

# Settling for a Citizen?

## H-1B Visas and the Marriage Choices of International Students in the United States

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### Abstract:

For foreign nationals on temporary visas, marrying a U.S. citizen provides permanent access to the U.S. labor market, and drastically reduces the wait time for becoming a U.S. citizen. I use data on foreign doctoral graduates in the U.S. to investigate the impact of changes in visa restrictions on the likelihood of marriage to a U.S. citizen. I exploit a severe and unexpected drop in the numerical limit of H-1B visas in 2004, followed by an expansion in 2006, and the fact that citizens from five countries had access to alternative work visas not subject to these caps. This natural experiment permits me to compare marriage rates of temporary resident Ph.D. graduates from countries with and without alternative visas, before and after the policy changes. I find that foreign-born graduates are highly sensitive to changes in visa availability. Those graduating after the drop were 18 percentage points more likely to marry a U.S. citizen if they did not have access to alternative work visas. The expansion in 2006 led to a corresponding 26.5 percentage point decrease in the rate of those married to a U.S. citizen. Furthermore, the distribution of those married to a citizen shifted toward graduates from top programs, and away from lower ranked ones.

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## 1. Introduction

The options available to foreign-born individuals looking to work in the U.S. depend largely on their education. For the high-skilled, the H-1B visa is the largest temporary work program available in the U.S. (Doran, Gelber, and Isen 2016). The current immigration system places a yearly numerical limit, or cap, on H-1B visas. A growing literature exploits the drop in this cap, from 195,000 to 65,000 in fiscal year (FY) 2004, to study the effect that binding visa restrictions have on labor market outcomes (Kato and Sparber 2013; Shih 2016; Peri, Shih, and Sparber 2015; Mayda et al. 2018; Amuedo-Dorantes and Furtado 2019). While both family- and employment-based visas figure prominently in the U.S. government's policy agenda, economists have focused their research primarily on employment visas. The alternative channel of access to the labor market and permanent residency through marriage to a U.S. citizen has received little attention in the literature. In contrast with other family-based visas, there are no limits to the number of immigrants allowed to enter the country and given work permits via marriage, and the wait from application to approval is usually a few months. Thus, marriage to a citizen is a viable option to work legally in the U.S. I investigate the impact of changes in visa restrictions on the likelihood of high-skilled temporary residents marrying a U.S. citizen, and find that restrictions on the H-1B visa significantly increased marriage to a citizen and access to the US labor market.

Marriage to a citizen removes barriers to entry to the US: it has no skill requirements and provides near-immediate access to a permanent resident visa (i.e. a green card), and hence a work permit, usually considerably faster than other family-based visas. About one-fourth of all green cards awarded from 2000 to 2018 were obtained through sponsorship by a U.S. citizen

spouse.<sup>1</sup> It does not suffer the quotas and time limits imposed by employment-based visas, nor the uncertainty of visa lotteries. Yet, to the best of my knowledge, there is no economic research on whether high-skilled temporary residents consider marriage to a citizen as a way to immigrate to the U.S. in response to visa restrictions. Researchers have examined how marriage to a citizen affects immigrants' integration into the labor market (Chi 2015; Meng and Gregory 2005), their earnings (Chi and Drewianka 2014; Furtado and Song 2015), and their labor force participation (Furtado and Theodoropoulos 2009, 2010). Azzolini & Guetto (2017) deals with how acquisition of citizenship affects the likelihood of marriage to a citizen, and Stevens et al. (2012) presents descriptive evidence on cross-nativity marriages among migrants to the U.S. However, there is no research on how visa restrictions may affect the marriage decision itself.

This paper synthesizes the economic literature on the returns to marriage, the impact that migratory restrictions have on immigrants, and the self-selection of immigrants. To investigate the effect of visa restrictions on marriage to a citizen, I develop a measure of married to a citizen based on the time it takes to become a permanent resident. Foreign students who marry a citizen can become permanent residents within a year of marriage whereas those who marry a permanent resident or non-resident must wait significantly longer to get residency. I then use changes in the number of H-1B visas granted in 2004 and again in 2006 to identify the causal effect of visa restrictions on marriage to a citizen. I find that high-skilled immigrants are highly responsive to these policy changes. Individuals from countries bound by the H1-B visa cap and graduating in 2004 and 2005 were 18 percentage points more likely to be married to a U.S. citizen within a year, relative to those with substitute visas available. The expansion in 2006 is

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<sup>1</sup> Author's estimates using data published in the Department of Homeland Security's Yearbook on Immigration Statistics, available at <https://www.dhs.gov/immigration-statistics/yearbook>

associated with an almost commensurate decrease of 26.5 percentage points relative to 2004-2005. The magnitude and direction of these results are robust to changes to the composition of the treated and control countries, and to specific fields of degree or citizens of specific countries. I interpret this as a “harvesting effect”: the cap-drop incentivized recent graduates to get married sooner, which mechanically reduced the pool of couples who were still unmarried by 2006. This, together with a lower incentive for couples to shorten their courtship period thanks to a significant expansion of visa availability, would explain the drop observed after 2006.

Finally, I explore how high-skilled foreign graduates self-select into marriage to a citizen by using the ranking of the PhD graduate’s program as a proxy for unobserved ability. I find that PhD graduates’ response to each policy change depends on the ranking of their school. During the drop in the H-1B cap, individuals who graduated from the top 20 programs were the ones most likely to marry a citizen (28.5 percentage points). Moreover, I find evidence that this increase was not offset after the expansion in 2006, so that the overall increase from 2004 to 2009 was 20.4 percentage points for those at the top. Furthermore, those from schools ranked 51-100 became 23.9 percentage points *less* likely to marry citizens after 2004. This is evidence of positive selection into marriage to a citizen on the basis of observable quality of education, and the unobservable traits associated with it.

## **2. The H-1B and alternative work visas**

Created as part of the Immigration Act of 1990,<sup>2</sup> the H-1B visa program allows U.S. employers to hire foreign workers in specialty occupations. It is one of the few nonimmigrant

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<sup>2</sup> As part of the Federal Government, U.S. Citizenship and Immigration Services’ fiscal year  $t$  begins on October 1<sup>st</sup> of  $t - 1$  and ends on September 30<sup>th</sup> of  $t$ . From now on I use ‘year’ and ‘fiscal year’ interchangeably, except for citations of legal documents and published research.

visas that allows holders to simultaneously work in the U.S. and seek permanent residency without the risk of losing their lawful status (also known as a dual-intent visa). The numerical limit of H-1B visas that could be granted, as well as the employers who could apply for them, has varied over time. In 2001 it was temporarily set to 195,000 and special rules were introduced that exempt employees of higher educational institutions, nonprofit research organizations, and government research organizations (hereafter referred to as academic institutions) from counting toward the cap. In 2004, the provision that had increased the limit in 2001 was allowed to expire, thus exogenously bringing the limit back to 65,000. The exemptions for academic institutions were left in place, however, and starting in 2006 a rule was introduced exempting the first 20,000 beneficiaries with U.S. postgraduate degrees from counting toward the cap (a rule also known as the Advanced Degree Exemption, or ADE).<sup>3</sup> Each year from 2004 to 2006, over 60,000 approved applications went to applicants with a master's degree or higher. United States Citizenship and Immigration Services (USCIS) does not provide information on the share of postgraduates from US institutions, but this was clearly a substantial expansion for them.

