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Will the US Keep the Best and the Brightest (as Postdocs)?
Career and Location Preferences of Foreign STEM PhDs

Ina Ganguli and Patrick Gaulé

2.1 Introduction

A key factor behind the emergence and persistence of US leadership in science, technology, engineering, and mathematics (STEM) fields has been its ability to attract and retain top-tier talent from other countries. Foreign students represent half or more of PhD students, and they tend to be more productive during the PhD than natives (Gaulé and Piacentini 2013). More generally, the foreign-born make disproportionate contributions to US science and engineering (Stephan and Levin 2001).

Talented foreigners have typically come to the US as graduate students and have stayed in the US in academic or industry careers. An especially common career path among foreign PhD students is obtaining a postdoctoral position upon graduation. Postdocs, while an important part of the scientific labor force, are characterized by low pay and uncertain career trajectories. The NSF estimates that over 57 percent of postdocs in STEM fields were in the US on temporary visas in 2015; in chemistry, 64 percent of postdocs were temporary visa holders (NSF 2016). Yet relatively little is

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known about both postdoc careers in general and the transition from the doctoral program to postdocs for foreign students in particular.

A few prior studies have used survey data collected at the end of the doctoral program to document the career and location choices of foreign STEM doctoral students. In another chapter in this volume, Roach, Sauermann, and Skrentny (chapter 8) compare foreign and native STEM doctoral students in terms of their entrepreneurial intentions, with foreign PhDs being more likely to express founder intentions or career preferences to join start-ups. They also report that 70 percent to 80 percent of foreign PhD students have intentions of working in the US, at least temporarily. Others have shown that individuals in US graduate programs with foreign bachelor's degrees and/or on temporary visas are more likely to take postdoc positions or other academic positions after graduation compared to US counterparts, likely because individuals in the US on temporary visas are constrained in their employment opportunities due to visa restrictions (Stephan and Ma 2005; Amuedo-Dorantes and Furtado 2019). One reason foreign students may prefer and ultimately end up in postdoc positions is that academic institutions are not subject to H-1B visa caps. For example, Amuedo-Dorantes and Furtado (2019) provide evidence suggesting that visa restrictions lead students to "settle" for academia. Grogger and Hanson (2015) also show using the Survey of Earned Doctorates that the foreign-born STEM doctoral students who report that they are intending to stay in the US in the year after they finish their degree are positively selected, measured indirectly through indicators such as having received fellowships during their studies. Finally, Finn (2010) measures stay rates of foreign-born doctorate recipients by country of origin and field of study using tabulated data from Social Security records.

An important aspect of using survey data collected only at the end of the PhD program—as well as aggregate estimates—is that these measures are the result of both supply- and demand-side factors.[1] For instance, students may plan to return to their home countries because they have failed to secure positions in the US. Similarly, a student may report planning to do a postdoc because no industry position was actually available to that student. Thus it is problematic to interpret these plans as necessarily reflecting preferences. By contrast, in this chapter we analyze a novel survey of currently enrolled doctoral students using a hypothetical choice methodology in order to elicit preferences among a set of options that are assumed to be available.[2]

1. A related literature has studied preferences for academic versus industry careers among currently enrolled doctoral students without focusing on differences between foreign and domestic students. See, e.g., Roach and Sauermann (2010).

2. Closest to the approach of our study is the work of Zeithammer and Kellogg (2013), who use conjoint analysis to study return migration preferences among US-educated Chinese STEM doctoral students. They ask approximately 300 Chinese STEM doctoral students studying at US universities questions about a series of hypothetical job choices with varying job attributes, such as salary, US location, public versus private firm, and job role (e.g., scientist manager). They find that Chinese doctoral graduates tend to remain in the United States because of a

Our study thus contributes to the existing literature by focusing on the supply side of the market by identifying and comparing the preferences of foreign and US graduate students for an academic versus industry career and for a US versus foreign location for a postdoc position. We leverage data from an original survey we conducted in the fall of 2017 of 1,605 current doctoral students in a major STEM field—chemistry—studying at 54 US institutions about their career and location preferences.

First, we estimate the career preferences of foreign and US STEM students for different types of postgraduation jobs—postdocs, industry, or teaching positions—using both hypothetical choice methods and more standard Likert-scale measures of preferences for different careers. Using a large sample of students across a range of departments, we are able to compare the preferences of foreign and US students within the same PhD program and area of specialization. We find that foreign students are much more likely to prefer a postdoc position upon graduation, reporting an 11-percentage-point higher likelihood of accepting a postdoc position at a top university compared to US students on average. US and foreign students both similarly place the highest preferences on industry jobs, but our results point to a notable difference in the types of academic jobs they prefer; foreign students value research-oriented academic careers more than US students (postdoc jobs), while US students value teaching more.

