

## **Stay Rates of Foreign Doctorate Recipients from U.S. Universities, 2009**

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## Executive Summary

This study estimates the stay rate of foreign nationals who receive doctorates in science and engineering from U.S. universities. Stay rates presented in this study are as of 2009, the most recent year for which data are available. Stay rates are estimated using tax records in a way that does not violate individual confidentiality.

The 2009 stay rate for all foreign doctorate recipients, including those on permanent visas at graduation, was 64 percent for those graduating five years earlier, and 66 percent for those graduating 10 years earlier.

The 2009 stay rate of doctorate recipients on temporary resident visas at the time of graduation behaved slightly differently for different cohorts. For those graduating five years earlier, the stay rate was down slightly from that recorded two years ago. However, for those graduating 10 years earlier, the stay rate in 2009 reached an all-time high.

Overall, stay rates for temporary residents have never been higher. The trend is easiest to see when the five-year rate is averaged together with the 10-year rate. There was a steady increase through 2007, with the 2009 stay rate showing no increase but staying very close to the all-time high of 62 percent reached two years earlier.

China and India are countries of special interest because they account for a large and growing share of new doctorate recipients and are subject to some restrictions not faced by most other countries when seeking permanent resident status. When comparing the history of stay rates for these two countries with that of all other countries, however, there is no apparent evidence that visa restrictions have reduced stay rates for China and India.

This report also estimates stay rates for those who received doctorates in 1993. The stay rate has been almost constant at 57 percent two years after graduation and 56 percent 16 years later, in 2009.

In addition to addressing the changes in stay rates over time, the study also finds that:

- Doctorate recipients from a few disciplines (i.e., agricultural sciences, economics, and other social sciences) have substantially lower stay rates than do those in other science and engineering disciplines.
- Women have stay rates that are slightly higher than men.
- Stay rates vary greatly depending on country of citizenship and these differences have persisted for a long time. China, India, Iran, Romania, Bulgaria, and Yugoslavia have stay rates that are well above average. Countries with the lowest stay rates include: Saudi Arabia, Thailand, Jordan, Brazil, South Africa, Chile, New Zealand and Indonesia.

## Introduction

This report provides estimates of stay rates for foreign students who received doctorates in science or engineering (S/E) from U.S. universities. For this paper, the stay rate represents the proportion of foreign doctorate recipients from U.S. universities who stayed in the United States after graduation for any reason and is always specific to a particular year. Each line in the tables that follow describes a different group of these degree recipients.

## Data and Methods

The stay rate estimates were derived by assembling groups of Social Security numbers of foreign doctoral recipients and obtaining a special tabulation of data from tax authorities. If a foreign doctorate recipient earned \$5,500 or more and paid taxes on it for the year(s) specified, he or she was defined as a *stayer*. Adjustments were made for missing Social Security numbers, mortality, and for the relatively small proportion of recent doctorate recipients who stay in the United States but do not earn at least \$5,500. The method used to make adjustments to data received from tax authorities is described in detail in the Technical Appendix. However, the effect of these adjustments is quite small. The stay rates reported here are typically only slightly higher than the rates that can be deduced from tax payments with no adjustments.

## Trends in Doctorate Awards

Table 1 shows the number of S/E doctorates awarded, by citizenship status. The number of doctorate awards grew substantially from 1987 to 1992. From 1997 to 2001, the awards to U.S. citizens declined. From 1997 to 2001, doctorate awards to foreign citizens declined as well. However, from 2003 to 2009 doctorate awards to foreign citizens have increased dramatically -- by almost 50 percent -- and awards to U.S. citizens have increased by about one-third.

Research and development are very common work activities for recent doctorate recipients. The most recent data on total U.S. R&D expenditures indicates these expenditures have grown (in inflation adjusted terms) by only 20 percent from 2003 to 2008.<sup>1</sup> Thus, it appears that after a period of no growth in doctorate awards, these awards have been growing faster than R&D expenditures in recent years. While there are other types of work that employ doctorates, these data on doctoral degree awards and R&D expenditures suggest that supply may have been increasing faster than demand during the period since 2003.

**Table 1. Science and Engineering Doctorates Awarded by U.S. Universities, by Citizenship Status, Selected Years, 1987-2009**

Citizenship Status	1987	1992	1997	1999	2001	2003	2005	2007	2009
Temporary visa	4,468	8,092	7,507	7,238	7,943	8,382	9,990	11,959	12,588
Permanent visa	1,089	1,383	2,281	1,654	1,270	1,098	1,112	1,222	1,523
<b>Total, foreign citizens</b>	<b>5,557</b>	<b>9,475</b>	<b>9,788</b>	<b>8,892</b>	<b>9,213</b>	<b>9,480</b>	<b>11,518</b>	<b>13,548</b>	<b>14,111</b>
<b>U.S. citizens</b>	<b>12,966</b>	<b>14,559</b>	<b>16,112</b>	<b>15,915</b>	<b>15,049</b>	<b>14,635</b>	<b>14,912</b>	<b>16,022</b>	<b>19,509</b>

Source: National Science Foundation, Division of Science Resources Statistics. [Science and Engineering Doctorate Awards: 1996](#), and [Science and Engineering Doctorate Awards: 2005](#), (NSF 97-329) and (NSF 07-305). Susan T. Hill, project officer. Arlington, VA. Also, unpublished data from NSF for 2007.

<sup>1</sup> National Science Foundation, "New NSF Estimates Indicate that U.S. R&D Spending Continued to Grow in 2008," (NSF 10-312), January 2010.

## Stay Rates of Recent Graduates

Table 2 shows that the five-year stay rate for all foreign students receiving doctorates in 2004 was 64 percent. Note, however, that the stay rate for this class in 2006, two years after their graduation, was 68 percent. The stay rate for this class declined only four percentage points during the period from two to five years after graduation. This is significant because many new doctorates take postdoctoral research appointments, but only a fraction of them are still in postdoctoral appointments five years after graduation. Since we observe only a small decline in stay rates from year two to five after graduation, an assumption could be made that foreign doctorate recipients from U.S. universities routinely take regular employment in the United States after completing postdoctoral appointments.

Table 2 also shows stay rates by degree field. Life science has the highest stay rate. Agricultural and social sciences have below average stay rates, with economics having the lowest rate of all.

**Table 2. Percentage of Foreign Students Receiving S/E Doctorates in 2004  
Who Were in the United States, 2005-2009**  
(includes students on temporary and permanent visas)

Degree Field	Foreign Doctorate Recipients	Percent in the United States				
		2005	2006	2007	2008	2009
Physical science	1,711	78	76	73	71	70
Mathematics	583	74	72	67	64	64
Computer science	510	72	69	70	68	66
Agricultural science	454	54	52	51	49	46
Life science	2,144	76	74	72	73	72
Computer/EE engineering	1,110	76	73	72	71	68
Other engineering	2,444	71	68	66	65	63
Economics	659	47	44	45	44	43
Other social science	948	54	51	50	51	50
<b>Total, all fields</b>	<b>10,563</b>	<b>70</b>	<b>68</b>	<b>66</b>	<b>65</b>	<b>64</b>

Source: Oak Ridge Associated Universities.

## Long-Term Stay Rates

The data presented so far indicate that stay rates fall only slightly during the first five years after graduation. Data in Table 3 indicate that this is true during the period five to ten years after graduation as well. The 2009 stay rate for all S/E doctorates awarded by U.S. universities to foreign citizens in 1999, 66 percent, is in the same range as stay rates of the class of 2004 in 2009. This 10-year stay rate for the class of 1999 did decline slightly during the last six years of the period examined. Still, two-thirds stayed in the United States after 10 years. This provides additional evidence about how stay rates increased over the past two decades. The increase has occurred almost entirely because more recent graduates have higher stay rates. There is no evidence that stay rates for any given class tended to increase as time since graduation increased. Stay rates were rising during the 1990s, and, during this period, the five-year stay rate always exceeded the 10-year stay rate. In recent years stay rates leveled out at a fairly high level. Thus, the 10-year stay rate for the class of 1999 shown in Table 3 is not lower than the five-year stay rate shown in Table 2. Indeed, for the first time the five-year stay rate (64 percent) is slightly lower than the 10-year stay rate (66 percent).