Figure 1 shows the total number of H-1B visa petitions and approvals for new employment from 2001 to 2010, as well as the cap for each year.<sup>4,5</sup> From 2001 to 2003 the cap was not binding, but each year since the cap dropped in 2004 the number of petitions has

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<sup>3</sup> See “Characteristics of Specialty Occupation Workers (H-1B): Report for Fiscal Year 2004”, and the reports for 2005 and 2006.

<sup>4</sup> The number of visas approved may include petitions filed in previous years. As such, it is possible to have more visas approved than visas requested each year. Moreover, these counts include petitions from employers not subject to the cap, which explains why the number of approvals may exceed the cap.

<sup>5</sup> It does not include petitions for workers who already hold an H-1B and are transferring between employers, or for those intending to work beyond the initial 3-year period (“Characteristics of Specialty Occupation Workers (H-1B): FY2008, Annual Report” 2009)

exceeded the number allowed by the cap. These differences in availability of substitutes to the H-1B, together with the cap-drop in 2004, created a quasi-experiment that permits comparing outcomes of interest for citizens from countries bound by the H-1B cap (“treated”) to those from countries with substitute visas available (“control”),<sup>6</sup> before and after 2006. However, it should be noted that neither of these substitute visas allow dual-intent, and so they are not perfect substitutes for the H-1B.<sup>7</sup> This is a strong reason for temporary residents from non-bound countries to still prefer applying for H-1Bs even while having alternative work visas at their disposal, and it is likely to bias the estimated effect of the cap-drop towards zero.

Kato and Sparber (2013) were the first to take advantage of the fact that citizens from five countries had access to alternative work visas. The TN visa was created as part of the North America Free-Trade Agreement (NAFTA) for citizens of Canada and Mexico. The H-1B1 visa was introduced in 2004, setting aside some H-1B visas for people from Chile (1,400) and Singapore (5,400). Finally, the E-3 visa was created in 2005 for Australian citizens, with a cap of 10,500 visas. Neither the H-1B1 visas nor the E-3 visas reached their caps during the period I consider in this paper. Moreover, there is no limit to the number of individuals that can work in the U.S. with TN visas, and they can be renewed indefinitely (Amuedo-Dorantes and Furtado 2019). These alternative visas allow holders to work temporarily in the U.S. without having to apply for an H-1B, making them “less bound” by the H-1B cap, less likely to be affected by H1B policy changes than the rest of foreign citizens, and thus a suitable control group.

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<sup>6</sup> I use the terms “restricted”, “bound”, and “treated” interchangeably to refer to citizens from countries without alternative visas and thus restricted by the cap. Similarly, “not-bound”, “non-bound”, and “control” are used interchangeably to refer to those from countries with substitute visas available.

<sup>7</sup> H-1B1 visas are taken from the overall H-1B visa cap and share many of its characteristics, the notable exception being that they do not allow visa holders to concurrently work in the US and apply for permanent residency or citizenship.

Kato and Sparber (2013) use the quasi-experimental setting outlined above to study the effect this restrictive H-1B policy had on the flow and composition of undergraduate students seeking to study in the US and find that the new visa restrictions discouraged applicants who would be bound by the H-1B cap after graduation, particularly those in the top quintile of the SAT score distribution. Amuedo-Dorantes and Furtado (2019) follow the same approach using data on recent graduates from U.S. institutions and find that, relative to graduates from countries with substitute visas, those from countries restricted by the cap became more likely to choose academic employers, which are exempt from the cap. Mayda et al. (2018) use a triple difference approach to report a significant reduction in new hires of all H-1B workers due to the more stringent cap restrictions.

These previous papers show evidence of unintended consequences of this visa policy. In this paper I contribute by giving evidence of another one, I consider marriage to a citizen as an option that temporary residents may turn to when facing stronger visa restrictions. I develop a new measure of married to a citizen based on the time it takes to become a permanent resident and using it to investigate the extent to which temporary residents responded to more stringent visa conditions by marrying a U.S. citizen. I also contribute to this literature by considering the introduction in 2006 of 20,000 H-1B visas reserved for applicants holding graduate degrees from U.S. institutions as a second treatment, to study the effect of a contraction, as well as an expansion, in the available quota. Disentangling the consequences of these opposing changes is important for two reasons. First, I am interested in the effect the cap drop would have had in a world in which the ADE was not instituted. A weakening of restrictions in 2006 is likely to have mitigated the impact of the drop in 2004, at least for graduate students. Thus, previous literature that groups post-2004 into a single time period likely underestimated the pure effects of the cap-

drop, which were experienced during 2004 and 2005 only.<sup>8</sup> Second, it presents an opportunity to study the consequences of a reversal in policy, a negative shock to the supply of high-skilled labor, followed by a positive one shortly afterwards.

### 3. Data

I use the Survey of Earned Doctorates (SED) and the related Survey of Doctorate Recipients (SDR)<sup>9</sup> to analyze the effect of changes in visa caps on the likelihood of marrying a citizen. The SED is a census of all recipients of doctorates from U.S. institutions from 1920 to present, collected once at the time of graduation. Among other things, they ask for their gender, race and ethnicity, citizenship status at the time of graduation, country of birth and citizenship, field of degree, marital status, post-graduation plans, and work and employer-related data if employed. The SDR is a longitudinal biennial survey tracking a sample selected from the SED, of individuals residing in the U.S., who obtained a doctorate degree in science, engineering or health, and are 76 years old or younger. It keeps track of the variables collected at the time of Ph.D. graduation, as well as other relevant information about respondents including the start year of current and previous jobs for calculating actual experience since PhD, and employer size. More importantly, the SDR allows me to keep track of each respondent's marital status and four categories of "citizenship or visa status": native U.S. citizens, naturalized U.S. citizens, permanent residents (i.e. green card holders), and temporary residents.

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<sup>8</sup> Mayda et al. (2018) consider two treatment periods, 2004-2007, and 2008-2009. The latter corresponds to years in which there was so much demand for H-1B visas that the cap was reached within a week of the start of the application period.

<sup>9</sup> Both are maintained by the National Science Foundation.

I keep all individuals employed at the time of survey, who declared being temporary residents at the time of PhD graduation. A critical issue is that the nationality or visa status of the respondent's spouse is not requested as part of the SDR or SED questionnaire. However, it can be identified indirectly from the data. Permanent residents can sponsor their spouses (and other relatives) to get green cards, but they are subject to yearly numerical limitations. Moreover, each country is only allowed a maximum 7% of the number of visas granted each year. This, coupled with past high demand, means that approved petitions for spouses of permanent residents became backlogged, meaning that even if someone's application was approved, they had to wait for a visa became available. From 2001 to 2009 relatives of permanent residents faced wait times of at least 4 years. Citizens of countries with high visa demand (e.g. India and China), would have to wait for over a decade before receiving a green card. Thus, if a person marries a non-citizen, they would have to wait a minimum of four years to receive permanent residency.

