# Visa Policy Changes and Post-Graduation Job Relatedness among Foreign Doctorate Recipients: Evidence from the American Competitiveness Acts

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**Abstract**

I use the Survey of Earned Doctorates to study effects of two "American Competitiveness Acts" on foreign doctoral recipients' job relatedness. The Acts resulted in the increase in the working-visa cap, and the creation of an uncapped visa category for non-profit organizations (e.g., universities). Results suggest visa policy changes under American Competitiveness Acts increased foreign doctoral recipients' job relatedness, which was further associated with the rise in university employment among foreign doctorates. The main findings are robust to changes to specification or sample, and other possible mechanisms (e.g., selection on the field of study) are unlikely to explain the findings.

**Keywords**: visa policy, H-1B, foreign doctorate, job relatedness, employment

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# 1 Introduction

Many doctoral students face the career choice between academia and industry (Sauermann and Roach, 2012). But after years of specialized training, many students ask a more fundamental question upon graduation: can I find a job related to my field of study (Robst, 2007)? Things can be even more complicated for international students: the job offer and employment status—either in academia or in industry, regardless of job relatedness—are contingent upon the procurement of visa status for employment. Therefore, visa policy changes could potentially affect occupational choices of foreign doctorate recipients. In this paper, I study the H-1B program in the U.S. and examine effects of changes in H-1B's program rules around 2000 on foreign doctorate recipients' post-graduation job relatedness, and analyze possible mechanisms behind the effects.

The H-1B visa is a U.S. visa that allows U.S. employers to hire foreign workers. The Immigration Act of 1990 set a cap of 65,000 on new H-1B visas for each fiscal year. In 1998, the H-1B annual cap was temporarily increased to 115,000 for 1999 and 2000 by the American Competitiveness and Workforce Improvement Act (ACWIA), and further increased to 195,000 for 2001, 2002, and 2003 by the American Competitiveness in the 21st Century Act (AC21) passed in October 2000. Moreover, the AC21 was the first immigration act that created an uncapped H-1B category for non-profit research organizations, such as universities. In this paper, I focus on the effects of these two acts. The H-1B cap returned to 65,000 (but with additional 20,000 visas for U.S. postgraduate degree recipients) in the H-1B Visa Reform Act of 2004 (Funke, 2015).

The Survey of Earned Doctorates (SED) shows that both universities and the industry absorb about 40% of recent foreign doctorate recipients in the U.S., respectively.[1] Those who work in universities are more likely to work related to their field of study. Therefore,

[1]Note that the AC21 created the uncapped H-1B category for not only universities, but also other non-profit organizations that might be considered as employers in the industry. However, the SED only surveys whether graduates work in "universities" or "business and industry" (as well as a much smaller sector "government" for foreigners). That said, most uncapped H-1B visa holders should work in U.S. universities given that most employers in "business and industry" are not non-profit organizations.

the above H-1B visa policy changes could generate two types of effects on foreign doctorate recipients' occupational choices: industry employers became potentially more able to hire foreign doctorate recipients following the ACWIA and AC21, but might not always be able to offer jobs related to their field of study; on the other hand, foreign doctorate recipients were likely to work in universities (and other non-profit organizations) with uncapped H-1B visas, and these jobs could be more related to their field of study.

Prior research studies two scenarios related to the context of visa policy changes in this paper. Lan (2012, 2013) exploits the natural experiment of the Chinese Student Protection Act of 1992 (CSPA), which established permanent residence for Chinese students in the U.S. after the 1989 Tiananmen Square Protests. He finds that many CSPA beneficiaries—who no longer needed H-1B visas—left academia, and did not necessarily take jobs related to their field of study. Amuedo-Dorantes and Furtado (forthcoming) examine an opposite setting of the H-1B Visa Reform Act of 2004, under which the H-1B cap was reduced from 195,000 to 65,000, but uncapped H-1B visas for non-profit organizations were not affected. They find that the H-1B Visa Reform Act of 2004 raised foreign students' likelihood of employment in academia. In this paper, two American Competitiveness Acts (in particular, the AC21) generated a mixture of both types of effects of visa policy changes: foreign doctorate recipients, similar to CSPA beneficiaries, could potentially have more occupational choices in both academia and industry with the increase in the H-1B cap, and industry jobs are statistically less related to students' field of study; on the other hand, the newly created uncapped H-1B category made university jobs a good option to secure the valid work permit in the U.S. It is thus an empirical question to determine the sign of the effects of H-1B visa policy changes on job relatedness, and furthermore, the channel through which visa policy changes affected job relatedness among foreign doctorate recipients.

To study this, I utilize the Survey of Earned Doctorates (SED) sample from 1995 and 2006, and focus on the most recent cohort of graduates in each sample. The year of graduation varies from 1990 (when H-1B visas became capped) to 2004 (when the H-1B Visa

Reform Act was passed), and during this period of time, the ACWIA and AC21 came into effect. Pooling the above samples of recent doctoral recipients, I observe both citizens/permanent residents who need not to acquire visa status for employment and other foreigners who need visas to work in the U.S., and compare their post-graduation outcomes before and after visa policy changes were introduced by the ACWIA and AC21. I find that as the result of visa policy changes under American Competitiveness Acts, foreign doctorate recipients became more likely to take jobs related to their field of study, and this was associated with the rise in university employment.

I conduct several additional tests to check the robustness of the above findings. First, I find that pre-trends are indistinguishable from zero, suggesting foreign doctorate recipients' post-graduation job relatedness should follow similar trends with citizens and permanent residents in the absence of visa policy changes. Second, I conduct placebo tests in which I suppose that visa policy changes occurred in other years, and find less or no significant effects in these "placebo treatment years". These suggest trends in job relatedness among foreign doctorate recipients were most likely to be affected by two American Competitiveness Acts. In addition, I examine several types of changes to specification or sample, and find the main results remain robust.

I further discuss the mechanisms behind the effects of visa policy changes on foreign doctorate recipients' job relatedness. The SED shows that jobs in universities are generally more related to the field of study among doctoral recipients, including foreigners. Hence, the positive effect of visa policy changes on foreign doctorate recipients' job relatedness could be mainly through the rise in university employment, encouraged by the uncapped H-1B category created in the AC21. In particular, the ACWIA, which increased the number of H-1B visas but did not create the uncapped H-1B category, had no significant effect on job relatedness. On the other hand, I find no significant effects of visa policy changes on job relatedness conditional on either university or industry employment. I also find no evidence of selection on the field of study related to visa policy changes. These suggest the creation

of the uncapped H-1B category, rather than the increase in the H-1B cap, might play a more crucial role in affecting foreign doctorate recipients' post-graduation job relatedness.

