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Attracting Talent

Location Choices of Foreign-Born PHDs in the US

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ATTRACTING TALENT:

LOCATION CHOICES OF FOREIGN-BORN PHDS IN THE US

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Abstract

We use data from the National Science Foundation to examine the post-degree location choices of foreign-born students receiving PhDs from US universities in science and engineering. Individuals with advanced training in science and engineering are important inputs in the process of innovation. They are more likely than other college graduates or post-graduates to produce and to commercialize patents. Where they choose to live and work affects the global distribution of innovation capacity. In low-income countries, there are few opportunities to obtain advanced training in science and engineering, requiring students to pursue degrees abroad with many going to the United States. The success of these countries in luring back home students who obtain graduate degrees from US or other foreign universities determines their capacity for indigenous research and development. Over the period 1960 to 2008, 77% of foreign-born S&E PhDs state that they plan to stay in the United States. Graduates from low-income countries are relatively likely to seek US residence. However, intent to stay is noisy signal of actual location outcomes. Remaining in the US after graduation requires obtaining a work visa, which are in limited supply. Only 43% of S&E PhD recipients plan to stay *and* have made a commitment or signed a contract with an employer. Intent to stay and having a job may therefore be a more accurate measure of which graduates succeed in establishing residence in the United States.

We find that the foreign students more likely to stay in the US are those with stronger US ties, measured in terms of having a permanent residence visa or attended a US college, or stronger academic ability, measured in terms of parental educational attainment, the student's success in obtaining graduate fellowships or scholarships, and the rank of the student's university and academic department. Foreign students staying in the United States thus appear to be positively selected in terms of academic ability. These results are stronger for the joint outcome of intending to stay and having obtained a job, reinforcing the interpretation of positive selection. We also find that foreign students are more likely to stay in the United States if in recent years the US economy has had strong GDP growth, the birth country of the foreign student has had weak GDP growth, or the birth country has had an external debt crisis or major natural disaster. Foreign students are less likely to remain in the US if they are from countries with higher average income levels. As a country develops, its students obtaining degrees abroad become less likely to stay in the United States and more likely to return home. Education and innovation may therefore be part of a virtuous cycle in which education enhances prospects for innovation in low-income countries and innovation makes residing in these countries more attractive for individuals with advanced training in science and engineering.

I. Introduction

In the global competition for talent, workers trained in science and engineering have great allure (Kapur and McHale, 2005). They are key inputs in the production of knowledge, with graduates in S&E fields patenting at much higher rates than graduates in other fields (Hunt and Gauthier-Loiselle, 2010), thereby enhancing a country's potential for economic growth (Jones, 1995a,b). During the last half century, obtaining an advanced degree in science and engineering, especially for individuals from low-income regions, often meant studying in the United States (Freeman, 2009), the country which has produced more S&E doctorates than any other. In 1975, the share of science and engineering PhDs graduating from US universities was 47% of the total among students from major Asian nations and advanced European economies. While this share fell to 25% in 2004, reflecting a broader internationalization of higher education (Bound, Turner, and Walsh, 2009), the United States remains a major location for S&E training.

The population of students pursuing S&E PhDs has globalized, making it common for individuals to study in one country and to work in another. In 2007, students born outside the United States accounted for 53% of US PhDs awarded in S&E fields, up from 21% in 1960 (Figure 1). Growth in the foreign-born share of US PhDs has come entirely from low and middle-income countries (Figure 2). Many of these countries are now growing at much faster rates than the United States. Students from emerging economies who go abroad for advanced training may find it increasingly attractive to return home after completing their degrees. Finn (2010) estimates that for the 2005 cohort of US PhDs, 67% of foreign-born doctorates were working in the United States two years after graduation. While the two-year "stay rate" for foreign-born PhDs rose from 54% in 1994 to 71% in 2001, it fell over the 2000s.

In this paper, we examine the post-degree location choices of foreign-born students

receiving PhDs from US universities. Data are from the NSF Survey of Earned Doctorates (SED), which contains information on the characteristics of all individuals receiving a PhD from a US university over the period 1958 to 2008. The SED asks individuals if they plan to stay in the United States after completing their degree. Over the sample period, 77% of foreign-born S&E PhDs state that they plan to stay in the US, signalling intent, and 43% plan to stay *and* have made a commitment or signed a contract with an employer, signalling intent plus success in finding a job. We consider both outcomes, as well as the selection of foreign-born PhDs into broad sectors of employment (academia, private sector, public sector).

Combining the SED with data on economic conditions in the birth country of foreign students, we examine how location choices relate to student ability and to economic conditions in the US and in the birth country. All results include controls for birth-country and degree-field fixed effects. We find that the foreign students more likely to stay in the United States are those with stronger US ties, measured in terms of having a permanent residence visa or completed their BA degree at a US college or university, and stronger academic ability, measured in terms of parental educational attainment, the student's success in obtaining graduate fellowships or scholarships, and the rank of the student's university and department. Foreign students staying in the United States therefore appear to be positively selected in terms of ability. These results are stronger for the joint outcome of intending to stay and having obtained a job, reinforcing the interpretation of positive selection.

We also find that foreign students are more likely to stay in the United States if in recent years the US economy has had strong GDP growth, their birth country has had weak GDP growth, or their birth country has had recent natural disasters. Foreign students are less likely to remain in the US if they are from countries with higher average GDP levels. Because we control

for birth-country fixed effects, this result indicates that for a given country, its students studying abroad are less likely to stay in the US, the more developed the country becomes (controlling for recent business-cycle conditions). We also examine the impact of specific types of economic shocks in the birth country (banking crises, currency crises, civil and military conflict) on the intent to stay in the US.

Our work contributes to several bodies of recent literature on international migration. One related body considers the causes of emigration (Docquier, Lohest, and Marfouk, 2007), including how average income affects bilateral migration flows (Clark, Hatton, and Williamson, 2007; Ortega and Peri, 2009; Mayda, 2010) and the impact of the structure of labor earnings on skilled migration (Rosenzweig, 2006; Belot and Hatton, 2008; Brücker and Defoort, 2009; de Grip, Fouarge and Suaermann, 2009; Grogger and Hanson, 2011). These studies suggest that emigrants are positively selected in terms of schooling and that more-educated migrants favor destination countries that reward skill more heavily. Our work shows that there is positive selection in migrant location choices even among the most highly educated individuals and that selectivity is pro-cyclical. Zucker and Darby (2009) find that top scientists are relatively likely to launch high-technology companies, suggesting that the countries that attract more able PhD recipients may enjoy a larger boost to innovation.[1]

A second body of related work examines the impact of high-skilled immigration on economic outcomes in sending and receiving countries. Beine, Docquier, and Rapport (2001, 2008) find evidence of brain gain, in that greater opportunities for high-skilled emigration in low-income countries increase incentives for educational attainment sufficiently to offset the human capital lost to labor outflows. Blanchard, Bound, and Turner (2009) suggest further that flows of

[1] In other related work, Hunt (2011) finds that immigrants entering the US on student or temporary works visas are much more likely to produce patents than individuals entering the country on a green card (the majority of whom would have obtained a permanent visa through having relatives in the United States).

students to the US for PhD training may improve the quality of higher education in sending countries, further enhancing local human-capital accumulation.[2] Our work indicates that the increase in incentives for educational attainment in low-income countries may be strongest among the most able, which enhances the quality of local human capital, but also that the highly talented who do succeed in going abroad for advanced training are the least likely to return home, at least immediately following their education. In receiving countries, Hunt and Gauthier-Loiselle (2010) and Kerr and Lincoln (2011) find that US regions that attract more high-skilled immigrants produce larger numbers of S&E patents. The tendency of the most able PhDs to remain in the United States may in part explain the positive impact of high-skilled immigration on patenting, given the proclivity on these individuals for innovation. These location patterns also imply that poor countries sending students to the US for advanced S&E training may see those with the greatest innovative potential choose not to return home.

Among US universities, Stuen, Mobarak, and Maskus (2010) find that academic departments that have a larger fraction of graduate students who are foreign born produce a higher number of scientific publications and generate more citations on these publications. However, Borjas and Doran (2012) find negative effects on the academic productivity of US mathematicians from the arrival of Russian mathematicians following the collapse of the Soviet Union. In a related vein, Borjas (2009) and Lan (2011) show that larger supplies of foreign-born PhDs in cohorts defined by degree year and field (either for all PhDs in the former or for recent PhDs in the latter) are associated with lower earnings for US-born PhDs. Our findings suggest that immigration-related competition effects in the job market for US-born PhD recipients may be stronger for positions that tend to attract more able graduates.

In section 2, we describe the data used for the project and broad trends regarding the

[2] On the production of PhDs in the United States, see also Chiswick, Larsen, and Pieper (2010).

location choices of foreign PhD students educated in the United States. In section 3, we present our baseline empirical specification and results. In section 4, we present extended empirical results. And in section 5, we conclude.

II. Data and Empirical Setting

The Survey of Earned Doctorates covers all individuals receiving a PhD from an accredited US institution from 1958 forward. We have data through 2008, which include 1.6 million observations. From this sample, we drop individuals who were born in the United States or in US territories (N=1.1 million); obtained degrees before 1960, years for which we lack national economic data (N=2,000); obtained PhDs from non-research universities (N=9,000); are missing data on place of birth (N=56,000); or are missing data on post-graduation plans (N=6,000). We further drop individuals 45 years of age or older at time of degree (N=28,000), which consists primarily of those who complete their PhDs over multiple decades and who may not be comparable to the full-time students that constitute the bulk of the sample.

We focus the analysis on graduates in science and engineering fields, for which the link to innovative activity is strongest. Using data from the 2003 US National Survey of College Graduates, Hunter and Gauthier-Loiselle (2010) find that foreign-born scientists and engineers are substantially more likely than other college graduates or post-graduates to have produced a patent and more likely still to have produced a patent that has been commercialized. S&E fields include life sciences (agricultural, biological, and health sciences), physical sciences (atmospheric, earth, and ocean sciences; chemistry; mathematics and computer science; and physics), and engineering. For comparison, we present some results for non-S&E fields, which include education, humanities, law, management, and social sciences.

