Data appendix A gives a more detailed description of how we identified control students, made sure that they were not getting major funding from their own government, searched for the locations of both the Fulbrights and their controls, and found their publication and citation information.

It is possible that our sample differs in important respects from the population of Fulbrights or foreign students in general due to our method of

20. In cases where there was no control student with the same advisor in the same year, we identified a student with the same advisor graduating within three years before or after the Fulbright. If no students met the latter criteria, we chose a student graduating in the same year in the same major field, but with a different advisor.

collecting data. Particularly, it is possible that the students for whom we are able to find location data over the Internet will be more research-active than students we were unable to find, because one of our sources for location data is the publication record itself. However, it is important to note that, because we apply the same search criteria for all the students in our database, any biases introduced by our procedure apply equally to Fulbrights and controls.

In the following sections, we use these data to compare mobility, publications, citations, and collaboration patterns for the 488 foreign students who received US doctorates in S&E. As explained earlier, the sample was constructed with the aim of choosing controls that are observationally identical to the Fulbright students. Nevertheless, in the regressions we also include control variables to account for any differences that may exist between treatment and control groups as well as differences across the 244 pairs. All of the analysis includes the following control variables:

Ranking of PhD Institution: We use the (log of the) 1995 relative ranking of the US PhD institution (by field) from the National Research Council (Goldberger, Maher, and Ebert Flattau 1995) as a control for the quality of PhD training. Note that a lower rank signifies higher quality.

Field Dummies: Fields differ widely in the number of articles published per year and even in conventions regarding citing precedents. We categorized each student by the first field listed in their (ProQuest) dissertation record. We divided fields into the seven groups listed in table 3.2.[21] Since the control was chosen from the same department as the Fulbright, the distribution across fields of study should be exactly identical. There are differences, however, since often the fields specified in ProQuest are quite narrowly defined and many dissertations list more than one field. Students of the same advisor and department may list different fields and, even if the fields listed are identical, might choose to list them in different order.

PhD Year Dummies: The PhD year is divided into 6 categories (<1995, 1995 and 1996, 1997 and 1998, 1999 and 2000, 2000, 2001 and 2002, and >2002.)[22] Table 3.3 divides our sample by PhD year and we once again see a similar but not identical distribution between Fulbrights and controls, since the control was the closest available foreign student within three years

21. Because of the limited number of observations, we could not meaningfully divide the field dummies into more categories and we were unable to converge the instrumented model for most output variables. We experimented with different field groupings and qualitative results were not affected.

22. While in principle we would have wanted to use a full set of dummies for year and years since graduation, in practice we found it difficult to estimate some of our models including a full set of dummies. We *have* estimated some regressions with dummies for each year and did not find results to differ substantially from the results using the more grouped year variables. This is likely due to the fact that our samples of controls and Fulbrights are similar in terms of PhD year.

Table 3.3 Distribution of controls and Fulbrights, by year of PhD

Year of PhD	Controls	Fulbrights	Total
1991	1	0	1
1992	2	0	2
1993	7	5	12
1994	15	17	32
1995	11	23	34
1996	31	27	58
1997	45	36	81
1998	38	40	78
1999	33	34	67
2000	28	22	50
2001	13	22	35
2002	9	10	19
2003	7	6	13
2004	2	1	3
2005	2	1	3
Total	244	244	488
Average	1997.881	1997.897	1997.889

of the Fulbright's PhD (although the mean and median year of graduation are the same.) Note that since our variables cover the span of time from PhD until 2007, PhD year also proxies for the length of the period over which the person can accumulate publications, citations, and collaborations.

Gender: We obtained data on the gender of the scientist using information from web searches (e.g., photographs, the use of personal pronouns in web bios), using a web-based algorithm for identifying the probable genders of given names when no other information was available.[23]

Log of Real GDP Per Capita of Home Country (Five Years before PhD Receipt): The gross domestic product (GDP) per capita of the scientist's country of origin may affect the quality of predoctoral training or the average financial resources available for the student's doctoral education and may also capture the standard of living in the environment of returnees.

Tables 3.2, 3.3 and 3.4 give descriptive statistics on the control variables.

3.5 Does the Fulbright Program Promote Mobility of US-trained PhDs to Foreign Countries?

Most Fulbrights return to their home country for some time post-PhD, as required. Only 12.3 percent of our Fulbright sample appeared to have remained in the United States continuously and 23.4 percent appeared never to have been in their home country post-PhD and thus to not have fulfilled

23. The gender-guessing program is found at: http://www.gpeters.com/names/baby-names.php.

their home country residency requirement, although they could have fulfilled the requirement in short segments that we did not observe. For the other 76.6 percent of the Fulbright students in our sample, we were able to find evidence that they did spend some time in their home country after receiving their PhDs, compared to only 36.1 percent of our control group of US-educated foreign-origin non-Fulbrights.

We observe our sample of 244 Fulbright scholars for a total of 2,299 person-years post-PhD. 76.4 percent of these years are spent outside the United States and 63.9 percent in the home country itself. In contrast, the 244 controls spent only 34.5 percent of their 2,359 observed person-years outside the United States and 27.9 percent in their home countries. This US stay rate of approximately 65 percent for control students is nearly identical to the average stay rate estimated in a much larger sample by Finn (2007), who found that 67 percent of foreign students who received their doctorates in 1998 (close to the average PhD year in our sample) were observed in the United States in 2003. The top row of table 3.4 documents these dramatic differences in the rates of return to home countries between Fulbrights and controls.

We have empirically modeled the number of years spent either outside of the United States or in the home country as a function of the standard control variables listed earlier, including PhD year dummies. Each dependent variable is estimated using Poisson estimation in two different specifications related to the Fulbright variable:

1. With a single Fulbright dummy variable
2. With a Fulbright dummy and an interaction term between the Fulbright and the log of GDP per capita of their home country to allow different effects for different kinds of countries

The impact on location of being a Fulbright estimated from these regressions are given in table 3.5.[24] The results in this table indicate that Fulbrights of all income per capita levels spend substantially more time outside the United States than do controls, and spend this time in their home countries. The effect is largest for Fulbrights from lower-income countries, who spend 240 percent more time outside the United States than controls. The vast majority of the time they spend outside the United States is spent in their home countries. Even Fulbrights from countries at the 90th percentile of GDP per capita spend about 49 percent more years in their home country than do controls. There is no significant difference in the number of years spent in countries that are neither the United States nor the home country, with the difference being particularly miniscule for the wealthier countries.[25]

24. Full equations available upon request from authors.
25. Differences can be seen by comparing columns (2) and (4) of table 3.5.

