

# **Stay Rates of Foreign Doctorate Recipients from U.S. Universities, 2011**

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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 2011, 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 2011 stay rate for all foreign doctorate recipients, including those on permanent visas at graduation, was 68 percent for those graduating five years earlier, and 65 percent for those graduating ten years earlier.

The 2011 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 up more than 4 percentage points from that recorded two years ago to 66 percent, nearly equal to the all-time high. For those graduating ten years earlier, the stay rate in 2011 increased only slightly but did reach a new all-time high of 62 percent.

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 ten-year rate. The average of these two cohorts was 56 percent in 2001, but increased fairly steadily to 64 percent in 2011.

This report also estimates stay rates for those who received doctorates in 1995. This 16-year stay rate was 61 percent in 2011, up substantially from the 56 percent 16-year stay recorded two years earlier 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.
- The highest five-year stay rate by discipline is 79 percent in computer science, and the second highest is 77 percent in computer/electrical engineering.
- Women have stay rates that are slightly higher than men. They are close one year after graduation, but the men's stay rate declines more over time than the women's.
- 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: Thailand, Jordan, Brazil, South Africa, Chile, New Zealand and Indonesia.
- The country of origin of foreign doctorate recipients who stay in the United States has become less diverse than in the past. Two countries, China and India, together accounted for nearly half of S/E doctorate awards and 66 percent of all doctorate recipients who are in the United States five years after graduation.
- Data on intentions to stay as reported to the NSF *Survey of Earned Doctorates* are good predictors of actual stay rates one year after graduation.

## 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 doctorate 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 in recent years. Most of the growth in doctorates awarded to foreign citizens occurred prior to 2007, however. Since then U.S. citizen doctorate awards have increased much faster than awards to foreign citizens, with the result that the proportion of all S/E doctorates awarded to foreigners has declined from a high of 46 percent in 2007 to 40 percent in 2011.

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 7 percent from 2006 to 2011. [NSF, 2013] 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 in recent years.

**Table 1. Science and Engineering Doctorates Awarded by U.S. Universities, 1997-2011**

Citizenship Status	1997	1999	2001	2003	2005	2007	2009	2011
Temporary visa	7,507	7,238	7,943	8,382	9,990	11,959	12,588	12,240
Permanent visa	2,281	1,654	1,270	1,098	1,112	1,222	1,523	1,559
<b>Total, foreign citizens</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>13,799</b>
U.S. citizens	16,112	15,915	15,049	14,635	14,912	16,022	19,509	20,639
<b>Total, U.S. and foreign</b>	<b>25,900</b>	<b>24,807</b>	<b>24,262</b>	<b>24,115</b>	<b>26,430</b>	<b>29,570</b>	<b>33,620</b>	<b>34,438</b>
<b>Percent foreign</b>	<b>38%</b>	<b>36%</b>	<b>38%</b>	<b>39%</b>	<b>44%</b>	<b>46%</b>	<b>42%</b>	<b>40%</b>

Source: National Science Foundation, Division of Science Resources Statistics. Science and Engineering Doctorate Awards: 2005, (NSF 07-305). Susan T. Hill, project officer. Arlington, VA. Also, unpublished data from NSF using the SED Tabulation engine, <https://nces.norc.org/NSFTabEngine/#WELCOME>

## Stay Rates of Recent Graduates

Table 2 shows that the five-year stay rate for all foreign students receiving doctorates in 2006 was 68 percent. Note, however, that the stay rate for this class in 2008, two years after their graduation, was 74 percent. The stay rate for this class declined only 6 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 small 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. Computer science has the highest five-year 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 2006  
Who Were in the United States, 2007-2011**  
(includes students on temporary and permanent visas)

Degree Field	Foreign Doctorate Recipients	Percent in the United States				
		2007	2008	2009	2010	2011
Physical science	2,158	79	76	73	71	68
Mathematics	733	76	75	74	69	67
Computer science	900	83	81	80	81	79
Agricultural science	432	57	54	51	49	48
Life science	2,649	79	77	75	73	73
Computer/EE engineering	1,550	83	82	80	79	77
Other engineering	3,053	80	77	74	72	71
Economics	752	53	51	48	47	46
Other social science	1,071	56	53	52	50	51
<b>Total, all fields</b>	<b>13,298</b>	<b>76</b>	<b>74</b>	<b>71</b>	<b>70</b>	<b>68</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 2011 stay rate for all S/E doctorates awarded by U.S. universities to foreign citizens in 2001, 65 percent, is nearly as high as the stay rates of the class of 2006 in 2011. This ten-year stay rate for the class of 2001 did decline slightly during the last six years of the period examined. However, nearly two-thirds stayed in the United States after ten years. This provides additional evidence about how stay rates increased over the past two decades. See Figure 1. 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.