II.A. Rising Presence of the Foreign Born among US PhD Recipients

Figure 1 shows that the share of US PhDs in S&E fields going to foreign-born students rises steadily over time. In non-S&E fields, the share of PhDs going to foreign students also rises over time, but is much lower, in most years around half of the S&E value. In Figure 2, we see that low and middle-income countries account for nearly all of the growth in the foreign-student share of S&E PhDs.[3] The share of PhDs going to students from high-income countries, other than the United States, is flat over the five-decade period, due in part perhaps to the strengthening of graduate education in Australia, Canada, Europe, and Japan (Freeman, 2009).

Among low-income countries, China and India are by far the largest sources of PhD students to US universities, as seen in Figure 3a. Over the period they account for an average of 84% of students from low-income nations completing US science or engineering PhDs.[4] Among middle-income countries, shown in Figure 3b, Korea and Taiwan are the largest source countries, accounting for an average of 42% of PhD recipients from this income group. The next largest middle-income source countries for S&E PhDs are Russia, Iran, and Turkey.

China and India are large source countries for PhD students in part because they have large populations. However, students from the two countries also exhibit relatively high propensities to purse PhD education in the United States. Figure 4a shows S&E PhDs awarded on a per capita basis. US PhDs awarded reach a peak late in the sample period of 3.0 per 10,000 population in China and 1.7 per 10,000 population in India but only 0.6 per 10,000 population in other low-income countries. Korea and, especially, Taiwan stand out for having very high

[3] The definitions of income groups are per capita GDP of less than $800 for low-income countries, between $800 and $8,000 for middle-income countries, and above $8,000 for high-income countries. Income values are averages for the period 1985-1994. Our income classification closely mirrors that for the World Bank over the same period.

[4] In Figure 3a, the shares for China are inflated in the 1970s (and in Figure 3b the shares for Taiwan are deflated) owing to the fact that during this period many individuals born in China and who obtained US PhDs were citizens of Taiwan, having moved from mainland China to Taiwan in 1949 or shortly thereafter.

propensities to pursue US PhD training. Over the period, US S&E PhDs awarded average 13 per 10,000 population in Korea and an astounding 30 per 10,000 population in Taiwan. For comparison, the ratios are only 1.5 per 10,000 population in other middle-income countries and 2 per 10,000 population in non-US high-income countries (the majority of students from which may pursue their advanced training at home or close to home). Over the period, US S&E PhDs awarded to US-born individuals average 34.0 per 10,000 population.

II.B Post-Degree Location Decisions for Foreign PhD Recipients

The SED asks PhD recipients about their post-graduation plans. For our analysis, the two questions of primary interest are:

"In which country do you intend to live after graduation (within the next year)?" and

"What is the status of your post-graduation plans (in the next year)?"

For the second question, we are most interested in those answering, "Have signed a contract or made a definite commitment for postdoc or other work."[5] Figure 5a shows that the majority of foreign-born PhD recipients intend to stay in the United States, with average affirmative responses of 87% for those from low-income countries, 67% for those from middle-income countries, and 70% for those from high-income countries.[6]

For foreign-born students on a temporary residence visa, which is 70% of the sample, staying in the US past completion of the PhD requires that they obtain employment, such that they can transition from a student visa to an employment visa (such as the H-1B temporary visa for

[5] Other responses to this question are: returning or continuing in pre-doctoral employment, negotiating with one or more specific organizations, seeking position but have no specific prospects, other full-time degree program, do not plan to work or study, and other.

[6] Among S&E PhD recipients born in the US, the average fraction planning to stay in the country is 96%.

high-skilled workers or an employer-sponsored legal permanence residence visa or green card).[7] For graduates who are temporary visa holders, intent to stay in the United States means little without a job, as they are dependent on their employers to apply for a work visa. A much smaller fraction of foreign-born PhD recipients intends to stay in the US *and* has signed a contract or made a definite commitment for employment, as seen in Figure 5b, indicating that intent to stay in the US may be a noisy indicator of the fraction that actually succeeds in staying. Over the sample period, the share of graduates intending to stay in the US and having obtained a job averages 46% for low-income countries, 35% from middle-income countries, and 42% from high-income countries. In the analysis that follows, we use both measures of intent to stay in the US (i.e., with and without conditioning on having secured a job).

There is non-monotonicity in the relationship between the desire to stay and birth-country income levels. If highly skilled individuals choose locations based on the proportional (i.e., Mincerian) return to skill, as in Borjas (1987), one would expect the probability of staying in the US to be higher for PhDs from other rich countries, where returns to skill tend to be relatively low (e.g., Hanushek and Zhang, 2006). If individuals instead choose locations based on absolute differences in income between countries, as in Grogger and Hanson (2011), one would expect the opposite. What we see in Figure 5 is an intermediate outcome, with the probability of staying in the US lowest for individuals from middle-income countries. Results in section 3 suggest that this pattern in part reflects middle-income countries having relatively high growth rates (and the location choices of PhD recipients being sensitive to current economic conditions).

To see location choices for individual countries in more detail, Table 1 shows the fractions

[7] Another option for recent foreign-born graduates of US universities is Optional Practical Training, which allows current or former students to work in the United States temporarily (up to 29 months for S&E degree recipients) as long as the position is related to the student's field of study and is approved by the degree-granting institution and US immigration authorities. OPT is often used as a transition to an H-1B visa.

intending to say in the US and intending to stay and having a job for low-income countries that supply at least 400 S&E PhDs over the sample period and middle-income countries that supply at least 1500 S&E PhDs over the period. Intent to stay in the US rises from the first half of the sample (1960-1984) to the second half (1985-2008) in 15 of the 18 low-income countries and 11 of the 18 middle-income countries; intent to stay/have a job rises over time for 14 of 18 low-income countries and 10 of 18 middle-income countries. In each income group, there are only two countries in which intent to say/have a job is greater than 50 percent.

To examine the characteristics of foreign-born PhD recipients who intend to stay in the United States and who have secured a job, we utilize data from the SED on student background and from the National Research Council on the rankings of university PhD programs by department (National Research Council, 1995 and 2003).[8] Table 2 shows the fraction of S&E PhD recipients intending to stay in the US or intending to say and having a job by individual characteristics. Table A1 gives summary statistics on these characteristics and other variables used in the empirical analysis.

An important factor affecting student ability to stay in the US is visa status. The SED reports whether foreign-born students are naturalized US citizens, have a legal permanent residence visa, or have a temporary residence visa (e.g., a student visa). Being a citizen or having a green card guarantees that a graduate can work in the United States. There are two primary channels through which individuals obtain green cards: being sponsored by a family member who

[8] Not all PhD programs represented in the SED data are ranked by the NRC. Programs absent in the NRC include multi-disciplinary programs and programs that are specific to a few universities (e.g., cognitive science) or programs in less renowned universities. In the regression analysis, we control for whether a program is ranked. A further issue with the NRC rankings is that they are available for only two time periods, the early 1990s and the early 2000s. In the analysis, we use three alternative measures of department ranking: the earlier ranking, the later ranking, and the average of the rankings. We report results for the latter measure.

is a citizen or legal permanent resident or being sponsored by a US employer.[9] Having a green card (or already being a citizen) therefore indicates the strength of the graduate's ties to the US, either through family connections or through connections to a US employer. Obtaining a green card often takes six or more years (and becoming a citizen an additional five years), meaning that these connections must have been established well before the date at which we observe the student completing the PhD degree. In Table 2, the likelihood that a foreign-born graduate intends to stay in the US is much higher for those who are citizens or who are legal permanent residents. The likelihood is also higher for those who attended high school or completed their BA in the United States (a result that holds whether we examine all foreign-born students are just those who are not legal permanent residents).

We have three measures of the academic ability of the PhD recipient: success in obtaining graduate fellowships or scholarships, the quality of the university and of the academic department awarding the PhD degree, and the education level of the parents. The first two measures indicate the ability of the student as perceived at the time he or she begins graduate school (when most graduate funding decisions are made) and the third is an indication of the student's family background (an interpretation that depends on conditioning on average educational levels in the birth country, which we do in the regression analysis by virtue of controlling for birth-country fixed effects).

Over the sample period, the primary sources of financial support for students are university research assistantships or teaching assistantships (55%), US fellowships or scholarships (11% of students), foreign fellowships or scholarships (4%), family support or own funds (11%), and other or unnamed sources of support (19%). In Table 2, individuals with fellowships,

[9] Smaller numbers of green cards are available to refugees, which over the sample period would apply primarily to individuals from Cuba, Cambodia, Laos, or Vietnam, and via a lottery.

scholarships, RAships, or TAships are much more likely to intend to stay in the United States. The exceptions are individuals on foreign fellowships or scholarships or fellowships from the Ford Foundation, the Fulbright Program, the Mellon Foundation, or the Rockefeller Foundation, each of which imposes restrictions that are meant to compel the graduate to return to the home country after completing the PhD. We interpret the positive correlation between university financial support and intent to stay in the US as an indication that students with higher academic ability are less likely to desire to return home after their studies.

A large literature documents intergenerational persistence in schooling, earnings and other economic outcomes (e.g., Solon, 1999; Black and Devereux, 2010). Intergenerational persistence in schooling may reflect better educated parents raising their children to value education, passing along genes that are associated with academic success, or being better able to provide financially for the higher education of their children. PhD recipients whose mother or father has a BA degree are more likely to intend to stay in the United States and to intend to stay/have a job. These correlations provide further evidence of positive selection of stayers in terms of actual or potential academic performance.

Regarding university or department quality, Table 2 shows no difference in intent to stay in the US by overall ranking of the university or by ranking of the student's specific PhD program. However, the joint outcome of intending to stay in the US and having a job is more common among individuals graduating from top 20 universities or top 15 academic departments. Similar results obtain for alternative measures of university or department ranking.