Understanding the effects of visa policy changes on foreign doctorate recipients' post-graduation job relatedness has important policy implications. Immigrants contribute to the U.S. in terms of innovation (Hunt and Gauthier-Loiselle, 2010; Foley and Kerr, 2013) and total factor productivity (Peri et al., 2015); the effects are especially large among doctoral-level scholars (Gaulé and Piacentini, 2013; Moser et al., 2014). As doctoral students usually receive several years of specialized training (which are costly for U.S. graduate schools), job unrelatedness and skill mismatches among foreign doctorate recipients might lead to suboptimal outcomes for the economy, and having them work in their related fields could generate high returns to education, at least for their research fields.

This paper also contributes to the literature of labor economics and economics of education. Job relatedness and education-occupation mismatches are crucial issues in the labor market (Heijke et al., 2003; Robst, 2007), which could be associated with unemployment (Manacorda and Petrongolo, 1999; Thisse and Zenou, 2000), labor productivity (Patterson et al., 2016), and earnings (Vahey, 2000; Nordin et al., 2000; Di Pietro and Urwin, 2006; McGuiness and Sloane, 2011; Caliendo et al., 2012). This paper sheds light on this topic by pointing out that increasing the number of working visas by sector for high-skilled immigrants could generate positive effects on job relatedness among them.

The main findings of this paper lead to a further question related to labor market policies: if the degree of post-graduation job relatedness did rise among foreign students, what were the main "contributors" behind the effects on job relatedness? In the context of this paper, two American Competitiveness Acts guaranteed both unlimited visas for university jobs and a much higher visa cap for industry jobs. This paper shows that although both sectors became more able to hire foreigners, there was no clear evidence of the within-sector rise in job relatedness. Instead, the sector-specific policy (i.e., the creation of the uncapped visa category for university jobs) could play a key role in affecting job relatedness than the

vis policy towards all types of jobs (i.e., the rise in the total H-1B cap).

The rest of the paper is structured as follows. Section 2 introduces the background of this paper. Section 3 discusses data and empirical analysis. Section 4 presents main findings of the effects of H-1B visa policy changes on job relatedness among foreign doctorate recipients in the U.S. Section 6 concludes the paper.

# 2 Background

This section introduces the background of this paper. I first discuss the H-1B visa program in the U.S., and how the program rules changed in two American Competitiveness Acts passed around 2000. I then focus on job relatedness and analyze how visa policy changes could potentially affect foreign doctorate recipients' post-graduation job relatedness.

## 2.1 H-1B Visas and American Competitiveness Acts

The H-1B visa is a U.S. visa category established in the Immigration and Nationality Act of 1965 (Hutchinson, 1981). It allows U.S. employers to hire foreign nationals that are not citizens or permanent residents. The Immigration Act of 1990 set an annual cap of 65,000 for new H-1B visa each fiscal year. This act intensified the "competition" of sponsoring H-1B status for foreign nationals among U.S. employers, as only a limited number of foreigners could obtain the H-1B visa each year.

The H-1B program has long been considered as a tool for enhance American competitiveness, as it absorbed high-skilled immigrants from other countries. It experienced an "oversubscription crisis" in 1997, when H-1B admissions reached the annual cap and the U.S. high-tech industry faced shortages of skilled information technology professionals (Hahm, 2000). As a result, on October 21, 1998, the American Competitiveness and Workforce Improvement Act (ACWIA) was passed by the U.S. government, which increased the annual H-1B cap to 115,000 for 1999 and 2000. The H-1B cap was further increased to

195,000 under the American Competitiveness in the 21st Century Act (AC21) in October 2000, and remained at 195,000 in the next few years, until it returned to 65,000 in 2005 under the H-1B Visa Reform Act of 2004. Another new H-1B program rule under the AC21 was the creation of the uncapped H-1B category for jobs in non-profit organizations, and a large number of such jobs are concentrated in universities.

Many studies have discussed how the U.S. economy—especially its high-tech industry—benefits from the H-1B program (Hahm, 2000). Kerr and Lincoln (2010) find that the H-1B program increases science and engineering employment among immigrants, and has positive effects on patenting among firms dependent upon foreign workers. The H-1B program also affects employment structures of U.S. firms, in the sense that the H-1B program leads to increasing overall employment of skilled workers, and in particular, the rise in skilled immigrant employment at the firm level (Kerr et al., 2011), although only a subset of firms that are dependent on foreign professionals might benefit from H-1B visas (Ghosh et al., 2014; Doran et al., 2015). In general, researchers find the complementary role of foreign professionals (e.g., Peri et al., 2015; Aobdia et al., forthcoming).

The H-1B program also has potentially positive effects on U.S. academia. Researchers generally recognize that inflows of international students result in a brain gain for the U.S. (Dreher and Poutvaara, 2011), and indeed, foreign academicians start to contribute to U.S. scientific productivity even starting from their doctoral training (e.g., Gaulé and Piacentini, 2013; Freeman and Huang, 2015; Borjas et al., 2017), and can further boost U.S. research and development in their academic careers (Borjas and Doran, 2012; Moser et al., 2014).

Foreign nationals also benefit from the H-1B program. Clemens (2013) studies Indian software engineers whose H-1B admissions are randomly chosen (due to the H-1B oversubscription), and finds the huge earning gap between those who remain in the U.S. and those who move back to India. Similarly, the earning gap exists in academia between the U.S. and other countries. But another related question specifically for foreign doctorates is the earning gap between industry and university jobs in the U.S. In general, industry jobs

offer higher salaries (and there is a minimum salary requirement for capped H-1B visas). Lan (2012) finds that following the passage of the Chinese Student Protection Act, many Chinese students left academia after obtaining permanent residency (thus H-1B visa status became no longer applicable). On the other hand, foreigners might still prefer university jobs if such jobs become unrestricted by immigration laws. This is exactly reflected in Amuedo-Dorantes and Furtado's findings (forthcoming): foreign doctorates became more likely to choose university jobs after the H-1B Visa Reform Act, because university jobs provided a secure option for foreigners to obtain the valid work permit in the U.S.

## 2.2 Job Relatedness among Foreign Doctorate Recipients

I now focus specifically on job relatedness among foreign doctorate recipients in the U.S. Job relatedness is an important topic in labor economics, as it is positively associated with labor market outcomes (e.g., Vahey, 2000; Nordin et al., 2000; Di Pietro and Urwin, 2006; Boschma et al., 2009; McGuiness and Sloane, 2011; Caliendo et al., 2012; Venhorst and Cörvers, 2018). Researchers have long observed that the major or field of study is one of the most important determinants of post-graduation job-relatedness among post-secondary professionals (e.g., Robst, 2007; Ohyama, 2015). On the other hand, employment characteristics play a less crucial role (Boudarbat and Chernoff, 2012).

This is possibly similar for doctorates, especially for foreigners. Unsurprisingly, universities usually (although not always) provide jobs that are related to doctorates' field of study, as research positions are much more common in universities, and are more specialized than industry jobs. Also, only a subset of U.S. firms—usually larger and high-tech ones—sponsor H-1B visas for international students (e.g., Ghosh et al., 2014; Kerr et al., 2015), and it is not always possible to provide highly related jobs for doctorates who receive specialized training in the graduate school, given within-firm occupation constraints. In Section 3 and 4, I will show that the degree of job relatedness is indeed higher among university jobs in SED data used in this paper.