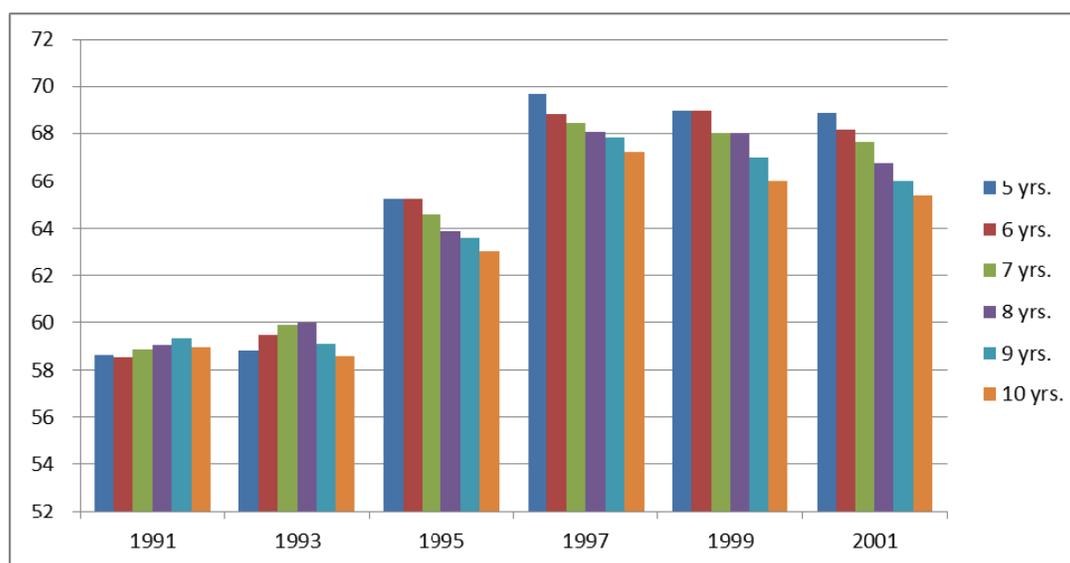
**Table 3. Percentage of Foreign Nationals Receiving S/E Doctorates in 2001  
Who Were in the United States, 2002 to 2011**  
(includes students on temporary and permanent Visas)

Degree Field	Foreign Doctorate Recipients	Percent in the United States									
		2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Physical science	1,634	83	81	79	78	76	76	75	73	73	72
Engineering	3,088	81	77	74	73	73	72	71	70	69	68
Life science	1,967	80	77	76	75	74	74	73	73	72	72
All other science	2,886	63	61	60	58	57	56	55	55	55	54
<b>Total</b>	<b>9,575</b>	<b>76</b>	<b>73</b>	<b>71</b>	<b>70</b>	<b>69</b>	<b>68</b>	<b>68</b>	<b>67</b>	<b>66</b>	<b>65</b>

Source: Oak Ridge Associated Universities.

Figure 1 shows that the stay rate for the Class of 2001 declines between five and ten 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 5 to 10 Years After Receipt of Doctorate,  
for Doctorates Awarded in 1991, 1993, 1995, 1997, 1999, and 2001**



Source: Oak Ridge Associated Universities.

Table 4 shows the stay rate for those receiving doctorates in 1995. The stay rate for this cohort in 2011, a 16-year stay rate, was 61 percent. Table 4 also shows the stay rate separately by sex. The stay rate for females was higher than that for males. Females accounted for only 22 percent of the class of 1995, so the total stay rate is dominated by the behavior of males.

**Table 4. Percentage of Foreign Nationals Receiving S/E Doctorates in 1995 Who Were in the United States from 1997 to 2011, by Gender**

	1997	1999	2001	2003	2005	2007	2009	2011
Female	66	69	69	68	68	68	67	66
Male	64	65	65	64	63	62	61	60
<b>Total</b>	<b>65</b>	<b>65</b>	<b>66</b>	<b>65</b>	<b>64</b>	<b>64</b>	<b>62</b>	<b>61</b>

Source: Oak Ridge Associated Universities.

### 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 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 Table 2, which included permanent residents, this table shows much the same pattern, with the highest stay rates in computer science and computer/EE engineering. However, the overall stay rate, 66 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 2006 Who Were in the United States, 2007-2011, by Degree Field**

Degree Field	Foreign Doctorate Recipients	Percent in the United States				
		2007	2008	2009	2010	2011
Physical science	1,975	78	75	72	69	66
Mathematics	666	75	73	72	67	65
Computer science	798	81	79	78	79	77
Agricultural science	400	55	51	48	46	46
Life science	2,260	78	76	74	71	70
Computer/EE engineering	1,453	82	81	79	78	76
Other engineering	2,845	79	76	73	71	70
Economics	676	50	47	45	43	42
Other social science	876	51	49	46	45	46
<b>Total, all fields</b>	<b>11,949</b>	<b>75</b>	<b>72</b>	<b>70</b>	<b>68</b>	<b>66</b>

Source: Oak Ridge Associated Universities.

Table 6 shows that three countries account for most of the foreign students receiving doctorates: China, India, and South Korea. Two of these, China and India, also have very high stay rates. In 2006 China and India accounted for nearly half (47 percent) of all S/E doctorates. However, because their stay rates were so much higher than average, together they accounted for 66 percent of those who graduated in 2006 and were still in the United States in 2011. The fact that two countries accounted for nearly half of all S/E doctorate degrees earned by foreigners on temporary visas is a new phenomenon. The comparable figure for China and India combined in the class of 2004, just two years earlier was 38 percent. [Finn, 2012] Since these two countries also have stay rates that are well above average, the increase in their share of total degrees was a major factor in increasing the five-year stay rate to a near record level in 2011.

Countries with above average rates in 2011 include not only China (85 percent) and India (82 percent), but also Iran (92 percent), and Romania (83 percent). The countries with the lowest stay rates are Thailand (19 percent) and Chile (18 percent), but there are several other countries with stay rates below 40 percent including Taiwan, Japan, Jordan, Mexico, Argentina, and Brazil.

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 58 percent in 2001 then stayed at levels near 65 percent from 2003 to 2011.

