Best and Brightest? The Selectivity of Foreign-Born Ph.D. Recipients in the U.S.*

Valerie Bostwick, Joseph Staudt, Bruce A. Weinberg †

March 2024

PRELIMINARY: PLEASE DO NOT CITE OR CIRCULATE.

Abstract

This paper examines the selectivity of foreign-born, U.S.-trained Ph.D. recipients, relative to their U.S.-born and trained counterparts, in terms of both their training/laboratory environments in graduate school and their post-graduation labor market outcomes. We find strong evidence of positive selection, both pre- and post-graduation, and across the observed choices that Ph.D. recipients make (e.g. field or sector of employment). Moreover, we find that the selectivity of the foreign-born is largest for Ph.D. recipients who are more firmly attached to the U.S. labor market. Finally, we show that, though this positive selection results in the U.S. attracting the "best and brightest" foreign-born Ph.D. recipients, they tend to study high-demand fields, suggesting that there is minimal reason for concern over "crowding out" of U.S.-born doctorates.

JEL Classification Numbers:
Keywords:

*Thanks ... All errors are ours. Any opinions and conclusions expressed herein are those of the authors and do not represent the views of the U.S. Census Bureau. The Census Bureau has ensured appropriate access and use of confidential data and has reviewed these results for disclosure avoidance protection (Project 7507193: CBDRB-FY24-CES022-001).

†Bostwick: Kansas State University and IZA, vkbostwick@ksu.edu; Staudt, U.S. Census Bureau, joseph.staudt@census.gov; Bruce A. Weinberg, Ohio State University, IZA, and NBER, weinberg.27@osu.edu.

1 Introduction

Immigrants comprise nearly half of U.S. STEM workers with doctoral degrees (Kerr and Lincoln, 2010) and contribute disproportionately to U.S. innovation and long-run growth.[1] As the United States strives to maintain its global competitiveness and leadership in innovation, substantial public funds have been directed toward the training of foreign-born graduate students. Given these facts, it is valuable to know whether the U.S. is attracting and retaining the "best and brightest" trainees within this highly-educated population.

This paper examines the selectivity of foreign-born, U.S.-trained Ph.D. recipients who are supported on research grants, bench-marking them against their U.S.-born and trained counterparts. Our unique data allow us to compare these groups across many dimensions, including the research/laboratory environments they experienced during graduate school as well as their post-graduation labor market outcomes. Overall, we find strong evidence that foreign-born Ph.D. recipients are positively selected, both pre- and post-graduation and across observed choices (e.g., field or sector of employment) as well as unobserved characteristics (e.g., "ability"). Moreover, foreign-born Ph.D. recipients who exhibit the strongest attachment to the U.S. labor market also appear to be the most positively selected. Finally, we show that these foreign-born Ph.D. recipients tend cluster into economically critical high-demand fields, suggesting that crowding-out effects on their U.S.-born peers are likely to be small.

In order to make this analysis possible, we link comprehensive micro-level Census data on individual characteristics, labor market outcomes, and employer characteristics to data from the UMETRICS project, which provides information on research environments for graduate students (and others) supported on sponsored projects, including funding duration, timing, and source. These data are, in turn, linked to ProQuest's Dissertation and Theses data, which allow us identify the degree year and field of specialization for each Ph.D. recipient.

This linked dataset provides several advantages over previous studies, which have largely relied on the Survey of Earned Doctorates (SED) to compare U.S.- and foreign-born Ph.D. recipients.[2] First, our population-wide tax and administrative records on employment and earnings in the U.S. allow us to follow all Ph.D. recipients in our sample four years post-degree, tracking whether they are working in academia or industry and how their earnings and sector change over time. In contrast, the SED provides self-reports on the intention to stay in the U.S., has many reporting gaps, and only tracks actual (self-reported) labor market outcomes for about 10% of respondents who are part of the Survey of Doctorate

[1] Hunt and Gauthier-Loiselle (2010) shows that increases in the share of foreign-born college graduates leads to increases in the number of patents per capita.

[2] See Kahn and MacGarvie (2020) for a summary of this literature.

Recipients (SDR). Second, we can control for a rich set of variables that characterize the research environment (in terms of both funding and research personnel) in which Ph.D. recipients trained while in graduate school, a unique strength of the UMETRICS data.

We first examine training environments, comparing the research settings experienced by U.S.- and foreign-born Ph.D. recipients during graduate school. The U.S.-born tend to work in labs with larger teams and a lower faculty-to-other personnel ratio, are paid by fewer awards, and are paid by larger awards. To assess the overall value of these lab characteristics, we use their coefficients from earnings regressions to generate a composite index of training environment quality. We find that, on average, foreign-born workers experience better training environments.

Next, we turn to post-graduation earnings differences between foreign- and U.S.-born Ph.D. recipients. Our analysis reveals a 17% unconditional earnings premium for the foreign-born and a 4.5% premium after controlling for a variety of factors, including sector of employment (academia vs. industry), field, age, gender, Ph.D.-granting institution, and the characteristics of the lab in which they worked while in graduate school. Nearly all attenuation of the foreign-born earnings premium is due to variation in employment sector (41%) and field (58%). Thus, the foreign-born are much more likely than their U.S.-born peers to receive a Ph.D. in a more lucrative field (such as engineering) as opposed to a lower paying field (such as biology) and they are also more likely to take a higher-paying industry job rather than an academic job.

We also provide evidence of increasing selection of the best foreign-born graduates into the U.S. labor force after initial job placements, with the foreign-born earnings premium growing with time from degree. After four years of post-degree employment, foreign-born Ph.D. recipients earn 6.2% more than their U.S.-born counterparts (as opposed to 4.5% initially). Furthermore, the sample of foreign-born Ph.D. recipients who are still employed in the U.S. after four years have higher initial earnings than their peers who eventually leave the U.S. labor market.

The persistence of a foreign-born earnings premium, even after controlling for our rich set of individual-level characteristics, suggests that foreign-born Ph.D. recipients may be further positively selected on unobservable characteristics, such as ability (or willing to work longer hours and/or in jobs that offer compensating differences). Indeed, a sensitivity analysis reveals that selection of the foreign-born in terms of unobservable covariates (like ability or motivation) is stronger than selection on any of our observed covariates, with the exception of field. All told, our results strongly suggest that the U.S. retains the best and brightest foreign-born students, even within field.

Finally, we consider whether foreign-born STEM workers who stay in the U.S. are from

in-demand fields and the extent to which they might depress opportunities for U.S.-born trainees. We examine the fields in which Ph.D. recipients specialize and find stark differences, with foreign-born Ph.D. recipients nearly twice as likely to study engineering as their U.S.-born counterparts (and slightly more likely to study mathematics). In contrast, U.S.-born Ph.D. recipients are more likely to study biology and health/medicine. These differences are consistent with the regression decompositions discussed above and are highly consequential, with mathematics and engineering being the two highest paying fields and biology and health/medicine being among the lowest (Jiang et al., 2023). More generally, we find that a 10 percentage point increase in the fraction of foreign-born in a field is associated with nearly $12k (17% relative to the overall mean) higher average initial earnings of Ph.D. recipients in that field and an over $15k higher earnings (15%) three years after graduation. This positive relationship between a field's earnings and foreign-born representation indicates that the foreign-born are studying in high-demand fields and that, to the extent that the foreign born crowd out native-born students, strong incentives still remain for entry into these field.

This paper adds to an existing literature on selection among foreign-born doctorates in the U.S.. Prior studies have found mixed results on the relationship between ability and return migration. Grogger and Hanson (2015) use measures of academic potential (measured at the time of entering graduate school), such as parental education and having received merit-based financial support, from the the 1960-2008 Survey of Earned Doctorates (SED) to show that foreign-born STEM Ph.D. recipients who *intend* to remain in the U.S are positively selected. However, Kahn and MacGarvie (2020) find no relationship between the rank of the Ph.D.-granting institution and foreign-born students' *actual* propensity to remain in the U.S. We build on this finding, showing that those foreign-born graduates who do actually stay in the U.S. are positively selected and have higher earnings. We also show that this is not a temporary phenomenon by documenting the longer-term earnings premia of foreign-born STEM Ph.D. recipients up to 4 years after graduation.