Since neither research nor teaching institutions would be subject to H-1B caps, it is unlikely that the differences in preferences for teaching versus research are due to potential visa restrictions. A potential explanation for the preference of foreigners toward academic careers may be that they are more able (e.g., due to a differential selection mechanism). However, controlling for proxies for ability, such as GRE scores or publications during the PhD, does not noticeably affect the results.

Second, we examine students' location preferences using a novel revealed preference approach based on a hypothetical choice method. Here we ask each respondent to report how likely (in terms of percent chances out of 100) they are to choose a postdoc position when given pairs of postdoc offers, where the offers include postdoc positions in top-50 chemistry departments in either US or non-US universities (based on the Shanghai Ranking). Our empirical strategy is based on comparing foreign and domestic students who are presented with the same hypothetical choice. While respondents across the board have a strong preference for US locations, foreign students are even more likely to prefer US locations. We estimate that foreign students are 13 percentage points more likely to choose a (hypothetical) postdoc offer in the US than in a non-US department even when controlling for the

large salary disparity between the two countries rather than because of an inherent preference for locating in the United States. In contrast to their work, we focus on choices among postdoctoral offers, varying only the employer (and implicitly location) on a larger sample covering both domestic and foreign students from different countries studying in the US. This enables us to directly compare the preferences of foreign students to those of US domestic students.

difference in the rank of the programs and baseline preferences for doing a postdoc and when comparing students within the same PhD program.

In sum, our findings show that foreign and US chemistry PhD students have significantly different preferences for careers, with foreign students being more likely to prefer academic careers and doing a postdoc. Foreign students also value a US location more than US students. Our results suggest that while the US is currently managing to retain talented foreign graduate students as postdocs, it is important for future research to understand why foreign students have greater preferences for postdoc positions in the US than native students and to what extent these preferences are driven by visa policies. We discuss possible explanations and directions for future research in the final section of the chapter.

2.2 Methodology

In this chapter, we are interested in measuring graduate students' preferences for different careers and different locations through an original survey. To measure preferences for academic careers, we use two types of questions. First, we use more standard Likert measures by asking respondents to rate the attractiveness of academic and other careers "leaving job availability aside." This approach follows closely that of Roach and Sauermann (2010) in their study of PhD career preferences.

Second, we use a hypothetical choices methodology. This methodology echoes conjoint analysis in marketing (see Zeithammer and Kellogg 2013 as discussed earlier) and has recently been used in labor economics to measure preferences over job attributes (e.g., Wiswall and Zafar 2017; Mas and Pallais 2017). This methodology essentially presents respondents with sets of jobs that vary in their attributes and asks them to state their probabilistic choices. To measure career preferences, we ask students to imagine that they have three job offers and then select how likely they are (percent chance out of 100) to accept one offer over the other. Importantly, the total chances the student allocates to the three offers should add up to 100. This ensures that they can't report a preference for each type of career. The choices are (1) Research Scientist/Engineer at Private Sector Firm (e.g., DuPont, Novartis); (2) Postdoctoral Research Fellow at Top US University (e.g., Berkeley, MIT); and (3) Assistant Professor at Top Liberal Arts College (e.g., Swarthmore College). Here we will interpret choosing the option to do a postdoc as a preference for an academic career.[3] The exact wording of both questions is

3. In many STEM fields, faculty placements out of graduate school are almost unheard of and postdocs are a necessary step in an academic career. While a sizeable number of students do postdocs and then go on to industry careers, we offer an industry career as an option in the counterfactual question. We thus interpret choosing a postdoc as a preference for an academic career, since those who have a preference for industry can choose the industry research scientist job offer.

available in appendix A. To estimate preferences for academia, we will run regressions of the type

$$PreferAcademia_i = \beta Foreign_i + \partial X_i + \varepsilon_i,$$

where i indexes students, $PreferAcademia_i$ is one of the three preferences measures as described previously, $Foreign_i$ is an indicator variable for foreign student, and X_i is a vector of controls including graduate school fixed effects, gender, marital status, enrollment year, and field of study.

To measure preferences for different locations, we also use a hypothetical choices methodology. Here we ask respondents to choose between two postdoctoral job offers that only differ in the employer (university) and hence location. We view STEM postdoctoral positions as being well suited for this type of analysis, since these positions are very similar across universities in terms of content (heavy research focus) and salary.

We are interested in the choices that involve a US university and a foreign university and whether foreign students report different preferences than native students when confronted with such choices. More specifically, we are interested in the propensity of foreign and native students to choose the US university when presented with the same two alternative choices. For instance, we might offer students a hypothetical choice between a postdoctoral position at Harvard and the University of Toronto and then see whether foreign students are more or less likely to choose Harvard, holding the counterfactual opportunity set fixed. We will be running regressions of the following type:

$$PreferUS_{i,jk} = \beta Foreign_i + \partial X_i + \gamma_{jk} + \varepsilon_{i,jk},$$

where i indexes students and j and k index the universities in the postdoc offers. $PreferUS_{i,jk}$ is an indicator variable for choosing the US option with a high probability (70 percent or more), $Foreign_i$ is an indicator variable for foreign student, X_i is a vector of student characteristics (graduate school fixed effects, gender, marital status, enrollment year, field of study), and γ_{jk} is a fixed effect for the university pair.