For S&E PhD recipients, part of the motivation for staying in the United States after their degree may be to obtain a post-doctoral fellowship, which in many fields serves as an apprenticeship necessary for graduates to succeed in launching independent careers. Is intending

to stay in the US synonymous with seeking a postdoc? The SED includes a question about whether graduates intend to take a postdoc, but only for years 2003 and later. Among all foreign-born S&E graduates, 53% intend to take a postdoc, compared to 51% of US-born graduates. Among foreign-born S&E PhDs planning to stay in the US, 55% intend to take a postdoc and among those planning to stay in the US who have also obtained a job 53% intend to take a postdoc. The choice to stay in the United States thus does not appear to be dictated by the desire for a postdoctoral fellowship.

The SED asks students about the sector in which they intend to seek employment, which applies to graduates who are not seeking further study or taking a postdoc, traineeship or other temporary position after their degree. Table 3 reports the desired sector of employment for foreign-born PhD recipients not intending to stay in the US, intending to stay, and intending to stay and having a job. Those not intending to stay in the US are relatively more likely to choose academia or government jobs, perhaps reflecting sectors where foreign demand for PhDs is relatively strong. Those intending to stay in the US are relatively likely to select private industry. And those intending to stay/have a job are even more likely to select the private sector.

III. Baseline Results

To begin the empirical analysis, we estimate a linear probability model of the intent to stay in the United States for recent S&E PhD recipients born outside the US. We pool observations across time and include as regressors measures of the student's ties to the US (whether a naturalized citizen, whether has a green card, whether received BA from a US college) and academic ability (whether father has a BA, whether mother has a BA, whether student received graduate fellowship or scholarship), the quality of the graduate's degree program

(whether university is ranked among the top 40 US universities, whether PhD program is ranked by the National Research Council among the top 15 departments), recent economic conditions (average growth in log per capita GDP in the US and in the birth country over the previous five-year period, average log per capita GDP in birth country over the previous five-year period), demographic controls (gender, marital status, quadratic in current age, quadratic in age at completion of BA degree), a cubic time trend, dummies for the PhD degree field, and dummies for the birth country. Standard errors are clustered by the country of birth of the graduate.

III.A Intent to Stay in the United States

Table 4 presents the baseline regression results. In first column, we see that intent to stay in the US is positively associated with being a US citizen, having a green card, or having received a BA from a US university. Each of these variables is an indicator of the strength of the graduate's ties to the United States. Not surprisingly, intent to say is more likely among those with stronger US connections, be they family or professional, which facilitate obtaining the right to permanent residence. Intent to stay is more likely for graduates whose father has a BA but is uncorrelated with whether the mother has a BA.[10] In many poor countries, educational attainment of women lags well behind that of men, especially in earlier decades. The father's education may therefore be a stronger indicator of the student's "inherited" ability. Because we control for birth-country fixed effects, the effect of the father's educational attainment is relative to the average in the student's origin country (within the SED sample).

Additional measures of individual ability include the student's success in obtaining graduate fellowships or scholarships. Intent to stay is more likely among students whose primary funding for their doctoral education was a university research assistantship, a university teaching

[10] The correlation between father having a BA and mother having a BA is 0.55.

assistantship, a university fellowship, or a scholarship. However, intent to stay is less likely among students receiving their primary financial support from a foreign government or other foreign institution or from US donors whose support tends to be conditional on students returning to their home countries after completing their degrees.[11] The primary funding alternative to fellowships or scholarships is own funding or family support. We thus see that students who succeed in obtaining financial support from the university or other US sources are more likely to desire to stay in the US than students on restricted funding or family funding. There is no correlation between intent to stay and the ranking of the university or of the graduate degree program.

Turning to economic conditions, intent to stay in the US is weaker in years following higher per capita GDP growth in the birth country and stronger in years following higher per capita GDP growth in the US. These findings suggest that recent business-cycle conditions affect PhD recipient location choices, with students favoring the country with the stronger recent growth record. There is a negative correlation between intent to stay and the recent average level of per capita GDP in the birth country. Because the regressions include controls for birth country fixed effects, this result indicates that intent to stay weakens as a country develops. Graduates are more disposed to stay in the US earlier in the birth country's development process and more disposed to leave the US later in the development process. One explanation for this finding is that developed countries are likely to have relatively strong demand for R&D labor, making desire to return home increasing in the level development. (In the aggregate, there is an obvious feedback mechanism, with the number of S&E PhDs locating in a country affecting its rate of economic growth.)

[11] The latter category includes the Fulbright Program, the Ford Foundation, the Rockefeller Foundation, and the Mellon Foundation.

Finally, we see that men are weakly less likely to intend to stay in the US and that there is no correlation between marital status and intent to stay. Overall, the results suggest that intent to stay in the United States is stronger for PhD recipients with higher observed ability (measured at the start of their programs, when funding decisions are made), from countries with weaker recent economic growth or earlier in their development trajectory, and following periods of stronger US economic growth.

These general patterns are largely robust to various sample restrictions. A first issue is that the sample includes a mix of temporary visa holders, green card (legal permanent residence visa) holders, and naturalized US citizens. One may imagine that the responsiveness of location choices to individual characteristics or economic conditions may differ among these groups, owing to the relative freedom of legal permanent residents to choose where to live and work. The second column of Table 4 drops US citizens from the sample and the third column further drops green-card holders, both of which have a right to permanent residence in the United States. These restrictions have little impact on the results, as coefficient estimates are similar across the first three columns.

A second issue is that the results may be affected by the presence in the sample of students from China and Taiwan, the two largest source countries for US PhD students, which together account for an average of 27% of foreign-born US PhD recipients in S&E fields. In the fourth column of Table 4, we drop students whose birth country is China or Taiwan from the sample. The exclusion has little impact on the coefficient estimates. A third issue is that the sample spans five decades, during which there were dramatic changes in the labor markets for highly educated students in the US and abroad and in the international options for doctoral education in science and engineering. Such changes may have altered the composition of students choosing to pursue

PhD training in the United States, which may in turn affect estimation results for PhD-recipient location choices. In the fifth column of Table 5, we restrict the sample to 1990 and later. The results are again similar to the first column. Finally, one may imagine that male and female PhD recipients may make location choices subject to different constraints. In many poor countries, females with an S&E PhD are rare, especially early in the sample period, suggesting that the unobserved characteristics of males and females may differ. Such differences may in turn affect the estimation results. The sixth column of Table 4 restricts the sample to be men only and the seventh column restricts the sample to be women only. The two sets of coefficient estimates turn out to be similar, assuaging this concern.

III.B Intent to stay in the US with job in hand

The large majority of foreign-born PhD recipients intend to stay in the United States. However, they cannot unless they obtain a job from a US employer who agrees to apply for an immigration visa on their behalf (or they have a US relative who can sponsor their visa application). One may therefore be skeptical that intent to stay in the US accurately indicates which graduates succeed in staying. We turn next to using the more restrictive measure of intent to stay *and* having signed a work contract or committed to an employer.

Table 5 uses the more restrictive measure of intent to stay as the dependent variable. There are a few PhD recipients with missing information on having a job, slightly reducing the number of observations for the analysis in the first column of Table 5 relative to that for Table 4. Comparing the first columns of Tables 4 and 5, we see than in both specifications intent to say is positively correlated with being a naturalized US citizen, having a green card, having attended college in the US, or having a more educated father. Results are also similar for success in

obtaining graduate fellowships or scholarships and for recent economic conditions. Where results between the two tables differ is in terms of the importance of the university ranking and the PhD program ranking. Students graduating from top 40 universities or from top 15 PhD programs are more likely to intend to stay in the US and to have secured a job. University quality appears to be positively correlated with finding a job in the US job market.

In the second column of Table 5, we restrict the sample to individuals who intend to stay in the United States and analyze whether they have secured a job. We are thus examining factors associated with the employment success of those signaling that they desire to remain in the US. Among those desiring to stay, there is a negative correlation between having obtained a job and being a naturalized citizen or having a green card. One interpretation of this result is that individuals without a residence visa feel greater pressure to find a US job and are therefore more likely to have signed an employment contract.[12] Having secured a job is positively but weakly correlated with the father's and the mother's education and strongly positively correlated with past success in obtaining graduate fellowships or scholarships. In going from the first column to the second column of Table 5, the coefficient of having a foreign fellowship or scholarship goes from negative to positive. By conditioning on intent to stay in the US, we are eliminating from the sample individuals obligated by their scholarships to return home after their education. Once we restrict the sample to stayers, the impact of having a foreign scholarship looks very similar to the impact of having a US fellowship or scholarship. The rank of the university and department continues to be strongly positively associated with securing a job. We also see that whereas for stayers recent economic growth in the birth country does not affect success on the US job market

[12] An alternative interpretation of this result is that there is negative selection in terms of ability of individuals who leave graduate school with a secure visa status. If the majority of recent PhD recipients who already are naturalized or who already have green cards achieved permanent residence through family members, which appears to be likely, the finding in the second column of Table 5 would indicate that individuals entering the United States on family-based immigration visas tend to be negatively selected in terms of their ability to find a job.

(not surprisingly), recent economic growth in the US is positively correlated with job market success. Foreign-born PhD recipients are more likely to have found a job after a period of strong US growth. Finally, we see a negative coefficient on birth-country per capita GDP, indicating that stayers from countries that are earlier in their development process are more likely to have secured a US job. This result may indicate positive selection of these individuals in terms of motivation or ability: when a country is relatively poor, the small numbers of its students who go to the US for advanced training may be individuals with relatively strong prospects of success on the job market.

IV. Extended Results

IV.A Responsiveness of Location Decisions to Economic Shocks

So far, we have defined business-cycle conditions purely in terms of recent per capita GDP growth in the US or in the birth country of the PhD recipient. In many poor countries, GDP growth is volatile, due to frequent financial crises, natural disasters, or civil or military conflict. We turn next to whether the type of shock that disrupts the birth-country economy matters for the location decisions of foreign PhD recipients. We consider three classes of shocks, the incidence of which is defined as the average over the year of graduation from the PhD program and the year preceding graduation. Table 6 displays the results.