**Table 6. Percentage of Temporary Residents Receiving S/E Doctorates in 2006 Who Were in the United States, 2007 to 2011, by Country of Origin**

Country of Origin	Doctorate Recipients	Percent in the United States				
		2007	2008	2009	2010	2011
China	4,121	92	91	89	87	85
Taiwan	452	56	48	44	41	38
Japan	194	53	50	45	43	38
South Korea	1,197	58	52	48	45	42
India	1,496	89	88	85	83	82
Thailand	218	27	24	20	19	19
Other East Asia	188	59	57	57	57	58
Jordan	89	44	42	37	37	37
Iran	125	91	90	89	92	92
Israel	55	53	44	38	38	41
Turkey	321	66	63	58	56	56
Other West Asia	318	74	70	72	72	68
Pacific/Australasia	112	70	69	61	60	55
Egypt	113	65	58	55	48	48
Other Africa	269	71	68	65	65	64
Greece	110	60	55	53	53	47
United Kingdom	84	74	67	69	66	64
Germany	130	67	66	61	56	53
Italy	126	64	61	59	59	57
France	107	64	62	62	56	62
Romania	163	90	88	87	84	83
Spain	54	55	52	44	47	47
Other EU countries	269	55	50	50	50	48
Russia	188	73	78	78	74	73
Ukraine	57	88	86	78	73	76
Bulgaria	42	75	69	66	63	63
Other Europe	175	75	71	72	70	70
Canada	326	59	57	55	56	55
Mexico	173	45	41	38	38	39
Argentina	81	47	45	35	33	31
Brazil	131	40	40	41	39	37
Chile	52	13	15	15	18	18
Colombia	85	52	49	44	42	41
Venezuela	56	49	44	42	42	42
Other Central South America	164	66	63	57	57	56
Country not reported	108	NA	NA	NA	NA	NA
<b>Total, All countries</b>	<b>11,949</b>	<b>75</b>	<b>72</b>	<b>70</b>	<b>68</b>	<b>66</b>

Source: Oak Ridge Associated Universities.

NA = not available

**Table 7. 5-Year Stay Rates for Foreign Students on Temporary Visas Receiving S/E Doctorates, for Selected Countries, 2001-2011**

Country/Region	2001	2003	2005	2007	2009	2011
China	98	93	95	94	89	85
India	89	90	89	83	79	82
Europe	53	63	67	67	60	62
Canada	66	63	60	56	53	55
South Korea	22	36	44	42	42	42
Japan	24	39	41	33	40	38
Taiwan	41	48	52	43	37	38
Mexico	31	22	32	33	35	39
Brazil	26	26	31	32	33	37
<b>All countries</b>	<b>58</b>	<b>64</b>	<b>67</b>	<b>63</b>	<b>62</b>	<b>66</b>

Source: Oak Ridge Associated Universities.

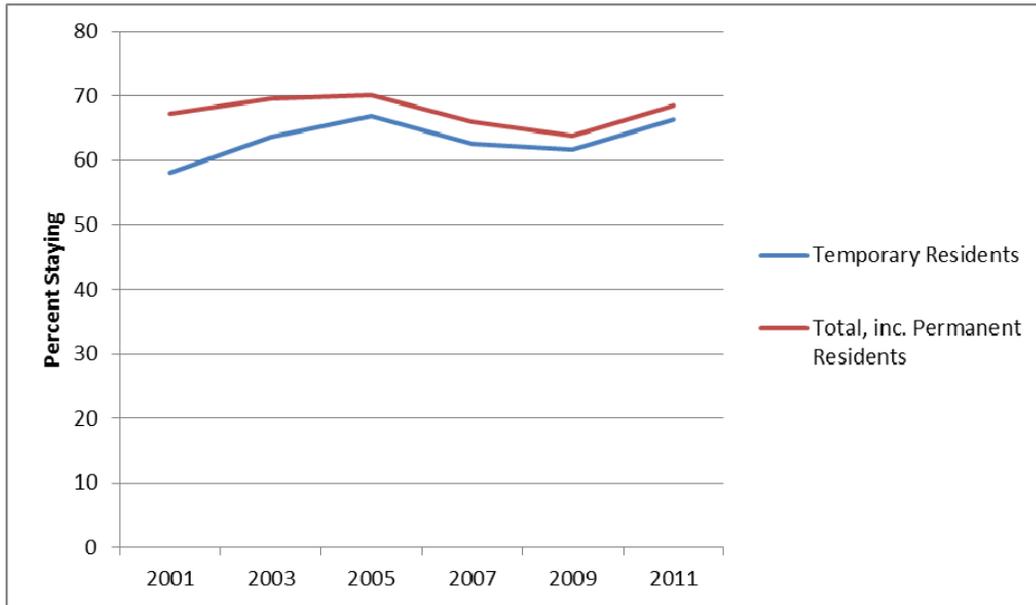
### Have Stay Rates Declined?

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 2011 for three different cohorts: persons who received a doctorate five, ten, and 16 years previously. Thus, there are three observed stay rates for 2011. However, this is only the second time the 16-year stay rates have been estimated, whereas the five-year and ten-year stay rates are available for several previous years. Therefore to address the question of whether stay rates have declined we first use the five- and ten-year rates.

Changes in the five-year stay rates are shown in Figure 2. While five-year stay rates increased substantially prior to 2003, Figure 2 shows that after 2005 they declined temporarily but by 2011 are not appreciably below the 2005 highs.