A related literature investigates the role that differences in preferences between U.S.- and foreign-born doctoral students play in selection into the U.S. labor market. Ganguli and Gaulé (2020) find that international doctoral students in chemistry have stronger preferences than their domestic peers for receiving post-doctoral training in the U.S. On the other hand, Roach et al. (2019) find that foreign-born Ph.D. students have stronger preferences for working in entrepreneurial firms (but are less likely than their U.S.-born peers to be employed by such firms due to visa restrictions). We complement these findings, showing that foreign-born STEM Ph.D. recipients are actually much more likely to take higher-paying industry jobs, conditional on staying in the U.S., rather than academic jobs.

The rest of the paper is organized as follows: Section 2 describes our data and how it allows us to assess the selectivity of foreign-born Ph.D. recipients across a variety of dimensions, Section 3 presents our results, and Section 4 concludes.

2 Data

Our data are unique in allowing us to identify the place of birth for a large sample of Ph.D. recipients who can also be linked to comprehensive tax records as well as a variety of detailed information on their demographics, degree, and the characteristics of the labs in which they worked while in graduate school. These linkages enable us to estimate the foreign-born earnings premium and examine the extent to which it is driven by observed choices such as field or sector of employment. They also allow us to examine whether the foreign- and U.S.-born select into different training environments while in graduate school and assess whether these environments play a role in determining the foreign-born earnings premium.

2.1 UMETRICS

Our sample of graduate students is obtained from UMETRICS, which is maintained by the Institute for Research on Innovation and Science (IRIS) at the University of Michigan (UMETRICS, 2018, Q4; Nicholls et al., 2022).[3] The data are derived from university payroll and human resources records and track all payments made by university grants to employees and vendors (Lane et al., 2015). Our vintage of UMETRICS includes grant transactions at 25 major research universities, which account for more than one-third of federally funded academic R&D.

Graduate Students UMETRICS includes the job titles of individuals receiving payments from grants, allowing us to identify their occupations, which include "faculty", "graduate student", "postdoc", "undergraduate", and "staff" (Ikudo et al., 2019). The UMETRICS graduate students comprise the core of our sample. Though UMETRICS graduate students are not representative of all graduate students, they are likely a fair representation of grant-supported graduate students in STEM fields at large research universities.

Training Environment A unique strength of the UMETRICS data is that its transaction structure allows us to construct a variety of detailed measures of lab characteristics – both in terms of funding and personnel – in which graduate students worked while they were in

[3]The UMETRICS data are stored in a data enclave at IRIS. Annually, a snapshot of the data are transferred to the Federal Statistical Research Data Centers (FSRDCs).

graduate school. No other data source offers this opportunity at scale. We characterize a graduate student's lab environment based on four variables. First, we measure the number of grants that pay each graduate student. Students paid on more grants might get more research exposure and be in higher demand, but it may also reflect churn, which would likely be a negative factor. Second, we measure the average size (in dollars) of the grants that pay the graduate student. Presumably working in better funded labs is positive for students. Third, we measure the number of other personnel paid on the grants that pay the graduate student (team size). It is hard to say *ex ante* whether this is beneficial or detrimental to students. Lastly, we measure the ratio of faculty to other lab personnel on the grants that pay the graduate student under the assumption greater exposure to researchers who are overwhelmingly more senior is beneficial. Using these lab characteristics, we can examine differences in the typical training environment experienced by foreign-born and U.S.-born Ph.D. recipients as well as determine whether these differences translate into earnings gaps after graduation.

2.2 ProQuest Dissertations

IRIS provides a crosswalk between the ProQuest Dissertation and Theses Database (ProQuest, 2018) and UMETRICS employees, which we use to identify graduate students and link them to their dissertations.[4] Since not all UMETRICS graduate students go on to earn their Ph.D., this linkage allows us to focus on the approximately 14,900 who complete a doctoral degree. We can then determine these Ph.D. recipients' field of study and the year in which they received their Ph.D., allowing us to track *post-degree* labor market outcomes.

2.3 Demographic Characteristics

We obtain demographic information on each Ph.D. recipient by linking them to the Individual Characteristics File (ICF), which is part of the infrastructure of the Longitudinal Employer-Household Dynamics (LEHD) program at the U.S. Census Bureau (Vilhuber et al., 2014), and is derived from administrative and survey data from the Social Security Administration (SSA) and Census.

Place of Birth For this paper, the most important piece of information from the ICF is each UMETRICS Ph.D. recipient's place of birth, which can be one of 35 region/country

[4]Some graduate students link to multiple dissertations and some dissertations are linked to multiple graduate students. We only retain the graduate students that match, 1-to-1, to a ProQuest dissertation, which enables us to think of graduate students and dissertations interchangeably.

codes.[5] We code Ph.D. recipients born in the United States as "U.S.-born" and code all others as "foreign-born".[6] It it worth noting that foreign-born status is not synonymous with citizenship because people born outside of the U.S. can become citizens. However, there is likely substantial overlap and place of birth is often used as a reasonable proxy for citizenship (Brown et al., 2018).

Other Demographic Characteristics In addition to a Ph.D. recipient's place of birth, we use the ICF to obtain other demographic characteristics. In particular, we identify each Ph.D. recipient's gender and age, which are used as covariates in regressions.

2.4 Labor Market Outcomes

To track the post-degree labor market outcomes of UMETRICS Ph.D. recipients, we link them to a variety of confidential data from the Internal Revenue Service (IRS) and the U.S. Census Bureau.[7] In particular, we link them to the universe of W2 tax records (2005-2018) and to the universe of unemployment insurance earnings records (2005-2018) from the Longitudinal Employer-Household Dynamics (LEHD) Program at the Census Bureau.

W2 Tax Records The Internal Revenue Service (IRS) requires that U.S. employers file form W2, which lists wages paid to and taxes withheld from each employee. The form allows us to track each Ph.D. recipient's annual earnings as well as identify their employer using federal tax identification numbers (EIN). We use the EIN to identify which employers are universities (see IPEDS section below), enabling us to determine whether a Ph.D. recipient is working in a university or non-university job.

[5] Central Asia, South East Asia, Middle East and North Africa, Caribbean, Central America, South America, Africa, Oceania, Not Specified, U.S. or territory, Mexico, Philippines, Vietnam, India, Germany, Puerto Rico, El Salvador, Cuba, United Kingdom, Canada, China, South Korea, Taiwan, Guatemala, Japan, Haiti, USSR Core, Jamaica, Colombia, Poland, Iran, Dominican Republic, Italy, Former Socialist Europe, Western Europe. A graduate student is coded as U.S.-born if they have a place of birth value of "U.S. or territory" and is coded as foreign-born otherwise. See here for more: https://lehd.ces.census.gov/data/lehd-snapshot-doc/latest/sections/person_level/icf.html#details_icf_us_pob

[6] Though "non-U.S.-born" is more precise, we ease exposition by using "foreign-born" with the understanding that "foreign" is relative to the United States.

[7] Using personally identifiable information (PII) such as name and birth date, Census assigns individuals to a Protected Identification Key (PIK) which is an internal, person-level identifier. This is done through the Person Identification Validation System (PVS), which is a probabilistic match (Wagner et al., 2014). Once an individual is assigned to a PIK, we can link them to a wide variety of confidential data housed at Census.

Longitudinal Employer-Household Dynamics (LEHD) The LEHD data are built using state-level unemployment insurance (UI) earnings records (Vilhuber et al., 2014).[8] These data allow us to track each Ph.D. recipient's quarterly earnings and identify their employer using a state tax identification number (SEIN). Fortunately, most SEINs can be mapped to EINs and so we can use this information to identify university employers and determine whether a Ph.D. recipient's earnings are from a university or non-university (see the IPEDS section next).