How could two American Competitiveness Acts potentially affect post-graduation job relatedness among foreign doctorate recipients? First, with the increase in the H-1B cap, both the university and industry sector could absorb more foreigners. The degree of job relatedness would be affected by visa policy changes if two sectors absorbed foreign doctorates disproportionately, which was similar to the context of the CSPA (Lan, 2012). Second, with the creation of the uncapped H-1B category, foreign doctoral recipients might prefer university jobs to secure the work permit in the U.S., which would further affect job relatedness. The above mechanisms reflect the direct effects of visa policy changes on job relatedness among foreign doctorate recipients.

However, it is possible that visa policy changes affected trends in job relatedness through indirect channels. First, visa policy changes might affect the labor market structure within each sector. Specifically, if industry jobs became statistically more (or less) related to doctorates' field of study, then visa policy changes could still affect foreign doctorate recipients' job relatedness even if the industry and university sector followed similar trends in hiring foreigners after visa policy changes. Second, visa policy changes could result in selection on the field of study, and the field of study is a crucial determinant of job relatedness (e.g., Robst, 2007). It is unlikely that visa policy changes have any immediate causal effect on the field of study among foreigners given the length of the doctoral program, but pre-trends related to visa policy changes (such as shortages of highly educated professionals) might still result in selection on the field of study among foreign students. I will discuss both the direct and indirect mechanisms behind effects of visa policy changes in Section 4.

# 3 Data and Empirical Strategies

This section discusses data and empirical strategies. I first introduce the Survey of Earned Doctorates (SED) used in this paper. I then present descriptive statistics of the dataset. I conclude this section by analyzing the empirical strategies.

## 3.1 Data and Descriptive Statistics

In this paper, I use the integrated SED sample (Minnesota Population Center, 2016) that covers the survey year 1995, 1997, 1999, 2001, 2003, and 2006. In each subsample, I focus only on the most recent cohort of doctoral recipients within the five-year interval, but in the 2006 SED I only select those who graduated in or before 2004, and thus the graduation year in the sample varies from 1990 to 2004. I only include employed doctorates (which are more than 95% of all individuals in the sample).

The SED surveys demographic characteristics, educational background, and employment information. In particular, the SED surveys questions about the country of origin and visa status, hence I can determine foreign doctorate recipients who need to acquire the visa to work in the U.S., as well as citizens and permanent residents who do not need working visas. Citizens and permanent residents thus serve as the "control group" in this study.

Table 1: Descriptive Statistics: Individual Biographic Characteristics

| | Full sample | Citizens/per. res.† | Foreigners (H-1B) |
|---|---|---|---|
| Survey year | 1999.282 | 1999.193 | 1999.546 |
| | (4.080) | (4.032) | (4.209) |
| Age | 37.565 | 37.962 | 36.380 |
| | (6.711) | (7.158) | (4.962) |
| Male | 0.587 | 0.555 | 0.681 |
| | (0.492) | (0.497) | (0.466) |
| Asian | 0.242 | 0.106 | 0.650 |
| | (0.428) | (0.307) | (0.477) |
| White | 0.598 | 0.714 | 0.250 |
| | (0.490) | (0.452) | (0.433) |
| Under-rep. minorities | 0.159 | 0.178 | 0.100 |
| | (0.356) | (0.383) | (0.300) |
| Minority | 0.160 | 0.180 | 0.100 |
| | (0.367) | (0.384) | (0.300) |
| Number of children | 0.818 | 0.784 | 0.918 |
| | (1.071) | (1.072) | (1.062) |
| Observations | 23,369 | 17,506 | 5,863 |

Standard deviations are in parentheses. †: "per. res." means "permanent residents".

Table 1 presents the descriptive statistics of biographic characteristics. I first present statistics in the full sample, and then in the subsample of citizens/permanent residents and

foreigners who need H-1B visas, respectively. Survey years were concentrated around 1999. The average age of doctorates in the sample was 37.6 years, while foreigners were slightly younger. Note that based on the design of the data structure in this paper, respondents were surveyed up to five years after graduation. 58.7% of doctorates in the sample were male, while there were more male doctorates among foreigners. 24.2% of doctorates were Asians. There were many Asian-born students who received doctoral education in the U.S., while there were also 10.6% of citizens or permanent residents in the sample that were Asians. The whites were majorities of doctorates. Other doctorates were considered to be "under-represented minorities" in the SED. Note that the SED also has another minority measure independent from the race variable. This minority measure, however, appears to be very similar to the option of "under-represented minorities" within the race variable. Finally, the average number of children among all doctorates in this sample was less than 1, while foreign doctorates had slightly more children.

Table 2: Descriptive Statistics: List of Major Fields (Major Group)

| | Full sample | Citizens/per. res. | Foreigners (H-1B) |
|---|---|---|---|
| CS/math | 0.075 | 0.064 | 0.107 |
| Biology/related | 0.314 | 0.333 | 0.257 |
| Physics/related | 0.083 | 0.077 | 0.100 |
| Chemistry/related | 0.067 | 0.064 | 0.077 |
| Social sciences | 0.239 | 0.278 | 0.122 |
| Engineering | 0.200 | 0.159 | 0.322 |
| Health-related | 0.021 | 0.024 | 0.014 |
| Observations | 23,369 | 17,506 | 5,863 |

Table 2 presents the list of major fields. For simplicity, here I only list major groups: (a) computer science and mathematics; (b) biology and related fields; (c) physics and related fields; (d) chemistry and related fields; (e) social sciences; (f) engineering; and (g) other health-related fields. There were around 0.1% of all doctorates in the sample reported other fields. The SED also surveys more detailed fields of study (e.g., economics, mechanical engineering), and in the empirical analysis I will control for the detailed fields. Table 2 shows that compared with citizens, foreign doctorates were relatively more likely

to major in computer science, mathematics, physics, chemistry, and engineering, but were significantly less likely to major in biology and social sciences.

Table 3: Descriptive Statistics: Post-Graduation Labor Market Outcomes

| | Full sample | Citizens/per. res. | Foreigners (H-1B) |
|---|---|---|---|
| Job relatedness | 0.726 | 0.724 | 0.733 |
| | (0.446) | (0.447) | (0.442) |
| Sector: college/ | 0.542 | 0.557 | 0.494 |
| university | (0.498) | (0.497) | (0.500) |
| Sector: industry | 0.368 | 0.335 | 0.466 |
| & business | (0.482) | (0.472) | (0.499) |
| Size of employer: | 0.212 | 0.214 | 0.208 |
| $< 500$ | (0.409) | (0.410) | (0.406) |
| Size of employer: | 0.620 | 0.622 | 0.613 |
| $> 5{,}000$ | (0.485) | (0.485) | (0.487) |
| Log annual wage | 10.928 | 10.922 | 10.945 |
| (adjusted) | (0.573) | (0.565) | (0.597) |
| Observations | 23,369 | 17,506 | 5,863 |

Standard deviations are in parentheses.

