

POLICY FORUM

STEM WORKFORCE

Rethinking immigration policies for STEM doctorates

Many Ph.D.'s follow an inefficient path to green cards through visas aimed at entry-level workers

By Michael Roach¹ and John Skrentny²

Despite broad consensus that high-skilled immigration can contribute to innovation and economic growth (1–3), there is considerable controversy regarding how to reform immigration policies, including for workers in science, technology, engineering, and mathematics (STEM) professions. Much attention has centered on entry-level IT workers (4, 5), but less consideration has been given to the visa pathways of STEM doctorates (6, 7) who, unlike entry-level IT workers, can bring firms advanced training at the frontiers of science and technology and contribute disproportionately to innovation and entrepreneurship relative to workers with bachelor's or master's degrees (3). We provide new insights on the visa progression, qualifications, and starting salaries of STEM doctorates in the U.S. context from a survey that follows a cohort of 1597 U.S. citizen (69.7%) and foreign-born (30.3%) science and engineering Ph.D.'s from U.S. research universities into their first-time industry R&D employment [see details in the supplementary materials (SM)]. We show that the H-1B visa has become the predominant first step for STEM Ph.D.'s employed in industrial R&D, not because it is legally required or the most suitable visa but because of inefficiencies and delays on the path to permanent residency. Our findings show that the H-1B—a highly contentious visa used primarily for entry-level workers—may be an inefficient pathway for U.S.-trained STEM doctorates and suggest the need to rethink visa policies to retain these highly specialized workers.

Lawmakers of both major U.S. political parties have supported policies that would facilitate retention of U.S.-trained STEM Ph.D.'s. In recent years, however, attention

has centered on the H-1B, which is problematic for U.S.-trained Ph.D.'s for two reasons. First, there are widespread concerns that firms use the H-1B to import cheap labor that displaces U.S. workers, especially in entry-level IT jobs (5). As a result, some reformers seek a reduction in the number of H-1Bs issued, and recently the Trump Administration tried to suspend issuance of new H-1B visas. However, there is little evidence on whether these concerns also apply to Ph.D.'s. To the extent that the H-1B is used to hire STEM Ph.D.'s, such sweeping reforms could drastically restrict U.S. companies' access to talented Ph.D.'s (8).

Second, STEM Ph.D.'s compete with entry-level workers for a limited number of H-1B visas allocated through a lottery system regardless of employer demand, level of occupation, or pay. This has heightened uncertainty for both workers and employers, leading U.S. firms—including Amazon, Google, and Microsoft—to open R&D centers in countries such as Canada where visas favor high-skilled STEM talent (9). Visa uncertainties also deter foreign Ph.D.'s from working in startups (10), placing young technology companies at a disadvantage in their ability to hire recent doctorates. Congress did not design the H-1B to retain elite workers with advanced degrees from U.S. universities, and visa reforms tailored to foreign-born Ph.D.'s may be warranted.

VISA PROGRESSION

Upon graduation, foreign Ph.D.'s have different visa pathways to industry employment. First, STEM Ph.D.'s may work on their F-1 student visa for up to 3 years without an employment-based visa through the Optional Practical Training (OPT) program. However, to remain in the U.S. long-term, foreign Ph.D.'s need to transition to an employment-based visa. There are two visa paths—one authorizing permanent residency and the other authorizing temporary work.

The Immigration Act of 1990 created a complex series of merit-based permanent resident (“green card”) visa categories to

attract and retain highly skilled workers. These include the highest category (EB-1) for outstanding researchers and workers with “extraordinary ability.” The second category (EB-2) is for workers with advanced degrees or “exceptional ability.” The EB-2 also includes a special “National Interest Waiver” (NIW) category to expedite permanent residence for workers with skills deemed especially valuable to the country. STEM doctorates from U.S. universities are qualified upon graduation for EB-2 for advanced degrees, and they may also be qualified for the EB-1 under extraordinary ability, the EB-2 under exceptional ability, or NIW if they can meet specific criteria such as evidence of scientific publications, patents, awards, and commanding a high salary. Although workers must be sponsored by their employers for the EB-2 advanced degree or exceptional ability, they may self-sponsor through either the EB-1 or NIW.