Table 3.4 Summary statistics on controls and Fulbrights

	Mean	Standard deviation	Min.	Max.
Location				
Proportion of post-PhD yrs spent in the US (controls)	0.655	0.476	0	1
Proportion of post-PhD years spent in US (Fulbrights)	0.236	0.425	0	1
Proportion of post-PhD years spent at home (controls)	0.279	0.449	0	1
Proportion of post-PhD years spent at home (Fulbrights)	0.639	0.48	0	1
Background characteristics				
Female gender	0.25	0.433	0	1
Rank of PhD program	37.819	34.614	1	175
ln(home country GDP per capita)	8.809	0.88	5.817	10.22
Publications and citations pre- and post-PhD				
# articles published before graduation	2.873	7.310385	0	147
# first-authored articles published before graduation	1.434	1.878169	0	15
# high-impact or first- or last-authored articles published before graduation	0.561	1.15898	0	9
Total number of articles published	10.111	20.70215	0	333
First-authored articles	3.871	5.223715	0	51
High-impact articles	4.779	17.33071	0	331
Last-authored articles	2.463	5.543062	0	48
Total forward citations	110.084	180.3952	0	655
Total forward citations to first-authored articles	45.867	74.43971	0	268
Total forward citations to last-authored articles	13.387	27.12083	0	98
Total forward citations to high-impact articles	58.607	111.321	0	402
Collaboration				
Total publications with a US author	7.494	18.612	0	333
Total publications with a home-country author	3.516	10.333	0	128
Total publications with a non-US, non-home-country author	3.240	16.118	0	333
Total publications with a home-country author excluding self	1.887	7.142	0	106
Total publications with a US author excluding self	5.031	16.963	0	333
Total publications with a non-US, non-home country author excluding self	2.969	16.005	0	333
Total publications with an author in the home country AND an author in the US	1.445	5.048	0	83
Total publications with an author in the home country AND an author in another non-US country	1.059	5.345	0	83

Table 3.5 **Proportional effect of Fulbright on location estimation method: Poisson; values given as proportional difference between Fulbrights and controls**

	(1)	(2)	(3)	(4)
Dependent variable:	Years outside the US		Years in the home country	
	Average impact of being a Fulbright			
Fulbright dummy	1.106***		1.175***	
p-value	0.0000		0.0000	
	Adding interaction with log real GDP (per capita of home country 5 yrs prior to PhD)			
25th pctile		2.423***		2.749***
p-value		0.0004		0.001
50th pctile		1.423***		1.514***
p-value		0.000		0.000
75th pctile		0.808***		0.792***
p-value		0.000		0.000
90th pctile		0.537***		0.485**
p-value		0.0018		0.019

Notes: See text for list of control variables included. Robust standard errors in parentheses. Average effect calculated as $\exp(\text{Beta}_{\text{Fulbright}}) - 1$. Effect at income levels calculated as $\exp(\text{Beta}_{\text{Fulbright}} + \text{logGDP}^*\text{Beta}_{\text{FulbrightXLogGDP}})) - 1$

*Significant at the 10 percent level.

**Significant at the 5 percent level.

***Significant at the 1 percent level.

3.6 Do Foreign S&E Fulbright Students Create Less or More Knowledge and Have Less or More Impact on Their Fields Compared to Other Foreign Students?

In this section, we empirically measure whether Fulbrights publish more or less than other foreign students and whether they are cited more or less. The publication and citation data were taken from information on the Fulbright and control PhDs' publication histories from *ISI's Web of Science.*[26] From the *Web of Science,* we obtained information for the following publication-related variables.

Publication Counts: The number of articles on which the scientist is a contributing author. This may be a noisy measure of research output when articles have many authors.

First-Authored Publication Counts: The number of articles each year on which the scientist is the first author. In science, the first author is the major contributor to the research.

Last-Authored Publication Counts: The number of articles each year on which the scientist is the last author. In science, typically the last author will

26. Authors were matched to publications using information on post-PhD locations, authors' middle names, fields of research, coauthors on other work, and so forth.

be the person running the lab, who is often the Principal Investigator (PI) on the research grant funding the research. This variable is an indicator of the author's ability to secure research funding.

Publications in High-Impact Journals: The number of each year's publications in the top 50 percent of journals *in that field* as ranked by ISI's impact factors. We made this measure field-specific because different fields have very different conventions about citations. We did this by calculating impact relative to the mean impact within each field.

Forward Citation Counts: The total cumulative number of citations received *by articles published,* which proxy publication's impact on scholarship. We model citations for each of the four classes of articles previously described.[27] Table 3.4 displays the average levels of these publication and citation variables.

There are two general types of reasons why the Fulbrights and the controls might have different research productivity post-PhD. The first, and the one we are interested in testing, is that the return requirement of the Fulbright program leads otherwise identical PhD scientists to pursue different kinds of careers and to use their scientific knowledge in different ways, leading to different publication and citation patterns. The second is that non-US residents who get Fulbright funding to study in the United States are inherently different in ability or research proclivity from other non-US residents who study in the United States. The first of these reasons implies a causal impact of Fulbright on productivity while the second implies differences due to heterogeneity and selection.

We constructed our match between the Fulbright and control students with the goal of choosing controls that are as similar as possible in inherent ability and proclivity for research in order to isolate the causal impact of Fulbright scholarships. The criteria we used for matching were based on our priors about the characteristics most relevant for research output—institution, advisor/field, date of graduation, and region of origin. To the extent that US universities can observe the differences between students, the university admissions procedure may ensure that the Fulbrights and non-Fulbrights they admit to any specific department are likely to have equivalent abilities.

Moreover, whenever possible we have matched not just by institution and department but also by advisor. Faculty typically apply their own standards to the students they choose to advise and support on their grants.

Nevertheless, there may remain inherent differences between controls and Fulbrights. The sign of these differences is not obvious. Since Fulbright

27. Due to the extreme skewness of their distributions, citation counts are winsorized at the 95th percentile. Results are qualitatively similar if truncated at 99th percentile or not truncated at all.

recipients are chosen by merit, this would lead Fulbrights to have greater research potential than others studying in the United States. Similarly, as our earlier description suggested, Fulbrights may not be assigned to the best university that would have accepted them, again leading Fulbrights to be better than controls.