Table 3 presents the summary of post-graduation labor market outcomes. The first row shows that 72.6% of all employed doctorates had a job related to the field of study. This proportion is slightly higher among foreigners. There were significant differences in the employment sectors among two groups of people: foreign doctorates were less likely to work in U.S. colleges and universities, and were more likely to work in the industry and business sector. The differences in the size of the employer was small: approximately 21% of doctorates worked for employers with less than 500 employees, and 62% of doctorates worked for employers with more than 5,000 employees. Finally, the log annual wage, after the CPI adjustment, was 10.928, and foreign doctorates had higher average earnings.

The above three tables present statistics in the full sample that covers all SED panels in this paper. It is useful to split the full sample and discuss the "conditional" outcomes. In Table 4 I present job variables by graduation year. Panel A shows that before 2001, approximately 72% of doctorates had a job related to the field of study, and the average degree of job relatedness was slightly higher among foreigners. There were much fewer foreigners who worked in U.S. universities after graduation; in contrast, more than half

of all foreign doctorates worked in the industry or business sector. The above patterns reversed after 2001. Panel B presents a sharp increase in job relatedness among foreigners after 2001. Moreover, 59% of foreign doctorate recipients worked in U.S. universities, which was very close to the proportion among citizens and permanent residents.

Table 4: Jobs Before and After the Acts, by Graduation Year

| | Full sample | Citizens/per. res. | Foreigners (H-1B) |
|---|---|---|---|
| **A. Before 2001** | | | |
| Job relatedness | 0.726 | 0.729 | 0.715 |
| University jobs | 0.522 | 0.544 | 0.450 |
| Industry jobs | 0.386 | 0.348 | 0.509 |
| Observations | 16,840 | 12,825 | 4,015 |
| **B. In/after 2001** | | | |
| Job relatedness | 0.729 | 0.712 | 0.771 |
| University jobs | 0.593 | 0.593 | 0.591 |
| Industry jobs | 0.320 | 0.298 | 0.373 |
| Observations | 6,529 | 4,681 | 1,848 |

Observations are in brackets.

Table 5: Conditional Labor Market Outcomes

| | Conditional on | Full sample | Citizens/per. res. | Foreigners (H-1B) |
|---|---|---|---|---|
| Job relatedness | university | 0.807 | 0.801 | 0.829 |
| Log annual wage (adjusted) | university | 10.746 (0.518) | 10.760 (0.510) | 10.699 (0.542) |
| Observations | | 12,658 | 9,759 | 2,899 |
| Job relatedness | industry | 0.614 | 0.606 | 0.631 |
| Log annual wage (adjusted) | industry | 11.170 (0.581) | 11.152 (0.592) | 11.207 (0.556) |
| Observations | | 8,589 | 5,856 | 2,733 |

Standard deviations are in parentheses.

I further present descriptive statistics of post-graduation labor market outcomes conditional on the employment sector. Table 5 shows that university jobs were generally more related to doctoral recipients' field of study. Moreover, within both sectors, foreigners were more likely to choose jobs related to their field of study. On average, industry jobs were associated with higher earnings; compared with citizens and permanent residents, foreigners had relatively higher earnings in the industry sector, but lower earnings in U.S. universities.

## 3.2 Empirical Strategies

I now introduce the empirical strategies of this paper. I first estimate the following baseline specification:

$$R_{ijkt} = \alpha_0 + \alpha_1 T_k + \alpha_2 A_t + \alpha_3 (T_{kt} \times A_t) + \mathbf{X}_{ijkt}\alpha_4 + \varepsilon_{ijkt} \tag{1}$$

where $i$ indexes individual, $j$ indexes the major field of study in $i$'s graduate school, $k$ indexes the country of citizenship if $i$ is not a U.S. citizen or a permanent resident, and $t$ is the year of graduation. The dependent variable $R_{ijkt}$ is a binary indicator of job relatedness interviewed in the SED. $T_k$ is a indicator of the H-1B treatment, which equals 1 if $i$ is a foreign national that needs to acquire visa status for U.S. employment, and 0 otherwise (i.e., $i$ is a citizen or permanent resident). $A_t$ is a indicator of the timing of the AC21. $T_{kt} \times A_t$ is the interaction term between two variables, and is the variable of key interest. This term compares the difference in job relatedness between citizens/permanent residents and foreign nationals before and after the passage of two American Competitiveness Acts. Although both the ACWIA and AC21 increased the H-1B cap, only the AC21 created the uncapped H-1B category for non-profit organizations such as universities. $\mathbf{X}_{ijkt}$ is the vector of control variables, such as demographic characteristics and educational background.

One can further explore the above baseline specification by estimating a model within an event-study framework, with additional controls:

$$R_{ijkt} = \beta_0 + \beta_1 T_k + \sum_{\substack{1990 \leq y \leq 2004 \\ y \neq 1997, 1998}} \beta_2^{(y)} T_k \times \tau_y + \mathbf{X}_{ijkt}\beta_3 + \kappa_{jt} + \varepsilon_{ijkt} \tag{2}$$

By estimating Equation 2, I can account for the possible heterogeneity in the treatment effect by year. Furthermore, I now include the field-by-year fixed effects $\kappa_{jt}$ in Equation 2, which captures the demand and supply of doctorates by the field of study in the U.S. labor market in each specific year. In both Equation 1 and 2, I cluster the standard errors at the

field-by-year level.

In Equation 2 I omit the graduation year 1997 and 1998, when the H-1B program was oversubscribed (Hahm, 2000) and the ACWIA was passed one year later. I mainly focus on the coefficients of $\{\beta_2^{(y)}\}$. For $y \geq 1999$, the coefficients reflect how visa policy changes under two American Competitiveness Acts affected job relatedness among foreign doctorate recipients. On the other hand, one would expect coefficients for $y < 1999$ to be indistinguishable from zero, so that trends in job relatedness should be similar regardless of citizenship status in the absence of visa policy changes.

Even if the estimation of Equation 2 presents the significant association between visa policy changes and job relatedness among foreign doctoral recipients, one might worry about whether visa policy changes had "direct" effects on job relatedness, or the effects weere through some intermediate factors that are influenced by visa policy changes. As discussed in Section 2, one concern is that visa policy changes could result in changes in job relatedness within each employment sector. One way to examine this mechanism is to run the similar specification conditional on the employment sector. Another possible concern is selection on the field of study. Selection on the field of study might affect trends in foreign doctoral recipients' job relatedness, as the rate of post-graduation university (and industry) employment, and furthermore, the degree of job relatedness vary by field of study (e.g., Robst, 2007), and the H-1B program does affect U.S. graduate school admissions (Shih, 2016). Although in Section 2 I argue that visa policy changes cannot generate any immediate effect on the field of study among international students given the length of doctoral studies and doctoral program applications, it is still useful to check selection on the field of study. One can use the proportion of the field of study as the dependent variable in the similar specification, and analyze whether visa policy changes resulted in selection on the field of study. These empirical investigations help understand how visa policy changes under the American Competitiveness Acts affected trends in post-graduation job relatedness among foreign doctoral recipients in the U.S.