In contrast, U.S. citizens can sponsor their spouses to become permanent residents immediately after marriage. There is no cap for the total number of these petitions that can be approved each year, and the time between application and approval was generally not longer than a year during the period I consider here.<sup>10</sup> This stark difference in wait times for green cards of spouses of U.S. citizens versus those of permanent residents allows me to identify individuals who married a citizen as someone who: i) was not a U.S. citizen or permanent

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<sup>10</sup> Shortly after being created in 2003, U.S. Citizenship and Immigration Services (USCIS) launched a plan to reduce a significant backlog of pending applications, i.e. "the number of pending applications that exceed acceptable or target pending levels for each case type". They estimated average processing time for each petition type by expressing the backlog in terms of months of receipts. The estimated processing time for petitions for alien relatives for which visas are available (such as for spouses of U.S. citizens) was 11 months or less in each of their quarterly updates to Congress. ("Backlog Elimination Plan, Fiscal Year 2006, 3rd Quarter Update" 2006)

resident at the time of PhD graduation; ii) was observed getting married in a subsequent survey year; and iii) became a permanent resident one to three years after they got married.<sup>11</sup> I restrict the sample to employed individuals who graduated from 2001 to 2009, and who were observed at least twice in the SDR, as marriage to a citizen cannot be detected for people observed only once.

In order to investigate the characteristics of those who marry a citizen, I use a measure of the quality of the Ph.D. program. Ginther et al (2011) found that quality of a biomedical research department at an academic institution can be measured by the amount of National Institutes of Health research dollars received in a given year. I generalize this measure of department quality by using the Higher Education Research and Development Survey (HERD),<sup>12</sup> to quantify the total expenditures on research and development (R&D) by year, institution, and broad field of degree. I then rank Ph.D. programs by level of expenditure, and group them into five categories of rank.

Table 1 contains weighted summary statistics on the sample for graduates from countries without substitute visas and thus bound by the H-1B cap (the treatment group), and those with substitute visas (the control group). Singapore is the only Asian country in the control group, so it is not surprising that the treated are much more likely to be Asian, and less likely to be white or Hispanic than those from countries with alternative visas. These mirror results for the sample used by Amuedo-Dorantes and Furtado (2019). Treated PhD graduates are more likely to be married overall, but also more likely to be married to a citizen. They graduate at around the

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<sup>11</sup> Temporary residents who were married at the time of Ph.D. graduation could still be classified as married to a citizen, provided they became permanent residents for a different marriage after Ph.D. graduation.

<sup>12</sup>Information on the survey and access to the microdata: <https://nsf.gov/statistics/srvyherd/>

same age and are less likely to work in academic or research jobs. The bottom of Table 1 has the distribution of graduates by funding rank of their PhD institution.<sup>13</sup> It is noteworthy that those from countries bound by the cap are significantly less likely to graduate from institutions ranked in the top 20.

#### 4. Empirical Strategy

The ideal experiment would compare a situation in which there is no policy intervention, and one in which the cap drops and everything else is held constant. For this reason, I am interested in estimating the effect the cap-drop would have had in a world in which no Advanced Degree Exemption (ADE) was introduced in 2006. In the absence of an ideal experiment, to isolate the immediate effect of the cap-drop I modify the empirical model used in Amuedo-Dorantes and Furtado (2019) by following Antwi et al. (2012) in defining two treatment periods.

Namely, I fit the following model:

$$(1) \quad \begin{aligned} MARCIT_{i,c,g,t} = & \alpha + \beta Bound_c + \theta_1 CapDrop_g + \theta_2 ADE_g \\ & + \pi_1 (Bound_c \times CapDrop_g) + \pi_2 (Bound_c \times ADE_g) \\ & + \mathbf{X}_{i,t} \boldsymbol{\gamma} + \delta_c + \delta_g + \delta_t + \epsilon_{i,c,g,t} \end{aligned}$$

where  $MARCIT_{i,c,g,t}$  is 1 if Ph.D. graduate  $i$  from country  $c$  who was a temporary resident when they graduated in year  $g$  is married to a citizen in year  $t > g$ , and 0 otherwise.  $Bound_c$  indicates the treatment group. It is 0 for temporary residents born in Australia, Canada, Chile, Mexico, and Singapore, and 1 for everyone else.  $CapDrop_g$  is 1 for cohorts graduating since 2004 and zero otherwise, and similarly  $ADE_g$  indicates cohorts graduating since the Advanced

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<sup>13</sup> The top program has rank 1, and higher values of rank imply a lower position in the rankings.

Degree Exemption in 2006. The E-3 visa was available to Australians beginning in 2005, so in their case  $CapDrop_g$  is 1 for individuals who graduated in 2004, and 0 for all other graduation years. My coefficients of interest,  $\pi_1$  and  $\pi_2$ , measure the effect of the cap-drop on the probability of marrying a citizen for graduates subject to the cap relative to those not restricted by the cap. The former captures the effect of the cap-drop in 2004-2005, relative to 2001-2003; and  $\pi_2$  captures the effect of the ADE relative to 2004-2005.

The vector  $\mathbf{X}_{i,t}$  contains individual level characteristics related to marriage and employment choices: a quadratic function in age, a cubic function in years of experience after Ph.D., as well as a full set of dummies for gender, race/ethnicity, field of Ph.D. degree, funding rank of the Ph.D. program, field of occupation, employment sector, location of employer, and employer size. The terms  $\delta_c$ ,  $\delta_g$ , and  $\delta_t$  control for country of origin, graduation year, and survey year fixed effects.

## 5. The effect of visa restrictions on the likelihood of marriage to a citizen

Prior to estimating regressions, I examine the difference-in-differences in mean outcomes for the cap-drop in 2004 and the expansion in 2006. To estimate the effect of the cap-drop in 2004, I must also account for the expansion that happened in 2006 for postgraduates of U.S. institutions. It is not unreasonable to expect that Ph.D. graduates looking for work in the U.S. and faced with binding numerical restrictions in 2004 and 2005 may have had more incentives to consider non-labor market-related options for staying legally in the country. But, for the same reason, it is to be expected that these incentives diminished or reversed in 2006 and after. Table 2 compares the sample for these two time periods.

Panel A reports the weighted share married to citizens for graduates from treated and control countries, before and after 2004. During 2001-2003 temporary residents from countries

bound by the cap were 3.7% less likely to marry a citizen than those not bound by the cap, but this difference is not statistically different from zero. If we looked at 2004-2009 as a single “post-treatment” period, we would observe that the shares for graduates from treated and control countries were just as statistically different from each other after the policy came into effect as they were before. We may be led to conclude that a reduction of available visas as severe as the one experienced in 2004 had no significant effect.

Panel B shows the same shares, but for three time periods: pre-treatment (2001-2003), during the cap-drop (2004-2005), and after the expansion in 2006. Temporary residents from countries bound by the cap who graduated during the cap-drop were more likely to marry citizens than those not bound by the cap. This resulted in a relative increase of 14.8 percentage points in the share married to citizens. As expected, the expansion in 2006 had the opposite effect, leading to a relative drop in the share married to citizens of 19.5 percentage points.

However, these are comparisons of sample means, and so they cannot be interpreted as if comparing outcomes of individuals with similar characteristics, and do not control for changes in factors that may have affected marriage decisions over time. The following section details my strategy to get a better difference-in-differences estimate of the causal effect that these changes to the H-1B cap had on the probability of high-skilled temporary residents marrying a U.S. citizen.