2.3 Data: Survey of Chemistry Doctoral Students

Our main data source is an original survey of US chemistry PhD students conducted in the fall of 2017. To construct our sampling frame, we first identified a set of 54 research-intensive US universities that grant PhDs and are internationally renowned in the field of chemistry (see list in appendix B).[4] We gathered the names and emails of all individuals (approximately 9,000)

4. This set corresponds to all US universities listed in the top 200 universities in the world according to the Academic Ranking of World Universities (Shanghai Ranking) in its chemistry subject ranking.

that were listed as graduate students in the chemistry departments of these universities either on graduate student directory websites or on individual laboratory websites.[5] We then sent email invitations to these students asking them to answer an online survey on the Qualtrics survey platform. To ensure a reasonable response rate, we sent two rounds of reminders and provided incentives to complete the survey in the form of a lottery to win Amazon gift certificates. We obtained approximately 1,600 complete responses corresponding roughly to an 18 percent response rate, which is quite consistent with survey response rates of this population (see, e.g., Sauermann and Roach 2013). However, collecting survey data prior to graduation comes with a tradeoff, as we have lower response rates than in the end-of-degree surveys.

The survey included a set of basic demographic questions as well as questions on undergraduate education, year of enrollment in the PhD program, progress in the PhD program, field of specialization, and career preferences questions discussed previously. Additionally, each respondent was presented with five consecutive hypothetical postdoc offer choices.

We coded each respondent as a foreign or a US student using a question in the survey about the country of the respondent's undergraduate institution. If the country was in the US, we coded the student as US, and if not, we coded the student as a foreign student. While we do not know each student's country of birth, the assignment of foreign status based on the country of undergraduate studies is commonly done in the literature (see, e.g., Gaulé 2014; Kahn and MacGarvie 2016).[6]

Table 2.1 provides summary statistics for the sample for US and foreign students. Approximately 30 percent of the sample are foreign, and most of the foreign respondents are from China (30 percent), followed by India (13 percent) and then Canada (5 percent).

We find a few differences between the US and foreign students in our raw data, with US students having slightly more women (8 percent higher) and being more likely to have enrolled in 2013. US and foreign respondents are similarly distributed across subfields within chemistry.

To assess the representativeness of our sample, we can compare our data with data collected by the National Science Foundation (NSF) and the

5. One issue we encountered is that some of the individuals we contacted reported having already graduated, reflecting, for example, the fact that some online directories and websites are not entirely up to date. We excluded such responses from our analysis sample.

6. While a growing number of foreign students have been pursuing undergraduate studies in the US, the vast majority of foreign students enrolled in US doctoral programs have a foreign undergraduate degree. For instance, Gaule and Piacentini (2013) report that in a large sample of chemistry PhD students graduating from a US department between 1999 and 2008, 88 percent of students with Chinese first and last names had received their undergraduate degrees in China (and a further 5 percent in Taiwan). We additionally checked in our sample whether we are missing a large number of respondents who are international students but did their undergraduate degree in the US using a name-matching algorithm. There are only a small number of respondents (18, or 1 percent of our sample) who have a Chinese/Indian/Korean last name, have a Chinese/Indian/Korean first name, and reported a US undergraduate institution.

Table 2.1 **Summary statistics at the student level (sample means)**

	US student	Foreign student	Difference
Female	0.465	0.379	0.086**
Married	0.161	0.193	–0.032
Enrolled 2015	0.209	0.205	0.004
Enrolled 2014	0.187	0.210	–0.023
Enrolled 2013	0.187	0.131	0.056**
Enrolled 2012	0.101	0.082	0.019
Enrolled 2011	0.022	0.017	0.004
Field of study			
Analytical	0.119	0.087	0.032
Biological/biochemistry	0.168	0.193	–0.025
Inorganic chemistry	0.172	0.146	0.025
Organic chemistry	0.180	0.173	0.007
Physical	0.154	0.146	0.008
Polymer	0.046	0.047	–0.001
Theoretical/computational	0.061	0.094	–0.033*
Other	0.101	0.114	–0.013
Country of undergraduate			
Canada		0.050	
China		0.302	
India		0.134	
Observations	1,201	404	

Note: Asterisks indicate the results of tests for equality of means. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

National Institutes of Health (NIH) through the 2016 Survey of Graduate Students and Postdoctorates in Science and Engineering, which is an annual census of all US academic institutions granting research-based graduate degrees (NSF 2016) for chemistry.[7] We find that our survey data include somewhat fewer foreign students/temporary visa holders (33.6 percent vs. 37.6 percent) and slightly more female respondents (44.3 percent vs. 40.9 percent). Given that the NSF/NIH Survey includes students enrolled at all US graduate degree–granting academic institutions, whereas our survey was limited to the top 54 chemistry programs, the numbers are quite close.