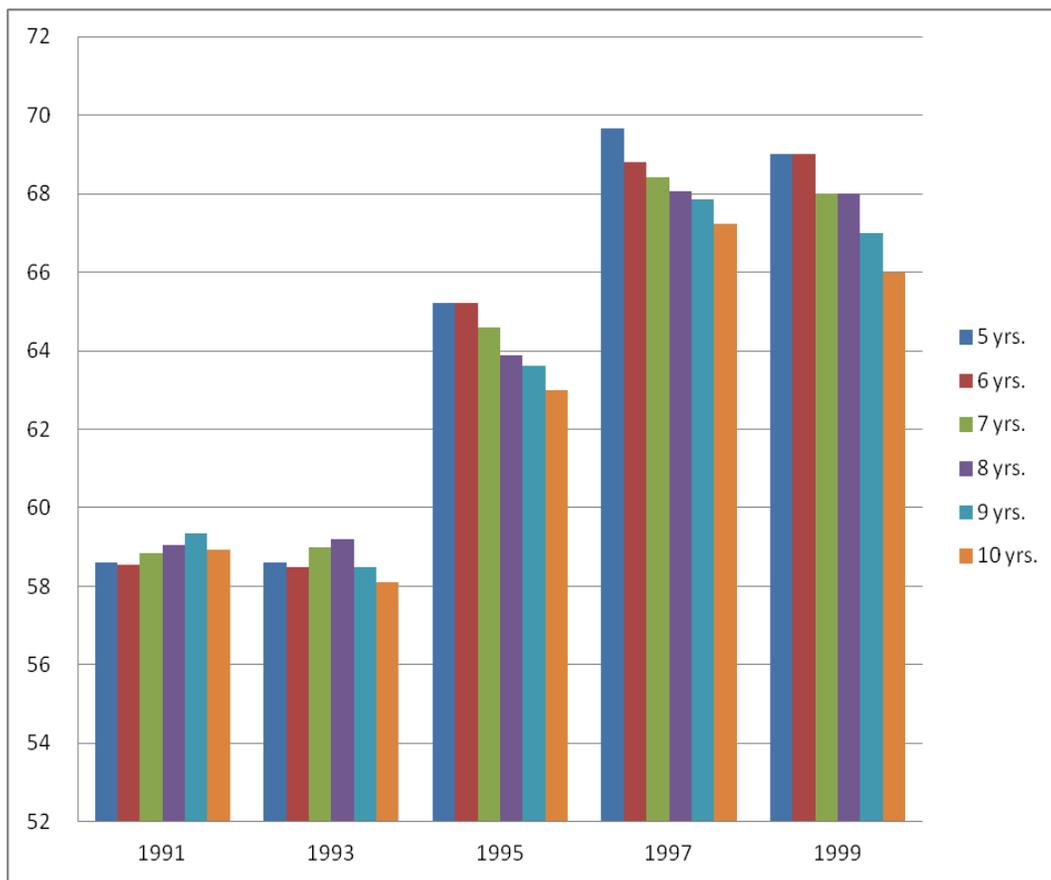
**Table 3. Percentage of Foreign Nationals Receiving S/E Doctorates in 1999  
Who Were in the United States, 2000 to 2009**  
(includes students on temporary and permanent Visas)

Degree Field	Foreign Doctorate Recipients	Percent in the United States									
		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Physical science	1,635	82	80	78	77	77	77	77	76	76	74
Engineering	2,595	77	76	75	72	71	70	70	70	69	68
Life science	2,115	80	78	78	78	78	77	76	76	76	75
All other science	2,878	60	59	59	57	56	56	55	55	55	53
<b>Total</b>	<b>9,223</b>	<b>73</b>	<b>72</b>	<b>71</b>	<b>70</b>	<b>69</b>	<b>69</b>	<b>68</b>	<b>68</b>	<b>67</b>	<b>66</b>

Source: Oak Ridge Associated Universities.

Figure 1 shows that the stay rate for the Class of 1999 declines between six and 10 years after graduation and includes the same data for earlier cohorts for comparison.

**Figure 1. Percentage of Foreign Nationals Receiving S/E Doctorates  
Who Were in the United States Five to 10 Years After Receipt of Doctorate,  
for Doctorates Awarded in 1991, 1993, 1995, 1997, and 1999**



Source: Oak Ridge Associated Universities.

Table 4 shows the stay rate for those receiving doctorates in 1993 and 1994. While the initial stay rate was lower than for more recent cohorts, the stay rate is remarkably stable over the 16-year period since graduation. While some leave the United States after gaining several years of work experience, these returnees are largely offset by others who left earlier but subsequently returned to the United States.

**Table 4. Percentage of Foreign Nationals Receiving S/E Doctorates in 1993 and 1994 Who Were in the United States from 1995 to 2009.**

	1995	1997	1999	2001	2003	2005	2007	2009
1994 Doctorates	60	59	60	61	60	59	59	57
1993 Doctorates	57	57	58	59	58	58	57	56

Source: Oak Ridge Associated Universities.

The stay rates shown in Table 4, while very stable over time, are somewhat lower than the stay rates observed for more recent cohorts. What caused the increase in stay rates among more recent cohorts? To get some insight we might examine the four largest source countries which accounted for nearly 60 percent of all doctorate recipients in 1994: China, India, Taiwan and South Korea. For many years, China and India have had the highest stay rates of any source countries. In 1994, these two countries supplied 34 percent of the new foreign doctorates and their combined stay rate was 90 percent. In the same year, Taiwan and South Korea together supplied 23 percent of new foreign doctorates and had a combined stay rate of only 28 percent.

In the decade following 1994, these same four countries remained the largest source countries. However, the relative contribution of the two highest stay rate countries, China and India, grew from 34 to 38 percent. An even bigger shift occurred with Taiwan and South Korea as their combined share of new foreign doctorates fell from 23 percent in 1994 to only 15 percent in 2004. So, while this simplified analysis ignores all the other countries, it still makes clear that part of the increase in stay rates from the 1994 cohort to the 2004 cohort occurred because two large source countries with the highest stay rates (China and India) provided an even larger share of the doctorate recipients, while two low stay rate countries (Taiwan and South Korea) saw their combined share decline. In fact, the relative decline in these two countries was due almost entirely to Taiwan, which accounted for 1,348 new S/E doctorate recipients in 1994 but only 395 in 2004.

### **Stay Rates for Temporary Residents**

The previous discussion focused on the stay rate of all students who were foreign citizens at the time they received doctorates from U.S. universities. This definition includes both those who have temporary visas and those with permanent visas. Most discussions of foreign graduate students, however, refer only to those on temporary visas. For example, the *NSF Survey of Graduate Student Support and Postdoctorates in Science and Engineering* is a source of information on total and foreign student enrollment in graduate S/E programs. However, it defines foreign students to include only those on temporary visas and combines those on permanent visas with U.S. citizens.

The temporary student visa definition of “foreign student” has worked well most of the time. However, during the 1990s, special legal provisions were passed to grant permanent visa status to foreign students from China. Since China was the largest source country, this temporarily reduced the number of foreign students, unless one used the broader definition that included permanent and temporary resident students. Also, since students from China had the highest stay rate, the fact that many Chinese students received permanent resident status while working on their doctorates tended to reduce the total stay rate for all countries if the temporary resident definition was used.

Notwithstanding the good reasons to define “foreign student” to include both those on permanent and temporary resident visas, there is value in the calculation of a separate stay rate for temporary residents as it conforms to the more typical definition of “foreign student.” Also, there are some historical statistics of stay rates by country of origin that were produced only for students on temporary visas, and a similar definition is needed to compare the data on recent cohorts with data from earlier cohorts. Thus, this section presents estimates of stay rates for foreign citizens on temporary visas at the time they received their doctorate degrees.

Table 5 shows the stay rates for temporary residents by degree field. Compared with the earlier table that included permanent residents, this table shows much the same pattern, with the highest stay rates in life science. However, the overall stay rate, 62 percent, is slightly lower when those with permanent resident visas at graduation are excluded.

**Table 5. Percentage of Temporary Residents Receiving S/E Doctorates in 2004 Who Were in the United States, 2005-2009, by Degree Field**

Degree Field	Foreign Doctorate Recipients	Percent in the United States				
		2005	2006	2007	2008	2009
Physical science	1,570	78	75	72	69	68
Mathematics	528	72	70	65	62	62
Computer science	460	71	67	67	66	65
Agricultural science	419	53	51	49	47	44
Life science	1,838	76	72	71	71	70
Computer/EE engineering	1,032	75	72	71	70	68
Other engineering	2,280	69	67	65	63	62
Economics	615	44	41	42	41	41
Other social science	751	45	42	41	42	41
<b>Total, all fields</b>	<b>9,493</b>	<b>69</b>	<b>66</b>	<b>64</b>	<b>63</b>	<b>62</b>

Source: Oak Ridge Associated Universities.

Table 6 shows that four countries continue to account for most of the foreign students receiving doctorates: China, India, Taiwan, and South Korea. Two of these, China and India, also have very high stay rates. The 5-year stay rate for Chinese doctorate recipients, 89 percent, is the highest observed for any country in 2009. The stay rate for India in 2009, 79 percent, is also high given that none of these were permanent residents at the time of graduation.

**Table 6. Percentage of Temporary Residents Receiving S/E Doctorates in 2004  
Who Were in the United States, 2005 to 2009, by Country of Origin**

Country of Origin	Doctorate Recipients	Percent in the United States				
		2005	2006	2007	2008	2009
China	2,769	93	92	91	91	89
Taiwan	395	48	43	37	38	37
Japan	170	48	49	44	44	40
South Korea	1,030	57	51	46	43	42
India	832	85	82	81	80	79
Thailand	302	17	14	13	12	12
Other East Asia	130	59	58	55	53	54
Jordan	94	42	35	31	29	30
Iran	46	91	94	94	89	89
Israel	52	59	64	67	59	54
Saudi Arabia	101	5	5	5	5	5
Turkey	324	52	45	44	43	40
Other West Asia	230	57	57	55	54	54
Australia	35	57	57	51	51	44
Indonesia	64	47	41	38	34	34
New Zealand & Other Pacific	21	59	49	43	38	33
Egypt	116	66	58	57	57	49
South Africa	26	38	28	28	33	28
Other Africa	183	64	61	64	62	63
Greece	92	59	53	48	45	41
United Kingdom	75	55	53	57	58	57
Germany	154	61	57	58	55	54
Italy	110	52	49	47	47	44
France	83	67	65	62	56	54
Romania	142	90	90	88	88	85
Spain	68	50	41	39	35	37
Other EU countries	260	54	54	51	50	49
Russia	170	76	75	73	73	70
Yugoslavia	54	84	88	88	84	84
Bulgaria	54	79	77	81	81	79
Other Europe	172	73	69	68	65	66
Canada	356	62	57	55	54	53
Mexico	168	42	42	37	35	34
Argentina	83	58	53	50	46	47
Brazil	135	35	36	33	32	33
Chile	38	27	27	30	30	30
Colombia	71	53	53	50	53	52
Peru	26	71	71	67	67	58
Venezuela	66	51	52	53	50	52
Other Central/South America	129	67	64	63	62	56
Country not reported	67	-	-	-	-	-
<b>Total, all countries</b>	<b>9,493</b>	<b>69</b>	<b>66</b>	<b>64</b>	<b>63</b>	<b>62</b>

Source: Oak Ridge Associated Universities.