IPEDS As noted, we link a publicly-available list of EIN tax identifiers for most U.S.-based universities to the W2 and LEHD earnings data, enabling us to determine whether a Ph.D. recipient's post-degree job placements are in academia or industry. The university EIN list is part of the Integrated Postsecondary Education Data System (IPEDS) and is maintained by the National Center for Education Statistics (NCSES).[9]

Attachment to the U.S. Labor Market In addition to using the W2 and LEHD earnings data to track the post-degree labor market outcomes of UMETRICS Ph.D. recipients, we also use it to identify subsamples of individuals defined by the strength of their post-degree attachment to the U.S. labor market. We do this because Ph.D. recipients typically have very high employment rates (Mervis, 2016; Milesi et al., 2014) and tend to be quite geographically mobile. Thus, when our U.S.-based W2/LEHD records indicate that a Ph.D. recipient has zero earnings, there is a high probability they they are in fact working, but outside of the U.S.[10] Thus, to avoid coding individuals with missing earnings, who are likely to be out of the U.S., as zeros, we conduct analyses conditional on positive earnings. Specifically, from the "full sample" of 14,900 UMETRICS Ph.D. recipients, we identify the 12,100 that have positive earnings one year after graduation ("initially-attached sample") and the 10,550 that have positive earnings in *all four* years after graduation ("fully-attached sample").[11]

Of course, conditioning on positive earnings creates samples of Ph.D. recipients who select into particular levels of attachment to the U.S. labor market and this selection may differ

[8] For the most up-to-date LEHD documentation, see https://lehd.ces.census.gov/data/lehd-snapshot-doc/latest/

[9] The EIN data can be found at https://nces.ed.gov/ipeds/datacenter/DataFiles.aspx under the title "Directory Information". We combine the datasets from 2002 to 2018.

[10] Tham et al. (2023) use a similar approach using W2/LEHD data combined with the full 2020 Decennial Census to examine the likelihood that lab personnel leave the U.S. after their lab experiences a delay in the arrival of grant funding. They find that the scientific workforce is, indeed, quite mobile with about half of personnel who receive zero post-delay W2/LEHD earnings also being absent from the 2020 Decennial Census, indicating that they left the U.S..

[11] Eliminating observations with zero earnings, who may well be out of the U.S., also allows us to estimate log earnings regressions.

for the U.S.- and foreign-born. For instance, if the foreign-born require a higher wage than their U.S.-born counterparts to stay and work in the United States, then the foreign-born selecting into the conditional-on-positive samples will have higher earnings, increasing the foreign-born earnings premium. On the other hand, if the foreign-born are willing to accept lower paying jobs in order to stay in the U.S., then this will decrease the premium. Overall, our results show that, as attachment to the U.S. labor market grows stronger, the foreign-born premium rises, (See Tables 1, 3 and **??**) suggesting that foreign-born Ph.D. recipients are, in fact, positively selected.

2.5 Summary Statistics

Table 1 reports summary statistics for the Ph.D. recipients in our full, initially-attached, and full-attached samples. Panel A displays labor market outcomes measured one year and four years post-degree. In both levels and logs, and across all samples and time-frames, foreign-born Ph.D. recipients earn more than their U.S.-born peers. Remarkably, this is even true in samples and time-frames that do not condition on positive earnings in the U.S., in which caseit seems likely that many foreign-born Ph.D. recipients have zero earnings because they are out of the U.S. labor force (and thus have their earnings coded as zero). Moreover, as the strength of attachment to the U.S. labor market increases, so does the foreign-born earnings premium, suggesting that the foreign-born stayers are even more strongly selected in terms of the choices and characteristics that lead to higher earnings. In terms of job placement, the U.S.-born are more likely than their foreign-born peers to be working in academia, less likely to be working in industry, and less likely to be out of the U.S. labor force (when sample construction allows this outcome).

Panel B displays the demographic characteristics of the Ph.D. recipients in our three samples. About a third of Ph.D. recipients are female, with the share of women being 4-5 pp higher among the U.S. born than among the foreign-born. The typical Ph.D. recipient receives their degree at around age 30 and the U.S.-born are 0.6-0.9 years younger than the foreign-born at graduation. However, there is no difference in when the typical Ph.D. recipient in our samples receives their degree, with 2012 being the average for both the U.S.- and foreign-born.

Finally, Panel C reports on the characteristics of the lab in which a Ph.D. recipient worked while they were in graduate school. The results are quite similar across all samples and time frames. The typical lab has about 1.3-1.4 team members (suggesting that most are quite small) and the U.S.-born tend to work on slightly smaller teams. About half of the personnel in a typical lab are faculty, with the ratio a bit lower for the U.S.-born. The

average award that supports a lab is worth about $350-375k and the U.S.-born tend to be paid by awards that are about $10-15k larger than their foreign-born peers. Finally, the typical Ph.D. recipient is paid by 2.2-2.5 awards, with the foreign-born being paid my 0.20-0.25 more awards. In sum, the U.S.-born tend to work in labs with slightly larger teams, a lower faculty to other personnel ratio, are paid by fewer awards, and are paid by larger awards.

2.6 Field Distribution

Figure 1 shows the distribution, over fields, of foreign- and U.S.-born Ph.D. recipients. Across all three samples, the foreign-born are far more likely than their U.S.-born peers to receive a degree in engineering. Indeed, depending on the sample, 48-51% of foreign-born Ph.D. recipients receive an engineering degree compared to 24-27% of the U.S.-born. By contrast, the U.S.-born are more likely to receive a degree in all other fields (with the exception of mathematics, where differences are quite small). This is especially true in biology, where 25-29% of U.S.-born Ph.D. recipients receive their degree in biology compared to about 17% of the foreign-born. The strong selection of the foreign-born into engineering will be crucial for understanding the raw foreign-born earnings premium (Section 3.2) as well as the extent to which foreign-born Ph.D. recipients crowd out their U.S.-born peers (Section 3.3).

3 Results

3.1 Lab Regressions

Table 2 displays regressions of various lab characteristics on the foreign-born indicator, which allow us to assess differences in the research environment between the U.S.- and foreign-born while they were in graduate school. To assess whether gaps for Ph.D. recipients grow or shrink with attachment to the U.S. labor market, Panels A, B, and C display regressions for the full, initially-attached, and fully-attached samples, respectively. Regressions in the odd columns only control for degree-year fixed effects. Those in the even columns add a gender indicator, quadratic in age, university fixed effects, and field fixed effects.

For all three samples, column (1) shows that, while in graduate school, the foreign-born were paid by more grants than their U.S.-born counterparts. Indeed, the foreign-born in the full, initially-attached, and fully-attached samples were paid by 6.9%, 8.9% and 9.4% more grants. Column (2) shows that these gaps remain after including covariates, although they decline to 5.0%, 6.8%, and 7.3%. These grant count gaps may reflect that the foreign-born have less stable funding as they bounce from lab to lab, that they have a more general set of

skills that translate across many labs, have a broader research agenda that requires work in multiple labs, are in higher demand, or possibly, are more research-oriented compared to the U.S.-born who may be more teaching-focused and thus paid by fewer grants during graduate school.[12] The larger coefficient for the fully-attached sample indicates that, whatever this difference in the number of grants represents, it is most pronounced among Ph.D. recipients who are most strongly attached to the U.S. labor market.

Column (3) indicates that the foreign-born tend to work in labs supported by smaller grants, with the average grant size (in dollars) being 10.9%, 8.9%, and 6.7% smaller for the foreign-born relative to the U.S.-born. However, column (4) shows that adding covariates substantially attenuates these differences, driving the average grant size gap to zero for all three samples.