For the location preferences, we offered each student five randomly selected counterfactual choices of postdoctoral positions. These choices were drawn from each possible pairwise combination of universities in the top 50 universities in the world in chemistry according to the Shanghai Rankings (see appendix C for a list). However, we focus here on the choices involving a foreign university and a US university—4,030 observations. We define "Strongly Prefer the US University" as selecting the chance of accepting the US postdoctoral position with a probability of 70 percent or more. Conversely, "Strongly Prefer the Foreign University" is defined as selecting

7. In this survey, the academic departments complete the questionnaire.

Table 2.2 Summary statistics at the choice level (sample means)

	US student	Foreign student	Difference
Strongly prefer US university	0.481	0.605	–0.124***
Strongly prefer foreign university	0.220	0.149	0.070***
Difference in university rank between US university and foreign university (lower rank corresponds to a better position in the Shanghai Rankings)	–6.93	–7.581	0.642
Location of foreign university			
Japan	0.277	0.277	–0.001
Germany	0.185	0.176	0.014
UK	0.130	0.128	0.012
Switzerland	0.099	0.121	0.011
China	0.085	0.083	0.010
Canada	0.047	0.040	0.007
France	0.049	0.045	0.008
Israel	0.047	0.035	0.008
Australia	0.042	0.045	0.007
Saudi Arabia	0.039	0.049	0.001
Observations	3,023	1,007	

Note: Asterisks indicate the results of tests for equality of means. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

the chance of accepting the foreign US postdoctoral position with a probability of 70 percent or more. Table 2.2 presents descriptive statistics on the choice-level data.

We observe that both US and foreign students tend to prefer the US university (with a considerably higher mean for "Strongly Prefer the US University" compared to "Strongly Prefer the Foreign University"). This may reflect some intrinsic preference for being located in the US, but it may also reflect a preference for higher-ranked universities, as the US universities in the choices tend to have a lower (i.e., better) rank. Perhaps surprisingly, we observe that foreign students have a stronger preference for US postdoctoral positions than do US students.

2.4 Results

We first investigate whether foreign and domestic students have different career preferences using our three main measures of career preferences: (1) the attractiveness of the tenure-track faculty job on a one- to five-point Likert scale, (2) the overall percent chance they will do a postdoc after the PhD, and (3) the percentage chance of choosing a postdoc versus an industry research position or teaching-focused position in the hypothetical job offer question. In figure 2.1, we show the raw means for US and foreign students for the third measure based on the three hypothetical job offers. While both

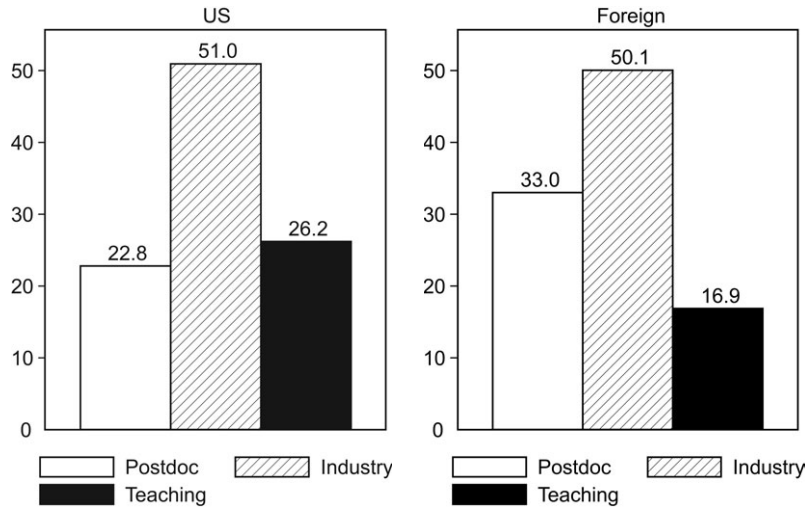


Fig. 2.1 Career preferences: hypothetical job offer question

Notes: See appendix A for text of survey question. Respondents were asked to rate how likely they were to accept one of three hypothetical job offers, reporting the percent chance (out of 100) of choosing each one. The choices were research scientist/engineer at private-sector firm (e.g., DuPont, Novartis), postdoctoral research fellow at top US university (e.g., Berkeley, MIT), and assistant professor at top liberal arts college (e.g., Swarthmore College).

