

# Labor Market Openness, H-1B Visa Policy, and the Scale of International Student Enrollment in the US

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## Abstract

International students have long comprised an important part of US higher education. However, little is known regarding the factors that encourage students from across the world to enroll in US colleges and universities each year. This paper examines the relationship between international enrollment and the openness of the US' skilled labor market, currently regulated by the H-1B program. Gravity regressions reveal that H-1B visa issuances to a country are positively and significantly related to the number of international students from that country. Causal estimates of the impact of labor market openness are achieved by exploiting a dramatic fall in the H-1B visa cap in October 2003. Triple difference estimates show that the fall in the cap lowered foreign enrollment by 10%.

**JEL Codes:** F22, I21, J11

**Keywords:** International enrollment, foreign students, determinants, globalization, higher education, H-1B policy.

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# 1 Introduction

Students from around the world have long pursued higher education in the US. Sustained growth over the last half century (figure 1) has transformed foreign students from emissaries of cultural and educational exchange to major constituents of US universities. In 2012, approximately 3%, 12%, and 30% of all bachelor's, master's, and Ph.D. degrees, respectively, were awarded to noncitizens. Within STEM<sup>1</sup> fields that figure is even higher, with foreign students earning roughly 40% of all graduate diplomas. Despite their large presence in US higher education, little is known about the factors that encourage thousands of foreign citizens to study in American colleges and universities each year.

This paper aims to elucidate how the openness of the US' skilled labor market affects the number of international students. The entry of college educated (skilled) foreign workers is currently regulated by H-1B visa policy. Foreign individuals who have employment agreements with US firms may still be denied access under H-1B regulations. As such, H-1B policy is the key tool that regulates the openness of the US' skilled labor market. This study evaluates whether H-1B policies that alter labor market openness impact foreign enrollment at US colleges and universities. Distinctly, this paper focuses on the *quantity* of international students, and as such, both complements and extends recent work by Kato & Sparber (2013) on the effect of H-1B policy on the quality of foreign college applicants.

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<sup>1</sup> STEM stands for Science, Technology, Engineering and Mathematics.

This research question bears importance for US higher education, whose colleges and universities lead the world in hosting international students.<sup>2</sup> Anticipating and shaping future foreign enrollment streams is not possible without understanding the relevant factors. The ability to adjust student composition is of tremendous value as foreign students may impart externalities that affect native educational attainment (e.g. Hoxby 1998, Borjas 2004, Hunt 2012, Jackson 2014) or university knowledge creation (e.g. Chellaraj et al. 2008, Stuen et al. 2012). Understanding how H-1B policies intersect with international student entry can be used to regulate the extent of these externalities.

Focusing on labor market openness through the H-1B program is particularly relevant for policymakers. Curiously, while the US tightly controls employment of foreign skilled workers by placing caps on H-1B visas, there are no quotas on foreign matriculation in US colleges and universities. Despite these opposing stances towards foreign students and high skill workers, policies targeted towards one group may affect the other. However, H-1B reforms are often made without considering the broader effects on foreign students. This paper informs high skill immigration policy by elucidating an unintended consequence of the H-1B visa program on US higher education.

Understanding how access to domestic labor markets affect the number of foreign students also informs changes in future high skill labor supply, innovation and economic productivity. As a sizeable portion of foreign students seek jobs in the US after graduation, policy makers using H-1B caps to reach targets for high skill labor supply

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<sup>2</sup> See the OECD report [http://www.oecd-ilibrary.org/education/how-is-international-student-mobility-shaping-up\\_5k43k8r4k821-en](http://www.oecd-ilibrary.org/education/how-is-international-student-mobility-shaping-up_5k43k8r4k821-en).

may inadvertently overshoot or undershoot if they fail to account for the impacts on international enrollment.<sup>3</sup> Such unanticipated changes in the supply of skilled labor may affect the wages and productivity of US natives (e.g. Borjas 2009, Peri et al. 2014). Additionally, because foreign students and high skill workers are key contributors to STEM innovation (Black & Stephan 2007, Kerr & Lincoln 2010, Chellaraj et al. 2008; Stuen et al. 2012), failure to regulate skilled foreign labor supply would have consequences for technological progress, and hence long run economic productivity growth.

Surprisingly, as the world leader in hosting international students, the US has been the focus of only a small number of studies on the determinants of international enrollment.<sup>4</sup> Previous attempts have taken a broad-sweeping approach, examining the relationship between international enrollment and a variety of potential factors within a gravity regression framework. The results from these studies have found many factors to be important, including bilateral trade (McMahon 1992); skill prices in home countries (Rosenzweig 2006); tuition fees and US government expenditures on higher education (Liu & Wang 2009); and home country GDP, demographic changes to young populations, and exchange rates (Bird & Turner 2014).<sup>5</sup>

This work extends existing research on the determinants of international student mobility in several key manners. First, I introduce measures of H-1B issuances by

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<sup>3</sup> Ruiz (2013) reports that 35% of all H-1B visas awarded in 2010 were to individuals transferring from an F-1 student visa. Furthermore, among those F-1 visa holders transferring to an H-1B visa, nearly 75% were individuals with graduate degrees.

<sup>4</sup> As foreign student entry to non-US destinations has grown, many recent studies have focused on understanding international student mobility to European Union nations (Brezis & Soueri 2013; González et al. 2011; Van Bouwel & Veugelers 2013) and to the United Kingdom (Naidoo 2007; Jena & Reilly 2013).