Doctorates are eligible to apply for permanent residency while on OPT and are not required to first transition to a temporary work visa such as the H-1B. The time to secure permanent residency varies depending upon the EB visa type and the worker's nationality, with processing times as short as 6 to 12 months for many Ph.D.'s on EB-1 to as long as 5 to 10 years for Ph.D.'s on EB-2 visas from countries where the high number of applicants has resulted in a wait list, such as India and China.

Another pathway for foreign Ph.D.'s is through the employer-sponsored H-1B, a “non-immigrant” temporary visa that Congress designed to fill short-term labor shortages for workers in specialty occupations with at least a bachelor's degree. Each year, the U.S. Citizenship and Immigration Services (USCIS) allocates 65,000 H-1B visas, plus an additional 20,000 for workers with a master's degree or higher from U.S. universities, for employees of for-profit firms (non-profits such as universities are exempt from these caps). Unlike EB visas, the H-1B gives little priority to worker qualifications and no special recognition to Ph.D.'s. Given that each year the number of H-1B applications far exceeds the number of visas available, the USCIS randomly selects workers until the quotas are met. Doctorates not selected in a given year may reapply the following year, so long as they have not exhausted their OPT eligibility. The H-1B is valid for 3 years and may be renewed for an additional 3 years. Although the H-1B is not required for permanent residence eligibility, in practice Ph.D.'s may use the H-1B as a bridge between OPT and a green card.

The array of different pathways that doctorates may take through the visa system is complex, and there is little empirical un-

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derstanding of which visas recent doctorates use in their first industry job, nor the sequencing and timing of visa progression. We provide detailed insights on the visa progression of foreign STEM doctorates from 39 leading U.S. research universities who graduated between 2010 and 2016 and transitioned to industry employment (see SM for details of sample by nationality and degree field). The survey provides previously unavailable microdata on STEM doctorates' visa progression, employment qualifications, starting salary and work benefits, and employer characteristics. We complement our survey with administrative data from the Department of Labor (DOL) on 2461 Labor Certification applications for foreign Ph.D.'s sponsored for an EB-2 visa. Our sample represents young, early-career Ph.D.'s who have many years of productivity ahead of them and are the focus of governments around the world seeking to attract and retain leading STEM researchers.

We asked foreign Ph.D.'s to report their first work visa, as well as their current visa after at least 3 years of industry employment. In their first job, two-thirds of Ph.D.'s were sponsored for an H-1B, the same visa used to hire entry-level workers with bachelor's degrees and that is at risk of restriction by Congress (see the first figure). Approximately 10% of foreign doctorates were either employer- or self-sponsored for permanent residency, and 16% remained on OPT without a sponsored work visa.

After at least 3 years of employment, 68% of doctorates have either received or been sponsored for permanent residency (see the first figure). Among Ph.D.'s who were first sponsored on an H-1B, 76% have transitioned to or are being sponsored for permanent residency (table S2). Although our sample does not reflect Ph.D.'s who may have left the United States as a result of visa delays, these patterns illustrate that the majority of Ph.D.'s obtain permanent residency early in their careers and that most do so by passing through the H-1B.

To obtain deeper insights into pathways for Ph.D.'s to gain permanent residency, we use DOL administrative data on EB-2 Labor Certification applications. Among foreign STEM Ph.D.'s employed in industrial R&D and sponsored by their employer for EB-2 visas, 20% progressed directly from OPT, whereas nearly 80% progressed through an H-1B (table S4). The average time from graduation to filing an EB-2 application is 1.1 years under OPT and 2.8 years under H-1B

(fig. S2). Although Ph.D.'s on H-1B wait ~18 months longer to be sponsored for permanent residency than Ph.D.'s on OPT, this wait time is much shorter than the full 6-year term of the H-1B visa. This suggests that employers are not using the H-1B as a trial period before sponsoring for a green card.