On the other hand, there are reasons why Fulbrights may be worse than controls. Fulbright commissions, Embassy staff, and the Fulbright Foreign Scholarship Board (FSB) may avoid funding the *most* promising students if they are believed to be less likely to spend their careers in their home country. Also, and perhaps most pertinently, many excellent students may not pursue Fulbright fellowships if they have strong preferences to remain in the US post-PhD or can afford to avoid funding that restricts their futures or both, and particularly if they receive funding directly from the universities. Finally, US departments may lower their admission standards for graduate students with outside funding.

In addition to our careful matching process, we have done several other things to remove or evaluate possible biases or both due to differing inherent research potential of Fulbrights and controls. First, we control for the GDP per capita of the home country during the doctoral program, since paired Fulbrights and controls often come from different countries. Second, in some specifications we include as control variables three measures of students' research output while in graduate school (including the year of PhD completion because of the lag between writing an article and getting it published), which we believe to be a good proxy for inherent ability. Including these pregrad publication variables may overcontrol in the sense that at least some of the Fulbright-control differences in pregrad publications may also be a result of being a Fulbright. For instance, if Fulbrights believe that they must return home to a nonresearch job, they may be less committed to getting their PhD research published. On the other hand, if Fulbrights are more concerned about having good chances of leaving their home country after two (or more) years of post-PhD residence, they may feel they need stronger credentials.

The specific pregrad publication variables included in these specifications are *total articles written while in graduate school (defined as all articles published up to and including the year following PhD receipt), first-authored publications while in graduate school, and high-impact first- or last-authored publications while in graduate school.* Note that first-authored articles are more prevalent during the PhD year than later. In fact, for the average student with any pregrad publications, 60 percent of the articles published during this graduate school time were first-authored, probably publications from their thesis work for whom the PhD student was the primary author.

Table 3.6 gives results of Poisson regressions of four measures of publications postgraduate school—total publications, first-authored publications,

Table 3.6 **Effect on Fulbright on publications and citations, coefficients and standard errors from Poisson regressions**

	(1) Total publications	(2) First-authored publications	(3) Last-authored publications	(4) High-impact publications	(5) Total (forward) citations	(6) Cites to first-authored pubs	(7) Cites to last-authored pubs	(8) Cites to high-impact pubs
				Panel A: Average impact of being a Fulbright				
Fulbright	–0.253	–0.13	–0.314*	–0.479*	–0.215*	–0.096	–0.115	–0.321**
	(0.161)	(0.118)	(0.191)	(0.262)	(0.129)	(0.130)	(0.169)	(0.155)
				Panel B: Adding pre-PhD publication controls				
Fulbright	–0.064	–0.064	–0.229	–0.224	–0.144	–0.035	–0.03	–0.288*
	(0.123)	(0.105)	(0.166)	(0.181)	(0.123)	(0.123)	(0.166)	(0.153)
				Panel C: Adding interaction with log real GDP (per capita of home country 5 yrs prior to PhD)				
Fulbright	–2.566	–3.204**	–7.179***	–1.914	–5.105***	–4.652***	–5.110**	–6.107***
	(2.029)	(1.394)	(2.526)	(3.152)	(1.724)	(1.775)	(2.371)	(2.009)
Fulbright*GDP	0.256	0.342**	0.750***	0.157	0.537***	0.504***	0.546**	0.633***
	(0.228)	(0.154)	(0.280)	(0.354)	(0.188)	(0.193)	(0.255)	(0.219)
				Panel D: Adding pre-PhD publication controls as well as interaction with log real GDP				
Fulbright	–2.054	–1.975*	–4.920***	–1.88	–3.411**	–2.787*	–3.631*	–4.274**
	(1.396)	(1.120)	(1.831)	(1.985)	(1.608)	(1.578)	(2.181)	(1.958)
Fulbright*GDP	0.221	0.213*	0.512**	0.183	0.359**	0.304*	0.394*	0.437**
	(0.152)	(0.122)	(0.199)	(0.214)	(0.175)	(0.172)	(0.234)	(0.216)

Notes: See text for list of control variables included. Robust standard errors in parentheses.

*Significant at the 10 percent level.

**Significant at the 5 percent level.

***Significant at the 1 percent level.

last-authored publications, and publications in high-impact journals—and citations to these publications. All equations include controls for field, PhD year, school rank, gender, and log of home GDP (five years before PhD receipt). The table lists only the coefficients on the Fulbright variables. Coefficients of all control variables for panel C are included as appendix B. All other results are available on request from the authors.

Panel A includes the coefficients on a single Fulbright dummy (without controls for pre-PhD publications). While the differences between Fulbrights and controls are all negative, very few of these measures are significant. At the 10 percent level of significance, Fulbrights have significantly fewer last-authored and high-impact publications and overall citations. Citations to high-impact publications, however, are significantly lower at the 5 percent level. Controlling for pregraduation research output, in panel B, we find no significant differences with the exception of cites to high-impact articles, which is now significant only at the 10 percent level. If this were all we had estimated, results would be very inconclusive.

However, a single dummy can obscure very disparate effects for Fulbrights from different backgrounds. Panel C allows the effect of the Fulbright dummy vary by GDP per capita by including an interaction term between the Fulbright dummy and GDP per capita. The interaction term is significantly positive for both first-authored and last-authored publications and for all four measures of citations. These results indicate that the impact of the Fulbright program on publications and citations differs across countries, with the effect becoming less negative (or even positive) as income increases. To measure the net effect and test its significance, in table 3.7 we report the percentage effect of being a Fulbright at four different percentiles levels of home-country GDP per capita.[28] The impacts are translated in the proportional difference between a Fulbright and a control at each income level.[29]

At very low GDP levels—the 25th percentile of all countries—the effect of being a Fulbright is significantly negative for all output measures. Fulbrights at this level have approximately 50 percent fewer total, first-authored, and highly cited publications and 82 percent fewer last-authored publications. The effect on citations is also large, with 86 percent fewer total citations and 77 percent fewer citations to high impact publications. Even at the 50th income percentile, while Fulbright-control differences fall by on average a third from their values at the 25th percentile, they remain highly significant. However, at the 75th percentile, effects are much smaller and none are significant for any publication or citation measure. Finally, Fulbrights from rich countries—at the 90th percentile of the income

28. The percentiles are taken from the Penn macroeconomic tables, for the year 1992—five years before the median PhD year in our sample.