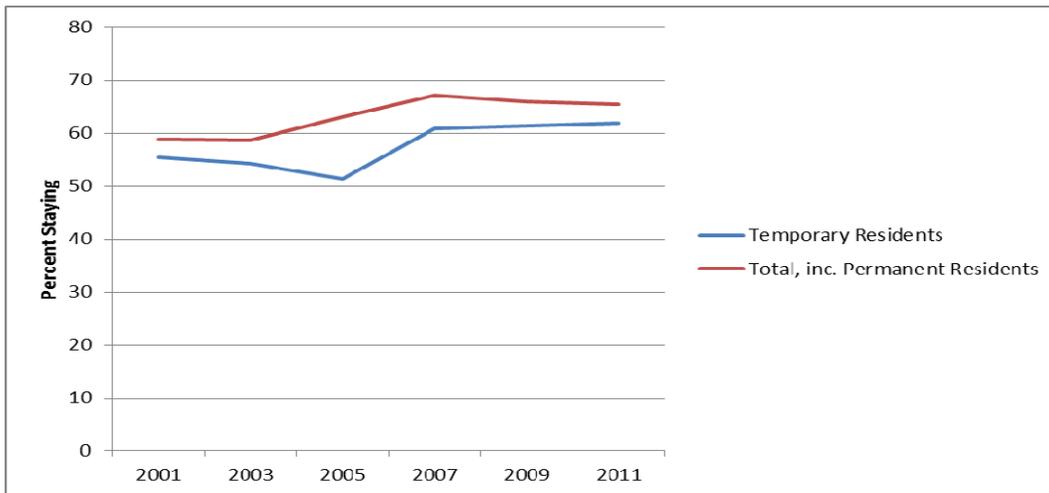
The trend in ten-year stay rates since 2001 is shown in Figure 3. The ten-year stay rate increased from 2001 to 2011. The temporary decline shown in Figure 3 for doctorate recipients with temporary resident visas at the time of graduation is due to an unusual event. After the Tiananmen Square pro-democracy 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 ten-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 period.

**Figure 2. 5-Year Stay Rates, 2001 to 2011**



Source: Oak Ridge Associated Universities.

**Figure 3. 10-Year Stay Rates, 2001 to 2011**

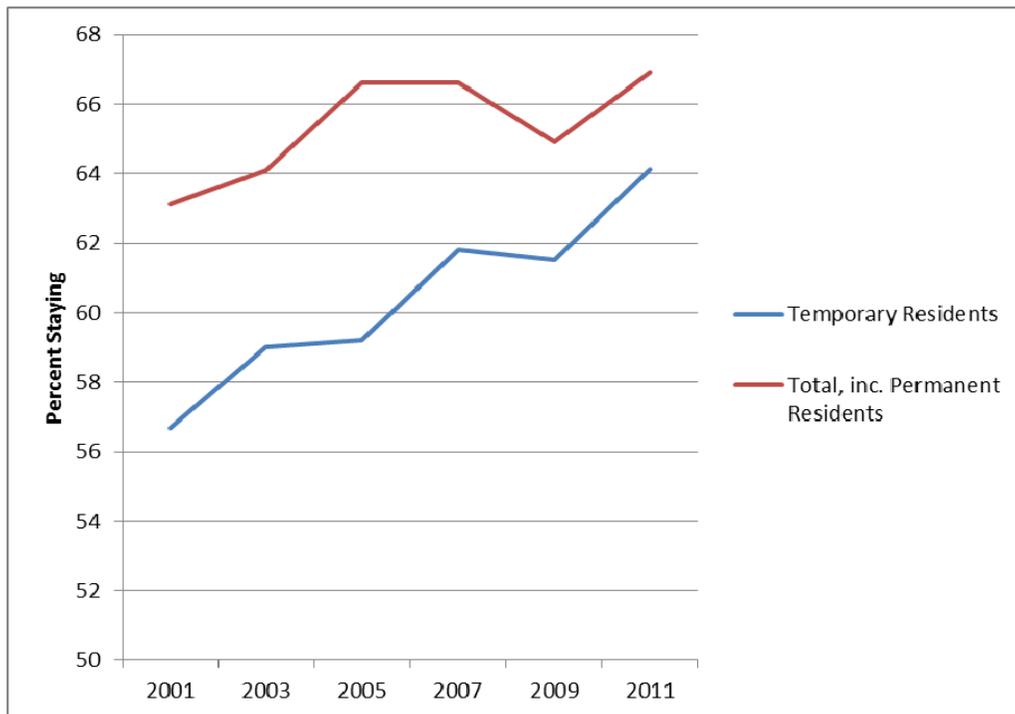


Source: Oak Ridge Associated Universities.

Perhaps the best way to summarize changes in stay rates in recent years is to average together the five-year and ten-year stay rates. This is shown in Figure 4. The trend is clearly up for those on temporary resident visas, with the highest level, 64.1 percent being recorded in the most recent year, 2011. For the total, the decade long trend in Figure 4 is also up, but the increase is not as dramatic.

Why does the total stay rate increase somewhat less than the stay rate for temporary residents in Figure 4? The answer is simple: permanent residents as a percentage of the total have declined from 22 to 12 percent over the period examined. Since permanent residents have stay rates higher than temporary residents (above 85 percent in 2011), the reduction in their share of the total tends to moderate the increase in the total stay rate.

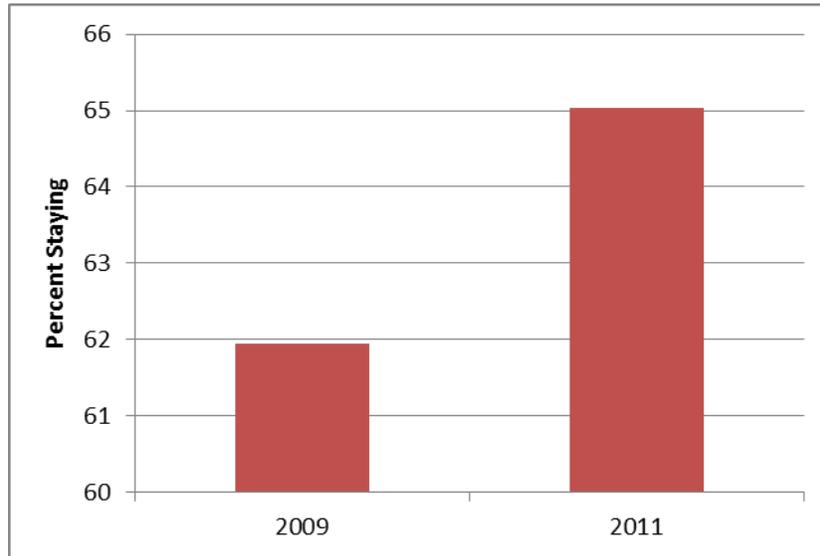
**Figure 4. Average of 5-Year and 10-Year Stay Rates, 2001 to 2011**



Source: Oak Ridge Associated Universities.