At the same time, the short duration of OPT work eligibility makes applying for permanent residency without first obtaining an H-1B an often impossible path for doctorates from India and China, who may wait several years to receive their green cards

This raises the question of why more doctorates don't transition directly to permanent residency. One possibility is that doctorates sponsored for permanent residence in their first job may be more qualified than those sponsored for H-1B (see SM). In regression analyses that control for demographics and degree field (table S6), we find no significant difference between Ph.D.'s sponsored for EB or H-1B visas in terms of the number of publications or patents prior to industry employment, two evidentiary requirements of a worker's

qualifications used in permanent residency applications. We also find no significant difference in starting salary as reported in our survey, nor in the offered wage as reported in the DOL EB-2 applications (see the second figure). Although we lack data to explore why firms sponsor some Ph.D.'s for EB and others for H-1B, these results show that Ph.D.'s sponsored for an H-1B may be qualified for permanent residency when first hired.

COMPARISON TO U.S. PH.D.'S

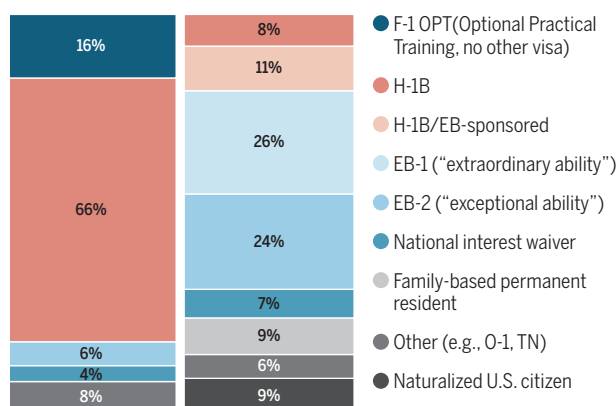
Arguably the greatest concern when considering changes in visa policies is potential adverse impacts on U.S. citizens. Though the preponderance of prior research has compared U.S. citizens to H-1B entry-level IT work-

ers (5, 12), there is little existing evidence comparing U.S. and foreign doctorates first-time employees in similar industry occupations. Data from the U.S. Bureau of Labor Statistics show that doctorates have the lowest unemployment and highest salaries of any level of educational attainment, with pre-COVID-19 unemployment of 1.1% and median annual salaries of approximately \$100,000 (13). Although these numbers do not distinguish between U.S. and foreign doctorates, the tight labor market for highly skilled Ph.D.'s does not suggest crowding out.

To examine possible differences in pay, we use our survey to compare the starting salary of U.S. citizen and foreign Ph.D.'s on temporary resident visas in their first industrial R&D job (see SM). In regression analyses that control for worker ability, demographics, work benefits, job start year, and employer type, we find no significant difference in pay between U.S. citizen and foreign doctorates (see the second figure). Instead, starting salary is driven primarily by degree field and proxies for worker ability (table S7). Though these comparisons do not allow for careful identification of the

Visa progression of foreign-born STEM Ph.D.'s

Employment visa in first job is shown at left, current visa after 3 to 9 years of employment is at right. Sample is foreign-born Ph.D.'s who were temporary residents at graduation and required a work visa in their first industrial job (N = 305).



because of per-country quotas. Our survey shows that Indian (78%) and Chinese (67%) doctorates are especially likely to be first sponsored for an H-1B compared to doctorates from other countries (55%) (table S4). Although the longest wait times of 5 to 10 years are for the EB-2, wait times for the EB-1 are just over 2 years (17). To examine whether Ph.D.'s differ in their use of EB-1 and EB-2 visas, we asked survey respondents sponsored for permanent residency their EB preference category: 46% reported that they were sponsored for an EB-2, 41% were sponsored for EB-1, and 10% for NIW (table S3). Moreover, a disproportionate share of doctorates from India and China are on EB-1 (50.8% and 54.2%, respectively) compared to doctorates from the rest of the world (20.0%, table S4), likely because of the shorter wait time relative to the EB-2.

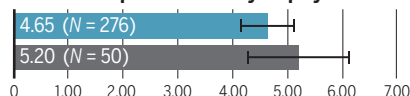
Together these findings demonstrate that a meaningful share of doctorates transition directly to permanent residency while on OPT. At the same time, the majority first pass through the H-1B, suggesting that the H-1B may be pressed into service to overcome gaps resulting from an inefficient immigration system.