29. These impacts are calculated as $\exp(\text{Beta}_{\text{Fulbright}} + \ln(\text{cutoffGDP})*\text{Beta}_{\text{FulbrightXLogGDP}})) - 1$ from panel B table 3.6 results.

Table 3.7 **Effect of Fulbright on publications and citations at different levels of GDP per capita of home country (5 years prior to PhD)**

	(1) Total publications	(2) First-authored publications	(3) Last-authored publications	(4) High-impact publications	(5) Total (forward) citations	(6) Cites to first-authored pubs	(7) Cites to last-authored pubs	(8) Cites to high-impact pubs
25th pctile	–0.502***	–0.504***	–0.817***	–0.535*	–0.860***	–0.621***	–0.672***	–0.772***
p-value	0.009	0.000	0.000	0.059	0.000	0.000	0.000	0.000
50th pctile	–0.343***	–0.282**	–0.587***	–0.449***	–0.642***	–0.344***	–0.407**	–0.547***
p-value	0.008	0.011	0.000	0.007	0.000	0.008	0.015	0.000
75th pctile	–0.169	–0.016	–0.177	–0.363	–0.205	0.042	–0.020	–0.188
p-value	0.292	0.902	0.295	0.053	0.454	0.764	0.904	0.154
90th pctile	–0.053	0.172	0.207	–0.310	0.239	0.348	0.295	0.121
p-value	0.839	0.408	0.563	0.282	0.736	0.155	0.308	0.618

Note: Excluding pregrad pubs. Corresponds to panel C of table 3.6. Reported effects equal $\exp(\text{Beta}_{\text{Fulbright}} + \text{logGDP}^*\text{Beta}_{\text{FulbrightXLogGDP}}) - 1$.

distribution—are not only significantly different from controls from similar countries for any publication or citation measure, but the point estimates of their difference are positive for six out of the eight measures of research productivity and impact.

Panel D adds measures of pregraduation publications into the regressions. This adds additional controls for heterogeneity in research ability and research proclivity, but may overcontrol if return requirements affect pre-PhD publications as well as post-PhD ones. We have calculated the effects of being a Fulbright at different income levels for this specification as well (available upon request from authors). Overall, they tell the same story as table 3.7. The magnitudes of the effects are remarkably similar, but for some dependent variables the statistical significance of the effect at the 50th percentile of GDP per capita is weaker.

Finally, as we mentioned earlier, a large number of the Fulbrights in our data set were from Mexico. This could be problematic if Fulbrights from Mexico were somehow different from other Fulbrights. To investigate this, we reestimated panel C of table 3.6 adding in an interaction term between a Mexico dummy and the Fulbright dummy (as well as the Mexico dummy itself.) For seven of the eight output measures, the Mexico interaction was insignificant, with an average p-value of 0.67.) In other words, Mexican Fulbrights were not different from other Fulbrights of similar income levels. However, for one measure, cites to first-authored articles, the interaction term with Mexico was significantly positive (5 percent level), meaning that Fulbrights from Mexico were more likely than Fulbrights from similar GDP countries to publish cited first-authored articles. We conclude that overall, the impact of the Fulbright program is similar for Mexicans and those from countries with similar GDP per capita, but that the negative impact on non-Mexican Fulbrights from middle income countries might be larger than indicated in table 3.7.[30]

To summarize results on publications and citations, research productivity and research impact of Fulbrights from poor countries is lower than that of comparable non-Fulbrights. Fulbrights differ most from controls in publishing articles in high-impact journals. Fulbrights are not significantly different from controls once income rises to the 75th percentile, with the exception of last-authored publications. Thus, even in countries at this GDP level, scientists appear to be affected by the return requirement in running their own labs (to the extent this is reflected by last-authorship). Finally, Fulbrights from the very richest countries (such as Canada and Western Europe) succeed as well as—or better than—controls from similar countries both in terms of publishing and in getting their work noticed around the world.

30. Mexico's 1992 GDP per capita was between the 50th and 75th percentile.

3.7 In What Ways do Fulbright Students Contribute to Their Home Countries' and the United States' Scientific Environments Compared to Comparable Foreign Students?

In this section, we examine the publication output of Fulbrights and controls to determine the extent to which the Fulbright program promotes knowledge production in different countries. We use information on the location(s) of the author(s) of the articles in our data set as an indicator of where papers where produced. Unfortunately, for the period under study, ISI did not link each institution with a particular coauthor, so we are limited in the kinds of collaboration variables we can calculate. We construct the following variables based on the articles authored by the people in our sample:

1. The total number of articles listing an author in the home country.
2. The total number of articles listing an author in the United States.
3. The total number of articles listing an author in a third country (not the home country and not the United States).
4. The total number of articles listing an author in the home country excluding those at the institution of the focal scientist.[31]
5. The total number of articles listing an author in the United States excluding those at the institution of focal scientist.
6. The total number of articles listing an author in a third country (not home and not the United States) excluding those at the institution of the focal scientist.
7. Total publications with an author in the home country and an author in the United States.
8. Total publications with an author in the home country and an author in a third country.

Table 3.4 gives averages for these variables. Note that collaboration variables 1, 2 and 3 are the same as 4, 5 and 6 except that the latter ones exclude the student's own institution from the count. The measures including the scientist him- or herself is a useful measure of the extent to which the Fulbright program promotes the creation of knowledge in a particular location, either through collaboration or through scientists' locations. The second set of variables allows us to ask whether Fulbright recipients are more likely to collaborate with *other* scientists in other home countries, United States or third-country institutions respectively, capturing spillover effects.

We begin, in the first panel of table 3.8, by examining the average effect of the Fulbright program on knowledge production in the home country,

31. We would have preferred to use the total number of articles coauthored by someone else from the home country, whatever institution they were at. This was not possible to calculate from *Web of Science* data from this period.