Ideally we would be able to construct an expanded figure, like figure 4 but including the 16-year stay rate. However, such data are not available. The 16-year stay rate was estimated for 2011, but the only previous year with a 16-year stay rate estimate was 2009. This permits a comparison of two data points, 2011 compared with 2009. Figure 5 provides this comparison, for each of these two years showing the average of the 5, 10, and 16-year stay rates.

**Figure 5. Average of 5-, 10-, and 16-Year Stay Rates, 2009 and 2011**  
(includes students on temporary and permanent Visas)

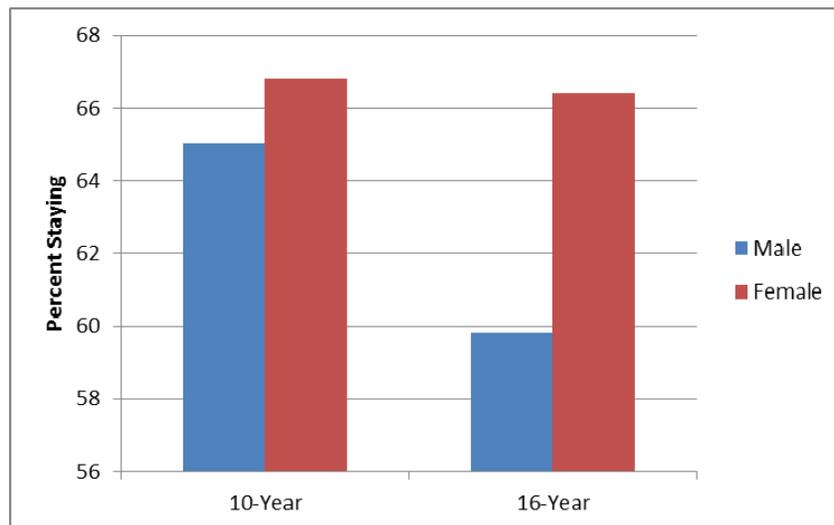


Source: Oak Ridge Associated Universities.

### Stay Rate Differences by Gender

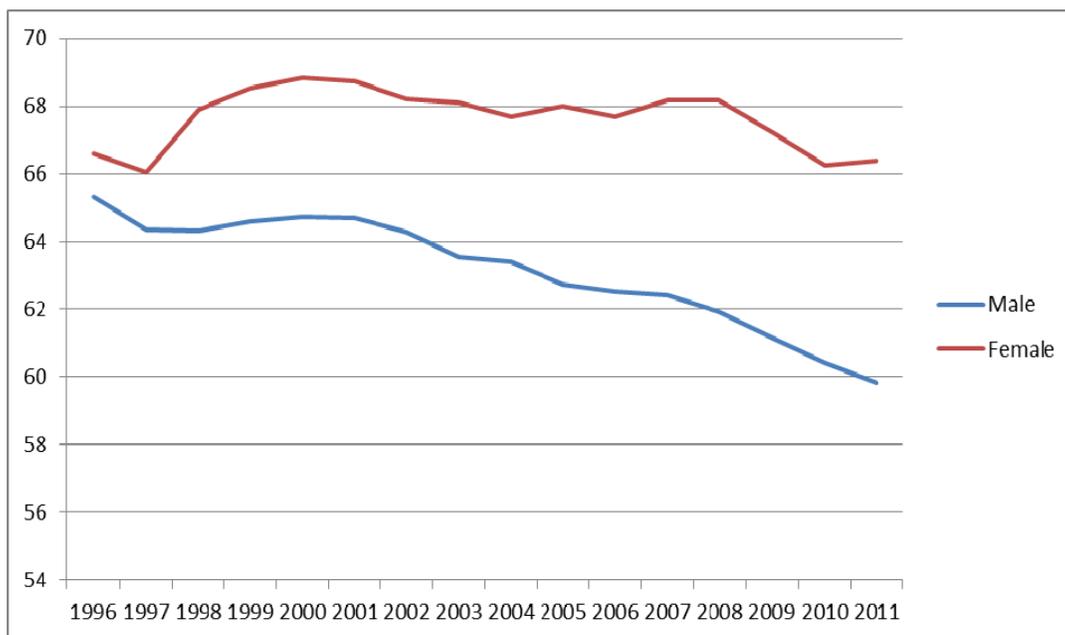
Figure 6 shows differences in stay rates by gender. Estimates by gender were made only for the ten-year and 16-year stay rates, but the graph for each shows that, in 2011, females stayed at a slightly higher rate than males, although the difference in 16-year stay rates is over six percentage points and could be termed substantial. Interestingly, the cohort used for the 16-year stay rates shown in Figure 6, the class of 1995, showed very little male-female difference in stay rates after one year. However, subsequently the female stay rate stayed constant at or above 66 percent, while the male stay rate declined steadily to about 60 percent. See Figure 7.

**Figure 6. 10-Year and 16-Year Stay Rates by Gender, 2011**



Source: Oak Ridge Associated Universities.