Table 2.3 Estimates of career preferences

	Attractiveness of tenure-track faculty job (1–5 Likert) (1)	Chances of choosing postdoc option (among 3 choices) (2)	Likelihood of doing a postdoc (3)
Foreign student	0.829***	9.864***	12.410***
	(0.081)	(1.504)	(1.962)
Mean of DV	2.971	25.283	54.017
Observations	1,590	1,585	1,517

Note: Controls: Graduate school fixed effects, gender, marital status, enrollment year, field of study. Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

US and foreign students overall prefer the industry choice, we can see that foreign students are more likely than US students to choose the postdoc and less likely to choose the teaching position.

Next we regress our measures of preferences for academia on an indicator variable for whether the respondent is a foreign student and control for a broad range of student characteristics, including gender, marital status, enrollment year, field of study, and graduate school. In table 2.3, we show that foreign students consistently report finding tenure-track faculty jobs more attractive than do US students and that they are 10 percentage points

Table 2.4 Estimates of career preferences: Chinese versus other foreign students

	Attractiveness of tenure-track faculty job (1–5 Likert) (1)	Chances of choosing postdoc option (among 3 choices) (2)	Likelihood of doing a postdoc (3)
Chinese student	0.882***	6.724***	8.749***
	(0.129)	(2.379)	(3.175)
Other foreign student	0.804***	11.310***	13.964***
	(0.093)	(1.726)	(2.229)
Mean of DV	2.971	25.283	54.017
Observations	1,590	1,585	1,517

Note: Controls: Graduate school fixed effects, gender, marital status, enrollment year, field of study. The number of observations may vary due to missing answers for some questions. Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 2.5 Ability differences between foreign and US students

	GRE score (self-reported) (1)	Publication in *Nature*/*Science*/*Cell* (2)	Pub in top chemistry journal (3)
Foreign student	82.838***	0.008***	0.006
	(5.424)	(0.003)	(0.012)
Mean of DV	770.461	0.004	0.095
Observations	1,780	4,030	4,030

Note: Controls: Graduate school fixed effects, gender, marital status, enrollment year, field of study. Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

more likely to choose a postdoc option when being offered a choice between postdoc, an industry research position, or a teaching-focused position. Foreign students also rate their chance of doing a postdoc overall as 12 percentage points higher.[8] These patterns hold for both Chinese students and other foreign students, although the effect is somewhat weaker for Chinese students (see table 2.4).

One possible explanation for the fact that foreign students are more interested in academic careers is that they may be of higher ability or more science-oriented due to selection into emigration or selection into US PhD programs. To investigate this possibility, we first estimate whether foreign students in our sample appear to be higher ability or more science-oriented (table 2.5). We find that even when controlling for student characteristics, including gender, enrollment year, field of study, and graduate school, for-

8. One should bear in mind that the self-assessed chance of doing a postdoc may already incorporate expectations about what type of options will be available.

eign students have significantly higher (self-reported) GRE scores and are more likely to have already published during the PhD in one of the premier journals (*Nature*, *Science*, or *Cell*). This finding is consistent with other studies finding that foreign students—particularly Chinese students, who make up the largest share of our foreign student sample—are higher ability and more productive in terms of publications during the PhD (see, e.g., Gaulé and Piacentini 2013).

Next we repeat the regressions of academic career preferences in table 2.4 and now control for ability, where we proxy for ability with the publications of the student and the self-reported GRE scores (see table 2.6). While the inclusion of these controls somewhat weakens the point estimate for foreign students, the estimate remains large and significant. This suggests that other factors may play a role in the differing preferences for academic careers between foreign and native US students. For instance, it may be the case that foreign students envision an academic career in their home countries, or there may be important cross-cultural differences in the attractiveness of academic careers.

Next we turn to the analysis of location preferences, where we consider the hypothetical choices respondents made between pairs of postdoctoral offers described previously. Here we regress whether the respondent reported a strong preference for the US postdoctoral option on an indicator variable for whether the respondent is a foreign student while controlling for student characteristics (gender, marital status, enrollment year, field of study, graduate school) as well as a fixed effect for the pair of universities being presented to the student (choice fixed effects). We are thus effectively comparing foreign and domestic students who are asked to choose between the exact same two postdoctoral options. We also report the results of another specification where the dependent variable indicates having a strong preference for the non-US postdoctoral option.

As was already the case in the raw descriptive statistics, foreign students have a *stronger* preference for US universities (table 2.7). This is especially true for Chinese students but also holds for other foreign students (table 2.8).

Table 2.9 presents some heterogeneity analysis to try to shed light on why this difference in preferences may arise. Already having a publication is associated with a greater preference for the US university (column 1) but does not have a differential effect for foreign and domestic students. There is some limited evidence that foreign students with high GRE scores are less likely to have a preference for the US university (column 2), although the estimates are very noisy here. Interestingly, foreign students who have a stronger preference for an academic career are less likely to strongly prefer the US university (column 3).