Table 3 presents difference-in-differences estimates of  $\pi_1$  and  $\pi_2$  from equation (1) under different specifications, as well as estimates using only one treatment period. Regardless of which specification is used, considering only one treatment period gives an estimated effect of the cap-drop that is indistinguishable from zero. Turning to estimates using two treatment periods, column (1) controls for graduation year, survey year, and country of origin fixed effects

only. The cap-drop is associated with a 16.2 percentage point increase in the likelihood of graduates from treated countries marrying a citizen, relative to graduates having alternative visas. The advanced degree exemption had the opposite effect, reducing the relative likelihood by 22.7 percentage points. Column (2) adds controls for gender and a quadratic function in age. This inclusion did not change the previous estimates significantly, suggesting that these demographic characteristics affect the likelihood of marrying a citizen similarly for treated and non-treated graduates. Column (3) also includes indicators for seven broad groups of fields of major, and indicators for four categories of funding rank of the PhD-granting institution. These also have little effect on the estimates. The inclusion of a cubic function in experience, and seven indicators for current occupation, increases the estimated effect of the cap-drop to a 17.8 percentage point increase in the likelihood of marrying a citizen. The most complete specification adds indicators for seven brackets of employer size, and nine indicators for employer region. The results are presented in column (5), and they show very little change with respect to the estimate in column (4). The most complete specification yields an estimated 18 percentage point increase in the likelihood of marriage to a citizen following the cap-drop, and a corresponding 26.5 percentage point decrease in marriage after 2006. Overall, the inclusions of these controls did not change the estimates significantly from those in the first specification.

The results in Table 3 suggest that the Advanced Degree Exemption effectively canceled out the initial effect the cap-drop had on the likelihood of Ph.D. graduates marrying citizens. One possible explanation is that the cap-drop coupled with the ADE expansion in 2006 gave rise to what Deschênes and Moretti (2009) call a “harvesting effect”; a situation in which a sudden, extreme event today precipitates an outcome for people already inclined to it and likely to experience it regardless. This “displaces” people who would have experienced the outcome

tomorrow to experiencing it today, and results in a corresponding reduction in occurrences tomorrow such that the total number of occurrences over both periods is not affected.<sup>14</sup> Applied to the setting in this paper, sudden visa restrictions may have incentivized immigrant-with-citizen couples to push their marriage dates forward, resulting in a spike in the relative likelihood to marry citizens during the cap-drop. A redistribution of “future” marriages to earlier dates would have mechanically reduced the pool of couples who were still unmarried by the time the ADE was instituted. This, together with a lower incentive for couples to shorten their courtship period thanks to a significant expansion of visa availability, would explain the drop observed after 2006.<sup>15</sup>

The results in Table 3 are comparisons of cohorts and has the risk of being driven by unobserved factors unrelated to the H-1B visa but nevertheless affecting the likelihood of marrying a U.S. citizen. I follow robustness checks similar to those in Amuedo-Dorantes and Furtado (2019) and report them in Table 4.

First, I consider that graduates from the year before each change in policy may have decided to take Optional Practical Training (OPT), and then faced new caps when their OPT was over. The SED questionnaire asks respondents to specify their postgraduation plans among postdoctoral positions, internships, traineeships, and other employment. I take students who graduated in 2003 and 2005, and who selected traineeship as their postgraduation plan, and then treated them as if they graduated in 2004 and 2006, respectively. The first column of Table 4

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<sup>14</sup> Referring to marked spikes in mortality during days of extreme hot temperature: “...almost all of this excess mortality is explained by near-term displacement. In the weeks that follow a heat wave, we find a marked decline in mortality hazard, which completely offsets the increase during the days of the heat wave. As a consequence, there is virtually no lasting impact of heat waves on mortality.” (Deschênes and Moretti 2009)

<sup>15</sup> It is also possible that divorce rates spiked after 2006. Unfortunately, the data did not allow me to identify divorce rates for enough years after 2006 to be able to test this.

shows an estimated effect of the cap-drop of 13.9 percentage points after this adjustment. A test of equality of coefficients cannot reject the null hypothesis that this coefficient and the benchmark coefficient from Table 3 are equal.

Next, I address concerns of the possibility that heavily represented occupations and countries experienced changes unrelated to the H-1B cap, but which nevertheless influenced temporary residents' likelihood of marrying U.S. citizens. According to reports published by U.S. Citizenship and Immigration Services (USCIS), each year since 2004<sup>16</sup> computer-related occupations received from close to one-third to over half of H-1B visas given for initial employment. Columns (2) and (3) show estimates of the fullest specification from Table 3 first excluding all individuals employed in computer-related occupations, and then for computer-related occupations only, respectively.

The estimated effect of the cap-drop for computer-related occupations is more than twice the benchmark estimate for the whole sample from Table 3, and about three times the estimated effect for the non-computer-related sample. Moreover, the spike experienced during the cap-drop was not offset by a comparative drop after 2006. Results of estimating a specification with just one treatment show a statistically significant average increase of 39.3 percentage points in the relative likelihood of marrying a U.S. citizen after the cap drop. This is evidence that high-skilled temporary residents in computer-related occupations are significantly more sensitive to H-1B visa policy changes than the rest of temporary residents. However, these results show that the overall effect of the cap-drop is not the result of people from computer-related occupations.

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<sup>16</sup> This is the earliest year for which the report is available. See <https://www.uscis.gov/tools/reports-studies/reports-and-studies>

As column (2) shows, those in other occupations had a similar reaction, albeit not one such as strong.

In addition, H-1B visas are disproportionately awarded to two countries. China and India received about 53% of H-1B visas issued between 2001 and 2009. Moreover, temporary residents from these countries face long wait times to obtain permanent residency, and new visa restrictions may decrease their stay rates in the U.S. (Kahn and MacGarvie 2018). It is reasonable to assume that those who leave the country are less likely to be married to U.S. citizens than those who stay. If graduates from China and India are indeed leaving the country at higher rates than graduates from other treated countries, then the share married to citizens would increase mechanically because they are more likely to stay. As columns (3) and (4) show, the cap-drop had a lower estimated effect on graduates from China and India.<sup>17</sup>

## **6. Visa restrictions and the self-selection of foreign PhDs into marriage to a citizen**

I now investigate how foreign PhD graduates self-selected into marriage to a citizen in response to these policy changes. I use the ranking of the PhD program as a proxy for unobserved ability to estimate how changes to the H-1B cap affected temporary residents of different levels of ability. I constructed a ranking of PhD programs by field of major using the Higher Education Research and Development (HERD) survey conducted yearly and maintained by the National Science Foundation (NSF). I partition my sample into 4 groups of R&D funding rank and repeat the previous analysis for each of these subsets. A more in-depth examination of the self-selection of foreign PhDs is left for Chapter 3 of this dissertation.