Columns (5) and (6) show that the foreign-born tend to work on smaller teams, but the differences are small and typically statistically insignificant (or marginally significant). These differences range from about 1-2% depending on the sample and are not substantially impacted by the inclusion of covariates.

Finally, columns (7) and (8) show that the foreign-born tend to work in labs with a higher ratio of faculty-to-other personnel, and that, if anything, including covariates increases the difference. Depending on the sample and specification, the foreign-born work in labs with a ratio that is about 1.5-2.5% higher than the labs in which the U.S.-born work.

In sum, while they are in graduate school, foreign-born Ph.D. recipients tend to be paid by more grants and to work on teams with more faculty relative to other personnel. There is also some evidence that foreign-born students are supported by smaller grants with smaller teams, but these results are smaller in magnitude and not statistically significant. Although it is not clear whether higher/lower values on these outcomes are necessarily "better", it does seem clear that the foreign-born experience *different* types of research environments than their U.S.-born counterparts when they are in graduate school.[13]

3.2 Earnings Regressions

In this section, we examine the selectivity of the foreign-born using post-gradation career outcomes. Table 3 reports regressions of log earnings on the foreign-born indicator, which gives the foreign-born earnings premium. Columns (1)-(2) reports regressions for the initially-

[12] In their survey of graduate students in chemistry, Ganguli and Gaulé (2020) find that the U.S.-born report putting a greater emphasis on teaching.

[13] In future versions of the paper, we will assess the overall value of these lab characteristics, using their coefficients from earnings regressions to generate a composite measure for the quality of the training environment. This will help us understand whether the foreign-born are trained in labs with characteristics that are associated with higher post-graduation earnings.

attached sample and columns (3)-(6) reports regressions for the fully-attached sample. Regressions in the odd columns only include degree-year fixed effects. Regressions in the even columns add a gender indicator, quadratic in age, measures of lab characteristics while the Ph.D. recipient was in graduate school, university fixed effects, field fixed effects, and an indicator for whether the Ph.D. recipient is currently working in an academic position (as opposed to in industry).

Column (1) shows that, for Ph.D. recipients with positive earnings in their first year after graduate school (initially-attached sample), the raw earnings gap between the foreign- and U.S.-born is 14.4%. Under the assumption that employers do not discriminate in favor of foreign-born workers, this is direct evidence that, relative to their U.S.-born peers, the foreign-born possess human capital that is more highly valued by employers. These differences are likely a combination of individual characteristics (e.g. ability) and choices (e.g. field of study or academic/industry job). Even after adding covariates, the foreign-born earnings premium remains, although it is substantially attenuated, at 2.3%. A Gelbach decomposition (reported in the table) indicates that 61.6% of the explained log earnings gap is accounted for by field fixed effects and 37.6% is accounted for by the academia indicator.[14] Thus, taken together, these two covariates account for practically all (99%) of the explained portion of the foreign-born earnings premium. The remaining conditional gap in earnings suggests that the foreign-born possess characteristics (again, perhaps ability or motivation) that lead to modestly higher earnings even after accounting for choices like field of study and job type. Interestingly, the Gelbach decomposition suggests that the university fixed effects expand the log earnings gap (though, by a modest 3%), suggesting that the foreign-born tend to graduate from lower ranked universities (or at least universities that tend to place graduates in lower paying jobs).

Columns (3)-(6) tell a similar story for Ph.D. recipients who have positive earnings, not only in their first year after graduate school, but in *all* years 1-4 after receiving their degree (the fully-attached sample). One and four years post-degree, the raw foreign-born earnings premia are 17.0% and 17.6%. The premia at both time horizons remain after controlling for covariates, but again decline substantially to 4.5% and 6.1%. As before, field fixed effects and academic placement play the primary roles in reducing these log earnings gaps, together accounting for 99% one year post-degree and 106% four years post-degree.[15]

[14]By "explained" log earnings gap, we mean the difference between the raw regression coefficient on the foreign-born indicator (in column (1)) and conditional regression coefficient in column (2): 0.1435 - 0.02279 = 0.12071, or 12.1%. The "unexplained" gap is simply the remaining gap after observable covariates have been accounted for: 0.02279, or 2.3%.

[15]Variables can account for over 100% if other variables expand the log earnings gap between U.S.- and foreign-born Ph.D. recipients. In our case, the university fixed effects increase the log earnings gaps, so that the other covariates explain more than 100% of the reduction in the gap from including covariates.

It is notable that the foreign-born earnings premium in the first year post-degree is larger for the fully-attached sample than for the initially-attached sample. This indicates that, relative to those who may leave the U.S. labor force after one year (initially-attached sample), Ph.D. recipients who are more strongly attached to the U.S. labor market, and end up working in the U.S. for all four years post-degree (fully-attached sample), possess human capital that is particularly valued by U.S. employers. That is, the foreign-born who exit the U.S. labor force, likely returning to their home country, tend to earn less in the U.S. than the foreign-born graduates who are more strongly attached to the U.S. labor market. Moreover, for the fully-attached sample, the raw and conditional log earnings gaps are larger in year 4 than in year 1. This suggests that, not only do the foreign-born earn more immediately after graduating, but their earnings grow at a faster rate than their U.S.-born counterparts.

Our results clearly show that foreign-born Ph.D. recipients are positively selected in terms of the observable choices they make, especially the field they study and the sector in which they work. However, the persistence of the foreign-born earnings premium, even controlling for these (and other) factors, suggests that foreign-born Ph.D. recipients may also be positively selected on unobservable characteristics, such as ability or motivation (or willing to work longer hours and/or in jobs that offer compensating differences).[16] To quantify this unobservable selection, we use methods from Cinelli and Hazlett (2020) based on the traditional omitted variable bias (OVB) formula.

Figure 3 shows contour plots that indicate how pairs of *hypothesized* associations (parameterized in terms of residual R-squared values) of unobservable covariates with log earnings (y-axis) and the foreign-born indicator (x-axis) would affect the foreign-born earnings premia.[17] Of particular interest is the contour for zero (the dashed red line), which plots pairs of associations that would completely eliminate the earnings gap between U.S.- and foreign-born Ph.D. recipients. For example, an unobservable covariate that had a residual R-squared of 0.05 with year-1 log earnings (conditional on observable covariates) and a residual R-squared of 0.01 with the foreign-born indicator (again, conditional on observable covariates) would

[16] An alternative explanation would be discrimination in favor of foreign-born Ph.D. recipients, but that seems unlikely.

[17] Using the notation of Cinelli and Hazlett (2020), let Y be the outcome in a linear regression (log earnings in our case), D be the "treatment" variable (foreign-born indicator in our case), X be a set of observable covariates, and Z be an unobservable covariate. Then the residual association, or partial R^2, of the unobservable covariate Z with the outcome Y (conditional on the treatment D and observable covariates X) is denoted $R^2_{Y\sim Z|D,X}$. This quantity would be obtained by regressing Y on D and X and computing the OLS residuals, regressing Z (if we could observe it) on D and X and computing the OLS residuals, and finally obtaining the R^2 value from regressing the first set of residuals on the second set of residuals. Similarly, the residual association of the unobservable covariate with the treatment (conditional on observable covariates) is denoted $R^2_{D\sim Z|X}$. This quantity would be obtained by regressing D on X and regressing Z on X, obtaining the OLS residuals for both regressions, and obtaining the R^2 value from a regression of the first set of residuals on the second set of residuals.

reduce the foreign-born earnings premium to zero. For reference, pairs of residual R-squared values for the observable covariates (conditional on the other observable covariates) are also plotted. These suggest that selection of the foreign-born in terms of unobservable covariates (like ability or motivation) is stronger than selection on any of the observed covariates, with the exception of field. In other words, if it were as strong as selection on any of the observed covariates (again, with the exception of field), unobservable selection would not eliminate the foreign-born earnings premia.