The first type of shock is natural disasters, based on data from the EM-DAT database (http://www.emdat.be/). Beyond their impact on GDP growth, disasters may destroy capital stock that is complementary to PhD labor, lowering the expected productivity of highly skilled workers. We measure the incidence of natural disasters either as the raw number of recent natural disasters or as the number of recent major natural disasters, defined as earthquakes greater than 7.0 Richter,

windstorms (i.e., hurricanes) with a duration of five or more days, or landslides or volcanoes affecting more than 1,000 people. In Appendix Table A1, the average disaster count is 7.3, meaning that the average graduate is from a country that has seven disasters per year; the average incidence of major natural disasters is 0.07 per year. For either the raw disaster count, in the first column of Table 7, or major-disaster incidence, in the second column of Table 7, there is a positive and strongly statistically significant impact of recent disaster incidence on intent to stay in the US and on intent to stay/have a job. A higher incidence of disasters in the birth country appears to encourage recent PhD recipients to seek employment in the United States.

The second type of shock is whether the country has had a recent financial crisis, as defined by Reinhardt and Rogoff (2008).[13] They categorize countries as whether they experience a banking crisis, an external debt crisis, or a currency crisis in a given year.[14] Appendix Table A1 shows that the annual crisis incidence for the average PhD recipient is 0.19 for banking crises, 0.06 for external debt crises, and 0.12 for currency crises. In the third through fifth columns of Table 7, the incidence of banking, external debt, or currency crises is positively correlated with intent to stay in the US. Of these, only the incidence of external debt crises is precisely estimated. For intent to stay in the US and have a job, coefficients for crisis incidence are each small and imprecisely estimated. Much of the impact of financial crisis on PhD location decisions may be absorbed by recent GDP growth in the birth country, whose impact remains negative and statistically significant.

The third type of shock we consider is civil or military conflict, measured using the Peace Research Institute Oslo database (http://www.prio.no/Data/). We define conflict incidence in the

[13] In unreported results, we use replace the Rogoff and Reinhardt measure with the measure of sudden stops developed by Cavallo (2007), which we extend over the full sample period. Results for the two measures are similar.
[14] They also document the occurrence of domestic debt crises, inflation crises, and stock-market crashes. We find no correlation between these events and intent to stay in the US for foreign-born PhD recipients.

current and preceding year either as there being more than 25 battle deaths in a year (average incidence of 0.25) or more than 1,000 battle deaths in a year (average incidence of 0.08).[15] The first measure captures whether any conflict occurred; the second captures which a significant conflict occurred. For either conflict measure, the relationship between intent to stay in the US and the recent incidence of military conflict is small and imprecisely estimated. One may expect that the long-run incidence of military conflict affects PhD location decisions. However, long-run incidence is absorbed in the birth-country fixed effects, meaning that the conflict measures included in the regression capture the impact of short-run deviations in conflict incidence on location decisions. These do not appear to affect the desire of foreign-born PhDs to remain in the United States.

Overall, the results show that the desire of recent foreign-born PhD recipients to stay in the United States after graduation is strongly positively related to recent natural disasters in the birth country, weakly positively related to recent birth-country financial crises, and unrelated to recent birth-country civil or military conflict.

IV.B Variation across Academic Disciplines

So far, we have pooled data across S&E fields and ignored disciplines outside of science and engineering. In Table 7, we replicate the regressions in the first column of Tables 4 and 5 separately for seven disciplinary categories. Three are S&E fields, physical sciences (atmospheric, earth, and ocean sciences; chemistry; mathematics and computer science; physics), life sciences (agricultural science, biological sciences, health sciences), and engineering; and four are non-S&E fields, social sciences (except economics), economics and management (finance, accounting,

[15] In unreported results, we also measured conflict incidence for events that have resulted in more than 1,000 cumulative deaths in an ongoing conflict. Results for this variable are similar to those for the other conflict measures.

marketing, management strategy, organizational behavior), humanities (including communications), and education. There is considerable evidence in the literature that skilled labor trained in in S&E fields contributes to innovation in the form of patenting. There is less evidence about the contributions to innovation of skilled individuals trained in non-S&E fields.

Panel (a) of Table 7 shows results using as the dependent variable intent to stay in the US. Results are similar across the three S&E fields, with most coefficient estimates in the first to third columns being close in value. Among non-S&E fields, it is economics and management for which results most closely resemble those for science and engineering. In all non-S&E fields, intent to stay in the US is positively correlated with being a naturalized citizen, having a green card, or having obtained a BA in the US. Having stronger family or professional ties to the United States affects location decisions in all PhD fields. Differences between S&E and non-S&E fields emerge when we examine correlates of academic ability. In all non-S&E fields, the coefficient on father's education is small and imprecisely estimated (and even negative for the humanities). Coefficient estimates in S&E and non-S&E fields are similar for having a RAship/TAship but not for having a fellowship or scholarship. Thus, the strong evidence of positive selection in ability that we observe for intent to stay in the US among S&E graduates is weaker outside of science and engineering. When we examine the impact of economic conditions on location decisions, economics and management is the only non-S&E discipline for which US per capita GDP growth, birth-country per capita GDP growth, and birth-country average income each has a statistically significant impact on the intent to stay in the United States. In the three other non-S&E fields, the link between economic conditions and location decisions for recent PhD recipients is relatively weak.

Panel (b) of Table 7 repeats the estimation in panel (a) using as the dependent variable intent to stay in the US and having a job. The qualitative results in panel (a) are replicated. Coefficient estimates are similar across the three S&E fields. Compared to S&E fields, in non-S&E fields there is weaker evidence of positive selection on academic ability for intent to stay in the US and the impact of US and birth-country economic conditions on location decisions is also weaker. It is again the case that among non-S&E fields results for economics and management are those that most closely resemble the findings for non-S&E fields.

V. Final Discussion

If innovation is the key to sustaining positive rates of long-run economic growth, highly skilled labor with training in science and engineering are the inputs that make innovation possible. Graduates in S&E fields have relatively high propensities to produce and to commercialize patents and the stars among these graduates have relatively high propensities to launch high-technology business ventures. Over the last half century, the United States has been the most important training ground for the global supply of science and engineering talent. Where S&E PhDs choose to locate after they have completed their education is likely to affect the global distribution of innovative capacity.

We find that the graduates with the strongest academic ability, measured in terms of their attributes and performance at the time they enter graduate school, are those most likely to intend to stay in the US and to find employment in the US job market. These results are consistent with a growing body of evidence that finds positive selection in emigration from low-income countries (e.g., Grogger and Hanson, 2011). The United States attracts the best and brightest to study at its universities and lures the best and brightest among these to stay in the US after their studies are

completed. We know less about the long-run location choices of these individuals in terms of how many end up remaining in the US as permanent residents or becoming citizens.

Policies surrounding student visas also shape the post-degree location choices of PhD recipients. Students receiving support from foreign institutions, or from private foundations that provide incentives for graduates to return to their home countries after the degree, are less likely to intend to stay in the US. This finding does not necessarily mean that restrictive scholarship funding is an effective means for low-income countries to produce a highly skilled labor force. At the application stage, such funding strategies could dissuade individuals from pursuing restrictive funding options or from seeking to study abroad at all.

Economic conditions are an additional important factor shaping the location choices of recent PhD recipients in S&E fields. A stronger US economy makes it more likely that graduates will intend to stay in the US and to find a job. A weaker economy in the graduate's home country has the same effect, as do recent external debt crises or natural disasters. The pro-cyclicality of the location choices of S&E PhDs could be a mechanism through which study abroad increases the amplitude of global business-cycle fluctuations.

As countries develop, they become more attractive locations for PhDs in science and engineering. There is obvious potential for a virtuous cycle in education and innovation, with returning S&E PhDs increasing innovation in the home country, thereby enhancing prospects for economic growth and raising the attractiveness of the home country as a location for future PhD recipients. Less is known about how such cycles initiate.

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Table A1: Summary statistics

	mean	st. dev.
= 1 if intends to stay in US	0.773	0.419
= 1 if intends to stay in US and has job	0.432	0.495
= 1 if naturalized citizen	0.088	0.284
= 1 if has green card	0.173	0.378
= 1 if earned BA degree in US	0.146	0.353
= 1 if father has BA degree	0.479	0.500
= 1 if mother has BA degree	0.276	0.447
= 1 if had RAship/TAship	0.516	0.500
= 1 if had fellowship, scholarship	0.106	0.307
= 1 if had Fulbright, Ford Foundation, etc.	0.001	0.026
= 1 if had foreign scholarship	0.038	0.192
= 1 if top 20 university	0.260	0.439
= 1 if top 40 university	0.484	0.500
= 1 if top 15 PhD program	0.048	0.213
= 1 if ranked PhD program	0.766	0.424
= 1 if male	0.800	0.400
= 1 if married	0.627	0.483
age at PhD degree	32.089	3.923
age at BA degree	22.791	1.954
birth country log pc GDP growth t-1 to t-5	0.057	0.035
US log pc GDP growth t-1 to t-5	0.033	0.008
birth country average log pc GDP t-1 to t-5	8.859	1.863
currency crisis, t to t-1	0.118	0.270
external debt crisis, t to t-1	0.055	0.215
banking crisis, t to t-1	0.189	0.361
number of natural disasters, t to t-1	7.254	8.875
major natural disasters, t to t-1	0.074	0.140
>25 battle deaths, t to t-1	0.250	0.435
>1000 battle deaths, t to t-1	0.081	0.274

Sample is foreign born recipients of a PhD in a science or engineering field from a US research university over the period 1960 to 2008 (N=262,616 except for birth country economic measures which have fewer observations owing to inclusion of lagged values in their construction).