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<sup>17</sup> Ideally, I would like to test whether specific countries in the control group are driving the results, first by including people born in Puerto Rico in the control group, and then by including all American citizens. Unfortunately, I am unable to do this because my method for identifying marriage to citizens fails for people who are never observed to be temporary residents.

a. *Theoretical framework*

Borjas (1987, 1991) was the first to apply Roy's (1951) model to study the self-selection of immigrants. The Roy model posits that, *ceteris paribus*, an individual will decide to migrate if their expected earnings in the host country ( $w_1$ ) are higher than those in the source country ( $w_0$ ), net of migration costs ( $C$ ).<sup>18</sup> For each individual, potential log earnings in either country depend on their level of skills ( $s$ ):

$$\log(w_0) = \alpha_0 + r_0s + \epsilon_0, \quad \epsilon_0 \sim N(0, \sigma_0^2) \quad (1)$$

$$\log(w_1) = \alpha_1 + r_1s + \epsilon_1, \quad \epsilon_1 \sim N(0, \sigma_1^2) \quad (2)$$

where  $s$  is the level of observed skills for each individual,  $r_j$  is the rate of return to observable skills in country  $j \in \{0,1\}$ ,  $\alpha_j$  is the minimum earnings attainable by someone with no skills in country  $j$ , and  $\epsilon_j$  is a random variable capturing individual-specific productivity shocks resulting from unobserved characteristics (Borjas, Kauppinen, and Poutvaara 2018). The distribution of skills in the source country is given by  $s = \mu_s + \epsilon_s$ , where  $\epsilon_s \sim N(0, \sigma_s^2)$ .

Borjas et al. (2018) define "time equivalent" costs as  $c = C/w_0$  and the index function

$$\begin{aligned} I &= \log\left(\frac{w_1}{C + w_0}\right) \approx [(\alpha_1 - \alpha_0) + (r_1 - r_0)\mu_s - c\pi] + [(r_1\epsilon_s + \epsilon_1) - (r_0\epsilon_s + \epsilon_0)] \quad (3) \\ &= \Delta\mu + (v_1 - v_0), \end{aligned}$$

where  $\Delta\mu = [(\alpha_1 - \alpha_0) + (r_1 - r_0)\mu_s - \pi]$  is the difference in earnings for an individual with average skills, net of migration costs. The difference in earnings due to differences in unobserved characteristics is given by  $v = (v_1 - v_0)$ ; where  $v_i = r_i\epsilon_s + \epsilon_i$  for  $i \in \{0,1\}$ . A

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<sup>18</sup> In the setting of this paper, the costs to an individual being sponsored by their potential employer are zero because they are already in the U.S., and the costs of applying for an H-1B visa are required by law to be paid by the sponsor. If they were to marry a citizen, however, they could be assumed to share the cost with their spouse. For simplicity and to stay faithful to the usual representation of the model, I will assume both options require a non-negative cost  $C$ .

person emigrates if and only if  $I > 0$ . The probability that someone from the host country emigrates is given by

$$\Pr(I > 0) = \Pr\left[\frac{v_1 - v_0}{\sigma_v} > -\frac{\Delta\mu}{\sigma_v}\right] = 1 - \phi\left(-\frac{\Delta\mu}{\sigma_v}\right) \quad (4)$$

Given that the distribution of the stochastic components of the model are assumed to be Normal, Borjas et al. (2018) derive that migrants will be positively (negatively) selected based on observable skills if the following correlation coefficient is positive (negative)

$$\text{Corr}(\epsilon_s, v_1 - v_0) = \frac{r_0\sigma_s}{\sigma_v}\left(\frac{r_1}{r_0} - 1\right). \quad (5)$$

Thus, immigrants are positively (negatively) selected when the rate of return to observable skills is higher (lower) in the host country. Selection based on unobservable skills is determined by the sign of the following correlation:

$$\text{Corr}(\epsilon_0, v_1 - v_0) = \frac{\sigma_0}{\sigma_v}\left(\rho_{01}\frac{\sigma_1}{\sigma_0} - 1\right), \quad (6)$$

where  $\rho_{01} = \text{Corr}(\epsilon_0, \epsilon_1)$ . Thus, immigrants are positively (negatively) selected on unobservable skills when the rate of return to unobservable skills is higher in the host country and if the unobserved characteristics are ‘transferable’ across countries so that  $\rho_{01}$  is sufficiently high.<sup>19</sup>

This model predicts who *wants* to migrate to and stay in the host country, but it does not say which immigrants will be more likely to marry a citizen. Previous research shows that having better economic prospects is associated with a higher likelihood of being married for males (Oppenheimer, Kalmijn, and Lim 1997; Musick, Brand, and Davis 2012). For females, college

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<sup>19</sup> A country with zero variance in the component of log wages due to unobservable characteristics ( $\epsilon_i$ ) would pay the same wage to people having different levels of unobserved ability, thus its interpretation as the “price” of unobservable skills in country  $i$ .

education meant a lower likelihood of marriage for most of the 20<sup>th</sup> century, but recent cohorts have behaved in opposite manner: college-educated females are now more likely to marry than those with less education (Goldstein and Kenney 2001; Cherlin 2010; Trimarchi and Van Bavel 2017; Musick, Brand, and Davis 2012; Ginther and Sundström 2010). To the degree that a degree from a higher-ranked institution signals better education and better economic prospects, graduates from higher-ranked institutions should be expected to be more likely to find a partner that would marry them.

b. *Earnings by Funding Rank of PhD Program*

Table 5 shows weighted average yearly earnings computed using restricted-use data from the 2010 and 2013 waves of the International Survey of Doctorate Recipients (iSDR).<sup>20</sup> In order to make earnings comparable over time and across countries of residence, earnings were converted to 2011 Purchasing Power Parity (PPP)-adjusted dollars.<sup>21</sup> A few things stand out from this table. First, while the average earnings of graduates from programs ranked in the top 50 are always higher in the U.S. (though not necessarily statistically different) than those working abroad, the opposite is almost always true for graduates from programs ranked 51 or above, with the only exception being people who graduated between 2001 and 2003 from programs ranked 100 or above. Individuals graduating from lower-ranked institutions were at best indifferent between working in the U.S. and abroad, with some of them having markedly better outcomes abroad.

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<sup>20</sup> A sample also drawn from the Survey of Earned Doctorates with the intention of tracking graduates no longer residing in the U.S., and collected for the first time for reference year 2010.

<sup>21</sup> I constructed deflators using two time series on Gross Domestic Product by country obtained from the World Bank:

$$earn_{ppp} = earn \times \frac{GDP, PPP (constant 2011 international \$)}{GDP (current US\$)}$$

These comparisons, however, do not control for known characteristics that may affect the decision to marry, or the fact that by 2010 and 2013, the reference years for the iSDR, those graduating 2001-2003 had more years of post-PhD work experience than those graduating post 2006. In order to take these into account, I regressed log earnings on the same covariates as the fullest specification in Table 3. shows predicted log earnings of PhD graduates residing in their home country and of those residing in some other country abroad, relative to predicted log earnings of foreign PhD graduates working the U.S. As can be seen from this graph, with the exception of those graduating from programs ranked 51 to 100, those working outside of the U.S. receive around 20% lower earnings than those working in the U.S.

*c. The Effect of Visa Restrictions by Funding Rank*

Table 6 presents the results of estimating the fullest model from Table 3 for each group of funding rank. Column (1) shows that during the period right after the cap dropped, years 2004-2005, graduates from the top 20 programs in their field were 28.5 percentage points more likely to marry citizens if they were from countries restricted by the H-1B cap than those from countries with substitute visas. They had the only statistically significant increase in likelihood during this period. After 20,000 visas were added in 2006, the relative likelihood fell for graduates from all ranks, when compared to 2004-2005. Importantly, the two policies did not cancel each other out for all categories of rank. Taking 2004-2009 as a single treatment period, column (1) shows a net increase of 20.4 percentage points for PhD graduates from the top 20 programs, and column (3) shows a net *decrease* in the likelihood to marry a citizen. Put together, these estimates provide evidence of positive selection into marriage to a citizen on the basis of observable quality of their Ph.D. program. These results also suggest that the average quality of students marrying into citizenship increased after 2004.

d. *Marriage and return migration costs*

Another way to explain the results in Table 6 is by considering that there are also costs to return migration. If time-equivalent return migration costs are decreasing in skills, then it is possible that only people with very low or very high skills will find it more beneficial to stay in the U.S.