Table 3.8 **Effect of Fulbright on location of articles and collaboration, coefficients and standard errors from Poisson regressions**

	(1) Total publications with any home co. author	(2) Total publications with any US author	(3) Total publications with any 3rd co. author	(4) Total publications w. any home co. author excl self	(5) Total publications with any US coauthor excl self	(6) Total publications with any 3rd co. author excl self	(7) Total publications with authors in home AND US	(8) Total publications with authors in home AND 3rd co.
				Panel A: Average impact of being a Fulbright				
Fulbright	0.566**	–0.646***	–0.144	0.393	–0.610***	–0.159	0.190	0.394
	(0.250)	(0.177)	(0.334)	(0.316)	(0.225)	(0.352)	(0.297)	(0.400)
				Panel B: Adding pre-PhD publication controls				
Fulbright	0.787***	–0.456***	0.367**	0.717**	–0.337**	0.399**	0.502**	0.903**
	(0.244)	(0.125)	(0.181)	(0.298)	(0.145)	(0.189)	(0.211)	(0.387)
				Panel C: Adding interaction with log real GDP (per capita of home country 5 yrs prior to PhD)				
Fulbright	2.588	–2.102	0.131	2.361	–0.18	0.711	7.072*	7.411
	(3.016)	(2.306)	(3.680)	(3.445)	(2.755)	(3.958)	(4.178)	(5.433)
Fulbright*GDP	–0.221	0.161	–0.03	–0.216	–0.048	–0.096	–0.752	–0.756
	(0.334)	(0.260)	(0.419)	(0.379)	(0.313)	(0.451)	(0.467)	(0.600)
				Panel D: Adding pre-PhD publication controls as well as interaction with log real GDP				
Fulbright	2.793	–1.769	–2.003	1.681	–0.528	–1.852	5.915**	4.664
	(2.250)	(1.592)	(1.910)	(2.139)	(1.798)	(1.938)	(2.679)	(3.211)
Fulbright*GDP	–0.221	0.146	0.263	–0.107	0.021	0.25	–0.598**	–0.411
	(0.251)	(0.174)	(0.208)	(0.232)	(0.198)	(0.211)	(0.296)	(0.360)

Note: See text for list of control variables included. Robust standard errors in parentheses.

*Significant at the 10 percent level.

**Significant at the 5 percent level.

***Significant at the 1 percent level.

controlling for the GDP per capita of the home country and other covariates but not controlling for pregrad research output (panel A). We find that Fulbrights produce many more articles (76 percent) that list an author in the home country than do controls ceteris paribus (column 1), an expected result given the location restrictions of Fulbrights.[32] Also expected, Fulbrights produce significantly fewer articles with at least one US author than controls, 48 percent fewer (column 2). Fulbrights do not, on average, author significantly more articles that list an address in a third (nonhome, non-US) country (column 3). Nor do they produce more articles from the home country after excluding the author's own affiliation (column 4).

However, panel B, which controls for pre-PhD publications, tells a somewhat different story. It shows that Fulbrights are significantly different from controls across all collaboration measures and that the magnitude of Fulbright on most collaboration variables is larger than without these controls. Further investigation shows that the differences between panels A and B are primarily due to a handful of people in fields with large labs who had many publications both before and after PhD receipt, each publication having many authors due to the large lab team. Thus, the pre-PhD publication variables are serving as a control for fields with large labs and many authors per article. Moreover, the endogeneity problems caused by including pre-PhD controls is less relevant for collaboration variables than for publication variables.[33] Taken together, this suggests that the panel B results are probably a better measure of the impact of Fulbrights' return requirements on collaboration.

In panel B, controlling for pregrad publications, Fulbrights have even more additional (postgrad) home country publications than do controls (120 percent more) and this remains almost as large when the Fulbright him- or herself is excluded. Fulbrights are also significantly more likely to collaborate with third country authors whether or not the Fulbright him- or herself is excluded, with around a 50 percent difference. The only effect that is smaller in panel B than in panel A—although still significant—is the lower level of publications with a US author, which drops to between 29 percent to 37 percent depending on whether the Fulbright is excluded.[34]

Perhaps more interesting than evidence on publications by location is evidence on collaboration across countries. Controlling for pre-PhD publications, Fulbrights produce significantly more articles that list both a home-country author and a US author (column 7, 65 percent more) or a home-

32. Percentages calculated as exp(beta) – 1.

33. Thus, in the publication and citation analysis, pre-PhD publications and post-PhD publications might both be negatively affected by the return requirement of the Fulbright. However, it is more difficult to see why the possibly negative impact of return requirements on pre-PhD publications would be capturing the same factors that affect later collaboration.

34. It is not surprising that results concerning the United States or third countries do not change when excluding the Fulbrights themselves, since few Fulbrights live outside their home country.

country author and a third-country author (column 8, 147 percent more). In other words, the return requirement does lead to more collaboration between the home country and other countries including the US.

Panel C of table 3.8 adds an interaction between Fulbright and the log of real GDP per capita, similar to earlier tables. Contrary to our results on publications and citations, in no instance does the impact of collaboration differ significantly by GDP level, even at the 10 percent level.[35]

Controlling for pregraduation research (in panel D of table 3.8) does not change our qualitative results and particularly does not change our conclusion that the impact of Fulbright on the collaboration and authorship variables does not depend on GDP per capita, with one important exception. Controlling for pregrad publications, while Fulbrights overall tend to have more publications with a home-country author and a US author, this impact is limited to those from lower income home countries. Thus, the coefficient of the interaction term between GDP per capita and Fulbright column in column (7) is significantly negative. Using this coefficient, Fulbrights from median GDP countries have 144 percent more home-country US collaborations than controls. However, at the 90th percentile of per capita GDP, the difference is tiny (0.04 percent) and insignificant.

To summarize the main findings of table 3.8, we find that Fulbrights on average stimulate more articles authored in their home countries and fewer articles authored in the United States. Fulbrights also stimulate collaborations between a home-country author (presumably themselves) and a US author or a third-country author. These effects are true irrespective of GDP levels. However, it is likely that the huge increase in home-country and US collaborations is limited to those from low or middle income countries.

3.8 Conclusion

The Foreign Fulbright Program imposes a legal requirement that students funded by the program return to their home countries before applying for a work visa in the United States. The program has a major impact on the postgraduation location choices of US-trained, foreign-born scientists, with Fulbrights spending more than twice as many postgraduation years abroad. The effect is particularly large for students from countries with low per capita GDP, countries that are not otherwise attractive destinations for PhD recipients in science and engineering. This flow of highly trained human capital to lower income countries, which would not otherwise have occurred, is likely to benefit those countries substantially.

One might ask, however, what the effects are for the progress of science in general of this relocation of scientists away from the countries with the

35. We therefore do not include a table similar to table 3.7 for collaboration variables at different GDP levels.

most fertile environments for research and toward countries farther from the scientific frontier. If the environment in which one does science really matters, one might expect that Fulbright-funded scientists from less-science-rich environments and environments with fewer resources would be less productive in their subsequent careers than otherwise similar scientists whose location choices were not constrained. We find that, on average, Fulbrights from these poorer countries do typically publish less and have less of an impact on global science.