Not all of the large source countries for foreign students display high stay rates in Table 6. Taiwan's stay rate was only 37 percent in 2009, and South Korea's was only 42 percent. Other countries with even lower low stay rates include: Saudi Arabia (5 percent), Thailand (12 percent), South Africa (24 percent), and Chile and Jordan (both 30 percent). Countries with above average rates in 2009 include not only China (89 percent) and India (79 percent), but also Iran (89 percent), Romania (85 percent), and Yugoslavia (84 percent).

The country-by-country variation in stay rates shown in Table 6 is similar to the patterns observed in previous years. Table 7 shows such a comparison for selected countries. For each of the classes examined in Table 7, students from China have the highest stay rate, and those from India have the second highest. Canada and Europe have stay rates that have been close to the average for all countries combined. South Korea, Brazil, Mexico, Taiwan and Japan have all had low stay rates. The overall pattern is one of stability in terms of country rankings, although there has been some change among the low stay rate countries as both South Korea and Japan have increased their stay rates and relative position among the lower stay rate countries. Table 7 also shows that the five-year stay rate for all countries combined rose from 45 percent in 1989 to a high of 67 percent in 2005, then declined to 62 percent in 2009.

**Table 7. Percentage of Foreign Students on Temporary Visas Receiving S/E Doctorates Who Were in the United States Five Years after Graduation, for Selected Countries, 2001-2009**

	1989	2001	2003	2005	2007	2009
China	-	98	93	95	94	89
India	-	89	90	89	83	79
Europe	-	53	63	67	67	60
Canada	-	66	63	60	56	53
South Korea	-	22	36	44	42	42
Japan	-	24	39	41	33	40
Taiwan	-	41	48	52	43	37
Mexico	-	31	22	32	33	35
Brazil	-	26	26	31	32	33
<b>All countries</b>	<b>45</b>	<b>58</b>	<b>64</b>	<b>67</b>	<b>63</b>	<b>62</b>

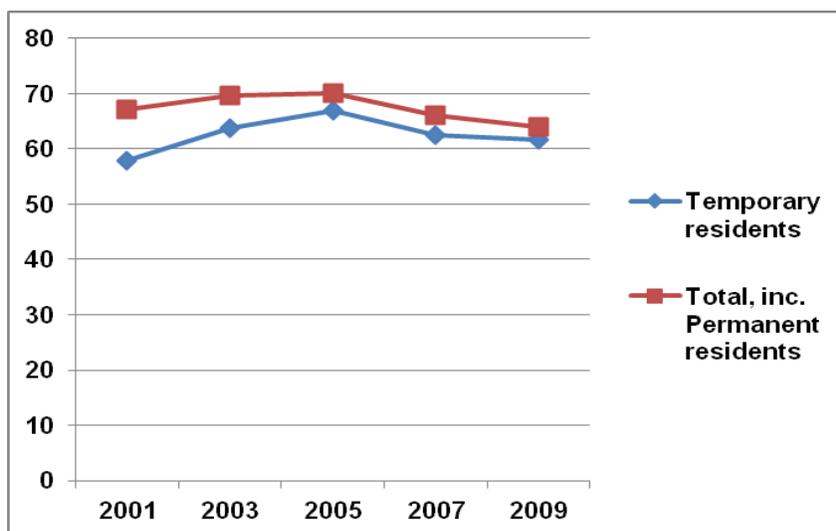
Source: Oak Ridge Associated Universities.

### Have Stay Rates Declined?

One complication confronting anyone who asks whether the stay rate is declining is that there may be a different stay rate for every cohort. This study presents estimated stay rates in 2009 for four different cohorts: persons who received a doctorate 5, 10, 15, and 16 years previously. Thus, there are four observed stay rates for 2009. However, this is the first time the 15 and 16-year stay rates have been estimated, whereas the five-year and 10-year stay rates are available for previous years. To address the question of whether stay rates have declined we use the five and 10 year rates as they are the only two with historical data available.

Changes in the five-year stay rates are shown in Figure 2. While five-year stay rates increased substantially during the decade of the 1990s, Figure 2 shows that after 2005 they have declined slightly.

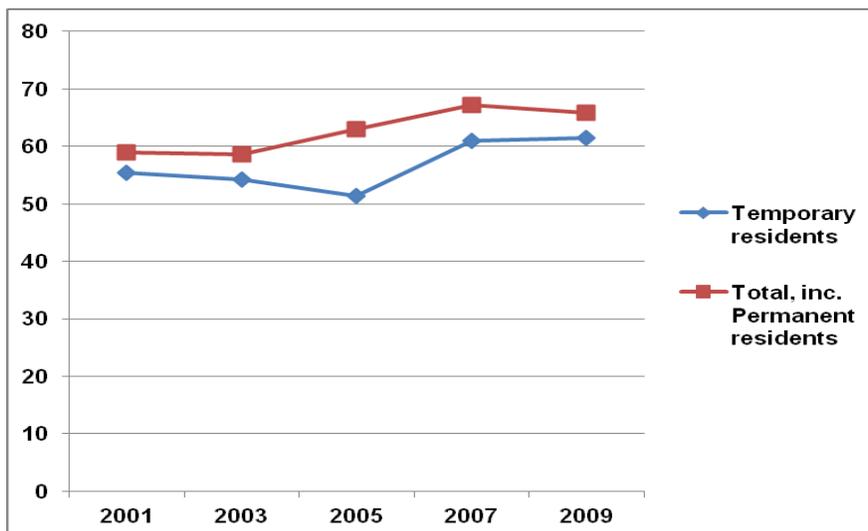
**Figure 2. Five-Year Stay Rates, 2001 to 2009**



Source: Oak Ridge Associated Universities.

The trend in 10-year stay rates since 2001 is shown in Figure 3. The 10-year stay rate increased from 2001 to 2009. The temporary decline shown in Figure 3 for doctorate recipients with temporary resident visas at the time of graduation is due to an unusual event. After the Tiananmen Square pro-democracy protests of 1989 resulted in a bloody suppression of peaceful dissent, the U.S. government passed the Chinese Student Protection Act of 1992. This resulted in many doctoral students from China receiving permanent resident status, when they would otherwise have graduated with temporary visas. Since China is the largest source country, and its doctorate recipients also have the highest stay rates, this could explain the relatively large gap between the stay rate for all and the stay rate for temporary residents around 2005. So the trend in 10-year stay rates is best observed by either examining the rate for all doctorate recipients, or, if temporary residents are of prime interest, then by comparing the rate at the beginning of the decade with the rate at the end of the decade. By either measure, stay rates increased over the decade.

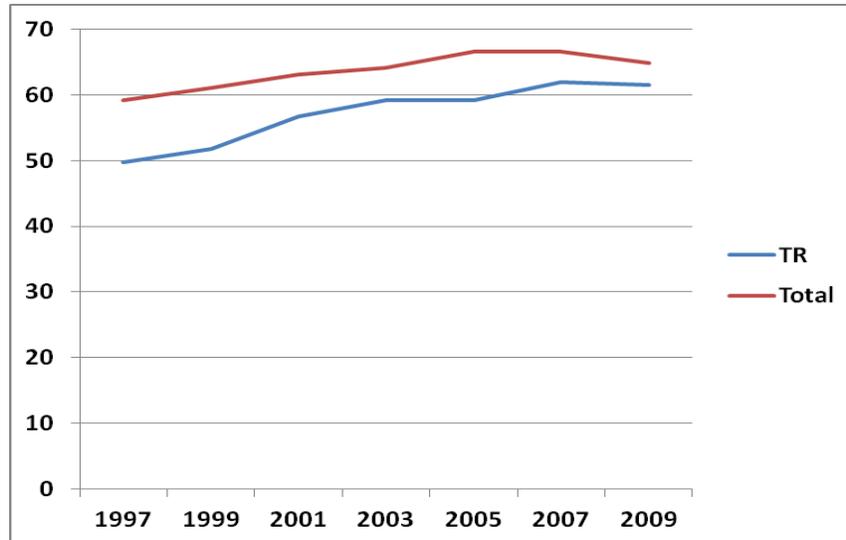
**Figure 3. Ten-Year Stay Rates, 2001 to 2009**



Source: Oak Ridge Associated Universities.