**Figure 7. Percentage of Foreign Nationals Receiving S/E Doctorates in 1995 Who Were in the United States, 1996-2011, 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, 2011. The five-year stay rate in 2011 is the percentage of the 2006 graduates estimated to be in the United States in 2011. 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, and some of these return at a later date. Others leave immediately upon graduation but may return to the United States in later years.

Data on the ten-year stay rate can be used to illuminate the circulation of early-career S/E doctorate recipients. The ten-year stay rate in 2011 was 65 percent, meaning that 65 percent were here after 10 years. This was reported in Table 3 and it includes doctorate recipients who were on either temporary or permanent visas at the time of graduation. Suppose we looked at stayers differently, instead of counting only those who were still here in 2011 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 2001? The answer is that, for the same cohort, such a rate would have 8 percent higher than the ten-year stay rate if five years residence were required, 16 percent higher if three years residence were required and 26 percent higher if only one year residence were required to qualify as a stayer.

These numbers do not by themselves measure circulation, if by that we mean persons whose migration involves changing countries more than once. Table 3 showed a ten-year stay rate of 65 percent, but the stay rate of this 2001 cohort in 2002 was shown as 76 percent. The proportion staying declined steadily over the first 10 years after receipt of the doctorate from 76 percent to 65 percent. This decline explains most of the data in the preceding paragraph indicating, for example, that the differently defined rate would be 26 percent higher than the ten-year stay rate if only one year residence were required to qualify as a stayer. However, the proportion in this cohort who stayed at least one year is higher than the proportion here in 2002, one year after graduation. If we examine this difference, it amounts to 5 percent of the total number in the cohort. Thus, one could conclude that 5 percent of the 2001 cohort were not in the United States in 2002, but did however spend at least one year here between 2003-2011. A similar calculation indicates that four percent of the 2001 cohort were not in the United States in 2004 (three years after graduation) but did, however, spend at least 3 years here during the 9 year period from 2002 to 2011.

These data indicate that circulation, defined as changing country of residence at least twice within the first 10 years after graduation, involves only a small proportion of the population of foreign doctorate recipients.

### Intentions vs. Stay Rates

Some earlier reports by the author, [Finn, 2005] used the method employed here to estimate stay rates shortly after graduation, e.g., one-year and two-year stay rates. The one-year and two-year stay rates for the class of 2006 can be read in Table 2, above, as 76 and 74 percent. We cannot tabulate these short-term stay rates for more recent cohorts because 2006 is the most recent year in which the NSF *Survey of Earned Doctorates* (SED) asked respondents to provide their social security numbers. If one wants information on the stay rate of more recent cohorts, then the intentions data generated by the SED is probably the best indication.

The SED asks about the new doctorate recipients plans after graduation. Table 8 shows responses possible to the question about intentions, and the stay rate one, two, three, four, and five years after graduation. There are 6,285 persons who indicated that they had definite plans and that these plans involved employment or postdoctoral study in the United States. Another 2,739 planned to stay in the United States for work or postdoctoral study but these plans were not definite at the time they responded to the survey. For example, they may have been in the hiring process. If we add these two groups together and divide by the total who responded regarding their plans (11,949-496) this indicates that 79 percent planned to stay in the United States after graduation.

**Table 8. Temporary Residents Receiving S/E Doctorates from U.S. Universities in 2006 Who Were in the United States, 2007 to 2011**

Post-graduation Plans	Foreign Doctorate Recipients	Percent in the United States				
		2007	2008	2009	2010	2011
Definite plans: US	6,285	94	91	88	85	80
Definite Plans: Outside U.S	1,525	6	8	9	10	9
Plan to Stay US, but not definite	2,739	86	84	80	77	72
Plan to Leave US but not definite	904	21	20	20	19	17
No Response on plans	496	64	63	59	56	53
<b>Total</b>	<b>11,949</b>	<b>75</b>	<b>72</b>	<b>70</b>	<b>68</b>	<b>66</b>

Source: Oak Ridge Associated Universities.