Table 1: Intent to stay in US among S&E PhD recipients by birth country, 1960-2008

	Intend to stay in US		Intend to stay in US, has job	
Low income	'60-'84	'85-'08	'60-'84	'85-'08
Bangladesh	1.000	0.852	0.667	0.485
Cameroon	0.582	0.779	0.165	0.242
China	0.901	0.941	0.524	0.524
Ethiopia	0.646	0.857	0.231	0.374
Ghana	0.605	0.833	0.231	0.351
Guyana	0.794	0.866	0.428	0.377
India	0.814	0.912	0.443	0.563
Indonesia	0.389	0.426	0.197	0.204
Kenya	0.514	0.657	0.192	0.325
Nepal	0.427	0.759	0.185	0.333
Nigeria	0.493	0.821	0.143	0.242
Pakistan	0.636	0.708	0.318	0.336
Sri Lanka	0.611	0.796	0.296	0.407
Sudan	0.237	0.549	0.090	0.214
Tanzania	0.406	0.515	0.206	0.230
Uganda	0.579	0.561	0.242	0.279
Vietnam	0.753	0.922	0.386	0.476
Zimbabwe	0.725	0.662	0.354	0.335
Middle income				
Argentina	0.660	0.709	0.376	0.429
Brazil	0.215	0.404	0.094	0.234
Chile	0.494	0.520	0.264	0.318
Colombia	0.445	0.675	0.231	0.372
Egypt	0.618	0.603	0.307	0.262
Iran	0.741	0.923	0.287	0.400
Jordan	0.532	0.525	0.233	0.182
Korea	0.778	0.598	0.417	0.294
Malaysia	0.463	0.530	0.234	0.283
Mexico	0.446	0.548	0.234	0.306
Philippines	0.517	0.769	0.257	0.382
Poland	0.853	0.857	0.532	0.486
Romania	0.827	0.898	0.505	0.553
Russia	0.896	0.896	0.561	0.549
South Africa	0.622	0.626	0.365	0.355
Taiwan	0.889	0.640	0.534	0.295
Thailand	0.360	0.282	0.110	0.108
Turkey	0.641	0.641	0.340	0.377

See Table A1 for description of sample.

Table 2: Location choices and characteristics of foreign-born S&E PhD recipients

		Intend to stay in US	Intend to stay in US, has job
US citizen	no	0.700	0.384
	yes	0.957	0.504
US permanent resident	no	0.685	0.381
	yes	0.921	0.472
High school in US	no	0.709	0.385
	yes	0.930	0.527
College in US	no	0.697	0.380
	yes	0.874	0.479
RAship, TAship	no	0.654	0.336
	yes	0.821	0.472
Fellowship, scholarship	no	0.725	0.389
	yes	0.745	0.459
Fulbright, Ford, Rockefeller	no	0.728	0.397
	yes	0.445	0.225
Foreign financial support	no	0.747	0.408
	yes	0.254	0.132
Father has BA degree	no	0.686	0.357
	yes	0.777	0.443
Mother has BA degree	no	0.703	0.371
	yes	0.796	0.468
Top 20 university	no	0.730	0.380
	yes	0.721	0.443
Top 15 program	no	0.741	0.409
	yes	0.720	0.474

See Table A1 for description of sample.

Table 3: Post PhD employment intentions

Desired sector of employment	Does not intend to stay in US	Intends to stay in US	Intends to stay in US and has job
Government	0.236	0.060	0.067
Academia	0.496	0.344	0.389
Private industry	0.104	0.328	0.497
Non-profit	0.077	0.141	0.040
Other, unspecified	0.087	0.127	0.007

The sample is foreign-born PhD recipients in science and engineering fields who are not pursuing further study or a temporary postdoc or trainee position after their degree.

Table 4: Baseline regressions results for intend to stay in US after PhD

Sample	All	Non-citizens	Non-resdnts	No China	1990-2008	Men	Women
naturalized citizen	0.202*			0.234*	0.170*	0.214*	0.161*
	(0.030)			(0.023)	(0.032)	(0.029)	(0.032)
has green card	0.174*	0.175*		0.225*	0.144*	0.183*	0.142*
	(0.036)	(0.036)		(0.025)	(0.043)	(0.033)	(0.042)
earned BA in US	0.048*	0.060*	0.071*	0.045*	0.056*	0.050*	0.044*
	(0.011)	(0.009)	(0.010)	(0.010)	(0.012)	(0.011)	(0.010)
father has BA	0.010*	0.011*	0.015*	0.014*	0.013*	0.011*	0.008~
	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.003)	(0.004)
mother has BA	-0.004	-0.004	-0.004	-0.003	-0.003	-0.005	0.001
	(0.004)	(0.005)	(0.006)	(0.005)	(0.003)	(0.005)	(0.003)
RAship/TAship	0.078*	0.086*	0.102*	0.090*	0.059*	0.083*	0.048*
	(0.017)	(0.020)	(0.019)	(0.014)	(0.020)	(0.018)	(0.012)
fellowship, scholarship	0.033*	0.044*	0.055*	0.031*	0.012	0.038*	0.013
	(0.010)	(0.012)	(0.012)	(0.010)	(0.013)	(0.011)	(0.008)
Fulbright, Ford, Rockefeller	-0.112*	-0.140*	-0.135*	-0.116*	-0.084~	-0.112*	-0.101
	(0.037)	(0.044)	(0.048)	(0.043)	(0.040)	(0.041)	(0.074)
foreign scholarship	-0.225*	-0.209*	-0.184*	-0.207*	-0.256*	-0.217*	-0.249*
	(0.033)	(0.033)	(0.031)	(0.029)	(0.030)	(0.034)	(0.026)
top 40 university	-0.008	-0.005	-0.004	-0.006	-0.002	-0.007	-0.011*
	(0.006)	(0.006)	(0.007)	(0.008)	(0.007)	(0.007)	(0.004)
top 15 program	0.004	0.009	0.012	0.009	0.008	0.007	-0.006
	(0.007)	(0.007)	(0.007)	(0.008)	(0.009)	(0.008)	(0.009)
ranked program	-0.012*	-0.012*	-0.013*	-0.015*	-0.008~	-0.011*	-0.015~
	(0.003)	(0.003)	(0.004)	(0.003)	(0.004)	(0.003)	(0.006)
birth country pc GDP growth	-0.508~	-0.585~	-0.742	-0.890*	-1.012~	-0.504~	-0.328
	(0.253)	(0.280)	(0.381)	(0.340)	(0.445)	(0.252)	(0.256)
US pc GDP growth	3.181*	3.446*	3.709*	3.228*	2.778*	3.331*	2.559*
	(0.659)	(0.706)	(0.821)	(0.654)	(0.593)	(0.670)	(0.708)
birth country average income	-0.043~	-0.051*	-0.071*	-0.125*	-0.077~	-0.043~	-0.026*
	(0.018)	(0.018)	(0.021)	(0.018)	(0.031)	(0.020)	(0.010)
male	-0.007	-0.008~	-0.010~	-0.008	0.000	0.000	0.000
	(0.004)	(0.004)	(0.004)	(0.005)	(0.004)	0.000	0.000
married	-0.007	-0.011	-0.017	-0.020~	0.007	-0.006	0.006
	(0.009)	(0.010)	(0.011)	(0.008)	(0.008)	(0.010)	(0.009)
Adjusted R squared	0.265	0.268	0.264	0.253	0.276	0.266	0.273
N	205022	187405	151934	148574	141383	162103	42919

All regressions include a quadratic in age at PhD degree, a quadratic in age at BA degree, a cubic in the year, dummies for birth-country, and dummies for PhD degree field. Standard errors (in parentheses) are clustered by birth country. ~(*) indicates significance at .05 (.01) level. Sample varies by column.

Table 5: Results for intend to stay in US and has a job

Sample:	All	Intends to stay in US
Outcome:	Intends to stay, has job	Has job
naturalized citizen	0.089*	-0.012
	(0.020)	(0.009)
has green card	0.065*	-0.026*
	(0.020)	(0.006)
earned BA in US	0.040*	0.005
	(0.008)	(0.009)
father has BA	0.010*	0.005
	(0.003)	(0.003)
mother has BA	0.001	0.004
	(0.003)	(0.003)
RA/TAship	0.096*	0.073*
	(0.008)	(0.005)
fellowship, scholarship	0.085*	0.081*
	(0.005)	(0.003)
Fulbright, Ford, Rockefeller	-0.052	0.006
	(0.036)	(0.039)
foreign scholarship	-0.065*	0.046*
	(0.015)	(0.011)
top 40 university	0.055*	0.075*
	(0.007)	(0.004)
top 15 program	0.030*	0.038*
	(0.007)	(0.007)
ranked program	-0.001	0.005
	(0.002)	(0.003)
birth country pc GDP growth	-0.339	-0.161
	(0.203)	(0.153)
US pc GDP growth	3.285*	1.986*
	(0.321)	(0.370)
birth country average income	-0.051*	-0.041*
	(0.011)	(0.007)
male	0.043*	0.056*
	(0.008)	(0.008)
married	0.018*	0.022*
	(0.006)	(0.003)
Adjusted R squared	0.107	0.055
N	197312	155542

Regressions include a quadratic in age at PhD degree, a quadratic in age at BA degree, a cubic in the year, dummies for birth-country, and dummies for PhD degree field. Standard errors (in parentheses) are clustered by birth country. ~(*) indicates significance at .05 (.01) level. Sample varies by column.

Table 6: Results for natural disasters, financial crises, and civil/military conflict

(a) Intend to stay in US

birth country GDP growth	-0.687~ (0.311)	-0.506~ (0.252)	-0.520~ (0.241)	-0.439 (0.263)	-0.502~ (0.246)	-0.558~ (0.246)	-0.573~ (0.247)
US GDP growth	2.855* (0.604)	3.117* (0.666)	3.203* (0.561)	3.183* (0.652)	3.173* (0.647)	3.213* (0.641)	3.194* (0.650)
birth country ave. income	-0.084* (0.015)	-0.043~ (0.018)	-0.043~ (0.018)	-0.045* (0.017)	-0.043~ (0.018)	-0.043* (0.016)	-0.041~ (0.017)
shock incidence	0.005* (0.001)	0.047~ (0.019)	0.023 (0.020)	0.028* (0.009)	0.008 (0.015)	-0.009 (0.014)	-0.012 (0.015)
shock measure	All natural disasters	major disasters	banking crisis	external debt crisis	currency crisis	>25 battle deaths	>1000 battle deaths
Adj. R squared	0.267	0.266	0.266	0.266	0.265	0.267	0.267
N	204784	204784	205022	205022	205022	201272	201272

(b) Intend to stay in US, has job

birth country GDP growth	-0.431~ (0.245)	-0.340~ (0.201)	-0.340~ (0.204)	-0.34 (0.215)	-0.343~ (0.196)	-0.374~ (0.200)	-0.379~ (0.203)
US GDP growth	3.128* (0.311)	3.224* (0.277)	3.286* (0.323)	3.285* (0.321)	3.289* (0.317)	3.30* (0.324)	3.313* (0.318)
birth country ave. income	-0.072* (0.011)	-0.051* (0.011)	-0.051* (0.011)	-0.051* (0.010)	-0.051* (0.011)	-0.051* (0.011)	-0.051* (0.010)
shock incidence	0.003* (0.001)	0.049* (0.015)	0.002 (0.012)	0.000* (0.010)	-0.005 (0.016)	0.000 (0.008)	-0.006 (0.009)
shock measure	All natural disasters	major disasters	banking crisis	external debt crisis	currency crisis	>25 battle deaths	>1000 battle deaths
Adj. R squared	0.107	0.107	0.107	0.107	0.107	0.107	0.107
N	197079	197079	197312	197312	197312	193668	193668

Other variables in the regression are identical to Table 4. See notes to Table 4 for estimation details.