Perhaps the best way to summarize changes in stay rates in recent years is to average together the five-year and 10-year stay rates. This is shown in Figure 4. The trend is clearly up for those on temporary resident visas, although 2009 showed no increase over 2007. For the total, the almost decade long trend in Figure 4 is also up, but only slightly, and did decrease slightly from 2007 to 2009. Why, did the total stay rate decline more than the stay rate for temporary residents from 2007 to 2009? An examination of the data for permanent residents indicates that their stay rates declined from 2007 to 2009, but only slightly. The proportion of all foreign doctorate recipients who were permanent residents declined as well, and this contributed to the decline in the stay rate for total doctorate recipients as the permanent resident stay rate has been close to 85 percent in recent years.

**Figure 4. Average of Five-Year and 10-Year Stay Rates, 2001 to 2009.**

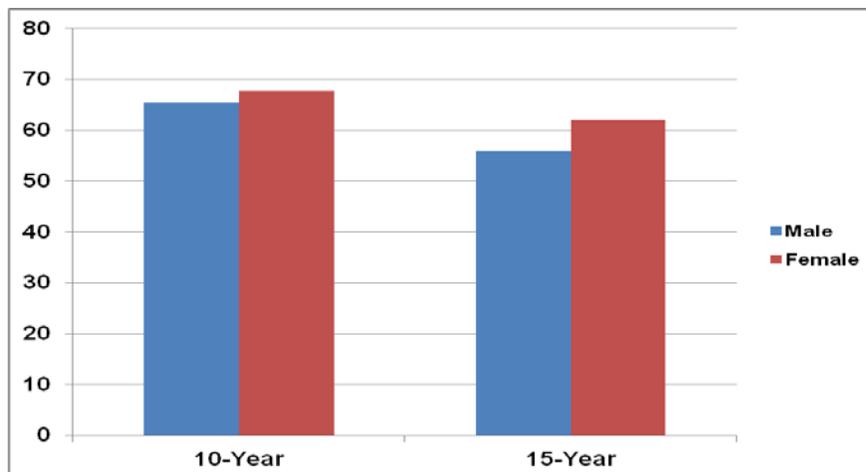


Source: Oak Ridge Associated Universities.

### Stay Rate Differences by Gender

Figure 5 shows differences in stay rates by gender. Estimates by gender were made only for the 10-year and 15-year stay rates, but the graph for each shows that, in 1999, females stayed at a slightly higher rate than males.

**Figure 5. Ten-Year and Fifteen-Year Stay Rates by Gender**



Source: Oak Ridge Associated Universities.

## Migration vs. Circulation

The stay rate discussion above has focused primarily on the most recent year for which we have data available, 2009. The five-year stay rate in 2009 is the percentage of the 2004 graduates estimated to be in the United States in 2009. However, it is incorrect to assume that all migration is one-way and that the migrants stay continuously. Some foreign doctorate recipients work in the United States for a while after graduation and then leave for work abroad, only to return at a later date. Others leave immediately upon graduation but may return to the United States after five or 10 years.

Data on the 10-year stay rate can be used to illuminate the circulation of early-career S/E doctorate recipients. The 10-year stay rate in 2009 was 66 percent. This was reported in Table 3 and it includes doctorate recipients who were on either temporary or permanent visas at the time of graduation. How much higher would this stay rate have been if, instead of counting only those who were still here in 2009 as stayers, we had counted those with at least five, three, or one year in the United States during the decade after they received their doctorate in 1999. The answer is that the 10-year stay rate would have been nine percent higher if five years residence were required, 16 percent higher if three years residence were required and 24 percent higher if only one year residence were required to qualify as a stayer. These results are summarized in Table 8 below.

A person who stays only one or two years after receipt of the doctorate may be staying just to obtain the additional training and experience associated with a postdoctoral appointment. This is also true of some who stay three, four or even five years before leaving. The widespread phenomenon of postdoctoral study surely explains a large part of the reason why, among those not here after 10 years, the number who had spent at least a year in the United States is nearly three times as large as the number who spent at least five years.

**Table 8. Percentage Increase in the 10-Year Stay Rate That Would Occur if Persons Staying any Five, Three, or One Years Out of Ten Were Counted as Stayers, 2007 and 2009**

	2007	2009
One year	21	24
Three years	12	16
Five years	7	9

Source: Oak Ridge Associated Universities.

One might think of the data in Table 8 as a measure of the degree to which young scientists move around the world to pursue their scientific careers. While there are some people who migrate once and reside permanently in the United States, others may move back to their home country or even move back and forth between countries to pursue their careers. Consider the data in Table 8 which indicate that the 10-year stay rate in 2009 would be nine percent higher if, instead of only counting those who were still here in 2009, we also counted those 1999 doctorate recipients who were here for at least five of the 10 years after 2009 but were not here in 2009. Does this indicate an increase in the extent to which young scientists move about the world? It probably does not.

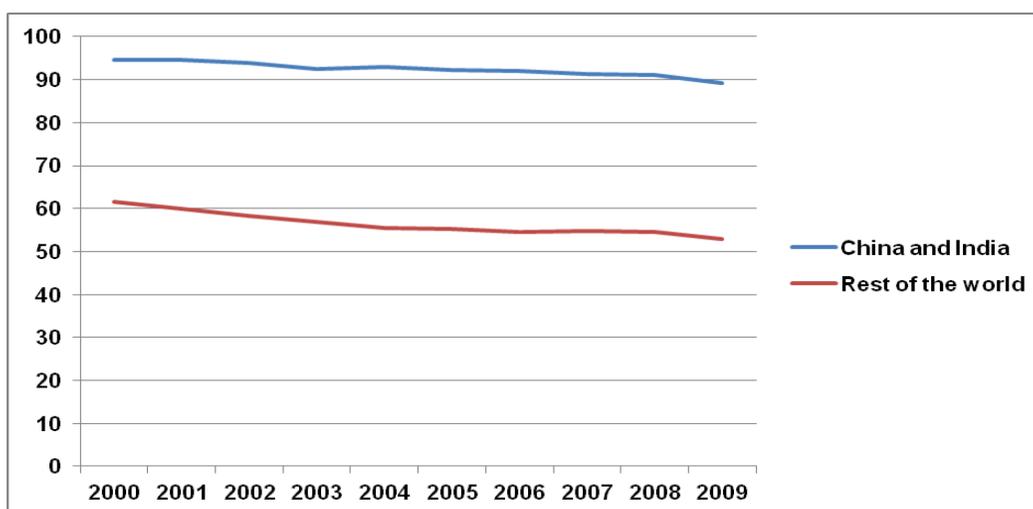
For the class of 1999 (shown in the column labeled 2009 in Table 8), the stay rate dropped from 73 percent after one year to 66 percent after 10 years, a decline of 7 percentage points (Table 3). For the earlier cohort shown in Table 8, those receiving doctorates in 1997 (column labeled 2007 in Table 8), the stay rate dropped from 71 percent after one year to 67 percent after 10 years a decline of only 4 percentage points. So, using identical assumptions to make estimates, we observe a greater fall off in stay rates over time for the most recent cohort, shown in Table 8. Table 8 thus does not indicate that the tendency of young scientists to move about has increased. In fact, much of the phenomenon measured in Table 8 can be explained by the tendency of some S/E doctorate recipients to conduct postdoctoral study or work in the United States for a few years before leaving.

## Impact of Restricting Access to Permanent Visas

Are stay rates constrained because of the difficulty of obtaining visas to work in the United States? Some scholars have expressed concern that this is so. For example, Guillermina Jasso of NYU estimated that as of the end of Fiscal 2006 there were 1.18 million individuals waiting for employment-based permanent residency in the United States, but, at the time, the number of employment based visas granted annually was about 120,000.<sup>2</sup> This led her and others<sup>3</sup> to express concern that the high stay rates which have characterized S/E doctorate recipients from India and China in the past may not be maintained.

India and China represent something of a paradox in this regard. Doctorate recipients from any country will face certain obstacles in applying for and receiving permanent resident status, which can permit them to work in the United States indefinitely. However, persons from India and China face an extra complication. If they wish to obtain a permanent visa using the second preference category for “persons with advanced degrees or aliens of exceptional ability,” they must deal with the fact that, by law, no more than seven percent of all the numerically limited immigrants in a given year can come from a single nation (North, 2011, p.4). This sometimes affects doctorates from the Philippines as well as those from India and China, but, in recent years, it has always applied to India and China. The effect is a longer backlog of applicants for permanent resident visas status from those countries. This could potentially cause doctorate recipients from China and India to become discouraged and leave the United States because of frustration with the difficulty of getting permanent resident status. But has it? To address that question, the data in Figure 6 and 7 are instructive.

**Figure 6. Percentage of Foreign Nationals Receiving S/E Doctorates in 1999 Who Were in the United States, 2000-2009, China and India vs. All Other Countries**



Source: Oak Ridge Associated Universities.