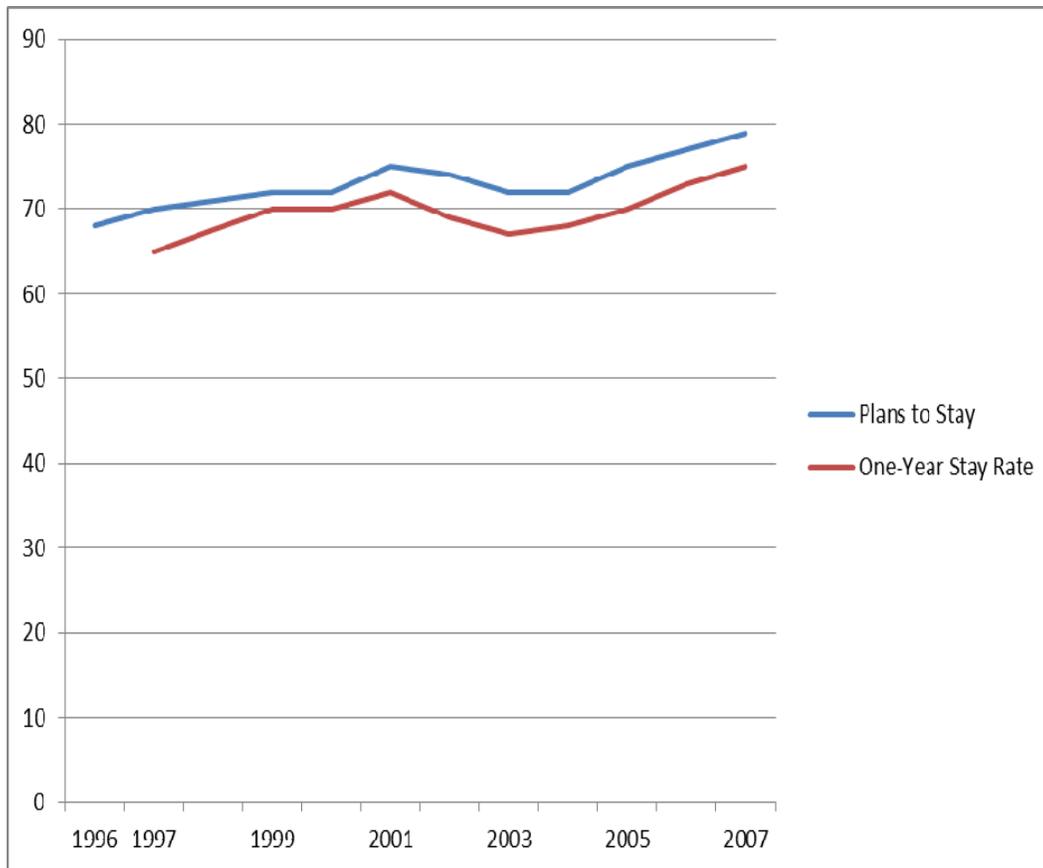
Are these intentions data believable? Yes. The 79 percent intentions rate obtainable from the first column in Table 8 comes from the survey responses. The 75 percent stay rate for 2007 in the same table came from the author's estimate based on a tabulation of the earnings records of these same respondents. So the intentions at graduation are only 4 percentage points higher than the 1-year stay rate estimated from tax data. While such a small discrepancy is pretty good, considering that the two estimates were produced with different data and methods, it may be the match is even better.

The SED data on the class of 2006 is actually computed on an academic year which ran from July 1, 2005 to June 30, 2006. To be counted as a stayer in 2007 using tax data they would have to have earned at least \$5,500 in calendar year 2007. So if a small proportion stayed after graduation but not long enough to earn \$5,500 in 2007, we might think of them as persons who stayed for less than a full year. Thus, it is reasonable to conclude that even though the intentions data are slightly higher than the one-year stay rate, the two different ways of estimating short-term stay rates are consistent. That this consistency has persisted for a decade is illustrated in Figure 8.

Based on the pattern in Figure 8 one can conclude that the intentions data from the SED have been good predictors of the (slightly lower) one-year stay rate for over a decade. Because we cannot estimate the

one-year stay rate for persons completing doctorates in 2007 and later, one must rely on the intentions data to estimate short term stay rates for those who received doctorates. The intentions data are reported in NSF's Science and Engineering Indicators -2014 (forthcoming), and in annual NSF reports of the SED, e.g., Doctorate Recipients from U.S. Universities-2011. The later report indicates that intentions to stay were slightly lower for the class of 2011 compared with the class of 2006, the most recent class for which stay rates are estimated in this report.

**Figure 8. Percentage of Foreign S/E Doctorate Recipients Reporting Plans to Stay vs. Actual 1-Year Stay Rate, 1996-2007**



Source: Oak Ridge Associated Universities.

### Summary and Conclusions

Stay rates continue to vary substantially by country of citizenship. Stay rates observed in 2011 are at or very near the highest levels observed in the recent past.

When one considers the combined five-year and ten-year stay rates in 2011 (i.e., graduates of 2006 and 2001), the stay rates for all foreign doctorate recipients including those on permanent resident visas at graduation are at a record high, and up substantially from ten years earlier. When one considers only those on temporary visas at graduation, the combined five and ten year stay rates in 2011 are at a record high as well and have also increased substantially over the previous decade.

The NSF *Survey of Earned Doctorates* produced good estimates of short-term stay rates.

## 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 107 groups of Ph.D. recipients who received S/E degrees from U.S. universities in 1995, 2001, and 2006.

Our method started with responses to the NSF *Survey of Earned Doctorates* (SED) 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, visa type if non-U.S. citizen, 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 names, 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. In total, groups of foreign citizens containing a total of 36,900 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 Federal income taxes and/or Social Security taxes on at least \$5,500 in earnings. For example, one group consisted of 2,789 persons on temporary visas who were shown by the NORC to have received engineering doctorates from U.S. universities in 2001. Some of these had missing information, but all 2,789 were forwarded to the Social Security Administration in one group. The Social Security Administration completed its standard validation process which used name, social security number and birthdate, but was likely to fail if any of these were missing. That left 2,524 with validated cases. This was just over 90 percent of the total. Missing social security numbers at NORC accounted for the great majority of cases not validated. However, this was not the only reason a record was not validated. If the birthdate and name associated with a social security number submitted by NORC did not match the birthdate and name associated with that number in the Social Security Master Earnings file that also could cause the record to fail the validation process. Finally, a few of the social security numbers submitted by NORC were invalid, e.g., never issued. The Social Security Administration reported that 1,613 of the 2,789 temporary residents awarded engineering doctorates in 2001 were recorded as having earned \$5,500 or more in the United States in 2011. This can be used to calculate a stay rate of 1,613/2,524 or 63.9 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.

After excluding individuals whose social security numbers failed the validation procedure, the Social Security Administration staff made an initial set of computer tabulations by calculating for each group the number with earnings of \$5,500 or more for various years up to and including 2011. Then SSA made sure that all of the cells reported contained enough individuals to assure confidentiality of any individual was not compromised.