Borjas (1987) and Chiquiar and Hanson (2005) show that “time equivalent” costs of migration do not play a role in deciding whether to migrate when either these costs are constant or if the costs are uncorrelated with skills. The costs to an individual being sponsored by their potential employer are zero because they are already in the U.S., and their sponsor is required by law to bear the full costs of applying for an employment visa as well as those for sponsoring the employee for a green card. If they were to marry a citizen, however, they may share the costs with their spouse. The costs of marriage licenses vary but are usually fairly low across states. For example, as of this writing, it can be as much as \$120 in Delaware for out of state residents<sup>22</sup>, or as low as \$25 in Prince George’s County.<sup>23</sup> The fees to file for permanent residency are also fixed, but not negligible.<sup>24</sup> Thus, instead of thinking about migration costs, we can consider time-equivalent marriage costs. I follow Chiquiar and Hanson (2005) in assuming that time-equivalent costs are decreasing in ability

$$\ln(\pi) = \mu_{\pi} - \delta_{\pi}S, \quad (7)$$

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<sup>22</sup> <http://co.kent.de.us/clerk-of-the-peace-office/marriage.aspx>. Accessed 6/3/2019.

<sup>23</sup> <https://princegeorgescourts.org/225/Marriage-License>. Accessed 6/3/2019.

<sup>24</sup> Of course, wedding ceremonies can be very expensive, but they are not required for civil unions, and thus they are unnecessary for obtaining legal status.

but I interpret these as marriage costs instead of immigration costs. I define time-equivalent return migration costs similarly and assume that they are decreasing in skills as well

$$\ln(\tau) = \mu_\tau - \delta_\tau s. \quad (8)$$

A person prefers staying in the host country if  $\ln w_1 - \pi > \ln w_0 - \tau$ . Figure 3 plots both these curves to reproduce a graph similar to Figure 2 of Chiquiar and Hanson (2005).<sup>25</sup> Contrary to their example, however, the presence of return migration costs means that it is the high-skilled that are positively-selected and the low skilled are negatively-selected. This is because the earnings in the host country are high enough relative to marriage costs for the low skilled that those with skills below  $s_L$  are better off staying in the host country. Those with intermediate skills ( $s_L < s < s_U$ ) face migrating costs that fall slower than marriage costs and so have higher expected net earnings from going back to their home country, while those with high enough skills face higher net earnings by marrying a citizen and find it better to stay in the host country.

## 7. Conclusions

In this paper I investigate the impact of changes in visa restrictions on the likelihood of high-skilled temporary residents marrying a U.S. citizen. Using data from a census of all Ph.D. graduates from U.S. institutions, collected at the time of graduation, together with a survey that follows a subset of them over time, I developed a measure of foreign-born individuals who were married to a citizen. Based on this measure, I obtained a differences-in-differences estimate of the causal effect of the cap-drop in 2004 on the likelihood of Ph.D. graduates marrying a U.S. citizen. I find that high-skilled temporary residents reacted strongly to these policy changes by

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<sup>25</sup> This assumes that  $\alpha_1 - \alpha_0 > e^{\mu\pi} - e^{\mu\tau}$ . That is, earnings for low skilled people in the host country are high enough relative to those in the source country that they are better off marrying and staying in the host country.

being more likely to marry citizens when visas became scarce and then reacting in the opposite direction after more visas became available.

A central question for public policy is whether immigration policies attract and retain high-quality immigrants. Kato and Sparber (2013) find that the cap-drop in 2004 was associated with a decrease in the quality of undergraduate students, as measured by their SAT scores. This outcome has potential negative impacts for future economic growth, as studying in the U.S. is one of the main channels young foreign nationals use to later join the workforce. I was able to investigate a related question: how did the changes to H-1B visa policies affect the “quality” of high-skilled temporary residents marrying U.S. citizens? My sample allows me to answer this for individuals who have already joined the U.S. labor market. Specifically, I investigated how changes to the H-1B cap affected temporary residents graduating from Ph.D. programs of different ranking. While graduates from the top 50 PhD programs had the highest increase during the cap-drop, the policy had no statistically significant effect on those from the lower-ranked schools. Moreover, there is evidence that the cap-drop may have resulted in permanent changes to the likelihood of marriage to a US citizen for those graduating from top 20 programs.

This research has implications for US immigration policy and joins previous papers in giving evidence of unintended consequences of one specific pair of immigration policies. Previous papers analyzed how agents reacted within the labor market. This paper finds that under stronger employment visa restrictions temporary residents may seek legal means outside of the labor market, in this case marriage to a citizen, to bypass these restrictions and seize job security. Furthermore, even though there are no skill requirements for marrying a U.S. citizen, these policies effectively shifted the skill distribution of those marrying citizens toward the highest skilled, and those in computer-related occupations.