3.3 Do the Foreign-Born Crowd Out the U.S. Born?

As discussed in Section 2.6, foreign-born Ph.D. recipients strongly select into engineering and the U.S.-born strongly select into biology. Section 3.2 showed that this selection is crucial for understanding the raw foreign-born earnings premium, with field choice explaining about 60% of the gap. In a last set of results, we conduct a field-level analysis that to shed some light on the extent to which foreign-born Ph.D. recipients crowd out their U.S.-born peers.

To examine possible crowding out, it is useful to consider two polar cases – one in which variation across fields in the supply of foreign-born Ph.D. recipients drive labor market outcomes and a second where variation in the derived demand for the foreign-born (e.g., as a function of underlying demand and the supply of U.S.-born Ph.D. recipients) drive differences in outcomes across fields. In the supply-driven case, we should observe lower earnings in fields with a large fraction of foreign-born Ph.D. recipients and in the demand-driven case we should see higher earnings in such fields.

It turns out that engineering not only has the highest shares of foreign-born Ph.D. recipients, but also has the highest pay. Meanwhile, biology has one of the lowest shares of foreign-born Ph.D. recipients and also the lowest pay. Indeed, starting and 3-year post-degree salaries for engineering are around $98k and $124k, while they are $58k and $78k for biology based on data from (Jiang et al., 2023).[18] Figure 2 shows that this relationship is quite strong – there is a strong association between the share of foreign-born in a field and the field's average earnings, with R-squared coefficients of 0.913 for year-1 earnings (left plot) and 0.910 for year-3 earnings (right plot). Specifically, a 10 percentage point increase in the fraction of foreign-born in a field is associated with nearly $12k (17% relative to the overall mean) higher average initial earnings of Ph.D. recipients from that field and over $15k (15%) higher earnings three years after graduation (both regression coefficients have

[18]For disclosure reasons, we use data from Jiang et al. (2023), which uses a similar sample of UMETRICS Ph.D. recipients. The earnings relative to the means were calculated as follows. Initial and year-4 earnings were taken from columns (4) and (7) of Table 1 and are $69,490 and $100,100. Dividing the regression coefficients by these baseline means, we get (10*1174.26)/69490 = 0.169 and (10*1510.7)/100,100 = 0.151.

p-values around 0.001).

The strong positive relationship between a field's earnings and foreign-born representation indicates that foreign-born Ph.D. recipients are disproportionately in high-demand fields and that, while there is surely some degree of crowding-out of their U.S.-born peers, the market appears able to bear a greater quantity of supplied labor from these fields. Put differently, the considerably higher earnings in the fields with many foreign-born Ph.D. recipients suggests that variation in the derived demand for foreign-born graduate students is a more important driver of cross field earnings than the supply of foreign-born graduate students.

4 Conclusion

This paper examines the extent to which foreign-born Ph.D. recipients are positively selected, relative to their U.S.-born peers, both in terms of the observed choices they make as well as their unobserved characteristics. Our findings reveal that foreign-born Ph.D. recipients who remain employed in the U.S. after graduation are positively selected, suggesting that the U.S. retains the "best and brightest" in economically critical fields. Specifically, our research demonstrates that foreign-born Ph.D. recipients tend to study in fields with high demand and better economic prospects, such as engineering. This not only contributes to the overall positive selection but also suggests limited crowding out of U.S.-born trainees in these lucrative fields.

The examination of post-graduation outcomes reveals a small but persistent earnings premium for foreign-born Ph.D. recipients, even after controlling for field of study and various other factors. Furthermore, our results indicate a growing earnings premium over time for foreign-born doctoral recipients. This positive trend suggests that foreign-born STEM Ph.D.s are not only positively selected, but they also experience faster earnings growth than their U.S.-born counterparts.

References

Brown, J. David, Misty L. Heggeness, Suzanne M. Dorinski, Lawrence Warren, and Moises Yi (2018), "Understanding the Quality of Alternative Citizenship Data Sources for the 2020 Census." Working Papers 18-38, Center for Economic Studies, U.S. Census Bureau, URL https://ideas.repec.org/p/cen/wpaper/18-38.html. 7

Cinelli, Carlos and Chad Hazlett (2020), "Making sense of sensitivity: Extending omitted variable bias." *Journal of the Royal Statistical Society Series B: Statistical Methodology*, 82, 39–67. 13, 20

Ganguli, Ina and Patrick Gaulé (2020), "Will the US Keep the Best and the Brightest (as Postdocs)? Career and Location Preferences of Foreign STEM PhDs." In *The Roles of Immigrants and Foreign Students in US Science, Innovation, and Entrepreneurship*, NBER Chapters, 49–69, National Bureau of Economic Research, Inc, URL https://ideas.repec.org/h/nbr/nberch/14108.html. 4, 11

Grogger, Jeffrey and Gordon H. Hanson (2015), "Attracting Talent: Location choices of foreign-born PhDs in the United States." *Journal of Labor Economics*, 33, S5–S38. 4

Hunt, Jennifer and Marjolaine Gauthier-Loiselle (2010), "How much does immigration boost innovation?" *American Economic Journal: Macroeconomics*, 2, 31–56, URL https://www.aeaweb.org/articles?id=10.1257/mac.2.2.31. 2

Ikudo, Akina, Julia I Lane, Joseph Staudt, and Bruce A Weinberg (2019), "Occupational classifications: A machine learning approach." *Journal of Economic and Social Measurement*, 44, 57–87. 5

Jiang, Xuan, Joseph Staudt, and Bruce A Weinberg (2023), "A tale of two fields? stem career outcomes." Working Paper 31835, National Bureau of Economic Research, URL http://www.nber.org/papers/w31835. 4, 14, 19

Kahn, Shulamit and Megan MacGarvie (2020), "The impact of permanent residency delays for STEM PhDs: Who leaves and why." *Research Policy*, 49, 103879, URL http://www.nber.org/papers/w25175https://linkinghub.elsevier.com/retrieve/pii/S0048733319301982. 2, 4

Kerr, William R. and William F. Lincoln (2010), "The Supply Side of Innovation: H-1B Visa Reforms and U.S. Ethnic Invention." *Journal of Labor Economics*, 28, 473–508, URL https://www.journals.uchicago.edu/doi/10.1086/651934. 2

Lane, Julia I, Jason Owen-Smith, Rebecca F Rosen, and Bruce A Weinberg (2015), "New linked data on research investments: Scientific workforce, productivity, and public value." *Research Policy*, 44, 1659–1671. 5

Mervis, Jeffrey (2016), ""employment crisis" for new ph.d.s is an illusion." *Science*, URL http://dx.doi.org/10.1126/science.caredit.a1600082. 8

Milesi, Carolina, Lance A Selfa, and Lynn M Milan (2014), "Unemployment among doctoral scientists and engineers increased but remained below the national average." *Psychology*, 89, 93–000. 8

Nicholls, Natsuko, Christopher Brown, and Jason Owen-Smith (2022), "Data dictionary for IRIS UMETRICS 2022 data release." 5

ProQuest (2018). Dissertations Theses Database, URL https://about.proquest.com/en/dissertations/. 6

Roach, Michael, Henry Sauermann, and John Skrentny (2019), "Are foreign stem phds more entrepreneurial? entrepreneurial characteristics, preferences, and employment outcomes of native and foreign science and engineering phd students." In *The Roles of Immigrants and Foreign Students in US Science, Innovation, and Entrepreneurship*, 207–228, University of Chicago Press. 4