Because Fulbrights are less likely to be in the United States, they also have fewer scientific publications with US authorship. Viewed from an admittedly narrow perspective, one might conclude that the United States does not reap the full benefit of its investments in the doctoral training of Fulbright Fellows, although it must be remembered these students represent a very small percentage of total PhD degrees granted in the United States.

However, the goal of the Fulbright Program was not to increase either United States or global science, but instead to "increase mutual understanding between the people of the United States and the people of other countries." It has been quite good at achieving this objective, by stimulating 65 percent more scientific collaborations between the United States and other countries than would otherwise have occurred.

This chapter has emphasized impacts on the creation of scientific knowledge. However, the presence of Fulbright scientists in their home countries may have large benefits to home-country science in other ways—for example, through teaching and mentoring, advising governments and firms, entrepreneurship etc.—that are not measured well by the publication variables we consider here. Indeed, many of the Fulbrights we studied are working at high levels in government agencies or international NGOs and cross-governmental agencies. The impacts on future global science are likely to be far greater than manifested in their personal publication records, and we intend to investigate these contributions in future research.

Appendix A

Data Appendix

Fulbright Data

The names of Fulbrights were obtained from volumes of *Foreign Fulbright Fellows: Directory of Students* published annually by the Institute of International Education (IIE) from 1993 to 1996.

Identifying Controls and Location Search Procedure

First, we entered data from the IIE volumes on the Fulbright Student's name, graduate institution, field of study, and country of origin. Then, we

searched for these students in the ProQuest database (described later) to find their date of graduation (for those who completed their studies) and advisor name. For those Fulbrights successfully completing their programs, we then performed searches on Google, Google Scholar, LinkedIn, and/or *Web of Science* to obtain as much information as possible on all the student's post-PhD locations and affiliations. The search time was limited to twenty minutes. If a student was not found at all on the web within twenty minutes, the searcher moved on to the next name.

For the students found on the web, we then searched for controls. We searched for controls obtaining PhDs in the same year, with the same advisor, at the same institution as the Fulbright. We clicked on the name of the student's advisor. If this step failed (i.e., there are no foreign students with the same advisor graduating in same year), we looked for a student with the same advisor graduating within three years of the Fulbright. When choosing controls, we alternated students graduating before the Fulbright with those graduating after the Fulbright so that on average controls graduate at the same time as Fulbrights. If this step failed, we chose a control graduating in the same year in the same field of study (e.g., biochemistry) at the same university.

We searched for the person's location on Google, Google Scholar, LinkedIn, and/or *Web of Science,* the combination of which allowed us to find both academics and nonacademics.[36] Since it tends to be easier to find academics on the web than others, we no doubt undersample nonacademics. However, this undersampling applies equally to Fulbrights and controls.

When someone at first was included in our sample but we later realized that we could not identify the location either of the Fulbright or the control for more than half of the years since PhD even after interpolating, we dropped the Fulbright-control pair. This led us to drop four pairs.

For schools listing prior degrees or biographical information in the dissertation, we used this information to infer the student's country of origin (see later). For schools that did not list prior degrees, if we found a potential control student, we looked them up on the web. If we could find their current location and evidence that they came from a foreign country (i.e., foreign undergraduate degree or biography), we recorded their name, year of PhD, current location, and estimated country of origin.

ProQuest Dissertations and Theses

The ProQuest Dissertations and Theses database is a database of almost all dissertations filed at over 700 US universities. We obtained information from this database on students' full names, advisors, fields of study, PhD

36. Many academics had CVs posted on the web. Nonacademics were more likely to be found on LinkedIn, conference or meeting programs, alumni associations, local news articles, or civic or religious organizations' websites. One person was even located via a DUI arrest. We made sure that the person we located had more than just their name in common with the student we knew (e.g., the PhD location or a previous employer might be mentioned).

completion dates, and undergraduate institution or country of birth or both. Starting in the 1990s, ProQuest began publishing online the full text of the first twenty-four pages of the dissertation.

Several universities require students to list biographical information in the front matter of the dissertation. Table 3A.1 lists these universities, which were identified by checking dissertations filed at the universities that are major producers of scientists and engineers in the United States. At some universities, the information includes a full biographical sketch (e.g., Ohio State, NC State), but in most cases, the information is limited to a list of previous degrees. Figures 3A.1 and 3A.2 present examples of this information drawn from dissertations filed at the University of Illinois and the Ohio State University.

The biographical information contained in these dissertations can be used to identify the country of origin of the student. Under the assumption that most students attend undergraduate programs in their country of origin, we treat the country of undergraduate degree as the country of origin. Using this information as a proxy for the nationality of the student will of course introduce some error, since not all students receiving undergraduate degrees do so in their country of origin. However, evidence from the NSF's *Survey of Earned Doctorates* suggests that the country of undergraduate degree is a very good proxy for the country of origin. For students completing doctorates in 2003 and 2004, the *SED* lists the country of undergraduate degree. For 84.9 percent of students, the country of undergraduate degree is the same as the country of citizenship. However, there is considerable heterogeneity across countries in the extent to which students pursue undergraduate studies outside their countries of origin. Table 3A.2 presents, for a selected

Table 3A.1 Universities listing biographic info in thesis

Auburn	Univ. California
Boston Univ.	Univ. Cincinatti
California State Univ.	Univ. Colorado
Clark	Univ. Connecticut
Cornell Univ.	Univ. Florida
Florida Institute Of Technology	Univ. Illinois
Fordham	Univ. Maine
George Washington Univ.	Univ. Massachusetts
Georgetown Univ.	Univ. Massachusetts At Amherst
Kansas State	Univ. Missouri
Louisiana State Univ.	Univ. Nevada
NC State	Univ. Oregon
OH State	Univ. Pittsburgh
OK State	Univ. South Alabama
Syracuse	Univ. South Carolina
Texas A&M	Univ. Virginia
Univ. Arkansas	

ALGORITHMS AND ARCHITECTURES FOR SOFT-DECODING REED-SOLOMON CODES

BY

ARSHAD AHMED

B.E., Regional Engineering College, Trichy, 1998
M.E., Indian Institute of Science, Bangalore, 2000

DISSERTATION

Submitted in partial fulfillment of the requirements
for the degree of Doctor of Philosophy in Electrical Engineering
in the Graduate College of the
University of Illinois at Urbana-Champaign, 2006

Urbana, Illinois

Fig. 3A.1 Sample dissertation page showing location of prior degrees
Source: ProQuest Dissertations and Theses Database.

list of countries, the share of students responding to the *SED*'s questions of who remained in their home country for undergraduate study. Students from Germany and Japan have the lowest rates of staying at home among the major producers of US graduate students (73 percent and 74 percent, respectively). However, the countries that send the most students (China, India, Taiwan, Korea, and Canada) have high stay-at-home rates for undergraduate study (98 percent, 93 percent, 89 percent, 76 percent, and 82 percent, respectively). Furthermore, counts of the number of doctoral recipients by country of origin, university, and year computed from a ProQuest sample have a correlation of 0.948 with analogous counts obtained from the *SED*.