Table 7a: Results by PhD field, Intend to stay in US

Field	physical sciences	life sciences	enginrng	social sciences	economics mngmnt	humanities	education
naturalized citizen	0.186*	0.205*	0.210*	0.321*	0.330*	0.345*	0.445*
	(0.025)	(0.031)	(0.038)	(0.019)	(0.031)	(0.019)	(0.023)
has green card	0.153*	0.190*	0.173*	0.329*	0.282*	0.333*	0.378*
	(0.032)	(0.044)	(0.033)	(0.022)	(0.029)	(0.015)	(0.028)
earned BA in US	0.047*	0.053*	0.040*	0.092*	0.064*	0.081*	0.090*
	(0.010)	(0.016)	(0.010)	(0.010)	(0.011)	(0.010)	(0.014)
father has BA	0.008~	0.016*	0.007~	0.004	0.005	-0.003	0.003
	(0.003)	(0.005)	(0.003)	(0.005)	(0.007)	(0.006)	(0.006)
mother has BA	-0.003	-0.008	-0.001	0.003	0.004	-0.003	-0.001
	(0.004)	(0.005)	(0.005)	(0.007)	(0.011)	(0.006)	(0.013)
RA/TAship	0.053*	0.076*	0.090*	0.079*	0.086*	0.094*	0.115*
	(0.016)	(0.014)	(0.020)	(0.013)	(0.010)	(0.017)	(0.016)
fellowship, scholarship	0.021	0.024*	0.037~	-0.01	0.046*	-0.006	-0.047~
	(0.011)	(0.007)	(0.018)	(0.010)	(0.008)	(0.016)	(0.023)
Fulbright, foundation	-0.136	-0.123~	-0.081	-0.136*	-0.310*	-0.033	-0.173~
	(0.071)	(0.062)	(0.067)	(0.039)	(0.050)	(0.067)	(0.079)
foreign scholarship	-0.193*	-0.201*	-0.254*	-0.163*	-0.140*	-0.154*	-0.133*
	(0.035)	(0.024)	(0.044)	(0.026)	(0.024)	(0.027)	(0.030)
top 40 university	-0.001	-0.017*	-0.001	-0.013~	-0.021	0.007	-0.021*
	(0.007)	(0.005)	(0.008)	(0.006)	(0.011)	(0.009)	(0.007)
top 15 program	0.009	-0.01	0.003	0.019	0.076*	0.017	0.000*
	(0.009)	(0.012)	(0.008)	(0.016)	(0.015)	(0.012)	0.000
ranked program	-0.020*	-0.023*	0.006	-0.026*	-0.041*	0.003	0.000*
	(0.007)	(0.004)	(0.004)	(0.007)	(0.012)	(0.008)	0.000
birth cty pc GDP growth	-0.394	-0.552~	-0.478	-0.479	-0.456~	-0.168	-0.37
	(0.234)	(0.230)	(0.294)	(0.295)	(0.223)	(0.292)	(0.272)
US pc GDP growth	3.934*	1.958*	3.544*	3.068*	4.670*	1.856*	2.322*
	(0.688)	(0.472)	(0.954)	(0.598)	(0.972)	(0.416)	(0.767)
birth cty average income	-0.020	-0.071*	-0.036	-0.032	-0.109*	-0.006	-0.053
	(0.017)	(0.015)	(0.023)	(0.036)	(0.041)	(0.025)	(0.043)
male	-0.004	-0.002	-0.006	-0.028*	-0.039*	-0.033*	-0.047*
	(0.005)	(0.006)	(0.005)	(0.009)	(0.010)	(0.008)	(0.011)
married	0.010	-0.025~	-0.003	-0.041*	-0.024~	-0.049*	-0.036*
	(0.009)	(0.011)	(0.009)	(0.009)	(0.011)	(0.007)	(0.009)
Adjusted R squared	0.197	0.355	0.266	0.303	0.249	0.288	0.369
N	68150	59219	77653	26489	25948	25678	17817

Samples are PhD subfields. See notes to Table 4 for details on the estimation.

Table 7b: Results by PhD field, Intend to stay in US/has job

Field	physical sciences	life sciences	enginrng	social sciences	econmics mngmnt	humanities	education
naturalized citizen	0.077*	0.096*	0.089*	0.144*	0.173*	0.119*	0.138*
	(0.018)	(0.027)	(0.022)	(0.014)	(0.034)	(0.014)	(0.017)
has green card	0.036	0.072*	0.075*	0.129*	0.127*	0.122*	0.092*
	(0.021)	(0.023)	(0.020)	(0.013)	(0.032)	(0.015)	(0.015)
earned BA in US	0.045*	0.040*	0.037*	0.044*	0.053*	0.036~	0.032*
	(0.009)	(0.011)	(0.012)	(0.011)	(0.012)	(0.014)	(0.011)
father has BA	0.006	0.013*	0.008~	0.005	0.000	-0.001	0.000
	(0.004)	(0.005)	(0.004)	(0.007)	(0.006)	(0.007)	(0.009)
mother has BA	0.010	-0.001	-0.002	0.010	0.009	0.011~	0.005
	(0.006)	(0.005)	(0.004)	(0.008)	(0.007)	(0.006)	(0.010)
RA/TAship	0.084*	0.082*	0.110*	0.108*	0.093*	0.117*	0.153*
	(0.008)	(0.009)	(0.007)	(0.007)	(0.009)	(0.010)	(0.012)
fellowship, scholarship	0.088*	0.069*	0.095*	0.061*	0.094*	0.058*	0.059*
	(0.008)	(0.005)	(0.007)	(0.009)	(0.008)	(0.010)	(0.015)
Fulbright, foundation	-0.134	-0.052	-0.064	-0.078*	-0.173*	0.044	-0.039
	(0.070)	(0.054)	(0.058)	(0.029)	(0.046)	(0.079)	(0.061)
foreign scholarship	-0.059*	-0.072*	-0.056*	-0.011	-0.035	-0.026	-0.014
	(0.020)	(0.013)	(0.019)	(0.018)	(0.021)	(0.015)	(0.009)
top 40 university	0.077*	0.010~	0.074*	0.037*	0.047*	0.053*	0.024*
	(0.009)	(0.005)	(0.007)	(0.007)	(0.009)	(0.008)	(0.008)
top 15 program	0.031*	-0.015	0.033*	0.027	0.098*	0.036~	0.000*
	(0.010)	(0.014)	(0.007)	(0.019)	(0.017)	(0.016)	0.000
ranked program	0.013	-0.020*	0.010~	-0.003	-0.013	0.026*	0.000*
	(0.007)	(0.004)	(0.004)	(0.009)	(0.013)	(0.009)	0.000
birth cty pc GDP growth	-0.388	-0.181	-0.329	-0.084	-0.352	0.159	-0.06
	(0.232)	(0.193)	(0.224)	(0.181)	(0.205)	(0.201)	(0.115)
US pc GDP growth	4.129*	0.825*	4.539*	0.958~	3.381*	0.415	-1.172~
	(0.353)	(0.277)	(0.403)	(0.409)	(0.572)	(0.368)	(0.501)
birth cty average income	-0.026~	-0.087*	-0.049~	-0.013	-0.066~	-0.007	0.006
	(0.012)	(0.010)	(0.019)	(0.020)	(0.031)	(0.011)	(0.016)
male	0.049*	0.051*	0.020*	0.027*	-0.001	0.013~	0.019
	(0.010)	(0.011)	(0.006)	(0.009)	(0.014)	(0.006)	(0.010)
married	0.035*	-0.014~	0.034*	-0.035*	0.003	-0.044*	-0.008
	(0.006)	(0.006)	(0.006)	(0.010)	(0.010)	(0.007)	(0.010)
Adjusted R squared	0.088	0.144	0.111	0.132	0.169	0.12	0.121
N	65544	57139	74629	25603	25068	24776	16839

Samples are PhD subfields. See notes to Table 5 for details on the estimation.