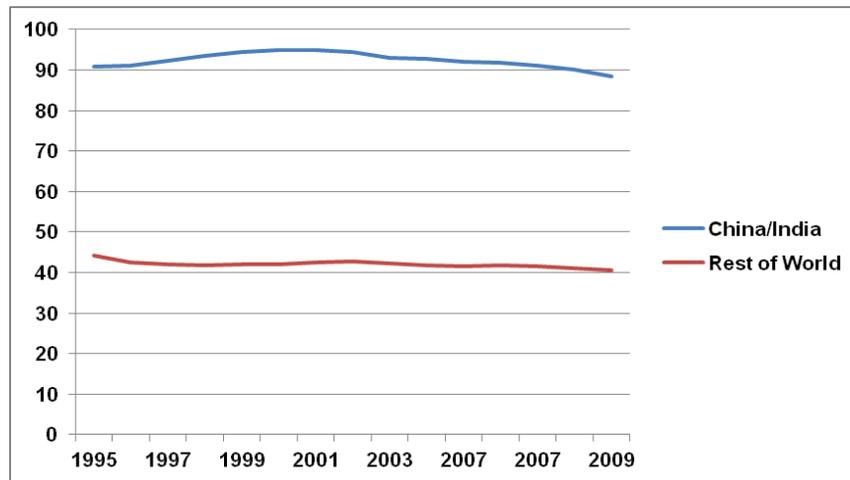
The stay rate for China and India is the highest line in Figure 6, indicating that doctorate recipients from these two countries are much more likely to stay in the United States throughout the 10-year period following graduation than are those from other countries. It is relatively easy for recent doctorates to obtain temporary work visas in the first years after graduation. For example, it is easy to get a visa for postdoctoral research appointments that often last three, four or even five years if the individuals string two or more postdoctoral appointments together. It is also relatively easy to find an employer who can help obtain a temporary visa for employment such as the H1-B visa. If the difficulties obtaining permanent-resident visas caused some to give up and leave the United States, one would expect to see evidence of this in Figure 6. Instead we see only a very modest and steady decline over time in stay rates.

<sup>2</sup> Freeman, Stephan, and Trumpbour, 2008, p 7.

<sup>3</sup> Wadhwa, 2009

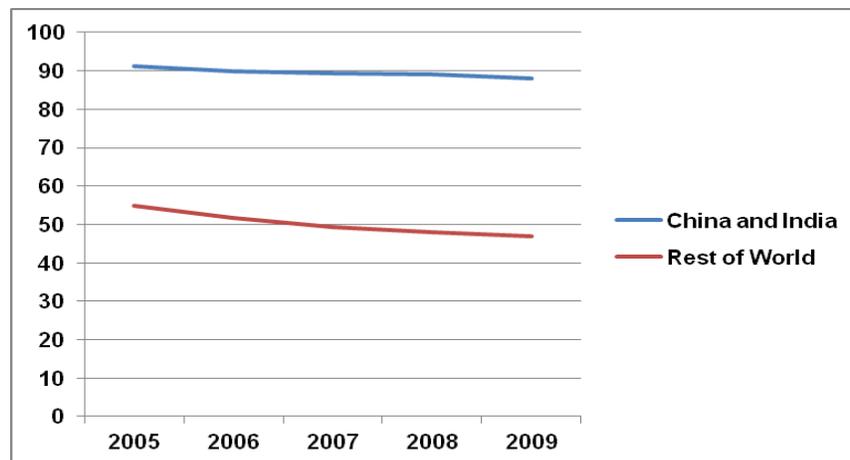
The downturn for China and India is even less than it is for the rest of the world. And, of course, the stay rate for China and India is very high even 10 years after graduation. Figure 7, which graphs the same stay rates for the doctorate recipients of 1994 shows that even with a 15 year time-frame the pattern is the same: China and India combined have stay rates that are more than twice as high as the rest of the world, and declines in stay rates over time are very slight. Figure 8 graphs stay rates for the doctorate recipients of 2004 but only those persons on temporary visas at graduation. Five years may not be enough time to be forced out of the United States because of problems obtaining a permanent visa, but it is relevant because we might see some increased downturn in stay rates beginning after three or four years if this more recent cohort feared that they would be unsuccessful in obtaining a permanent resident visa. However, Figure 8 also shows that China and India combined have a stay rate that is very high relative to the rest of the world, and the decline in stay rates over time is slight for both groups, but somewhat less for China and India.

**Figure 7. Percentage of Foreign Nationals Receiving S/E Doctorates in 1994 Who Were in the United States, 1995-2009, China and India vs. All Other Countries**



Source: Oak Ridge Associated Universities.

**Figure 8. Percentage of Foreign Nationals on Temporary Visas Receiving S/E Doctorates in 1994 Who Were in the United States, 1995-2009, China and India vs. All Other Countries**



Source: Oak Ridge Associated Universities.

The data in Figures 6, 7, and 8 do not support the view that the best and brightest have been returning home because of visa difficulties in the United States. While this report is confined to doctorate recipients from U.S. universities, if there were a general tendency for the best and brightest to return home because of visa difficulties, one would expect to see this affecting doctorate recipients as well as persons with other degrees.

## Future Stay Rates

The stay rate estimates in this report, while they are the most up-to-date estimates available, do not necessarily apply to the foreign doctorate recipients who have completed their degrees since 2004. We know that the number of foreigners granted S/E doctorate degrees by U.S. universities increased sharply later in the decade, so it is very unlikely that the total number of foreigners staying to work in the United States would be declining – even if there were a modest decline in the stay rates for classes graduating after 2004. Further, a decline in stay rates seems unlikely to happen. There are two different ways to come to this conclusion.

One way to anticipate future stay rates is to look at the changing country composition of foreign doctorate recipients. While there is no way to know the stay rate of foreigners who received doctorate degrees in years more recent than 2004, we do know that the countries with the highest stay rates in the past increased in numbers even faster than the total. In the class of 2004, seven countries had five-year stay rates above 70 percent: China, India, Iran, Romania, and Bulgaria. These seven high stay rate countries accounted for 40 percent of the total number of foreign S/E doctorate recipients in 2004. During the three-year period which includes 2007, 2008 and 2009, their share increased to 50 percent<sup>4</sup>. Another group of eight countries with stay rates below 43 percent in 2004 saw their share of the total decline slightly from 24 percent to 20 percent of the total over the same period, i.e., comparing 2004 with 2007, 2008 and 2009 combined. Thus, if stay rates of individual countries are unchanged in the more recent cohorts it follows that the total stay rate would increase over this period. If stay rates of individual countries decline slightly for the classes of 2007 to 2009, relative to the class of 2004, the change in country composition could offset this to produce a five-year stay rate for the classes of 2007 to 2009 that is unchanged from the 5-year stay rate of the class of 2004. Only if individual country stay rates decline substantially would any decline in the total stay rate be observed.

A different source of information about future stay rates is the intentions data that can be generated from the Survey of Earned Doctorates. Respondents fill out the survey about the time of graduation and are asked about plans for work or postdoctoral study after graduation. Those who report that they plan to work or study in the United States and have already signed a contract or have a definite commitment of employment, are described as having “definite plans to stay” in Table 9. Others who intend to stay in the United States but did not yet have such a commitment are included in the broader “plans to stay” category in the same table. Of these two different measures of intentions to stay in the United States after graduation, the more comprehensive one, “Plans to Stay” has been the closest to actual observed stay rates (Finn, 2010).

**Table 9. Percentage of Foreign Doctorate Recipients Reporting Plans to Stay in the United States After Graduation, 1998-2009**

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Definite Plans to Stay	46	47	48	52	50	47	47	49	53	52	53	53
Plans to Stay	65	67	67	72	70	68	69	72	75	76	77	74

Source: Special tabulation of data from the Survey of Earned Doctorates, prepared by National Opinion Research Center, prepared in 2011

Previously in this report, stay rates were calculated for cohorts completing doctorates in 2004 and earlier years. For example, Table 2 showed the estimated stay rate for the doctorate recipients of 2004 to be 70

<sup>4</sup> NSF, 2010 and NSF, 2011

percent after one year, and falling to 64 percent after five years. That tax-data based estimate of 70 percent after one year can be compared with the 69 percent reporting plans to stay in 2004 in Table 9. We would not expect the two to match exactly. The intentions data (69 percent with plans to stay in 2004) include the plans of many who did not yet have a solid commitment for work or postdoctoral study at the time the Survey of Earned Doctorates was administered to them. The tax based estimate of 70 percent staying after one year can be described as what they actually did, although it is subject to a small error because of the adjustments that were made to tax data. Thus, it is somewhat surprising that these two estimates are very close. The actual behavior may not be as close as the estimates based on plans to stay in the future, but, nevertheless, the plans are our best indicator of likely changes in stay rates. We can see from Table 9 that plans to stay are higher in the years subsequent to 2004, the most recent class for which stay rates were estimated in this report. Table 9 indicates that the proportion of new foreign doctorate recipients reporting that they plan to stay increased from 69 percent in 2004 to 74 percent in 2009. While this may be largely due to the increased share of the total accounted for by high stay rate countries such as China and India, it nevertheless suggests that we are likely to see higher total initial stay rates in the future.

### **Summary and Conclusions**

Stay rates continue to vary substantially by country of citizenship. Stay rates observed in 2009 are at or very near the highest levels observed in the recent past.

When one considers the combined five-year and 10-year stay rates in 2009 (i.e., graduates of 2004 and 1999), the stay rates for all foreign doctorate recipients including those on permanent resident visas at graduation are down slightly from the levels observed two or four years earlier but up relative to earlier periods. When one considers only those on temporary visas at graduation, the combined five and 10 year stay rates in 2009 have not declined appreciably and, indeed, have increased significantly over the previous decade.