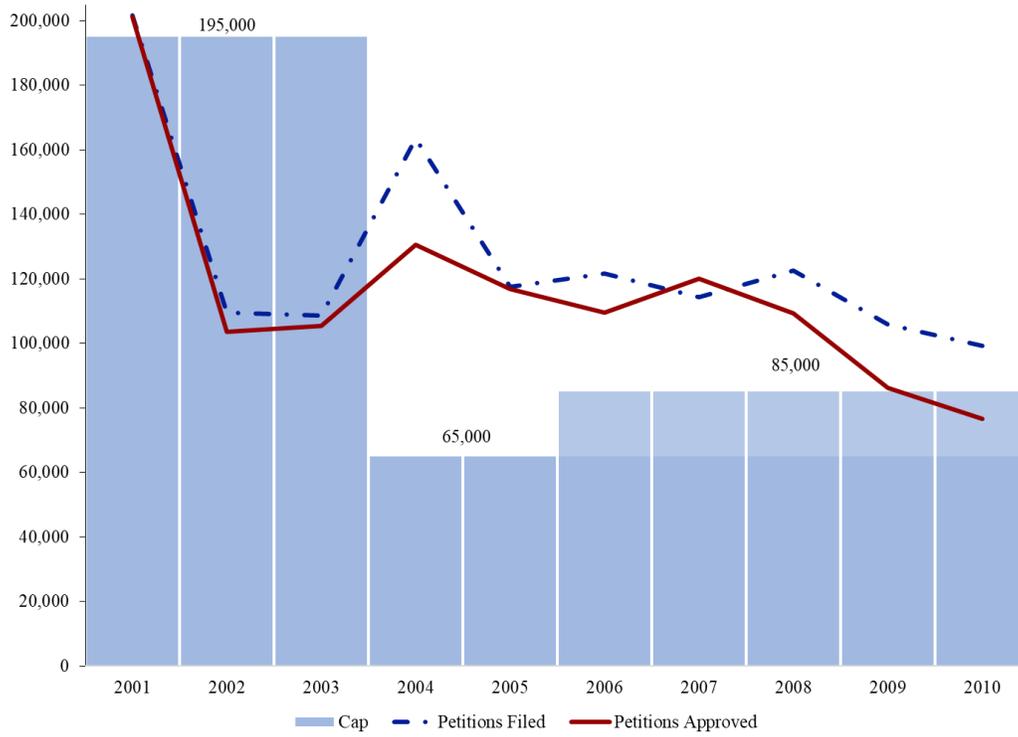
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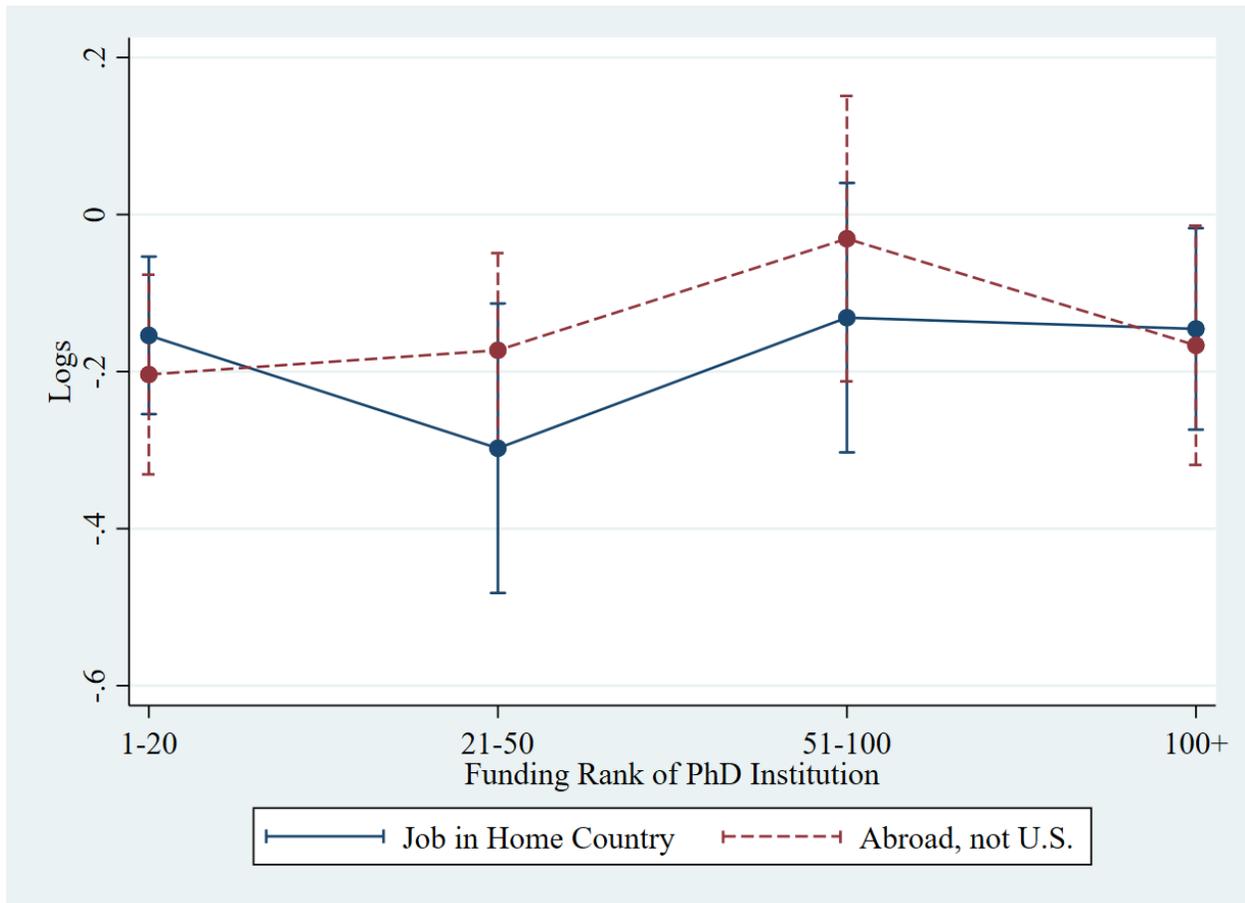
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**Figure 1: Official Cap and Number of New H-1B Petitions, 2001-2010**



Source: USCIS reports on H-1B petitions for fiscal years 2004-2010

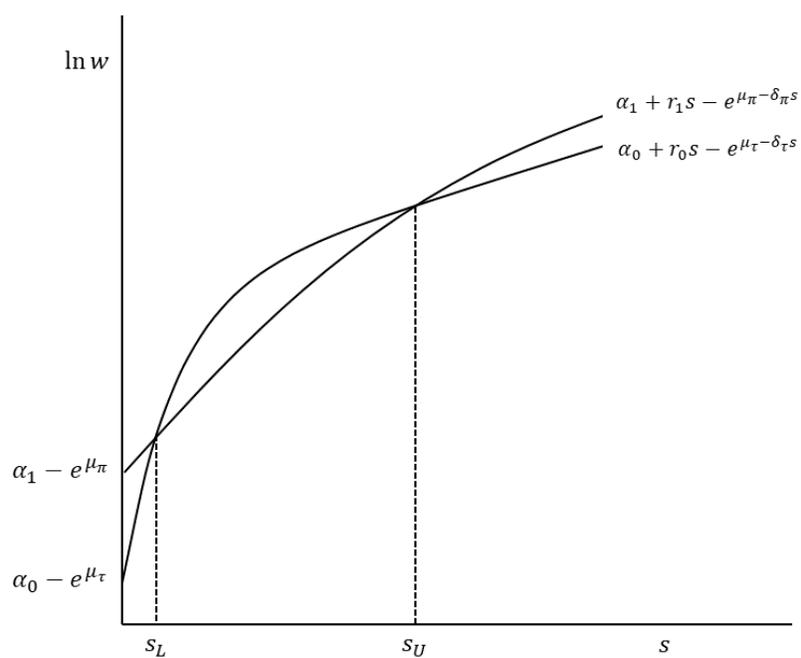
**Figure 2: Predicted Log Earnings Relative to Job in U.S., 2001-2010**



*Source:* Author's calculations using the 2010 and 2013 waves of the International Survey of Doctorate Recipients (iSDR)

*Note:* Mean earnings in 2011 dollars adjusted for Purchasing Power Parity (PPP)

**Figure 3: Self-Selection of Return Migrants**



*Note:* This figure depicts self-selection of return migrants the case in which return migration is costly and the cost decreases with the level of skills

*Source:* Adapted from Chiquiar and Hanson (2005)