Comparing qualifications

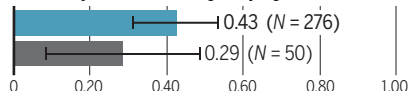
Graphs show predicted values from regression analyses (see tables S6, S7, and S9). (Left) Foreign doctorates first sponsored for H-1B (blue) are compared with those first sponsored for permanent residency (EB)(dark gray); EB-2 Labor Certification application wage offer is compared between applicants on H-1B and on OPT (Optional Practical Training, light gray). (Right) Foreign doctorates on H-1B (blue) are compared with U.S. citizen doctorates (red).

Comparison of H-1B and EB first visa

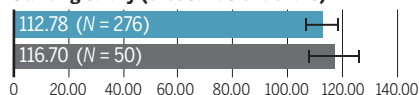
Publications prior to industry employment



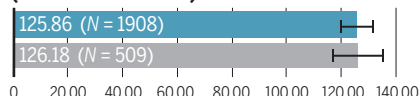
Patents prior to industry employment



Starting salary (thousands of dollars)

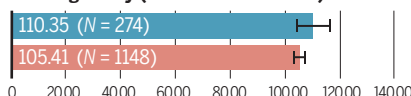


EB-2 labor certification wage offer (thousands of dollars)

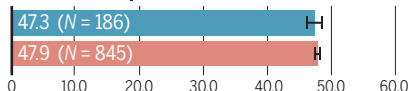


Comparison of H-1B and U.S. citizen workers

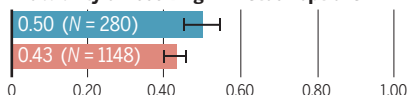
Starting salary (thousands of dollars)



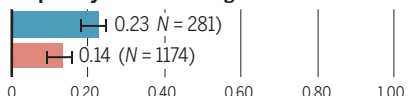
Hours worked per week



Probability of receiving firm stock options



Propensity to work for "big tech" firm



causal effects of immigration policies on wages, nor do they rule out the possibility that a greater number of foreign Ph.D.'s in the workforce could drive down wages for native Ph.D.'s (14), they provide suggestive evidence that often-cited concerns of foreign entry-level STEM workers being paid less than their native peers do not apply to STEM Ph.D.'s (5).

Another frequent concern is that employers may use visa sponsorship as leverage to exploit foreign workers in ways other than salary. For example, employers may require sponsored employees to work longer hours relative to U.S. citizens, or they may offer fewer benefits to offset the high costs of visa sponsorship. In regression analyses (table S9), we find no significant difference between U.S. and H-1B Ph.D.'s in hours worked, with both reporting an average of 47 hours per week (see the second figure). We also find that H-1B Ph.D.'s have a higher probability than U.S. Ph.D.'s of receiving firm stock options (see the second figure), a highly coveted financial benefit. This appears to be due to foreign doctorates' higher propensity to work in "big tech" firms like Google and Amazon that are more likely to give new employees stock options (see SM). H-1B Ph.D.'s are also nearly twice as likely to work for a big tech firm compared to other firms (see the second figure).

IMPLICATIONS

The role of the H-1B as the modal start of a complex path to permanent residency for elite, high-skilled STEM doctorates from U.S. universities is inconsistent with the U.S. government's classification of the H-1B as a guest worker visa for entry-level jobs. However, delays in the processing and wait times for a green card have made the H-1B the de facto first visa for the majority of doctorates, especially individuals from India and China. This inefficient visa path through the H-1B increases not only uncertainty for workers but also the costs for many employers who spend thousands of dollars per employee to first sponsor them for an H-1B and then several thousand more for permanent residency. These inefficiencies suggest that a streamlining of the path from doctorate to permanent residency or changes to the H-1B program may be warranted (15).

Visa reforms that specifically target STEM Ph.D.'s from U.S. universities—with oversight to avoid fraudulent dissertations and job offers—could have broad benefits by facilitating and easing doctorates' transitions to permanent residence. A simplified path toward permanent residency could be especially beneficial in leveling the playing field for early-stage technology startups that are at a disadvantage in hiring workers who require visa sponsorship (10). In

addition, exempting STEM Ph.D.'s from national quotas for green cards would not only facilitate their pathway to permanent residency but could also help U.S. firms to retain top scientists and engineers where they can contribute to innovation and economic growth. Our findings align with the proposed immigration policies of President-elect Biden, who within his first 100 days intends to implement a program that would provide recent STEM doctorates from U.S. universities with a green card that is exempt from national quotas. ■

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