Finally, we examine whether foreign and US students vary in their preferences depending on the difference in the Shanghai Rankings of the institutions offered. In figure 2.2, we show that foreign students strongly prefer the

Table 2.6 **Estimates of career preferences: controlling for ability**

	Attractiveness of tenure-track faculty job (1–5 Likert) (1)	Attractiveness of tenure-track faculty job (1–5 Likert) (2)	Likelihood of doing a postdoc (3)	Likelihood of doing a postdoc (4)	Chances of choosing postdoc option (among 3 choices) (5)	Chances of choosing postdoc option (among 3 choices) (6)
Foreign student	0.829***	0.721***	12.410***	11.246***	9.864***	8.405***
	(0.081)	(0.085)	(1.962)	(2.059)	(1.504)	(1.585)
Publication in *Nature*/*Science*/*Cell*		0.636		22.426		24.470**
		(0.593)		(15.812)		(11.037)
Publication in top chemistry journal		0.295**		3.063		4.056*
		(0.118)		(2.927)		(2.206)
GRE dummies	No	Yes	No	Yes	No	Yes
Mean of DV	2.971	2.971	54.017	54.017	25.283	25.283
Observations	1,590	1,590	1,517	1,517	1,585	1,585

Note: Controls: Graduate school fixed effects, gender, marital status, enrollment year, field of study. Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 2.7 **Estimates of location preferences**

	Strongly prefer US university (1)	Strongly prefer foreign university (2)
Foreign student	0.131***	–0.072***
	(0.023)	(0.017)
Mean of DV	0.512	0.202
Obs	4,030	4,030
R^2	0.309	0.277

Note: Controls: Choice fixed effects, graduate school fixed effects, gender, marital status, enrollment year, field of study. Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 2.8 **Estimates of location preferences: Chinese versus other foreign students**

	Strongly prefer US university (1)	Strongly prefer foreign university (2)
Chinese student	0.177***	–0.102***
	(0.037)	(0.027)
Other foreign student	0.111***	–0.059***
	(0.026)	(0.019)
Mean of DV	0.512	0.202
Obs	4,030	4,030
R^2	0.310	0.277

Note: Controls: Choice fixed effects, graduate school fixed effects, gender, marital status, enrollment year, field of study. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

US university across all ranks, and the difference in research rank between the domestic and foreign universities does not seem to have a differential effect for domestic and foreign students (table 2.9, column 4).

2.5 Discussion

In this chapter, we have reported the results of a novel survey of chemistry doctoral students enrolled at the top 54 US institutions aimed at understanding to what extent foreign and US students differ in their career and location preferences. Unlike previous studies focused on estimating career and location choices of foreign and US students, which have tended to rely on either survey data collected after students have completed their degrees or administrative data after students have obtained their first position, our data provide a measure of preferences before students are faced with demand-side factors.

We have documented that foreign and US students indeed appear to have significantly different career preferences, with foreign students being much more likely to prefer doing a postdoc and generally preferring academic

Table 2.9 Estimates of location preferences: controlling for ability and career preferences

	Strongly prefer US university (1)	Strongly prefer US university (2)	Strongly prefer US university (3)	Strongly prefer US university (4)	Strongly prefer US university (5)
Foreign student	0.132***	0.146***	0.137***	0.137***	0.131***
	(0.024)	(0.026)	(0.025)	(0.024)	(0.029)
Foreign student × has published	–0.022				0.001
	(0.073)				(0.073)
Has published	0.089**				0.080**
	(0.040)				(0.040)
Foreign × high GRE		–0.094*			–0.094*
		(0.056)			(0.055)
High GRE		0.067*			0.063
		(0.038)			(0.038)
Foreign × academic orientation			–0.111*		–0.151**
			(0.068)		(0.071)
Academic orientation			0.111**		0.087*
			(0.044)		(0.047)
Foreign × rank difference between the two schools				0.001	0.001
				(0.001)	(0.001)
Mean of DV	0.512	0.512	0.512	0.512	0.512
Obs	4,030	4,030	4,030	4,030	4,030
R^2	0.311	0.311	0.311	0.310	0.320

Note: Controls: Choice fixed effects, graduate school fixed effects, gender, marital status, enrollment year, field of study. Standard errors in parentheses. Academic orientation is proxied by an indicator variable taking value one for those respondents rating "faculty with research focus" as strictly more attractive than other career options. The main effect of rank difference between the two schools is not shown as it is absorbed into the fixed effect. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

careers more than US students. We also show using a hypothetical choice method that foreign students also value a US location more than US students, even controlling for the ability and career preferences of the students. The high value placed on US location by foreign students is consistent with high rates of intentions to stay (Roach, Sauermann, and Skrentny, forthcoming) and high aggregate stay rates (Finn 2010).