The data on country of origin is only available beginning in the late 1990s when universities began submitting digital copies of dissertations to be posted on the web by ProQuest. However, by 1996 or 1997 almost all dissertations are available in digital format.

VITA

January 31, 1973.	Born – Da-An, Jilin Province, China
September 1989 - July 1993.	Bachelor of Science in Electrical Engineering, Nanjing University of Science and Technology, Nanjing, China
September 1993 ·· April 1996.	Master of Science in Electrical Engineering, Nanjing University of Science and Technology, Nanjing, China
September 2002 ··· present.	Ph.D student, Analog VLSI Laboratory, Department of Electrical and Computer Engineering, the Ohio State University, Columbus, Ohio
Since June 2006.	RFIC design engineer, Freescale Semiconductor Inc., Boca Raton, Florida

PUBLICATIONS

Research Publications

P. Zhang, and M. Ismail "A New RF Front-End and Frequency Synthesizer Architecture for 3.1–10.6 GHz MB-OFDM UWB Receivers", *Proc.* 48th *Midwest Symposium on Circuit and System.* vol.2, pp.1119–1122. August 2005.

C. Garuda, X. Cui, P. Lin, S. Doo, P. Zhang, and M. Ismail "A 3–5 GHz Fully Differerential CMOS LNA with Dual-gain Mode for Wireless UWB Applications". *Proc.* 48th *Midwest Symposium on Circuit and System.* vol.1, pp.790··793. August 2005.

Y. Yu, L. Bu, S. Shen, B. Jalali-Farahani, G. Ghiaasi, P. Zhang, and M. Ismail "A 1.8V Fully Integrated Dual-band VCO for Zero-IF WiMAX/WLNA Receiver in 0.18μm CMOS", *Proc.* 48th *Midwest Symposium on Circuit and System,* vol.1, pp. 187···190, August 2005.

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Fig. 3A.2 Sample dissertation page showing location of prior degrees
Source: ProQuest Dissertations and Theses Database.

Publication Data

We obtained publication histories from ISI's *Web of Science.* Authors were identified using information on post-PhD locations, authors' middle names, and fields of research. For each publication by an author, we obtained all information available on the publication record itself, including publication year, title, coauthor names, author locations, complete backward citations, counts of forward citations, publication source, abstract, specific field (for example, marine and freshwater biology), and keywords.

It should be noted that our information on the number of forward citations received by an article includes self-citations. The median backward

Table 3A.2 **Share of PhD students at US universities who received undergraduate degrees in their countries of citizenship**

Australia	85.00%
Brazil	96.02%
Canada	82.51%
China	98.35%
Egypt	96.38%
France	82.05%
Germany	73.05%
Greece	80.51%
India	92.71%
Iran	88.33%
Israel	88.46%
Japan	73.51%
Mexico	89.19%
Nigeria	60.61%
Philippines	87.23%
South Korea	76.33%
Taiwan	89.19%
Thailand	87.28%
Turkey	95.57%
UK	63.64%
Weighted average across these countries	89.50%
Weighted average across all countries	84.79%

citation lag also includes self-citations. In future work, we intend to remove these citations. However, this requires downloading bibliographic data on each specific citing article, which is a very time-consuming process.

The ISI *Web of Science* database does not cover every scientific journal published worldwide. It lists articles from 6,650 scientific journals. Among Thomson's criteria for including a journal in the index are, "The journal's basic publishing standards, its editorial content, the international diversity of its authorship, and the citation data associated with it."[37] Journals must typically publish on time, implying a substantial backlog of articles forthcoming. They must publish bibliographic information in English, and must include full bibliographic information for cited references and must list address information for each author. Thomson also looks for international diversity among contributing authors, but regionally focused journals are evaluated on the basis of their specific contribution to knowledge. The number of citations received by the journal is a key factor in evaluation for inclusion in the index, with preference going to highly cited journals or journals whose contributing authors are cited highly elsewhere.

The ISI selection procedure is designed to select the most relevant scientific journals, independent of the location of their editorial offices. Since

37. "The Thomson Scientific Journal Selection Process" Available at: http://scientific.thomson.com/free/essays/selectionofmaterial/journalselection/ (accessed March 11, 2008).

such a large share of cutting-edge science research takes place in the United States, there will inevitably be a high share of journals in this index based in the United States. Journals that do not publish bibliographic information in English are less likely to be included, so articles written abroad and published in low-profile regional journals with limited readership beyond the region (as evidenced by a failure to publish bibliographic information in English) will be excluded from our data. As a result, our publication data should be viewed as information on scientists' participation in the international scientific community, rather than raw article counts. Still, the large number of journals included, and the special consideration given to regionally focused journals means that most of the relevant journals in which our scientists publish will be included. We examined the publication records of some of our scientists located outside the United States, and found that even what might seem like relatively obscure journals (e.g., *Revista Chilena de Historia Natura, Revista Brasileira de Ciência do Solo, Acta Pharmacalogica Sinica,* etc.) were all included in the ISI index. While it is possible that ISI data is less comprehensive for articles published in non-Roman alphabets, it should be noted that only a very small number of scientists in our sample are located in Asian countries (0.36 percent of our observations are on scientists located in China, 0.55 percent in Japan, 0.87 percent in Korea, 1.03 percent in Taiwan, and 1.5 percent in Thailand). Furthermore, these are scientists who began their careers in the United States and are thus likely to continue publishing in English-language journals.