# 4 Results

This section reports the empirical results of this paper. I first present main findings. I then conduct additional tests to check the robustness of the main conclusion of this paper. I finally discuss other possible indirect mechanisms behind the effects of visa policy changes.

## 4.1 Main Findings

I first report main findings of this paper. In Table 6, I run six regressions of post-graduation job relatedness on visa policy changes based on Equation 1 and 2. In Column 1 I focus only on foreign doctorates and run a regression which is essentially a first-difference model that compares job relatedness before and after visa policy changes. Results show that American Competitiveness Acts passed around 2000 had a significantly positive effect on job relatedness among foreign doctorates. I include the control group of citizens and permanent residents, and find an even larger effect size in Column 2. In Column 3 I rerun the model with individual controls, field of study fixed effects, and year fixed effects, and find the quantitatively similar effect of visa policy changes on foreigners' post-graduation job relatedness. In Column 4 I include field-by-year fixed effects (and thus field and year fixed effects are dropped), and find a smaller effect size, but the result is still significant.

The above specifications are all based on Equation 1. This simple difference-in-difference framework has a major concern that effects of visa policy changes could be heterogeneous over time. This is especially true in the context of this paper: I define the AC21 as the "treatment", while the passage of the ACWIA could also affect job relatedness through the increase in the H-1B cap. Furthermore, the magnitude of the effect might change over time. In Column 5 and 6 I run a specification similar to Equation 2, with years clustered into several intervals. In Column 5 I control for field and year fixed effects, and in Column 6 I control for field-by-year fixed effects. Both columns show that the coefficients for year clusters prior to passage of two American Competitiveness Acts (before 1999)

Table 6: Visa Policy Changes and Post-Graduation Job Relatedness

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Sample: | Foreign | All | All | All | All | All |
| | *Mean at* $y = 1997, 1998$, foreigners: $R = 0.686$ | | | | | |
| Treatment × Post | 0.056** | 0.072*** | 0.069*** | 0.048*** | | |
| | (0.023) | (0.023) | (0.017) | (0.017) | | |
| Treatment × (90 - 94) | | | | | 0.017 | 0.018 |
| | | | | | (0.023) | (0.022) |
| Treatment × (95 - 96) | | | | | 0.033 | 0.028 |
| | | | | | (0.023) | (0.023) |
| Treatment × (99 - 00) | | | | | −0.046 | −0.059 |
| | | | | | (0.049) | (0.055) |
| Treatment × (01 - 02) | | | | | 0.061** | 0.049* |
| | | | | | (0.028) | (0.027) |
| Treatment × (03 - 04) | | | | | 0.080*** | 0.057** |
| | | | | | (0.023) | (0.022) |
| Individual controls | No | No | Yes | Yes | Yes | Yes |
| Year fixed effects | No | No | Yes | No | Yes | No |
| Field fixed effects | No | No | Yes | No | Yes | No |
| Field-by-year FE | No | No | No | Yes | No | Yes |
| Observations | 5,863 | 23,369 | 23,369 | 23,369 | 23,369 | 23,369 |
| Adjusted $R^2$ | 0.003 | 0.001 | 0.026 | 0.030 | 0.158 | 0.160 |

Standard errors are in parentheses and are clustered at the field-by-year level. *: $p < .1$; **: $p < .05$; ***: $p < .01$.

are indistinguishable from zero. This suggests that both foreigners who need the H-1B visa and citizens and permanent residents who do not need the visa should follow similar trends in job relatedness in the absence of visa policy changes under American Competitiveness Acts. The coefficients for year clusters after passage of the AC21 (after 2000) are significantly positive, suggesting the association between visa policy changes and post-graduation job relatedness among foreigners. The coefficient for the year cluster 1999 and 2000 is negative (although insignificant). This indicates that the ACWIA might have an opposite effect on foreigners' post-graduation job relatedness, compared with the AC21. Although surprising at first glance, this might suggest the creation of the uncapped H-1B category for non-profit organizations—under only the AC21 but not the ACWIA—played a more important role in determining job relatedness than the increase in the H-1B cap. I further plot estimates of effects of visa policy changes by year in Figure 1, where I control for field and year fixed effects in the first sub-figure, and field-by-year fixed effects in the

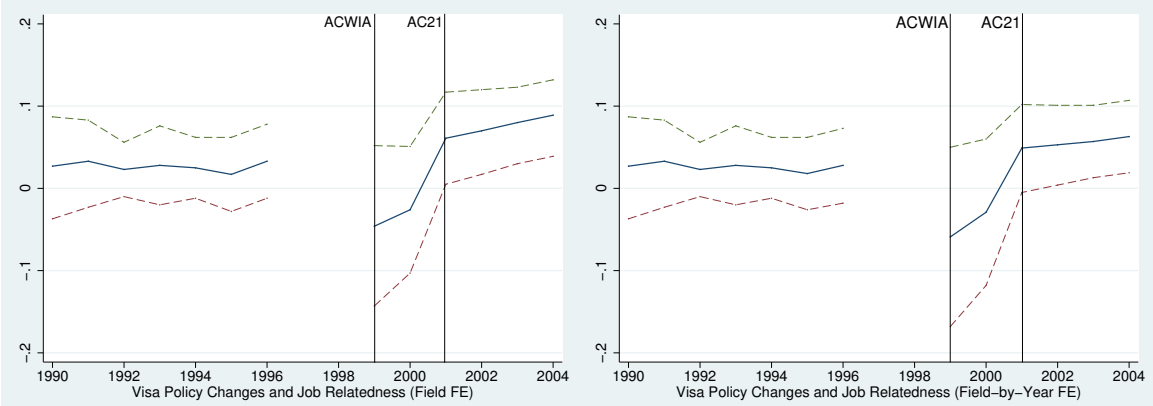


Figure 1: Visa Policy Changes and Job Relatedness: Estimates by the Graduation Year

second sub-figure. Results are consistent with the empirical conclusion of Table 1.

Results presented in Column 5, 6 of Table 6 suggest the different roles of the uncapped H-1B category and the rise in the H-1B cap under two American Competitiveness Acts. As analyzed earlier, a possible explanation is that the rise in the H-1B cap could lead to the increase in employment in both sectors, but the creation of uncapped H-1B category could largely encourage foreign doctorate recipients to take university jobs.