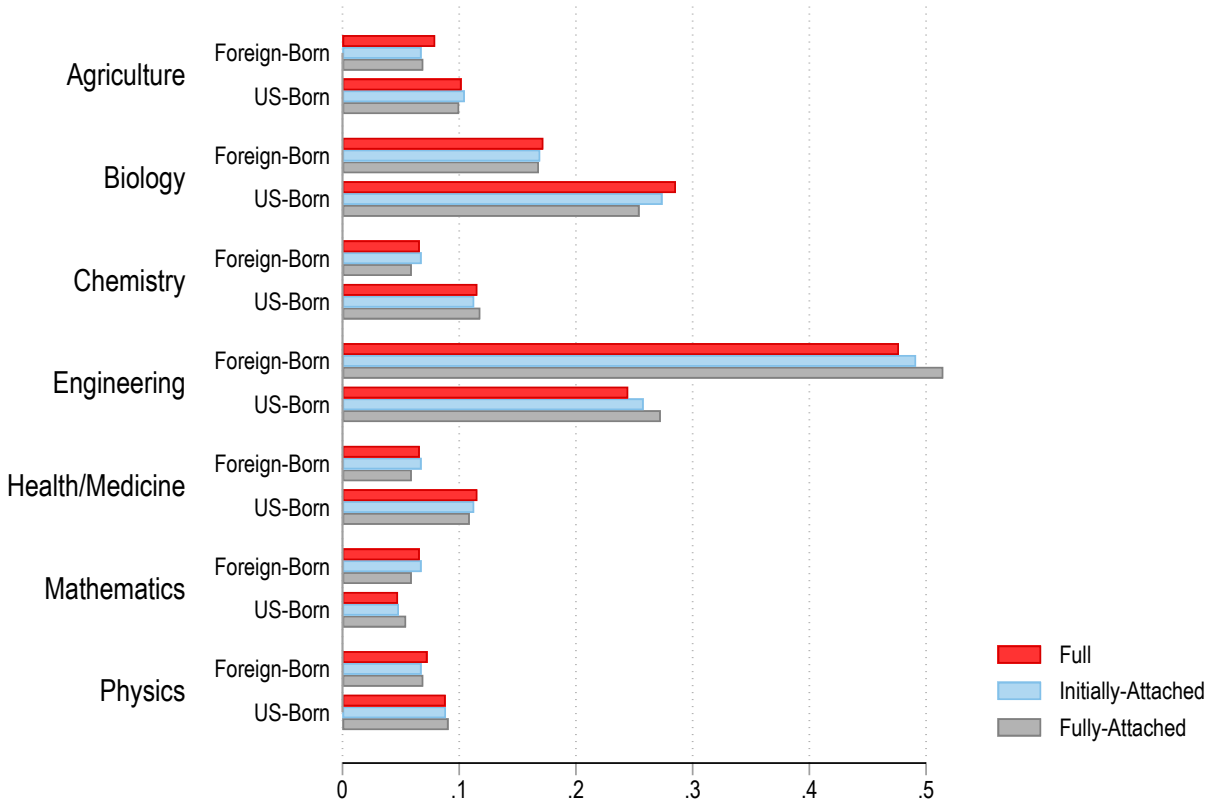
Tham, Wei Yang, Joseph Staudt, Elisabeth Ruth Perlman, and Stephanie Cheng (2023), "The effect of funding delays on the research workforce: Evidence from tax records." Technical report, Mimeo. 8

UMETRICS (2018, Q4). Institute for Research on Innovation and Science (IRIS), University of Michigan, URL https://iris.isr.umich.edu/. 5

Vilhuber, Lars, Kevin McKinney, et al. (2014), "Lehd infrastructure files in the census rdc-overview." *Center for Economic Studies, US Census Bureau Working Papers*. 6, 8

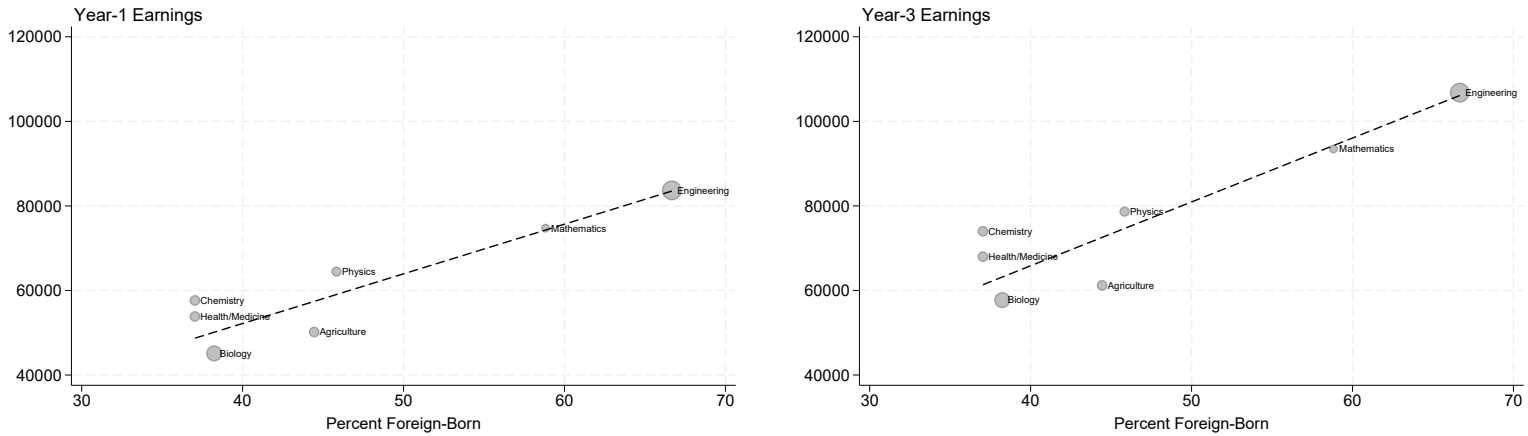
Wagner, Deborah, Mary Lane, et al. (2014), "The person identification validation system (pvs): applying the center for administrative records research and applications'(carra) record linkage software." Technical report, Center for Economic Studies, US Census Bureau. 7