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 employed full-time would have earned more than \$12,000 per year in 2011. 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**

In past studies of stay rates conducted by the author an adjustment was made for missing social security numbers. The rationale initially was that at least some of the doctorate recipients who did not provide a social security number may have not acquired one, and this may have been because they expected to leave the United States after graduation. That is, we could probably not assume that those missing social security numbers stayed at the same rate as persons who were otherwise similar but did report social security numbers. The proportion missing social security numbers from the older classes was small, e.g., around 5 or 6 percent for temporary residents receiving doctorates in the late 1990's. [Finn, 2003] Accordingly, we assumed that those with missing social security numbers stayed at half the rate of those in the same group who had provided valid social security numbers. If the true stay rate of those without social security numbers was different from what was assumed the error would be small because the total missing social security numbers was usually around 6 percent or even less in earlier years.

However, after the late 1990's the proportion failing to provide social security numbers to the SED steadily increased. There is good reason to believe that this increase was due to the increasing tendency of students wanting to keep their social security number private, not because they did not have one. It seems obvious that this issue has become of greater concern in recent years. For example, most colleges previously used social security numbers as student Identification numbers, but that practice was stopped, largely because of this concern. Another reason to believe that the increase in missing social security numbers is not due to an increase in persons intending to leave the USA after graduation is that the same increase occurred among foreign doctorate recipients with permanent visas. In fact, by 2005 the proportion of temporary residents missing social security numbers had reached 14.6 percent, and the proportion of permanent residents missing the same reached 19 percent. [Finn, 2010] 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. However, there is still a possibility that foreigners not providing social security numbers stay at a somewhat lower rate than those who do. Since we do not wish to bias upward the estimates provided in this report, and especially do not want to show an artificial increase in the stay rates that comes from changing the adjustments, it was decided to force the adjustment for missing social security numbers to have the same impact as it did in the last stay rate report issued by the author. [Finn, 2012].

An alternative estimate that included no adjustments for missing social security numbers resulted in stay rate estimates that are only 1 to 2 percentage points higher than the estimates provided in this report.

Another issue related to missing social security numbers is sampling. In all years the SED attempts to obtain completed questionnaires from 100 percent of doctorate recipients in science and engineering disciplines. However, in 2006, as an experiment, the SED only asked for a partial social security number for 10 percent of the doctorate recipients. This partial social security number, however, is not enough information to be useful for a match at the Social Security Administration. Thus, for purposes of this study it is as if the SED had been based on a 90 percent sample instead of a 100 percent sample in 2006. Our method for adjusting the five-year stay rate for missing social security numbers forced the adjustment to have the same impact on the estimated five-year stay rate as in our similar 2012 study [Finn, 2012] which estimated five-year stay rates for the class of 2004, a year in which 100 percent were asked for full social security numbers. Thus, we did not increase the adjustment for missing social numbers for the five-year stay rate in 2011 (class of 2006) as a result of the fact that 10 percent of the 2006 class were not even asked to provide full social security numbers.

Table A-1 shows the percentage from each cohort studied for which no valid social security numbers were available.

**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
2006	26.5	32.3
2001	7.8	6.7
1995	4.4	4.4

Notes: (1) Subtract 10 percent from the 2006 values to get the percentage that were asked for full social security numbers but failed to provide them. (2) The values for 1995 apply to the combined total of temporary and permanent residents.

Source: Oak Ridge Associated Universities.

The five-year stay rate estimate for 2006 doctorate recipients in 2011 was reported to be 68 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 70.3 percent

The ten-year stay rate estimate for 2001 doctorate recipients in 2011 was reported to be 65 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 66.8 percent.

The 16-year stay rate estimate for 1995 doctorate recipients in 2011 was reported to be 61 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 62.4 percent

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 NSF *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. However, for the 16-year stay rate this adjustment is more substantial, on the order of 4 percentage points.

### **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 the 2010 and earlier studies by the author. For example, the study completed four years ago assumed only 2.9 to 3 percent were not earning at least \$5,500. [Finn, 2010] 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 in reports by the author dated 2010 or earlier 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 five-year stay rates have changed over time. Thus, estimates that had previously reported for five- and ten-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 and 2011 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.

### **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 small. The 2011 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 five-year stay rate shown in Table 2 rate is 1.5 percentage points higher than it would have been with no adjustments. The ten-year stay rate shown in Table 3 is 2.4 percentage points higher than it would have been with no adjustments. The 16-year stay rate shown in Table 4 is 3.7 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 five-year stay rate is because of assumed losses due to deaths which increase as a cohort ages.

### **Supplemental Estimates for Persons who Stayed for a While But Left by 2011**

In a section titled Migration vs. Circulation there are alternative estimates provided to show how much higher stay rates would have been if we counted as stayers persons who stayed at least one, three, or five years after graduation but did not have at least \$5,500 in earnings recorded in 2011. For example, it was noted that the ten-year stay rate for those graduating in 2001 would have been 8 percent higher, if we chose to count as stayers those persons for whom the SSA had recorded earnings of at least \$5,500 in at least five years subsequent to 2001, but who were not here in 2011. These estimates were made possible by a tabulation provided by SSA which counted, for the 2001 doctorate recipients, the number who were had at least \$5,500 in earnings in any year between 2001 and 2011, any three years during that period, or any five years.

### **Sampling Error**

The NSF *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 2011 or who had earnings less than \$5,500. 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 NSF *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.

As indicated earlier, the *Survey of Earned Doctorates* requested only a partial social security number in 2006. This caused us to work only with the remaining 90 percent who were requested to provide a full social security number. The effect was that the 2006 *Survey of Earned Doctorates* was like a 90 percent sample survey for the purposes of this study. No attempt has been made to estimate the “sampling error” to be expected from this. However, sampling error tends to go down as the sampling rate goes up, and thus the error introduced by this can be expected to be very small, in general.

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