Table 7: Visa Policy Changes and Employment by Sector among Foreigners

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Employment: | University Employment | | | | Univ. & Government | |
| | *Mean at* $y =$ 1997, 1998, foreigners: $U = 0.372$ | | | | $U/G = 0.414$ | |
| Treatment $\times$ $\text{Post}_{2001}$ | 0.068*** | 0.066*** | | | 0.051** | |
| | (0.022) | (0.022) | | | (0.024) | |
| Treatment $\times$ $\text{Post}_{1999}$ | | | 0.060*** | 0.060*** | | 0.044* |
| | | | (0.022) | (0.022) | | (0.024) |
| Individual controls | Yes | Yes | Yes | Yes | Yes | Yes |
| Year fixed effects | Yes | No | Yes | No | No | No |
| Field fixed effects | Yes | No | Yes | No | No | No |
| Field-by-year FE | No | Yes | No | Yes | Yes | Yes |
| Observations | 23,369 | 23,369 | 23,369 | 23,369 | 23,369 | 23,369 |
| Adjusted $R^2$ | 0.115 | 0.120 | 0.114 | 0.120 | 0.139 | 0.139 |

Standard errors are in parentheses and are clustered at the field-by-year level. *: $p < .1$; **: $p < .05$; ***: $p < .01$.

To study this hypothesis, I reexamine Equation 1 but using university employment as the dependent variable. Column 1 and 2 show that the AC21 had a positive effect on university employment among foreigners. In Column 3 and 4 I redefine the timing of the treatment, and include both the ACWIA and AC21 in the binary post-treatment indica-

tor. Results still show the significant effect, but the effect size becomes smaller, indicating that including the ACWIA in the "treatment" could weaken the estimated effect on university employment, as it only resulted in the increase in the H-1B cap but not the uncapped H-1B category for university employment. In Column 5 and 6 I use university and government employment as the dependent variable—as most government jobs also belong to the uncapped H-1B category—and still find the positive effect of the AC21; however, the effect of the combination of two acts becomes smaller and less significant, again suggesting that the ACWIA did not result in the increase in university and government employment. In sum, Table 7 presents evidence that the rise in post-graduation job relatedness among foreign doctorate recipients following two American Competitiveness Acts appears to be closely associated with the rise in university employment. Including the ACWIA—which did not create H-1B visas specifically for universities—in the treatment indeed weakens effects on university employment among foreign doctorate recipients in the estimation.

## 4.2 Additional Tests

I now conduct additional tests to check the robustness of the main findings of this paper reported earlier. I consider three types of robustness checks: (a) placebo tests; (b) changes to specification; and (c) changes to sample.

I start with placebo tests. To do so, I assume that the AC21 first became effective in years other than 2001. I then estimate these fake treatment effects by "placebo year" based on Equation 1, and plot the distribution of all treatment effects. Ideally, the size of the treatment effect should be largest when visa policy changes occurred in 2001—which is the true year of the passage of the AC21.

In Figure 2 I plot the estimates in placebo tests. Note that now the point in each year does not represent the event-study estimate (i.e., similar to those in Figure 1); instead, each sub-figure of Figure 2 presents the distribution of the magnitude of the treatment effect by year. In the first sub-figure I examine job relatedness and in the second sub-figure

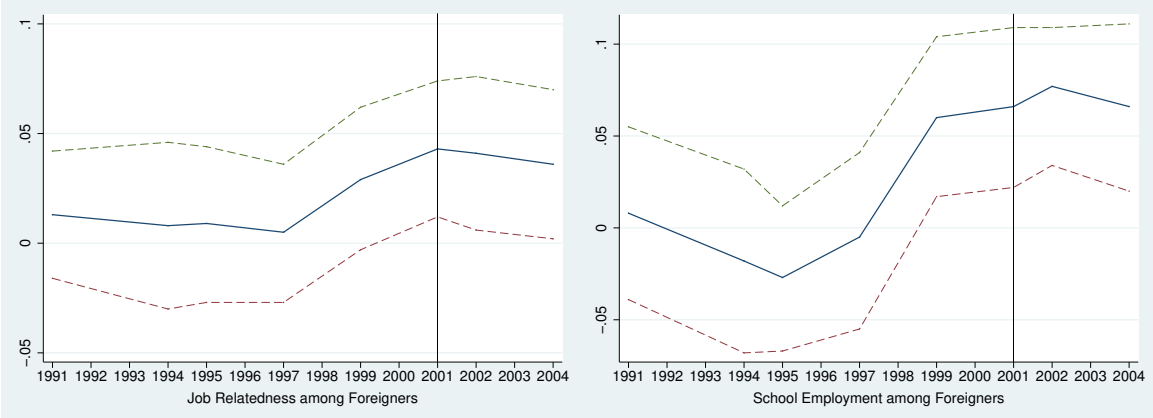


Figure 2: The Effects of Visa Policy Changes: Estimates by the Graduation Year

I examine school employment among foreign doctorate recipients in the U.S. Both sub-figures show that the effects of visa policy changes are largest around 2001, the exact year of the passage of the AC21. In particular, I find statistically insignificant effects for all years prior to 1999. The results of Figure 2 suggest that trends in job relatedness among foreign doctorate recipients are most likely to be affected by visa policy changes under American Competitiveness Acts, which are further associated with trends in university employment among foreigners affected by the acts.

I now turn to examine changes to specification. In Figure 3, I plot event-study estimates based on two variations of Equation 2. In the first sub-figure, I include the post-graduation job code into the specification and control for occupation-by-year fixed effects (instead of field-by-year fixed effects). Results are consistent with the main empirical conclusion discussed in Section 4.1: first, pre-trends are statistically indistinguishable from zero, indicating that both foreigners and citizens/permanent residents should follow similar trends in post-graduation job relatedness in the absence of visa policy changes; second, visa policy changes under American Competitiveness Acts, and in particular the AC21, positively affected job relatedness conditional on occupations by year; third, estimates for years between the passage of the ACWIA and AC21 are negative (although not significant), suggesting that only increasing the H-1B cap would not positively affect job relatedness among foreigners, and the creation of uncapped H-1B category played a different role than the

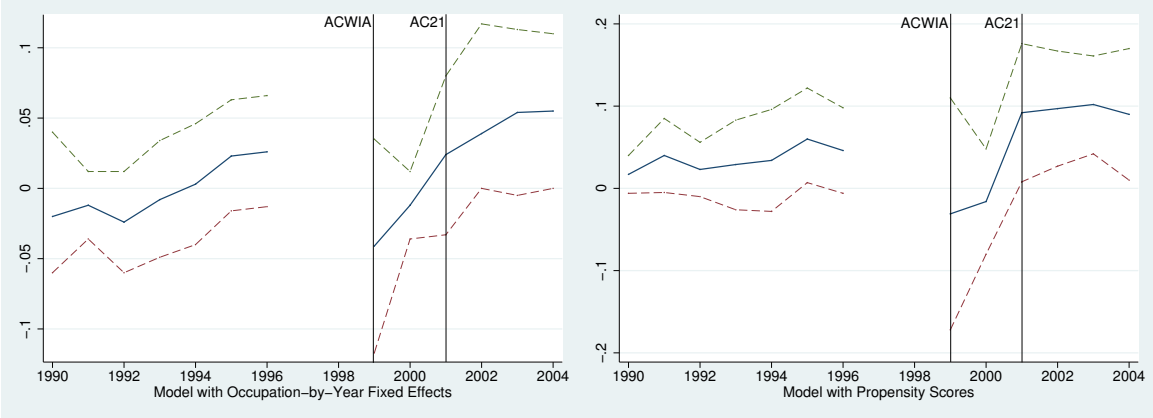


Figure 3: Changes to Specifications: Occupational Controls and Propensity Scores

rise in the H-1B cap in determining post-graduation job relatedness. Again, these results suggest that the main findings of this paper are robust when I control for post-graduation occupations in the empirical specification.