Figure 1

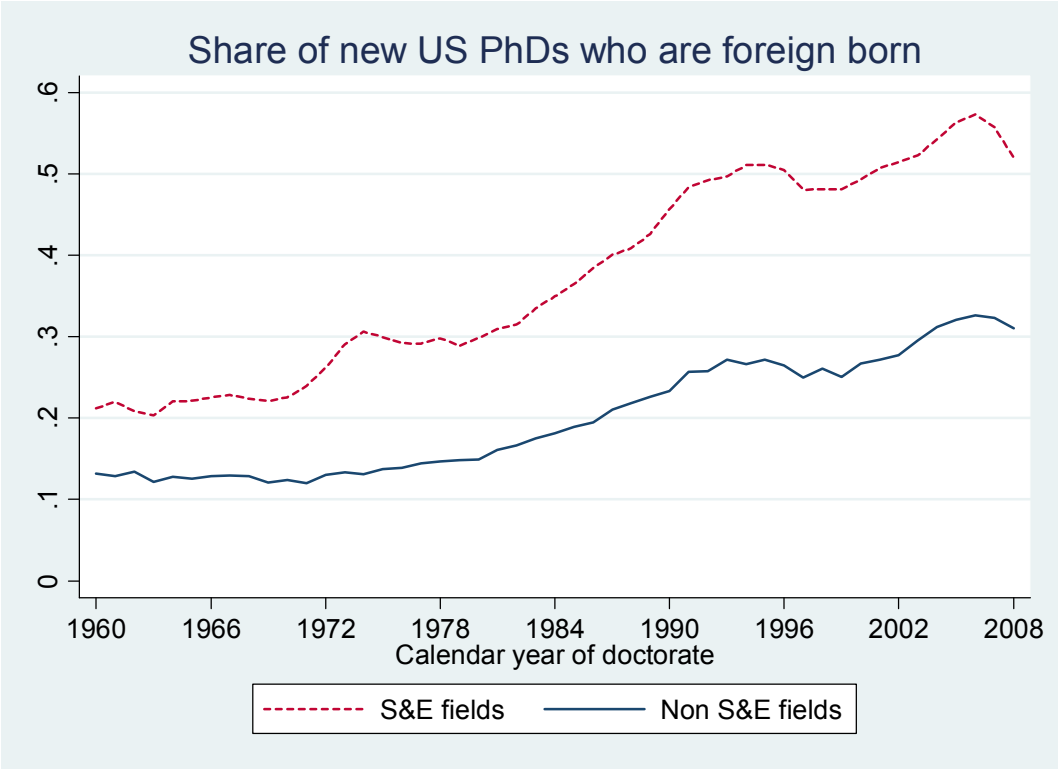


Figure 2: Foreign-born S&E PhDs by birth region

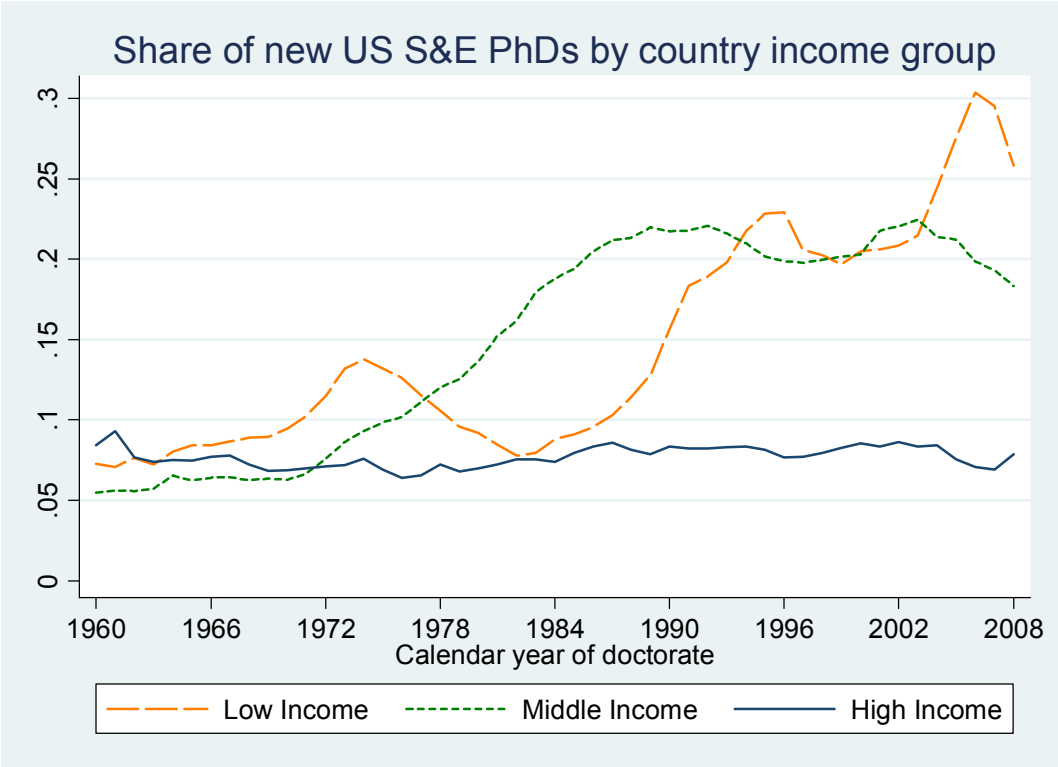
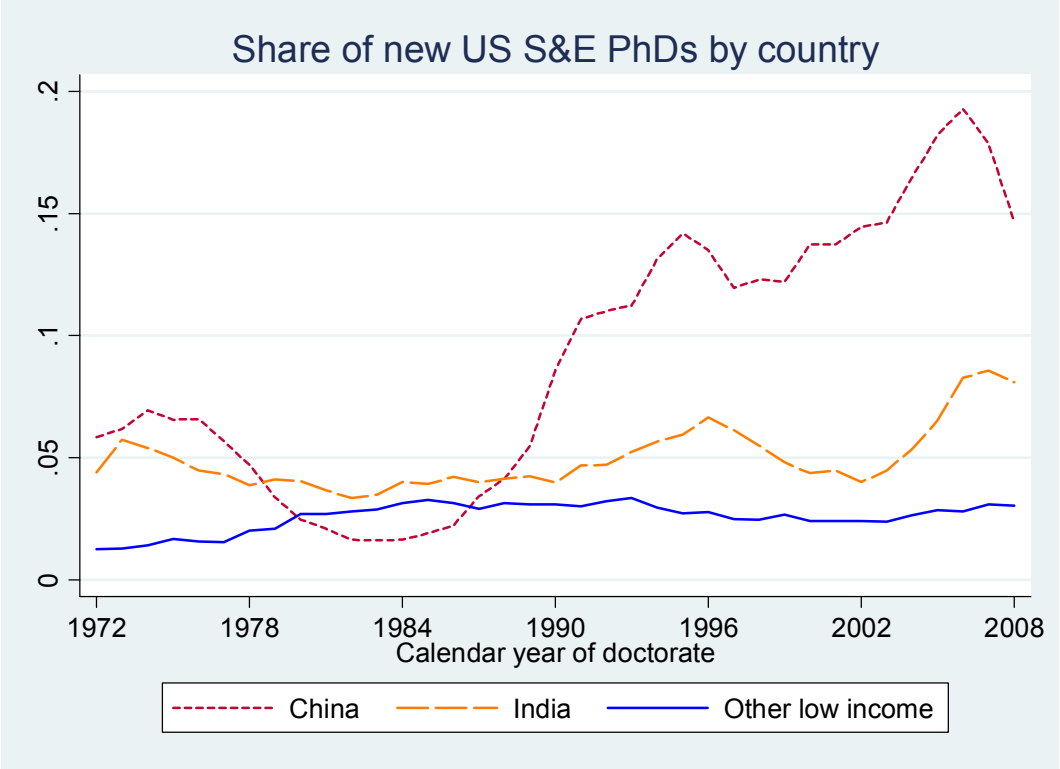


Figure 3: Foreign-born S&E PhDs by birth country

(a)



(b)

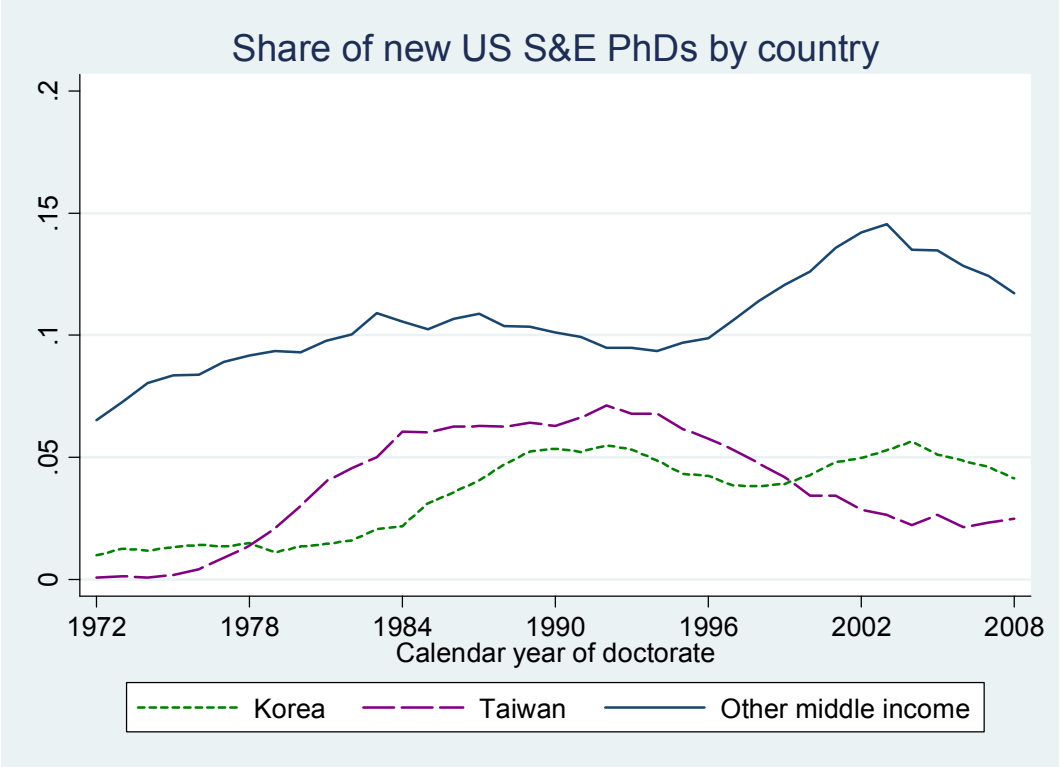
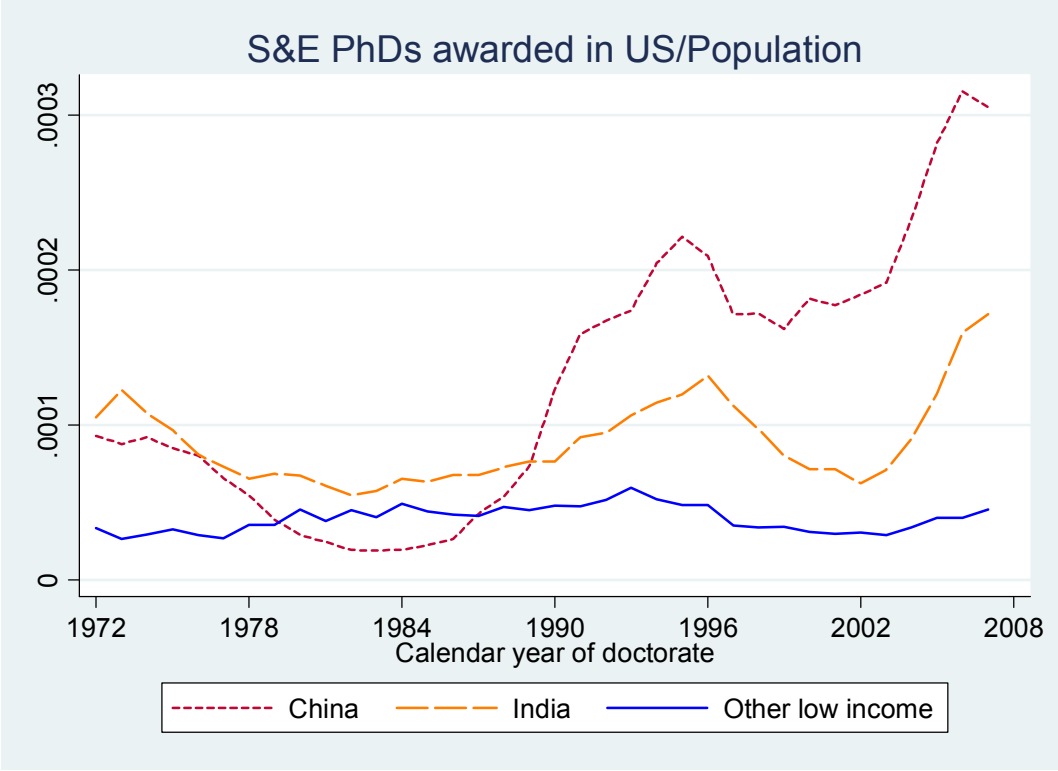