To verify more rigorously that our sample of publications is not biased toward finding articles by US-based researchers, we performed the following test. We had a research assistant collect data on the number of articles listed on scientists' CVs and the number of articles we obtained from ISI. We computed the share of a scientist's articles from the CV that were listed in the ISI database, and performed a *t*-test of difference in means between scientists outside the United States and those inside the United States. The average share of articles found on *Web of Science* was 0.705 for those in the United States and 0.651 for those outside the United States. We cannot reject the hypothesis of no difference in means (with a *t*-statistic of 0.788 and *p*-value of 0.433 for a two-tailed test).[38] We thus do not feel that a systematic US bias is introduced by restricting our attention to journals included in the ISI index.

We made sure to collect information on Fulbright and control publications at the same time, ideally on the same day. We did this to avoid biasing the data to include more pubs and cites for one of the groups because they were collected later and had more time to appear in the database.

38. We also tested the hypothesis that this depended on the number of years abroad by regressing the share of articles on ISI on the number of years abroad, and the coefficient on this latter variable was –0.001 with a standard error of 0.006 (insignificantly different from zero).

Appendix B

Full Regression Results for Selected Regressions (Corresponds to Panel C of table 3.6)

Table 3B.1 **Full regression results for selected regressions (corresponds to panel C of table 3.6)**

	Coefficients and standard errors from Poisson regressions							
	(1) Total publications	(2) First-authored publications	(3) Last-authored publications	(4) High-impact publications	(5) Total (forward) citations	(6) Cites to first-authored pubs	(7) Cites to last-authored pubs	(8) Cites to high impact pubs
Fulbright	–2.566	–3.204**	–7.179***	–1.914	–8.314*	–4.652***	–5.110**	–6.107***
	(2.029)	(1.394)	(2.526)	(3.152)	(4.756)	(1.775)	(2.371)	(2.009)
Fulbright *GDP	0.256	0.342**	0.750***	0.157	0.868	0.504***	0.546**	0.633***
	(0.228)	(0.154)	(0.280)	(0.354)	(0.536)	(0.193)	(0.255)	(0.219)
Log GDP per capita in home country 5 years before PhD	0.254	0.054	0.286**	0.458*	0.658***	0.123	0.248*	0.179
	(0.160)	(0.085)	(0.139)	(0.275)	(0.252)	(0.095)	(0.132)	(0.113)
Biological sciences	0.403	0.405*	0.572	0.254	1.488***	0.737***	0.669**	0.765***
	(0.255)	(0.239)	(0.413)	(0.368)	(0.360)	(0.215)	(0.300)	(0.260)
Engineering & computer science	–0.516**	–0.335	–0.186	–0.621	0.246	–0.431*	–0.081	–0.704**
	(0.260)	(0.227)	(0.376)	(0.379)	(0.535)	(0.254)	(0.310)	(0.321)
Earth/air/ocean sciences	–0.713**	–0.205	–0.463	–0.687*	–0.572	–0.469	0.33	–0.493
	(0.298)	(0.271)	(0.518)	(0.391)	(0.409)	(0.372)	(0.388)	(0.439)
Mathematics & statistics	–0.452	0.068	0.17	–0.003	–1.253***	–1.014**	–0.115	–0.819*
	(0.291)	(0.299)	(0.430)	(0.404)	(0.431)	(0.398)	(0.386)	(0.452)
Physical sciences	0.756**	0.36	0.312	1.254**	1.685***	0.651***	0.938***	0.983***
	(0.385)	(0.243)	(0.419)	(0.521)	(0.458)	(0.252)	(0.322)	(0.291)
Environmental science	–0.064	0.305	0.057	0.018	0.315	0.278	0.07	0.419
	(0.324)	(0.310)	(0.438)	(0.406)	(0.455)	(0.377)	(0.521)	(0.437)
Received PhD Pre-1995	0.824***	0.692***	1.812***	0.168	1.231*	0.600**	1.268***	0.554*
	(0.305)	(0.246)	(0.344)	(0.398)	(0.726)	(0.281)	(0.403)	(0.288)

(*continued*)

Table 3B.1 (continued)

	Coefficients and standard errors from Poisson regressions							
	(1) Total publications	(2) First-authored publications	(3) Last-authored publications	(4) High-impact publications	(5) Total (forward) citations	(6) Cites to first-authored pubs	(7) Cites to last-authored pubs	(8) Cites to high impact pubs
Received PhD in 1995–1996	0.761***	0.729***	1.490***	0.526	1.098*	0.584**	1.019***	0.504*
	(0.228)	(0.183)	(0.302)	(0.359)	(0.595)	(0.254)	(0.372)	(0.262)
Received PhD in 1997–1998	0.803***	0.472***	1.371***	0.670*	0.789	0.336	0.647*	0.259
	(0.257)	(0.161)	(0.292)	(0.400)	(0.629)	(0.240)	(0.360)	(0.247)
Received PhD in 1998–1999	0.107	0.128	0.648**	–0.308	–0.402	–0.266	–0.014	–0.198
	(0.230)	(0.158)	(0.313)	(0.346)	(0.582)	(0.257)	(0.394)	(0.265)
Received PhD Post-2002	–0.798***	–0.688**	–0.827*	–1.260***	–1.274**	–1.113**	–1.110**	–1.527***
	(0.298)	(0.321)	(0.444)	(0.448)	(0.632)	(0.483)	(0.565)	(0.554)
ln(Rank of PhD program)	0.05	–0.041	–0.042	0.141	–0.041	–0.083	–0.166**	–0.107
	(0.093)	(0.044)	(0.075)	(0.168)	(0.172)	(0.060)	(0.080)	(0.077)
1 if female	–0.420**	–0.298**	–1.027***	–0.351	–0.254	–0.329**	–0.827***	–0.421**
	(0.167)	(0.136)	(0.260)	(0.258)	(0.438)	(0.159)	(0.254)	(0.200)
Constant	–0.434	0.668	–2.486**	–3.109	–1.711	2.780***	0.21	2.729**
	(1.701)	(0.795)	(1.238)	(3.031)	(2.562)	(0.919)	(1.288)	(1.102)
Observations	488	488	488	488	488	488	488	488
Pseudo *R*-squared	0.23	0.11	0.21	0.25	0.4	0.23	0.21	0.27

Note: Robust standard errors in parentheses.

***Significant at the 1 percent level.

**Significant at the 5 percent level.

*Significant at the 10 percent level.

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Comment Paula E. Stephan

This chapter addresses an extremely important topic for this conference because of the considerable evidence that the foreign born contribute disproportionately to scientific productivity in the United States. Furthermore, it is assumed, and some anecdotal evidence exists, that if and when individuals return to their home country, the United States continues to benefit scientifically—either because of continued collaboration between the returnees

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