In the second sub-figure, I use propensity scores to reweight the sample and rerun Equation 2. This is a widely adopted method to account for possible influences of differences in characteristics between the treatment and control group on outcomes (e.g., DiNardo et al., 1996; Heckman et al., 1998; Blundell et al., 2014; Bailey and Goodman-Bacon, 2015). To do so, I first estimate propensity scores by running a logit of treatment status on control variables, and then estimate Equation 2 with weights constructed based on propensity scores. Event-study estimates based on this specification are generally consistent with the main findings of this paper.

I finally discuss changes to sample. In previous tables, I focus on the most recent cohort in each SED sample by survey year. In Table 8, I focus only on SED 2003 and SED 2006, but include doctoral recipients that received the doctoral degree between 1996 and 2004. One advantage of using these samples is that it is easier to account for trends in other social and economic characteristics in the U.S., as such trends should be similar in samples with a small range of survey years.

In this table I only study the AC21, and the *Post* indicator equals 1 if a student graduated in or after 2001. In Column 1 I focus only on foreign doctorate recipients and estimate a

Table 8: Visa Policy Changes and Job Relatedness: Other Samples

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Sample: | Foreign | All | All | All | All | All |
| Dependent variable: | Job relatedness | | | | Univ. employment | |
| | *Mean before the AC21*, foreigners: $R = 0.679$ | | | | $S = 0.426$ | |
| Treatment × $\text{Post}_{2001}$ | 0.092*** | 0.073*** | 0.067*** | 0.066*** | 0.079*** | 0.077*** |
| | (0.017) | (0.019) | (0.018) | (0.018) | (0.019) | (0.020) |
| Individual controls | No | No | Yes | Yes | Yes | Yes |
| Year fixed effects | No | No | Yes | No | Yes | No |
| Field fixed effects | No | No | Yes | No | Yes | No |
| Field-by-year FE | No | No | No | Yes | No | Yes |
| Observations | 3,886 | 17,595 | 17,595 | 17,595 | 17,595 | 17,595 |
| Adjusted $R^2$ | 0.011 | 0.003 | 0.184 | 0.185 | 0.113 | 0.113 |

Standard errors are in parentheses and are clustered at the field-by-year level. *: $p < .1$; **: $p < .05$; ***: $p < .01$.

first-difference specification with no control. I observe that visa policy changes under the AC21 had a positive effect on foreign doctorates' job relatedness. The effect sizes become smaller in Column 2, when I include citizens and permanent residents in the regression. In Column 3 I control for field and year fixed effects, and in Column 4 I control for field-by-year fixed effects, and find the similar magnitude of the effect. In Column 5 and 6 I use university employment as the dependent variable and rerun two regressions similar to those in Column 3 and 4. Results show that visa policy changes under the AC21 also increased university employment. In sum, the above results are consistent with the main findings of this paper: H-1B visa policy changes under American Competitive Acts resulted in the rise in job relatedness among foreign doctoral recipients in the U.S., and this was associated with the rise in university employment among them. Results of this table suggest the empirical conclusion of this paper is robust to change to sample.

## 4.3 Further Discussions

I conclude this section by further discussing the mechanisms behind the main findings of this paper. Previous tables suggest that the rise in job relatedness among foreign doctorate recipients could be associated with university employment. In theory, another related mechanism is that visa policy changes under American Competitiveness Acts had effects

on job relatedness within each employment sector, although prior studies generally find no clear evidence of the effects of H-1B visa policy changes on the employment structure (e.g., Kerr and Lincoln, 2010; Doran et al., 2015).

Table 9: Effects of Visa Policy Changes on Job Relatedness by Sector

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Sample: | Foreign | All | All | All | All | All |
| **A. University** | *Mean at* $y = 1997, 1998$, foreigners: $R = 0.831$ | | | | | |
| Treatment $\times$ $\text{Post}_{2001}$ | 0.006 | 0.041** | 0.031 | 0.031 | 0.038** | 0.036** |
| | (0.023) | (0.020) | (0.020) | (0.020) | (0.016) | (0.017) |
| Adjusted $R^2$ | 0.001 | 0.002 | 0.122 | 0.122 | 0.138 | 0.139 |
| Observations | 2,899 | 12,658 | 12,658 | 12,658 | 12,658 | 12,658 |
| **B. Industry** | *Mean at* $y = 1997, 1998$, foreigners: $R = 0.590$ | | | | | |
| Treatment $\times$ $\text{Post}_{2001}$ | 0.061* | 0.064* | 0.048 | 0.047 | 0.063*** | 0.039 |
| | (0.032) | (0.038) | (0.033) | (0.033) | (0.023) | (0.024) |
| Adjusted $R^2$ | 0.003 | 0.002 | 0.149 | 0.150 | 0.173 | 0.174 |
| Observations | 2,733 | 8,589 | 8,589 | 8,589 | 8,589 | 8,589 |
| Individual controls | No | No | Yes | Yes | Yes | Yes |
| Year fixed effects | No | No | No | Yes | Yes | No |
| Field fixed effects | No | No | No | No | Yes | No |
| Field-by-year FE | No | No | No | No | No | Yes |

Standard errors are in parentheses and are clustered at the field-by-year level.
*: $p < .1$; **: $p < .05$; ***: $p < .01$.

To study this, I examine whether visa policy changes affected job relatedness among foreigners within the industry and university sector. In Table 9, I study effects of visa policy changes on job relatedness conditional on university and industry employment in Panel A and B, respectively. In both panels, I first run a first-difference regression of job relatedness within the sample of foreign doctorate recipients. I then turn to the full sample and estimate Equation 1 from Column 2 to 6, in which I successively include the control variables. Results generally find no significant results of effects on job relatedness within each sector. Although Column 5 and 6 of Panel A present some evidence that visa policy changes did positively affect job relatedness for university employment among foreigners, the effect size was moderate at best, relative to the average degree of job relatedness within the university sector.

I conclude Section 4 by studying visa policy changes and selection on the field of study.

Previous analyses present evidence that visa policy changes under American Competitiveness Acts increased post-graduation job relatedness among foreign doctorate recipients, and this main empirical conclusion is arguably robust. I explain that the rise in job relatedness was associated with the rise in university employment among foreigners, and the effect on job relatedness within each sector was small. On the other hand, it is still possible that visa policy changes could generate indirect effects on job relatedness through selection on student characteristics. In particular, as job relatedness varies greatly from field to field (e.g., Robst, 2007), selection on the field of study could be the intermediate channel through which visa policy changes affected job relatedness among foreigners.