Figure 4: S&E PhDs awarded in US as share of birth-country population

(a)



(b)

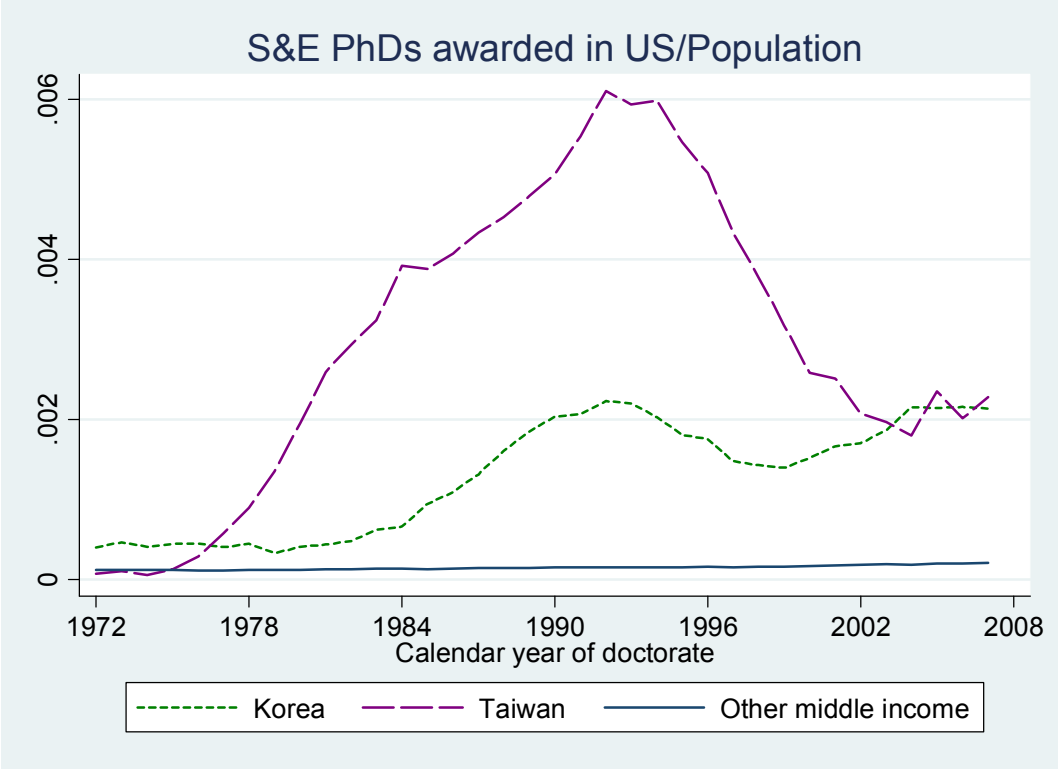
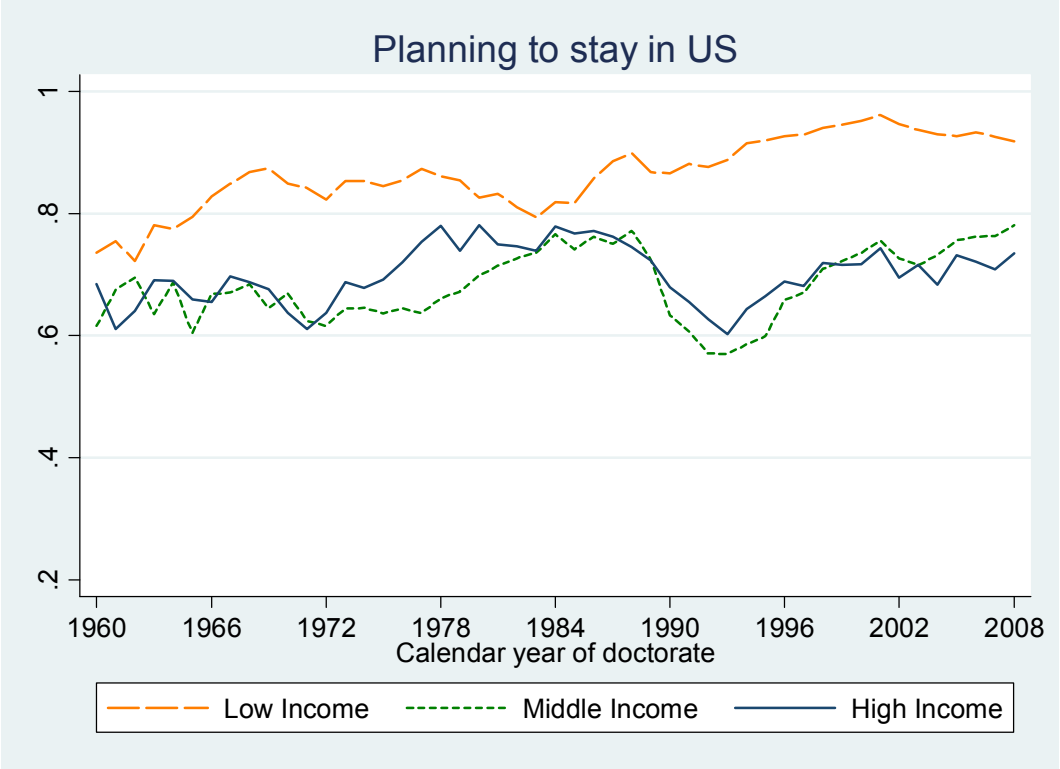
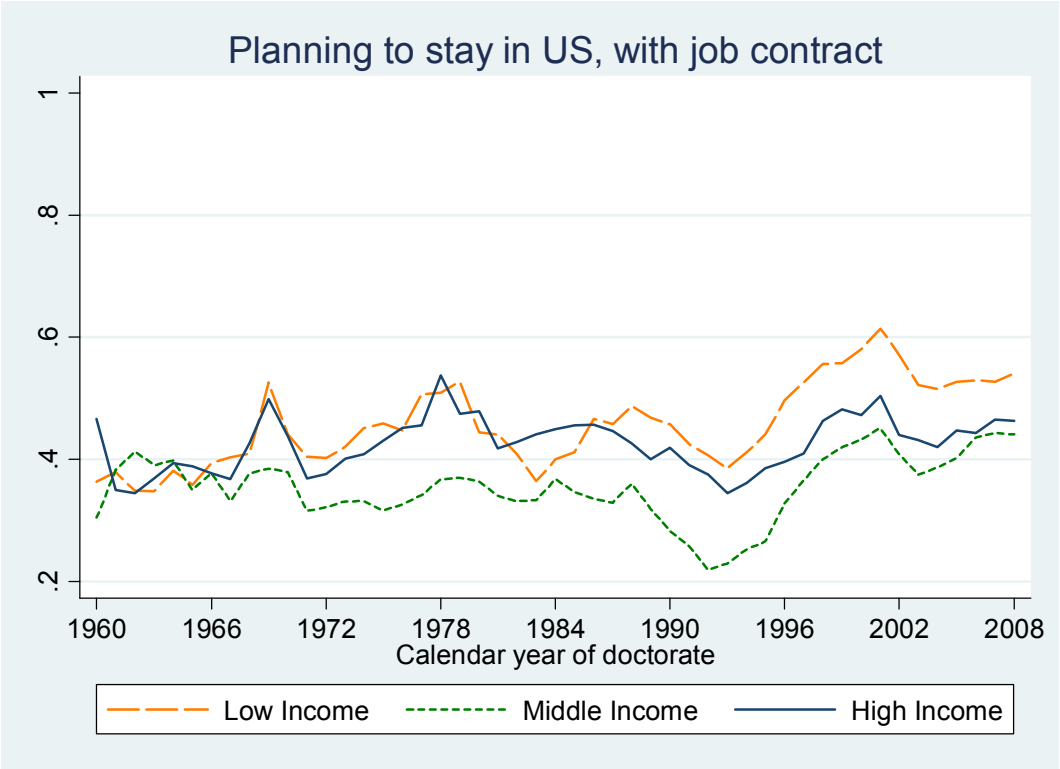


Figure 5: Share of new foreign-born S&E PhDs

(a)



(b)



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