One interpretation of our finding that foreign students have a stronger preference for US postdocs is linked to the availability of subsequent career options. Industry careers are the most likely eventual outcome, even for students who pursue postdocs, and it may be that access to industry careers in the US is differently impacted by a foreign postdoc across foreign and domestic students. Specifically, foreign students may be concerned that a foreign postdoc will limit their subsequent access to the US industry market if US postdocs are preferred in the US private sector. Conversely, US students may perceive foreign postdocs as enhancing their CVs without worsening their US industry career options.

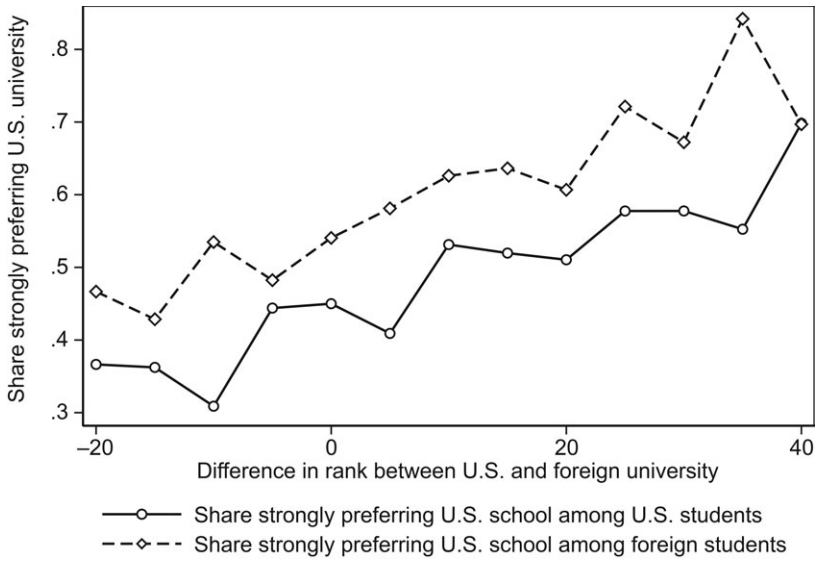


Fig. 2.2 Preferences for US location and university rank

Notes: Strongly preferring the US university means choosing the US option with a probability of 70 percent or more. The difference in rank of each pair of choices is calculated using the Shanghai Rankings of the institutions. A positive difference in rank corresponds to the US university having a better ranking than the foreign university.

Foreign students may also believe that leaving the US for a foreign postdoc will limit future private-sector options due to visa concerns. Foreign students are potentially "locked in" to a US location, as they have already incurred the costs of getting a visa or started the green card application process in the US. If they would like to eventually return to the US, then leaving the US for a two- or three-year postdoc, even if at a higher-ranked institution, may not be worth it if they eventually would like to pursue the US immigration path.

Another potential explanation is that the foreign students have ipso facto experienced migration to another country, while the US students would typically not already have had such an experience. Having a second migration to a different country might be relatively less appealing than a first migration experience.

While we cannot distinguish between these explanations for why foreign students prefer US locations for a postdoc more than US students with the data we have collected, we believe that our study points to important avenues for future research on these issues, particularly surrounding the role of visa policies in driving the preferences of foreign students. Moreover, the methodology we used in this chapter could be used in future research to tackle a wider range of questions regarding the preferences of foreign and domestic students. Some of the important questions we see as extensions of our study

include the following: What are the preferences of foreign students who have not yet arrived in the US? How do location preferences evolve over time in the same set of students? Among students enrolled in doctoral programs in other countries, do they have preferences for being located in those countries? Or did they have a preference for US doctoral programs but did not have the opportunity to study there? The answers to such questions would shed further light on our understanding of the allocation of talented and skilled individuals across countries—the global "market for talent."

Appendix A

Selected Survey Questions

[Question 1]

Q. Putting job availability aside, how attractive do you personally find each of the following careers?

	Not at all attractive (1)	Mostly not attractive (2)	Neutral (3)	Mostly attractive (4)	Very attractive (5)
Academic faculty with an emphasis on research (1)	○	○	○	○	○
Academic faculty with an emphasis on teaching (2)	○	○	○	○	○
Government research and development position (3)	○	○	○	○	○
Government (other) (6)	○	○	○	○	○
Industry position with an emphasis on research and development (4)	○	○	○	○	○
Industry (other) (5)	○	○	○	○	○

[Question 2]

Q. Now we want to ask you to do some simple evaluations of potential job offers. Imagine that you have just completed your dissertation and are looking for a **full-time position**. First, suppose you have the following job offers and you need to choose between them. Please rate how likely you are to accept one of them rather than the other. For each job offer, choose the percent chance (out of 100) of choosing each one. **The total chances given to each offer should add up to 100.**