In general, the H-1B program is indeed associated with enrollment of international students (Dreher and Poutvaara, 2011; Shih, 2016). However, H-1B visa policy changes should have no immediate effect on the choice of field among foreign doctorate recipients because (a) students, especially international students, need to spend at least one year in graduate school applications, and (b) students usually spend at least four years in the doctoral program. Hence, it is unlikely that any visa policy changes could immediately have a causal effect on the majority of the field of study among international students. On the other hand, in the context of this paper, the passage of two American Competitiveness Acts was largely due to shortages of foreign professionals in the U.S., and visa policy changes and selection on the field of study among international students could still be correlated through such shortages in the U.S. labor market. Hence, it is useful to examine effects of visa policy changes on the field of study among foreign doctorates.

Table 10 presents the findings. In each panel, I use the indicator of the major group of a field of study—namely, computer science or other engineering fields, biological and related sciences, physical and related sciences (including chemistry), and social sciences—as the dependent variable, and estimate the first-difference regression based on the sample of foreigners (Column 1), and Equation 1 based on the full sample (from Column 2 to 4). Note that as I use the field of study as dependent variables, I can no longer control for field

Table 10: Selection on the Field of Study

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Sample: | Foreign | All | All | All |
| **A. CS/engr.** | | | | |
| Treatment × $\text{Post}_{2001}$ | −0.056 | 0.007 | 0.026 | 0.026 |
| | (0.146) | (0.064) | (0.058) | (0.058) |
| Adjusted $R^2$ | 0.003 | 0.044 | 0.097 | 0.098 |
| **B. Biology** | | | | |
| Treatment × $\text{Post}_{2001}$ | −0.043 | 0.052 | 0.052 | 0.051 |
| | (0.154) | (0.057) | (0.057) | 0.058 |
| Adjusted $R^2$ | 0.002 | 0.012 | 0.025 | 0.028 |
| **C. Physics/chemistry** | | | | |
| Treatment × $\text{Post}_{2001}$ | 0.006 | 0.022 | 0.019 | 0.019 |
| | (0.099) | (0.035) | (0.034) | (0.034) |
| Adjusted $R^2$ | 0.001 | 0.002 | 0.029 | 0.030 |
| **D. Social sciences** | | | | |
| Treatment × $\text{Post}_{2001}$ | 0.049 | −0.036 | −0.050 | −0.051 |
| | (0.069) | (0.106) | (0.098) | (0.099) |
| Adjusted $R^2$ | 0.005 | 0.032 | 0.092 | 0.093 |
| Individual controls | No | No | Yes | Yes |
| Year fixed effects | No | No | No | Yes |
| Observations | 5,863 | 23,369 | 23,369 | 23,369 |

Standard errors are in parentheses and are clustered at the field-by-year level.
*: $p < .1$; **: $p < .05$; ***: $p < .01$.

or field-by-year fixed effects in this table.

Results generally show no significant evidence that visa policy changes under American Competitiveness Acts were associated with selection on the field of study among foreign doctorate recipients in the U.S. First-difference estimates in Column 1 suggest no difference in the "structure" of the field of study among foreigners before and after visa policy changes were made. I then include citizens and permanent residents in the sample as the control group, and examine differences in the field of study between two groups of doctorates, before and after visa policy changes. Again, I find no evidence of selection on the field of study among foreign doctorates. In sum, Table 10 shows no evidence of effects of visa policy changes on the field of study among foreigners, indicates that the selection on the field of study should not be the channel through which visa policy changes under American Competitiveness Acts affected foreign doctorate recipients' job relatedness.

# 5 Conclusion

Researchers have long observed that job relatedness is closely correlated with labor market outcomes (e.g., Di Pietro and Urwin, 2007; Caliendo et al., 2012). Job relatedness is a particularly interesting question for foreign doctorate recipients: on one hand, given U.S. universities' huge spending on international students, it is ideal that foreign doctorates could take jobs that are closely related to their field of study after graduation; on the other hand, as doctorates usually receive many years of highly specialized training, field-occupation matches among foreign doctorate recipients could be an efficient social outcome, especially for their academic disciplines in the U.S.

Besides job characteristics such as job relatedness, many foreign doctoral recipients need to further take U.S. visa policies into consideration when making post-graduation occupational choices, as only a limited number of foreign professionals are able to obtain required H-1B visa status for working in the U.S. Hence, changes in visa policies could affect foreign doctorate recipients' post-graduation job relatedness in the U.S. In this paper, I use the Survey of Doctorate Recipients (SED) to exploit the American Competitiveness and Workforce Improvement Act (ACWIA) passed in 1998, and the American Competitiveness in the 21st Century Act (AC21) passed in 2000, and examine effects of visa policy changes on foreign doctorates' job relatedness. Both two American Competitiveness Acts increased the H-1B cap for foreign workers, and the AC21 further created an uncapped H-1B category for non-profit organizations; for foreign doctorates, university employment thus became a secure option to obtain the work permit in the U.S.

In the empirical analysis, I compare job relatedness between foreigners (who need the H-1B visa) and citizens and permanent residents (who do not need the visa), before and after the passage of American Competitiveness Acts. Results show that visa policy changes under American Competitiveness Acts increased the degree of post-graduation job relatedness among foreign doctoral recipients in the U.S. I observe that the rise in job relatedness was associated with the rise in university employment, as university jobs were generally

related to doctorates' fields of study, and the rise in university employment was a result of the creation of uncapped H-1B category under the AC21. Specifically, the ACWIA (which only increased the H-1B cap) and the AC21 (which introduced both the increase in the H-1B cap and the uncapped H-1B category) played different roles in determining foreigners' job relatedness. Specifically, it was the creation of the uncapped H-1B category for non-profit organizations, rather than the increase in the H-1B cap, that resulted in the rise in foreign doctorate recipients' post-graduation job relatedness.

I conduct several additional tests to further discuss the above conclusion. First, I find that pre-trends are insignificant, suggesting that both foreigners and citizens/permanent residents should follow similar trends in job relatedness in the absence of American Competitiveness Acts. Second, I present placebo tests and find that the effect size is largest in the true year of the passage of the AC21, suggesting that trends in job relatedness among foreigners should be most likely to be caused by visa policy changes. Third, I show that the main findings of this paper are arguably robust to changes to specification or sample. Finally, I discuss other two possible mechanisms behind the effects. I find visa policy changes had no effects on job relatedness within the university and industry sector. This suggests that changes in foreigners' choices between the university and industry sector, instead of changes in the labor market structure within each sector, should mainly explain the results of this paper. I also find that visa policy changes did not result in selection on the field of study among foreign doctoral recipients. Therefore, although the field of study is an important determinant of job relatedness, it is unlikely to explain trends in job relatedness in the context of this paper.

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