The data in this report provide no support for the view that S/E doctorate recipients on temporary visas have had declining stay rates because of difficulty obtaining visas that would permit them to stay in the United States to work. This is illustrated by the cases of China and India. Even though immigrants from these two countries face limits not faced by most other countries, the S/E doctorate recipients from China and India have had stay rates near 90 percent, much higher than all other countries combined. While stay rates of India and China decline with years since graduation, this decline has been very slight and smaller than the corresponding decline in stay rates observed by all other countries combined. Further, one observes no abrupt decline in the stay rate several years after graduation – something one would expect to see if difficulty in obtaining permanent visas were causing increasing numbers to leave the United States.

Two different indicators suggest that stay rates are more likely to increase in coming years than to decline. One is the changing country composition of foreign S/E doctorate recipients. The share of all foreign S/E doctorate recipients coming from the five highest stay rate countries increased significantly from 2004 to 2009. Another is the intentions of doctorate recipients as stated in the Survey of Earned Doctorates. The proportion stating that they intend to stay in the United States after graduation increased from 2004 to 2009.

## TECHNICAL APPENDIX

This appendix provides information about the data and methods used to produce the results described in this report.

### Sources of Data

This project was discussed with staff of the National Opinion Research Center (NORC), the National Science Foundation (NSF), and the Social Security Administration to ensure that the methods chosen would comply with each organization's policy regarding the confidentiality of data on individuals. Data for the report pertain almost exclusively to a set of 115 groups of Ph.D. recipients who received S/E degrees from U.S. universities in 1993, 1994, 1999, and 2004.

Our method started with responses to the NSF *Survey of Earned Doctorates* for the years of interest. This survey is not a sample survey but rather a complete census of new doctorate recipients in the United States, administered at or near the time that they complete their doctorates. Among the questions asked of these persons are country of citizenship, degree field, and gender. Answers to these questions were used to define and identify groups for which stay rates were estimated (e.g., temporary residents graduating in 2004 with a degree in computer science). The NORC staff then prepared a data file containing the birth years and Social Security numbers of the persons in each of these groups. All the persons with the traits used to define the group were included, provided that NORC had a Social Security number and birth year for them. In total, groups of foreign citizens containing a total of 35,567 different persons were identified.

If no adjustments were to be made, the stay rate would be the proportion in a group that was recorded by the Social Security Administration to have paid either Federal income taxes and/or Social Security taxes on at least \$5,500 in earnings. For example, one group consisted of 1,838 persons who were shown by the NORC to have received life science doctorates from U.S. universities in 2004. Some of these were missing Social Security numbers but the remaining 1,614 were forwarded to the Social Security Administration in one group. The Social Security Administration found that 3 of these had Social Security numbers that were invalid, and 29 had birth years reported by the NORC that conflicted with the birth year recorded at the Social Security Administration. Because birth year differences might signify that an invalid Social Security number was recorded at the NORC, these cases were not used. That left 1,582 with presumed valid Social Security numbers. The Social Security Administration reported that 1,072 of the 1,582 individuals were recorded as having earned \$5,500 or more in the United States in 2009. This can be used to calculate a stay rate of  $1,072/1,582$  or 67.8 percent. Because this is a group statistic and no one outside of the Social Security Administration saw any individual earnings or tax data, the confidentiality of all the individuals in the group was preserved. In addition, it should be noted that no one who did not already have access to doctorate recipients' Social Security numbers (SSN) gained access to those numbers, including the author of this report.

As mentioned, Social Security Administration staff first checked to identify persons for whom the Social Security numbers provided were invalid. Also, they compared the year of birth provided for each Social Security number with the year of birth in the Social Security files for the person with that number. They then excluded from any tabulations persons with invalid numbers and persons for whom the birth years differed by more than one year. The primary concern that led to this birth year screen was the possibility that a Social Security number reported on the *Survey of Earned Doctorates* might be incorrect, yet would be treated by the Social Security Administration as valid if it was identical to one of the millions of numbers in the system. By requiring the birth year to match or be off by no more than one year, probably more than 95 percent of any such false matches were eliminated. Only 2.1 percent of foreign citizens had birth years that did not match within one year. A failure to match birth years in 2.1 percent of cases is not surprising since neither organization has 100 percent accuracy recording birth year. Further it's possible that some people report a different birth year to each organization. A previous study by the author (Finn, 2001) examined similar data for U.S. citizens. It found that 2.1 percent of U.S. citizen doctorate recipients from recent graduating classes had birth years that did not match when comparing records from the Social Security Administration and the *Survey of Earned Doctorates* in a fashion that was identical to the one used here. This is identical to the 2.1 percent rate of non-matches found here for foreign citizens in

this study. A more recent analysis of U.S. and non-U.S. doctorate recipients in 2004 found that the birth years of the *Survey of Earned Doctorates* did not match those of the Social Security Administration for 1.9 percent of foreign nationals but for only 1.0 percent of U.S. citizens. We exclude cases with birth years failing to match and thus assume that their stay rates are the same as others with similar characteristics whose birth years do match. Because foreign doctorate recipients are close to U.S. doctorate recipients in this regard, and because the number where there is not a birth year match is only 2.1 percent of the total, this is not a significant source of bias in the stay rate estimates produced in this report.

After screening out invalid Social Security numbers and numbers without birth years that matched (or were off by no more than one year), the Social Security Administration staff made an initial set of computer tabulations by calculating for each group the proportion with earnings of \$5,500 or more for various years up to and including 2009. This produced only one group where a problem of confidentiality occurred. The practical application of the Social Security Administration's confidentiality rules meant that it would report no proportion if a group had a calculated proportion of 100 percent or 0 percent as this would permit the identification of individuals by persons who could match Social Security numbers with names (e.g., the NORC staff who prepared the groups sent to the Social Security Administration). Further, to be safe, the Social Security Administration staff would not calculate a proportion if all but three persons in a group had earnings of \$5,500 or more. The original request defined New Zealand and "Other Pacific/Australasia" as two separate groups. Since one of these groups did not meet the confidentiality criteria, the two groups were combined.

The decision to use a threshold of \$5,500 in Social Security covered earnings as the basic unit of measurement was somewhat arbitrary. Any positive level of such earnings would presumably signify employment in the United States. However, if any positive Social Security covered earnings were used instead of the higher threshold of \$5,500, then persons who earn a few thousand dollars for a speech or a very short consulting assignment would be counted as residing in the United States that year. Doctorates can work for low wages, and a few do. However, even at the minimum wage, a person would have earned about \$12,000 per year in 2009. A \$5,500 threshold is high enough to capture nearly all that worked in the United States for more than a few weeks. Moreover, we can be positive that this threshold captures everyone who worked in the United States for most of the year.

### **Adjustment for Missing and Invalid Social Security Numbers**

One reason for missing or invalid Social Security numbers is data error. Respondents to the *Survey of Earned Doctorates* may fail to write down their numbers or may record their numbers incorrectly, or coders may make errors. If we were confident that other reasons were of no importance, we would not make any adjustments to account for missing Social Security numbers. However, it is possible that some of the time Social Security numbers are missing because some foreign graduates did not have Social Security numbers, even though the vast majority does.

Table A-1 shows how the proportion of doctorate recipients who are missing valid Social Security numbers varies by year of graduation and visa status. The proportion of foreign citizens missing Social Security numbers increased dramatically from the class of 1999 to the class of 2004. Why?

What appears to be the case is a substantial increase in the number of doctorate recipients who refuse to supply their Social Security number because of privacy concerns, accompanied by an increasing reluctance of universities to use Social Security numbers for identification purposes. Indeed, by 2007 and subsequent years the *Survey of Earned Doctorates* refrained from asking any of the respondents for full Social Security numbers. [This is why there are no estimates of two-year stay rates in this report.]

**Table A-1. Percent of Sample Missing Valid Social Security Numbers at Graduation, Foreign Citizens, by Year of Graduation and Visa Status**

Year of Graduation	Temporary Residents	Permanent Residents
2004	13.1	15.8.
1999	6.1	4.9
1993	5.8	3.9

Source: Oak Ridge Associated Universities.

There are no hard data indicating why the proportion of foreign national doctorate recipients providing Social Security numbers to the *Survey of Earned Doctorates* has declined. However, there is reason to believe that they, just like U.S. citizen doctorate recipients, increasingly want to restrict access to their Social Security number. Data obtained for all 2004 doctorate recipients indicate that 16 percent of U.S. citizens failed to supply Social Security numbers to the *Survey of Earned Doctorates*. [Finn, 2008] That is, the increased tendency to decline to supply a Social Security number has been at least as great among U.S. citizens as among non-citizens.

Also, Table A-1 shows that the increase in the percentage of doctorate recipients without valid Social Security numbers was slightly greater for foreign nationals who were permanent residents at the time of graduation than it was for those who were temporary residents at graduation. This suggests that there is something other than an intention to leave that is causing the increase in respondents without Social Security numbers.

The increased tendency for the more recent cohorts not to provide a Social Security number is a cause for concern since it increases the possibility for error in the estimated stay rates provided in this report. Also, as the possibility for error increases, it becomes more important whether and how to adjust estimates for missing Social Security numbers.