Figure 1: Field Distribution of Foreign-Born and U.S.-Born Ph.D. Recipients



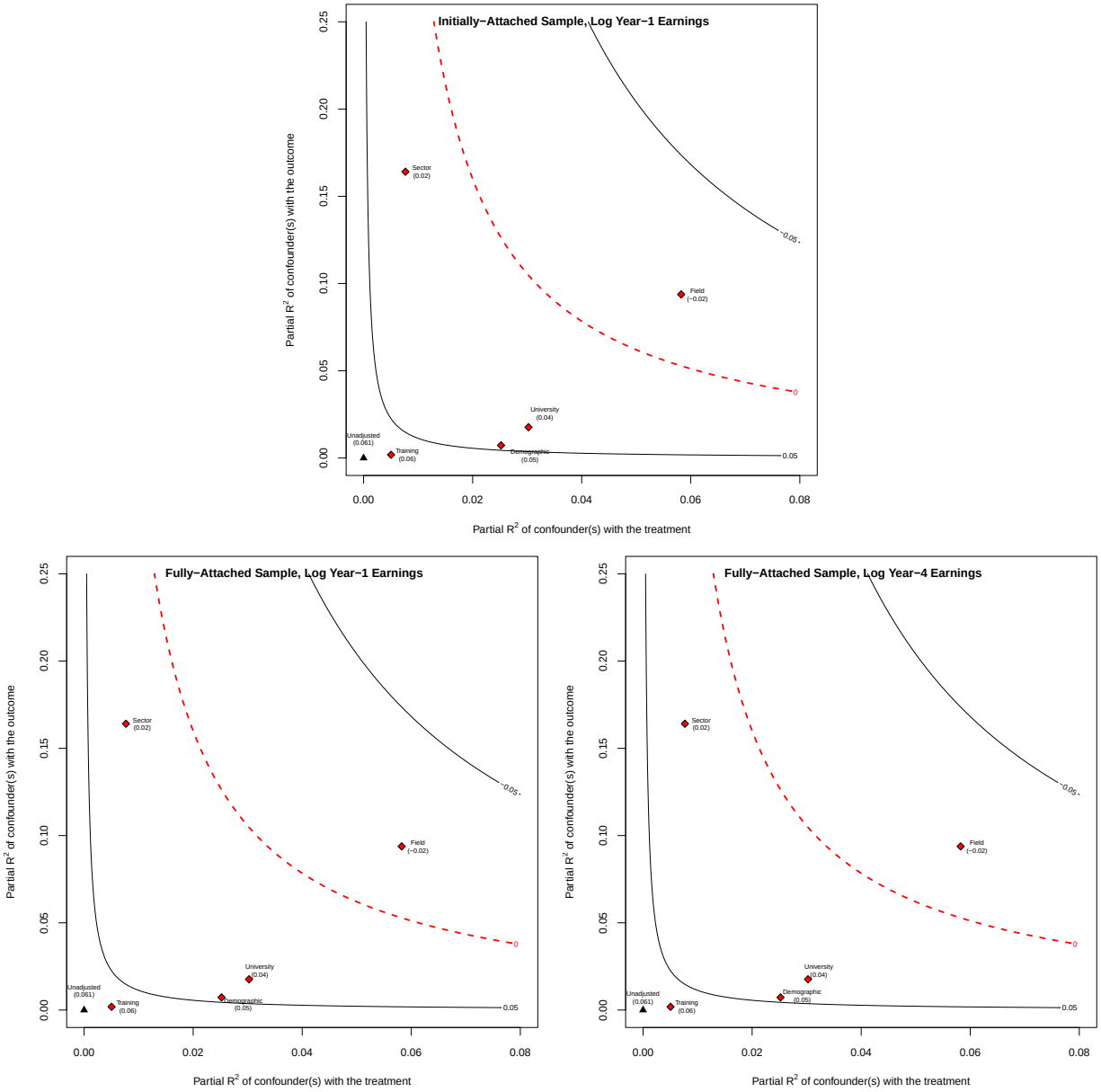
Notes – This figure shows the distributions, over field, of foreign-born and U.S.-born Ph.D. recipients for our three main samples. The "full" sample (red bars) includes all graduate students in UMETRICS that can be linked to their dissertation in ProQuest. The "initially-attached" (light blue bars) and "fully–attached" (gray bars) samples include the subset of graduate students from the full sample that have, respectively, positive earnings the first year after receiving their Ph.D. and positive earnings in all years 1-4 after receiving their Ph.D. For each sample and place of birth category, the shares of the seven fields sum to 1.

Figure 2: Mean Earnings and Fraction Foreign-Born Across Fields



Notes – This figure shows the relationship between the average earnings of Ph.D. recipients in a field (y-axis) and the fraction of Ph.D. recipients in that field who are foreign-born (x-axis). The foreign-born fraction is computed using our "full" sample – all graduate students in UMETRICS that can be linked to their dissertation in ProQuest. For Census disclosure reasons, we use field-level earnings data from Jiang et al. (2023), which uses a similar sample of UMETRICS Ph.D. recipients. The left and right plots use earnings one and three years post graduation, respectively. Each dot denotes a specific field, and dot size is determined by the total number of Ph.D. recipients in the full sample that receive their degree in that field. The dashed lines are weighted least squares (WLS) regression lines. The WLS slope coefficients are \$1,174.26 for year-1 earnings (left plot) and \$1,510.7 for year 3 earnings (right plot), which implies that a 10 percentage point increase in the fraction of foreign-born in a field is associated with nearly \$12k higher average initial earnings of Ph.D. recipients from that field and over \$15k higher earnings three years after graduation (both regression coefficients have p-values around 0.001). The R-squared values are 0.913 and 0.910.

Figure 3: Selection on Observable vs. Unobservable Covariates



Notes – This figure displays contour plots showing how pairs of *hypothesized* associations (parameterized in terms of residual R-squared values) of unobservable covariates with log earnings (y-axis) and the foreign-born indicator (x-axis) would affect the foreign-born earnings premia. The plots are created using the methods in Cinelli and Hazlett (2020). The top plot uses the "initially-attached" sample, which is the subset of UMETRICS graduate students that can be linked to their ProQuest dissertation and have positive earnings their first year after graduation. The bottom plots use the "fully-attached" sample, which requires these graduate students to have positive earnings in all years 1-4 after graduation. Of particular interest is the contour for zero (the dashed red line), which plots pairs of associations that would completely eliminate the earnings gap between U.S.- and foreign-born Ph.D. recipients. Each dot represents the associations of observable covariates with log earnings and the foreign-born indicator (conditional on all other covariates).

Table 1: Summary Statistics

	Full Sample			Initially-Attached Sample			Fully-Attached Sample		
	US	**Foreign**	**Diff.**	**US**	**Foreign**	**Diff.**	**US**	**Foreign**	**Diff.**
Panel A: Labor Market Outcomes									
Earnings (Year 1)	58,320	65,110	-6,790***	69,490	83,100	-13,610***	72,370	88,410	-16,040***
	(44,860)	(58,370)		(40,270)	(53,420)		(40,560)	(54,400)	
Earnings (Year 4)	85,760	89,590	-3,830***	92,350	109,600	-17,250***	100,100	127,000	-26,900***
	(69,440)	(101,800)		(70,990)	(104,600)		(69,790)	(103,100)	
Log Earnings (Year 1)				11.00	11.14	-0.14***	11.05	11.22	-0.17***
				(0.56)	(0.62)		(0.53)	(0.59)	
Log Earnings (Year 4)							11.37	11.54	-0.17***
							(0.53)	(0.64)	
Academic Placement (Year 1)	0.39	0.29	0.10***	0.47	0.37	0.10***	0.45	0.33	0.12***
	(0.49)	(0.45)		(0.50)	(0.48)		(0.50)	(0.47)	
Academic Placement (Year 4)	0.36	0.21	0.15***	0.37	0.24	0.13***	0.38	0.27	0.11***
	(0.48)	(0.41)		(0.48)	(0.43)		(0.49)	(0.45)	
Industry Placement (Year 1)	0.45	0.49	-0.05***	0.53	0.63	-0.10***	0.55	0.67	-0.12***
	(0.50)	(0.50)		(0.50)	(0.48)		(0.50)	(0.47)	
Industry Placement (Year 4)	0.55	0.52	0.02***	0.58	0.63	-0.06***	0.62	0.73	-0.11***
	(0.50)	(0.50)		(0.49)	(0.48)		(0.49)	(0.45)	
Out of U.S. Labor Force (Year 1)	0.16	0.22	-0.06***	0.00	0.00	0.00	0.00	0.00	0.00
	(0.37)	(0.41)		(0.00)	(0.00)		(0.00)	(0.00)	
Out of U.S. Labor Force (Year 4)	0.09	0.26	-0.17***	0.06	0.13	-0.07***	0.00	0.00	0.00
	(0.29)	(0.44)		(0.23)	(0.33)		(0.00)	(0.00)	
Panel B: Demographic Characteristics									
Female	0.36	0.31	0.05***	0.35	0.30	0.05***	0.34	0.30	0.04***
	(0.48)	(0.46)		(0.48)	(0.46)		(0.47)	(0.46)	
Age	29.38	30.28	-0.90***	29.40	30.09	-0.69***	29.41	30.03	-0.62***
	(2.81)	(3.04)		(2.84)	(2.96)		(2.85)	(2.96)	
Degree Year	2012	2012	0.00	2012	2012	0.00	2012	2012	0.00
	(3.00)	(3.06)		(3.00)	(3.04)		(2.99)	(3.03)	
Panel C: Lab Characteristics									
Team Size	1.38	1.37	0.01	1.36	1.33	0.04	1.38	1.36	0.02
	(2.26)	(3.73)		(2.20)	(2.16)		(2.23)	(2.20)	
Faculty Ratio	0.48	0.50	-0.02*	0.48	0.50	-0.03**	0.48	0.50	-0.02
	(0.68)	(0.77)		(0.68)	(0.80)		(0.70)	(0.82)	
Awards	2.24	2.44	-0.20***	2.25	2.50	-0.25***	2.26	2.52	-0.26***
	(1.52)	(1.68)		(1.54)	(1.72)		(1.56)	(1.74)	
Award Amount	366,800	351,000	15,800	365,000	353,800	11,200	372,900	359,900	13,000
	(945,000)	(940,700)		(967,600)	(1,0040,000)		(1,008,000)	(987,900)	
Arcsine Team Size	0.86	0.84	0.02*	0.86	0.84	0.01	0.86	0.85	0.01
	(0.66)	(0.65)		(0.66)	(0.64)		(0.66)	(0.65)	
Arcsine Faculty Ratio	0.40	0.42	-0.02**	0.40	0.42	-0.02***	0.40	0.42	-0.02**
	(0.42)	(0.40)		(0.42)	(0.40)		(0.42)	(0.40)	
Arcsine Awards	1.40	1.47	-0.07***	1.41	1.49	-0.09***	1.41	1.50	-0.09***
	(0.56)	(0.57)		(0.56)	(0.57)		(0.57)	(0.57)	
Arcsine Award Amount	12.67	12.57	0.10***	12.66	12.58	0.08***	12.67	12.60	0.07**
	(1.47)	(1.67)		(1.47)	(1.65)		(1.47)	(1.63)	
Ph.D. Recipient Count	7,350	7,550		6,200	5,900		5,500	5,050	