_____ **Job Offer #1:** Research Scientist/Engineer at Private Sector Firm (e.g. DuPont, Novartis) **Annual Salary:** $90,000 (1)

_____ **Job Offer #2:** Postdoctoral Research Fellow at Top U.S. university (e.g. Berkeley, MIT) **Annual Salary:** $50,000 (2)

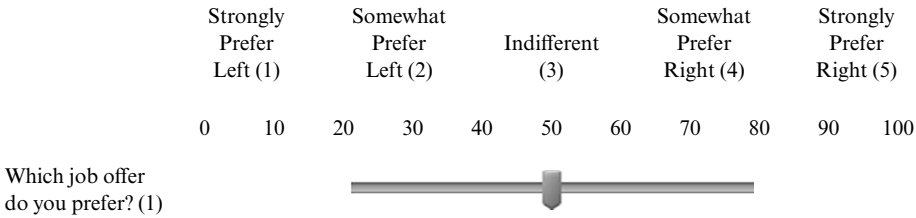
_____ **Job Offer #3:** Assistant Professor at top liberal arts college (e.g. Swarthmore College) **Annual Salary:** $70,000 (3)

[Question 3]

Q. Now, we will ask you to evaluate a series of job offers. Suppose you had the following two job offers. Please rate how likely you are to accept one of them rather than the other.

Job Offer #1
Employer: University X
Location: Location of University X
Job Title: Postdoctoral Research Fellow

Job Offer #2
Employer: University Y
Location: Location of University Y
Job Title: Postdoctoral Research Fellow



Note: University X and Y are two of the top 50 universities worldwide according to a bibliometric ranking of universities in chemistry (Shanghai Academic Ranking of World Universities ranking in chemistry). Each respondent was presented with five such choices, with the choices randomly selected among all pairwise combinations of the top 50 universities in chemistry. The analysis focuses on the choices that involve one US and one foreign university.

Appendix B

Universities Included in the Sampling Frame

Table 2B.1 Universities included in the sampling frame

Arizona State University	University of California, Irvine
California Institute of Technology	University of California, Los Angeles
Carnegie Mellon University	University of California, Riverside
Colorado State University	University of California, San Diego
Columbia University	University of California, Santa Barbara
Cornell University	University of Chicago
Duke University	University of Colorado
Emory University	University of Delaware
Georgia Institute of Technology	University of Florida
Harvard University	University of Houston
Indiana University	University of Illinois at Urbana-Champaign
Iowa State University	University of Maryland, College Park
Johns Hopkins University	University of Massachusetts Amherst
Massachusetts Institute of Technology	University of Michigan
North Carolina State University	University of Minnesota
Northwestern University	University of North Carolina at Chapel Hill
Ohio State University	University of Pennsylvania
Pennsylvania State University	University of Pittsburgh
Princeton University	University of South Florida
Purdue University	University of Southern California
Rice University	University of Utah
Stanford University	University of Virginia
State University of New York at Buffalo	University of Washington
Texas A&M University	University of Wisconsin–Madison
University of Texas at Austin	Washington State University
University of California, Berkeley	Washington University in St. Louis
University of California, Davis	Yale University

Appendix C

Top 50 Universities in the World in Chemistry according to the Shanghai Rankings

Table 2C.1 Top 50 universities in the world in chemistry according to the Shanghai Rankings

1	University of California, Berkeley	26	University of Texas at Austin
2	Harvard University	27	University of California, Irvine
3	Stanford University	28	Georgia Institute of Technology
4	California Institute of Technology	29	University of Michigan-Ann Arbor
5	Northwestern University	30	University of Minnesota, Twin Cities
6	Massachusetts Institute of Technology (MIT)	31	Peking University
7	University of Cambridge	32	University of Wuerzburg
8	Swiss Federal Institute of Technology Zurich	33	University of Colorado at Boulder
9	Kyoto University	34	University of Illinois at Urbana-Champaign
10	University of Pennsylvania	35	Tohoku University
11	University of California, Los Angeles	36	King Abdulaziz University
12	Yale University	37	University of Florida
13	University of California, Santa Barbara	38	Zhejiang University
14	Technical University Munich	39	Osaka University
15	Cornell University	40	Texas A&M University
16	Columbia University	41	University of California, Riverside
17	University of Oxford	42	Weizmann Institute of Science
18	University of California, San Diego	43	University of Wisconsin–Madison
19	University of Strasbourg	44	Monash University
20	Purdue University–West Lafayette	45	University of Chicago
21	Heidelberg University	46	University of Muenster
22	Rice University	47	University of Southern California
23	Swiss Federal Institute of Technology Lausanne	48	Tokyo Institute of Technology
24	University of Toronto	49	Nagoya University
25	University of Tokyo	50	Imperial College London

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