It is necessary to assume something about the stay rate behavior of the doctorate recipients without Social Security numbers. In reports dated 2005 and earlier by the author the simple expedient of assuming that those without Social Security numbers stayed at half the rate of the others was chosen. This was done on the grounds that the real value must be between zero and one, the proportion without Social Security numbers was small, and choosing a value in the middle, 0.5, meant that the total estimate could not be off by more than one or two percentage points. But things have changed. It could now make a difference of several percentage points, depending on what is assumed about those individuals missing Social Security numbers. Also, as the proportion missing Social Security numbers rose during the first half of the present decade there was increasing evidence that the failure to supply a Social Security number was probably not associated with any higher tendency to leave the United States after graduation. Recall the evidence noted above that permanent residents and U.S. citizens were not more likely to supply a Social Security number than persons with temporary visas. Also, a previous study reported that among temporary residents in 2006 those with firm plans to stay were missing Social Security numbers at about the same rate as all others. (Finn, 2010) For the more recent classes, those without Social Security numbers probably stayed at about the same rate as the others that supplied Social Security numbers.

However, there is a case for being conservative in making any assumption about the behavior of those without Social Security numbers. In this case, conservative means trying to make sure that the assumptions chosen cannot produce a large error. Accordingly, it was assumed that for the class of 1993 those without Social Security numbers stayed at half the rate of those who supplied valid Social Security numbers. For classes graduating in 1994 and 1999 those without Social Security numbers were assumed to have stayed at 60 percent of the rate of those who supplied valid Social Security numbers. For the class graduating in 2004 it was assumed those without Social Security numbers stayed at 80 percent of the rate of those who supplied valid Social Security numbers.

The five-year stay rate estimate for 2004 doctorate recipients in 2009 was reported to be 64 percent in Table 2 of this report. Had no adjustment been made to account for the presumed lower stay rate of those missing Social Security numbers, the estimate would have been 65.7 percent. If it were assumed that the stay rate for those missing Social Security numbers had been only half the stay rate of those with Social Security numbers, this stay rate would have been only 61.3 percent.

The ten-year stay rate estimate for 1999 doctorate recipients in 2009 was reported to be 66 percent in Table 3 of this report. Had no adjustment been made to account for the presumed lower stay rate of those missing Social Security numbers the estimate would have been 67.4 percent. If it were assumed that those missing Social Security numbers all left, this stay rate would have been 63.6 percent.

The 16-year stay rate estimate for 1993 doctorate recipients in 2009 was reported to be 56 percent in Table 4 of this report. Had no adjustment been made to account for the presumed lower stay rate of those missing Social Security numbers the estimate would have been 57.5 percent. If it were assumed that those missing Social Security numbers all left, this stay rate would have been 54.5 percent. The impact of the adjustment for missing Social Security numbers on 15-year stay rate estimate for 1994 doctorate recipients also reported in Table 4 was very similar to the impact on the 16-year stay rate estimate.

After adjustment for missing Social Security numbers, the proportion paying taxes on at least \$5,500 in covered earnings could be interpreted as a stay rate. This would be valid if we could assume that all doctorate recipients staying in the country pay taxes on at least this much in earnings. However, for any large group of doctorate recipients residing in the United States, it is likely that the percent paying taxes on at least \$5,500 in income is less than 100 percent. The principal reasons would be non-employment, part-time or part-year employment. Also, an entrepreneur might forgo a salary during the start-up of a business. Further, if we are examining data for persons receiving doctorates several years earlier, at least a few will not be paying taxes because they have died in the interim. Thus, adjustments were made for death and for the possibility of residing in the United States without earning \$5,500 or more.

### **Adjustment for Death**

Death rates were estimated by using the Period Life Table, 2007 published by the U.S. Social Security Administration (U.S. Social Security Administration, 2007). The assumed age distribution of doctorate recipients was taken from a special tabulation of the *Survey of Earned Doctorates* which computed the age distribution of S/E doctorate recipients who were temporary visa holders during the period 1993-2004. This showed, for example, that the median age was 31 and 7 percent were age 40 or older. This adjustment raises stay rates only slightly because death rates for people under age 40 are very low and because, for most of our estimates, only a few years elapsed between receipt of doctorate and year of estimated stay rate.

### **Adjustment for Residents Earning Less than \$5,500**

The NSF's 2006 *Survey of Doctorate Recipients (SDR)* was used to identify non-U.S. citizen doctorate recipients who graduated during the period 1993 to 2004 and who reported no earnings in 2005, or earnings that totaled less than \$5,500 in 2005. After reviewing these data and similar tabulations from earlier years when the SDR was conducted, it was assumed that 4 percent of the doctorate recipients in this study were in the United States but earning less than \$5,500. This assumption is slightly lower than the percentage found to be earning less than \$5,500 in the SDR tabulation noted above. However, it is slightly higher than would be indicated by earlier tabulations from the SDR and used in earlier studies by the author. For example, the study completed two years ago assumed only 2.9 to 3 percent were not earning at least \$5,500. That 3 percent assumption was based on tabulations from earlier SDR surveys, one of which was found to have been mis-specified in a way that underestimated the proportion with earnings less than \$5,500.

Changing this assumption had the effect of increasing slightly the estimated stay rates compared with what they would have been with the earlier assumptions unchanged. This was justified by the new information from the 2006 SDR. Unfortunately, this means that to some extent the stay rate estimates in this report will differ from those reported earlier by the author due to a change in assumptions. Even though this effect is small it might affect an attempt to discern small changes in the stay rate behavior of foreign doctorate recipients, e.g. to track how 5-year stay rates have changed over time. Thus, estimates that had previously reported for 5 and 10-year stay rates in 2001, 2003, 2005, and 2007 were re-estimated using the same adjustments for losses due to death and for residents earning less than \$5,500 as were used to make the 2009 estimates. These are the estimates shown in this report in Figure 1 and Table 7 where the stay rate estimates for the latest cohorts are compared with estimates for earlier cohorts.

The re-estimation of stay rates reported years ago using the same assumptions as were used to estimate stay rates in 2009 typically increased the older stay rates by only 1 percentage point. Table A-2 shows stay rates by type of university attended as reported in an older report (Finn, 2010). Table A-3 shows exactly the same table, only updated by using the same assumptions as were used throughout this report. Most of the stay rates increase by 1 percentage in Table A-3 compared with Table A-2. However, the focus of the table is on the difference in stay rates between those receiving doctorates from top-rated academic departments and those receiving doctorates from all other departments. That difference was 5 percentage points in 2007, and was unchanged when using the 2009 assumptions because all of the 2007 stay rates in Table A-3 are increased by the same amount compared with their values in Table A-2.

**Table A-2. Percentage of Temporary Residents Receiving Doctorates in 2002 Who Were in the United States, by Program Quality Ranking, 2003 to 2007**

Program Quality Category	Doctorate Recipients	Percent in the United States				
		2003	2004	2005	2006	2007
Top-rated programs	2,611	67	63	61	59	58
All other programs	5,239	70	68	65	64	63
Total, all programs	7,850	69	66	64	62	62

Source: Table 11, Finn, 2010.

**Table A-3. Percentage of Temporary Residents Receiving Doctorates in 2002 Who Were in the United States, by Program Quality Ranking, 2003 to 2007 (using 2009 assumptions)**

Program Quality Category	Doctorate Recipients	Percent in the United States				
		2003	2004	2005	2006	2007
Top-rated programs	2,611	69	65	62	60	59
All other programs	5,239	71	69	67	65	64
Total, all programs	7,850	70	67	65	63	63

## Effect of all the Adjustments

The adjustments for missing and invalid Social Security numbers had the effect of lowering stay rate estimates slightly. The adjustments for death and for persons residing in the United States without earning as much as \$5,500 in taxable income had the effect of increasing stay rates slightly. The net effect of all adjustments on the overall stay rate was very small. The 2009 stay rates for all doctorate recipients shown in tables 2, 3, and 4 were compared with that stay rate which would have resulted if no adjustments had been made. The 5-year stay rate shown in Table 2 rate is 1.4 percentage points higher than it would have been with no adjustments. The 10-year stay rate shown in Table 3 is 2.5 percentage points higher than it would have been with no adjustments. The 16-year stay rate shown in Table 4 is 3.3 percentage points higher than it would have been with no adjustments. The reason the adjustments have a larger impact on the longer term stay rates than on the 5-year stay rate is because of assumed losses due to deaths which increase as a cohort ages.

## Sampling Error

The *Survey of Earned Doctorates* is not a sample survey. Sampling was not employed to identify groups of Social Security numbers from the *Survey of Earned Doctorates* database. Each estimate for a stay rate in this report used the Social Security numbers of all doctorate recipients with valid Social Security numbers reported to the *Survey of Earned Doctorates*. Thus, there is no sampling error in the unadjusted stay rate estimates. However, one of the adjustments involved an assumption about the proportion of recent doctorate recipients in the United States who did not have any earnings in 2009 or who had earnings less than \$5,500. This assumption was guided by tabulations that were made using the *Survey of Doctorate Recipients*, which is a sample survey. A tabulation from the most recent survey year, 2006, produced an estimate for the proportion earning less than \$5,500 in 2005 that was higher than similar estimates using tabulations from earlier survey years. After examining the standard error of the estimate it was concluded that the difference was probably not due to sampling error. That is, the proportion earning less than \$5,500 in 2005 seems to actually be higher than the proportion earning less than \$5,000 in earlier years. (The threshold was increased from \$5,000 to \$5,500 to account for inflation but this had little impact as most of these respondents have no income at all.) However, we are interested in the proportion earning less than \$5,500 in 2009. The value observed estimated for 2005 is not necessarily a better predictor of the 2009 value than is the value observed in years prior to 2005. We made an assumption that about 4 percent of the foreign doctorate recipients who were in the United States in 2009 had earnings less than \$5,500. This was influenced by tabulations from the *Survey of Doctorate Recipients* but was an assumption not based directly on any one such estimate and thus was not directly influenced by sampling error.