Notes – This table reports means and standard deviations (in parentheses below the corresponding mean), for each of our three main samples, separately for foreign-born and U.S.-born Ph.D. recipients. It also contains the differences in the means between the U.S.- and foreign-born (*, **, and *** denote statistical significance at the 10%, 5%, and 1% levels). The variables include labor market outcomes such as earnings, log earnings, and sector of job placement one and four years after a Ph.D. recipient receives their degree. The variables also include demographic characteristics such as gender and age. Finally, the variables include degree year and various characteristics of the labs in which Ph.D. recipients worked while they were in graduate school such as team size, the faculty ratio, the number of awards, and the award amount. The "full" sample includes all graduate students in UMETRICS that can be linked to their dissertation in ProQuest. The "initially-attached" and "fully-attached" samples include the subset of graduate students from the Full sample that have, respectively, positive earnings the first year after receiving their Ph.D. and positive earnings in all years 1-4 after receiving their Ph.D.

Table 2: Foreign- and U.S.-Born Differences in Lab/Training Environments While in Graduate School

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Full Sample								
	Arcsine Award Count		Arcsine Award Amount		Arcsine Team Size		Arcsine Faculty Ratio	
Foreign-Born Indicator	0.06938***	0.05017***	-0.1092***	-0.02131	-0.02196**	-0.02177*	0.01357**	0.01968***
	(0.009276)	(0.009442)	(0.0259)	(0.0199)	(0.01074)	(0.01151)	(0.006728)	(0.006951)
Ph.D. Recipient Count	14,900	14,900	14,900	14,900	14,900	14,900	14,900	14,900
Panel B: Initially-Attached Sample								
	Arcsine Award Count		Arcsine Award Amount		Arcsine Team Size		Arcsine Faculty Ratio	
Foreign-Born Indicator	0.08937***	0.06756***	-0.08861***	-0.01843	-0.01858	-0.02089*	0.01913**	0.02548***
	(0.01035)	(0.01049)	(0.02846)	(0.02184)	(0.01182)	(0.01247)	(0.007451)	(0.007657)
Ph.D. Recipient Count	12,100	12,100	12,100	12,100	12,100	12,100	12,100	12,100
Panel C: Fully-Attached Sample								
	Arcsine Award Count		Arcsine Award Amount		Arcsine Team Size		Arcsine Faculty Ratio	
Foreign-Born Indicator	0.09396***	0.07249***	-0.06708**	-0.003738	-0.01279	-0.01333	0.01472*	0.01961**
	(0.0111)	(0.01121)	(0.03028)	(0.02346)	(0.01277)	(0.01343)	(0.007981)	(0.008192)
Ph.D. Recipient Count	10,550	10,550	10,550	10,550	10,550	10,550	10,550	10,550
Year FEs	×	×	×	×	×	×	×	×
Covariates		×		×		×		×

Notes – This table contains coefficients and standard errors (in parentheses below the corresponding coefficient) from regressions of lab characteristics on an indicator for whether the Ph.D. recipient is foreign-born (*, **, and *** denote statistical significance at the 10%, 5%, and 1% levels). Panels A, B, and C display regressions for the "full", "initially-attached", and "fully-attached' samples. The "full" sample includes all graduate students in UMETRICS that can be linked to their dissertation in ProQuest. The "initially-attached" and "fully-attached" samples include the subset of graduate students from the Full sample that have, respectively, positive earnings the first year after receiving their Ph.D. and positive earnings in all years 1-4 after receiving their Ph.D. Regressions in the odd columns only control for degree-year fixed effects. Those in the even columns add a gender indicator, quadratic in age, university fixed effects, and field fixed effects. In columns (1)-(2), the outcome is the number of grants that pay each graduate student. In columns (3)-(4), the outcome is the average size (in dollars) of the grants that pay the graduate student. In columns (5)-(6), the outcome is the number of other personnel paid on the grants that pay the graduate student (team size). In columns (7)-(8), the outcome is the ratio of faculty to other lab personnel on the grants that pay the graduate student. All of the outcomes are transformed using the inverse hyperbolic sine. This transformation accommodates zeros, which are possible because a small number of Ph.D. recipients in our sample are paid by "awards" that do not have a valid identifier (see data appendix for details).

Table 3: Foreign-Born Earnings Premia

	(1)	(2)	(3)	(4)	(5)	(6)
	Initially-Attached Sample		**Fully-Attached Sample**			
	Log Yr-1 Earnings		Log Yr-1 Earnings		Log Yr-4 Earnings	
Foreign-Born Indicator	0.1435***	0.02279**	0.1701***	0.04529***	0.1759***	0.06149***
	(0.0108)	(0.009614)	(0.01096)	(0.0097)	(0.01149)	(0.0105)
Decomposition (% of Total Gap)						
Field FEs		51.84		42.64		41.47
Academic Placement		31.59		30.01		27.69
Demographic Covariates		1.01		0.80		-1.70
Training		2.27		1.71		1.75
University FEs		-2.60		-1.80		-4.15
Unobservable Covariates		15.88		26.63		34.95
Ph.D. Recipient Count	12,100	12,100	10,550	10,550	10,550	10,550
R-Squared	0.0228	0.3043	0.0312	0.3187	0.0328	0.2895
Year FEs	×	×	×	×	×	×
Covariates		×		×		×

Notes – This table contains coefficients and standard errors (in parentheses below the corresponding coefficient) from regressions of log earnings on an indicator for whether the Ph.D. recipient is foreign-born (*, **, and *** denote statistical significance at the 10%, 5%, and 1% levels). The odd columns condition on degree year fixed effects and the even columns include additional covarariates (listed below). "Log Yr-1 Earnings" and "Log Yr-4 Earnings" are the log earnings of Ph.D. recipients one year and four years after they receive their Ph.D. The table also includes the percent contribution, from Gelbach decompositions, of each set of covariates to the reduction in the foreign-born coefficient. "Field FEs" include indicators for each of the seven fields, "Academic Placement" is an indicator for whether the Ph.D. recipient is working at a university, "Demographic Covariates" include an indicator for gender and a quadratic in age, "Training" includes the arcines of the number of awards, dollar amount of awards, team size, and the faculty ratio for the labs in which the Ph.D. recipient worked while they were in graduate school, and "University FEs" includes indicators for each of the 25 universities. The "initially-attached" and "fully-attached" samples include all graduate students in UMETRICS that can be linked to their dissertation that have, respectively, positive earnings the first year after receiving their Ph.D. and positive earnings in all years 1-4 after receiving their Ph.D.