**Table 1: Weighted Summary Statistics (2001-2009)**

	<b>Bound by H-1B Cap</b>		<b>Not Bound</b>	
	<b>Mean</b>	<b>S.D.</b>	<b>Mean</b>	<b>S.D.</b>
Married	0.72	0.45	0.67	0.47
Married to a Citizen	0.32	0.47	0.26	0.44
Female	0.27	0.45	0.36	0.48
Age at Ph.D.	30.8	3.83	31.0	4.74
Years of Work Experience	3.96	2.69	3.71	2.65
White	0.25	0.43	0.46	0.50
Black	0.03	0.16	0.01	0.11
Asian	0.68	0.46	0.26	0.44
Hispanic	0.03	0.18	0.27	0.44
Academic or Research Job	0.45	0.50	0.53	0.50
Industry	0.51	0.50	0.43	0.50
Government	0.03	0.18	0.04	0.20
Europe	0.16	0.37	0.00	0.00
Asia	0.75	0.43	0.06	0.23
North America	0.00	0.02	0.83	0.38
Central America and Caribbean	0.01	0.10	0.00	0.00
South America	0.03	0.17	0.04	0.20
Africa	0.03	0.18	0.00	0.00
Oceania	0.00	0.06	0.08	0.26
HERDS Funding Rank of Ph.D. Institution				
1-20	0.28	0.45	0.35	0.48
21-50	0.25	0.43	0.23	0.42
51-100	0.25	0.43	0.23	0.42
100+	0.22	0.42	0.19	0.39
N/A	0.00	0.04	0.00	0.00
Observations	4063		337	

Note: Author's estimates from restricted-use data on temporary residents who graduated after 2001 with a Ph.D. from a U.S. institution, interviewed in the 2003, 2006, 2008, 2010, and 2013 SDR. Higher Education Research and Development Survey (HERD) data obtained from <https://www.nsf.gov/statistics/srvyherd/>

**Table 2: Differences-in-Differences in the Weighted Share of Temporary Residents Married to Citizens**

<b>A: One Treatment Period</b>			
	<b>2001-2003</b>	<b>2004-2010</b>	
<b>T: Bound by H-1B Cap</b>	0.358 [0.48]	0.305 [0.461]	
<b>C: Not Bound by H-1B Cap</b>	0.327 [0.471]	0.239 [0.427]	
<b>T - C</b>	<b>0.032</b> (0.058)	<b>0.066</b> (0.051)	
<b>DID</b>		<b>0.035</b> (0.056)	
<b>B: Two Treatment Periods</b>			
	<b>2001-2003</b>	<b>2004-2005</b>	<b>2006-2010</b>
<b>T: Bound by H-1B Cap</b>	0.358 [0.48]	0.358 [0.48]	0.266 [0.442]
<b>C: Not Bound by H-1B Cap</b>	0.327 [0.471]	0.185 [0.39]	0.282 [0.451]
<b>T - C</b>	<b>0.032</b> (0.058)	<b>0.173***</b> (0.062)	<b>-0.015</b> (0.051)
<b>DID</b>		<b>0.141*</b> (0.073)	<b>-0.188***</b> (0.047)

Note.-Standard deviations are in brackets, and standard errors, clustered at the country of origin level, are in parenthesis. Author's calculations using restricted-use SDR and DRF 2001-2013. The sample consists of employed individuals who were temporary residents at the time of PhD graduation. Cap-Drop refers to fiscal years 2004 to 2005.

**Table 3: Likelihood of Marriage to a Citizen**

<b>Model Specification</b>	<b>(1)</b>	<b>(2)</b>	<b>(3)</b>	<b>(4)</b>	<b>(5)</b>
<b>One Treatment Period</b>					
Cap Drop: 2004-2009	0.006 (0.054)	0.008 (0.055)	0.008 (0.058)	0.010 (0.043)	-0.002 (0.046)
<b>Two Treatment Periods</b>					
Cap Drop: 2004-2005	0.162*** (0.054)	0.159*** (0.046)	0.163*** (0.047)	0.178*** (0.037)	0.180*** (0.038)
Advanced Degree Exemption: 2006-2009	-0.227*** (0.035)	-0.220*** (0.023)	-0.225*** (0.024)	-0.244*** (0.022)	-0.265*** (0.022)
Graduation Year FE	Y	Y	Y	Y	Y
Country of Origin FE	Y	Y	Y	Y	Y
Survey Year FE	Y	Y	Y	Y	Y
Demographic Controls	N	Y	Y	Y	Y
Field of Degree and School Rank	N	N	Y	Y	Y
Occupation and Experience	N	N	N	Y	Y
Employer Characteristics	N	N	N	N	Y
Dependent Variable Mean			.358		
Observations	4,400	4,400	4,393	4,393	4,393
R-squared	0.183	0.193	0.193	0.224	0.229

Notes: \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ . Standard errors clustered at the country-of-origin level. All regressions include a constant term.

**Table 4: Subsample Estimates of the Likelihood of Marrying a U.S. Citizen**

	(1)	(2)	(3)	(4)	(5)
Exclusions/Additions	OPT	No Computer-Related Occupations	Computer-Related Occupations	No China or India	Just China, India, and Control
<b>One Treatment Period</b>					
Cap Drop: 2004-2009	0.031 (0.068)	-0.058* (0.031)	0.393*** (0.077)	0.052 (0.047)	-0.062 (0.033)
<b>Two Treatment Periods</b>					
Cap Drop: 2004-2005	0.139* (0.083)	0.129*** (0.043)	0.416*** (0.080)	0.211*** (0.052)	0.122*** (0.017)
Advanced Degree Exemption: 2006-2009	- 0.255*** (0.040)	- -0.263*** (0.028)	- -0.072 (0.153)	- -0.228*** (0.042)	- -0.266*** (0.009)
Dependent Variable Mean	.358	.351	.396	.308	.418
Observations	4,393	3,660	733	2,678	2,052
R-squared	0.229	0.239	0.347	0.248	0.246

Notes: \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. Standard errors clustered at the country-of-origin level. All regressions include the same controls as the most complete specification in Table 3

**Table 5: Weighted Average Earnings (2010 PPP-adjusted dollars) by Funding Rank, Job Location, and Graduation Year**

Funding Rank	2001-2003		2004-2005		2006+	
	Job in U.S.	Job abroad	U.S.	Abroad	U.S.	Abroad
1-20	131,505	117,472	100,883	99,657	84,105	81,163
21-50	112,728	104,980	98,969	84,832	95,876	71,141
51-100	64,463	87,877	106,767	114,878	68,569	70,881
100+	85,678	79,202	77,529	93,395	62,190	68,968

Source: author's calculations using the 2010 and 2013 waves of the International Survey of Doctorate Recipients (iSDR)

Note: Mean earnings in 2010 dollars adjusted for Purchasing Power Parity (PPP)

**Table 6: Likelihood of Marrying a U.S. Citizen  
by HERDS Funding Rank of Ph.D. Institution**

<b>Funding Rank</b>	<b>1-20</b>	<b>21-50</b>	<b>51-100</b>	<b>100+</b>
<b>One Treatment Period</b>				
Cap Drop: 2004-2009	0.204** (0.082)	0.016 (0.096)	-0.239** (0.092)	0.072 (0.151)
<b>Two Treatment Periods</b>				
Cap Drop: 2004-2005	0.285** (0.108)	0.118 (0.134)	-0.046 (0.112)	0.195 (0.189)
Advanced Degree Exemption: 2006-2009	-0.137* (0.078)	-0.143* (0.080)	-0.273** (0.117)	-0.258*** (0.093)
Dependent Variable Mean	.297	.412	.357	.385
Observations	1,223	1,110	1,095	965
R-squared	0.303	0.347	0.296	0.377

Notes: \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. Standard errors clustered at the country-of-origin level. All regressions include the same controls as the most complete specification in Table 3.