## Identification of Highly Ranked Schools

There are two distinct reasons why one might ask whether the graduates of the most highly ranked doctorate programs are more likely to stay in the United States after graduation than are others graduating from less distinguished programs. First, as foreign doctorate recipients likely provide a benefit to the United States if they stay, then it would seem that the benefit would also vary by program quality. That is, the United States is likely to benefit more if graduates from the most highly regarded programs stay at a higher rate than other graduates.

Another reason to consider doctoral program quality is to better understand why some stay and others do not. Clearly, the reasons for staying (or not) are multiple and vary among individual doctorate recipients. However, it is understood that some doctorate recipients leave after graduation because they cannot readily find an attractive job in the United States. However, graduating from a highly ranked program generally increases the likelihood of receiving attractive job offers. This may be in part because the top programs attract the best students in the first place, but also because the doctorate is a research degree and the most highly regarded programs typically have faculty with superior research reputations.

We define program quality in terms of the research reputation of the faculty. This is a common practice. The National Research Council has produced studies of doctoral program quality with a wide variety of measures, but the one most frequently used to rank doctoral programs is the one measuring the scholarly

quality of the program faculty as determined by a survey of other academics. U.S. News and World Reports magazine also produces a ranking of graduate programs using a similar reputational ranking. For eight of the nine groupings of degree fields used in this report we used these two sources, the National Research Council and the U.S. News and World Reports faculty reputational rankings. For one grouping, Agricultural sciences, neither source proved suitable so we used another source. The number of universities defined as top rated varied by program from a low of 20 to a high of 24 programs. The details, including the names of schools that were defined as being highly ranked, are discussed below.

### **Defining Highly Ranked Doctoral Programs**

In general, the U.S. News and World Reports (USN) ranking of doctoral programs was the one used.<sup>5</sup> However, where possible we reviewed the comparable ranking produced by the National Research Council (NRC) in 1995, and added to our list of highly ranked doctoral programs any that were ranked in the top 15 by the NRC but not included within USN's top 20. See Tables A-4 to A-11.

One difficulty in using either of these two sources is that most of the nine discipline groupings used in this report are aggregations of several disciplines which were rated separately in the NRC study. In the case of computer science, economics, electrical engineering, and mathematics this was not a problem as each is treated as a separate discipline by both sources of rankings. In the case of life sciences we used the USN rankings for "biological sciences." In the case of "physical sciences" we started with separate rankings for chemistry and physics using USN, and then combined the two to get one ranking for "physical sciences." Seventeen of our 22 top-rated physical science schools were in the top twenty for both chemistry and physics. The remainder was ranked in the top 20 in either physics or chemistry and in the top 30 on the other one, or on the NRC ranking of geo-science departments. We used the NRC ranking for electrical engineering programs for our "Electrical and computer engineering" category. The USN reports a single ranking for engineering and that was used for our "Other engineering" category. Our grouping of "Other social sciences" includes all social and behavioral science disciplines except economics. To produce a composite ranking we identified the ranking of the four largest disciplines within this group (psychology, political science, sociology, anthropology) using both sources, then made up a composite list consisting of schools that ranked high in at least three of these disciplines. Eight of these schools were in the top 20 in two of the four social science disciplines examined and in the top 27 in at least one other; the other schools were in the top twenty on either three or on all four of the disciplines.

The agricultural sciences group was treated differently. As there was no suitable match in either the NRC or USN rankings, we used a different source which uses a different methodology to rank academic programs. The ranking used was produced by Academic Analytics, an organization which tracks publication data, including book publications, and uses these to rank graduate program faculty. This grouping of 24 universities includes several land-grant universities which are not included among the high ranked universities for any of our other eight discipline groups.

These rankings differ significantly from the ranking that would result if one tried to identify a list of the top 20 universities across all science and engineering disciplines. Even so, it is possible to take issue with the lists of highly ranked universities for any of the discipline groupings shown below on grounds that some doctorate recipients were in highly rated programs in a specific discipline but their university is not on any of the lists. For example, the University of Delaware is not on our list in "Other engineering" because USN ranked it 41<sup>st</sup>. However, the NRC ranking which provides separate ranking for 13 distinct engineering sub-disciplines ranked Delaware's chemical engineering faculty as 9<sup>th</sup> in the nation. It seems these are not necessarily in conflict as the University of Delaware's other engineering departments are not ranked so highly by the NRC. However, a person receiving a doctorate from the University of Delaware's Chemical Engineering program should be classified as graduating from a top-ranked program but will not be because we aggregated all engineering programs except Electrical and computer engineering into one group. Fortunately, this is a fairly extreme and unusual example, but it illustrates the problem.

While the difficulty caused by aggregating disciplines is not trivial, it does not seem likely to have a substantial effect. Even if 5 to 10 percent of doctorate recipients are incorrectly classified because of

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<sup>5</sup> Available at <http://grad-schools.usnews.rankingsandreviews.com/grad> accessed September, 2008.

aggregation of programs (and it would seem to be less than this) a finding that the graduates of the top-rated schools differ little in their stay rate from all other graduates is still of interest. Any misclassification can be viewed as “noise” in the dataset which weakens the result

**Table A-4. Highly Ranked Universities: Physical Science**

California Institute of Technology	U of Chicago
Columbia U	U of Michigan - Ann Arbor
Cornell U	U of Pennsylvania
Harvard U	U of Texas - Austin
Johns Hopkins U	U of Illinois - Urbana Champaign
MIT	U of Wisconsin - Madison
Northwestern U	UC - Santa Barbara
Penn State U - University Park	UC- San Diego
Princeton U	UC-Berkeley
Purdue U	UCLA
Stanford U	Yale U

**Table A-5. Highly Ranked Universities: Mathematics**

Brown U	U of Illinois - Urbana-Champaign
California Institute of Technology	U of Maryland - College Park
Columbia U	U of Michigan - Ann Arbor
Cornell U	U of Minnesota - Twin Cities
Harvard U	U of Pennsylvania
MIT	U of Texas - Austin
New York U	U of Wisconsin - Madison
Northwestern	UC -Berkeley
Princeton U	UC- San Diego
Stanford U	UCLA
U of Chicago	Yale U

**Table A-6. Highly Ranked Universities: Agricultural Science**

Clemson U	U of Minnesota - Twin Cities
Cornell U	U of Illinois - Urbana Champaign
Iowa State University	U of Wisconsin - Madison
Michigan State University	U of Arizona
Montana State University - Bozeman	U of California - Davis
North Carolina State University	U of Connecticut
North Dakota State University	U of Delaware
Purdue U	U of Florida
Rutgers the State University - New Brunswick	U of Kentucky
U of Arkansas, Fayetteville	U of Massachusetts - Amherst
U of Georgia	U of Missouri - Columbia
U of Maryland - College Park	Washington State University

**Table A-7. Highly Ranked Universities: Life Science**

California Institute of Technology	U of Michigan - Ann Arbor
Columbia U	U of Pennsylvania
Cornell U	U of Texas Southwestern Medical Ctr - Dallas
Duke U	U of Washington
Harvard U	U of Wisconsin - Madison
Johns Hopkins U	UC Berkeley
MIT	UC - San Diego
Princeton U	UC San Francisco
Rockefeller U	Washington U in St Louis
Stanford U	Yale U
U of Chicago	

**Table A-8. Highly Ranked Universities: Computer/EE Engineering**

California Institute of Technology	U of Maryland - College Park
Carnegie Mellon U	U of Michigan - Ann Arbor
Columbia U	U of Minnesota - Twin Cities
Cornell U	U of Texas - Austin
Georgia Institute of Technology	U. of Illinois - Urbana Champaign
MIT	U of Southern California
Northwestern	U of Wisconsin - Madison
Princeton U	UC - Santa Barbara
Purdue U	UC- San Diego
Stanford	UC - Berkeley
Texas A&M U	UCLA

**Table A-9. Highly Ranked Universities: Other Engineering**

California Institute of Technology	U of Maryland - College Park
Carnegie Mellon U	U of Michigan - Ann Arbor
Cornell U	U of Texas - Austin
Georgia Institute of Technology	U of Illinois - Urbana Champaign
MIT	U of Southern California
Northwestern	U. of Wisconsin - Madison
Princeton U	UC - Santa Barbara
Purdue U	UC - San Diego
Stanford	UC - Berkeley
Texas A&M U	UCLA

**Table A-10. Highly Ranked Universities: Economics**

California Institute of Technology	U of Maryland - College Park
Carnegie Mellon U	U of Michigan - Ann Arbor
Columbia U	U of Minnesota - Twin Cities
Cornell U	U of Pennsylvania
Harvard	U of Rochester
MIT	U of Wisconsin - Madison
New York U	UC - Berkeley
Northwestern	UC - San Diego
Princeton U	UCLA
Stanford U	Yale U
U of Chicago	

**Table A-11. Highly Ranked Universities: Other Social Science**

Arizona	U of Minnesota - Twin Cities
Columbia	U of Pennsylvania
Cornell U	U of Texas - Austin
Duke U	U of Washington
Harvard U	U of Wisconsin - Madison
Indiana U	UC - Berkeley
Northwestern	UC - San Diego
Princeton U	UCLA
Stanford	UNC
U of Chicago	Yale U
U of Michigan -- Ann Arbor	

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