<sup>5</sup> In related work, Grogger & Hanson (2013) find that increases in the strength of the US economy and weaker home country economic conditions both increase the likelihood Ph.D. recipients stay in the US.

country into the gravity regression framework. Controlling for other potential determinants helps mitigate omitted variable bias and allows variation in H-1B issuances to better reflect labor market openness. Additionally, utilizing the gravity framework affords comparisons to earlier studies that exclude H-1B issuance.

While gravity regressions and comparisons across the literature are useful, causal relationships are the important and relevant margin on which policies should be structured. Thus, the second contribution of this paper is to attain causal estimates by analyzing a natural experiment that decreased the openness of the US' skilled labor market. I focus on a policy-induced reduction in the H-1B visa cap from 195,000 to 65,000 in October 2003. This strategy builds on the difference-in-differences approach used by Kato & Sparber (2013) to evaluate how the fall in the cap affected the quality of foreign college applicants. A central contribution of this paper, therefore, is to focus on quantity—a complete understanding of the role of H-1B policy, and hence labor market openness, is not possible without examining both selection and scale.

Because several countries were exempt from H-1B visa caps, Kato & Sparber (2013) compare SAT scores sent to universities by applicants from non-exempt (treated) countries to those from exempt (control) countries. While comparisons between treated and control countries serve as a useful starting point, this difference-in-differences approach requires that the two types of countries would have followed parallel trends in absence of H-1B reform. To overcome this demanding assumption I utilize a triple difference framework that leverages the fact that graduate students were also largely exempt from H-1B limits, and can be used as a second counterfactual group to remove

differential trends across treated and control countries. Importantly, the triple difference approach requires a much weaker assumption: no other coincident factors differentially affected the enrollment behavior of undergraduates from treated countries.

The main finding of this paper is that changes in H-1B visa policy that alter labor market openness strongly affect international student enrollment. Gravity regressions reveal a large positive correlation between international enrollment and H-1B visas. The results are always statistically significant at the 5% level and remain robust after controlling for a variety of other factors, including exchange rates, trade, and home country GDP. In fact, factors that were found to have statistically significant relationships with foreign enrollment in prior studies lose significance when H-1B issuances are accounted for. The strong role of H-1B visas is even evident in the most rigorous specifications, which also control for country fixed effects, year effects, and country-specific linear time trends.

The triple difference analysis confirms the insights of the gravity regressions. Preferred average treatment effect estimates reveal that decreased labor market openness, due to the fall in the H-1B cap, lowered international enrollment by 10%. Inspection of pre-trends verifies that the triple difference strategy effectively mitigates differential trends between treated and control countries. The triple difference results are usually significant at the 5% level, with p-values ranging between 0.039 and 0.07, even after including various controls and country trends.

The impact of labor market openness on international enrollment may occur through several mechanisms. Decreased openness may be perceived as a signal of a less friendly

climate, thereby discouraging foreign citizens to study abroad. Alternatively, contractions in H-1B policy may weaken networks of information as fewer H-1B workers arrive and inform college age relatives and friends at home about opportunities in the US. Finally, decreases in labor market openness may lower the anticipated return to studying in the US, as international students reduce their expectations of finding employment and earning US wages after graduating.

Analysis of possible mechanisms finds support for the latter explanation—students respond to labor market openness due to changes in anticipated net returns to studying in the US. Stratified triple difference regressions confirm that the fall in the H-1B cap had stronger effects on students from countries with large expected returns from attending college in the US. Countries with the highest expected returns experienced a 16% decline in enrollment, while countries with lowest returns only saw enrollment decline by a statistically insignificant 5%.

The next section examines the close links between international students and the H-1B program to provide descriptive support for the notion that H-1B policies may impact foreign enrollment. Section 3 describes the data and presents the empirical analysis using gravity regressions. Triple difference analysis on the reduction in the H-1B cap are presented in section 4. Section 5 concludes.

## 2 International Students and the H-1B Visa Program

US high skill immigration policy maintains an unusually dichotomous set of regulations. Since the exemption of foreign students from national origins quotas in 1924, legislators

have maintained an open door for international students to enter US colleges and universities.<sup>6</sup> In contrast, high skill immigrant labor has typically been tightly controlled by the H-1B visa program, which restricts entry through a yearly cap set by congress. Since October 2003 the cap has been set at 65,000 H-1B visas per year. While the political stances towards these two programs have been rather different, the programs themselves have become closely intertwined.

The nexus between foreign students and the H-1B program arises rather organically. The foreign students of today are often the high skill immigrants of tomorrow, and as such, require an H-1B visa after graduation. Additionally, the link between foreign students and the H-1B program also manifests in legislation. Currently, an extra 20,000 H-1B visas each year are reserved for foreign students who graduate from US universities with advanced degrees (i.e. master's degree or higher). Additionally, since 2000 US higher education and non-profit institutions wishing to hire foreign skilled workers were exempt from H-1B limits, creating an open pathway for foreign master's and Ph.D. students to find academic and research-based employment.

Because these programs are closely connected, it is not surprising that they tend to attract similar types of individuals from abroad. Large portions of H-1B workers and foreign students are engaged in STEM fields. Roughly 30% of all international students earning bachelor's degrees from 2003-2012 majored in a STEM discipline (figure 2, left panel). That percentage is even larger at higher academic levels. Over 40% of all foreign

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<sup>6</sup> While there has not been a cap on student visas since 1924, there have been various policies that have restricted entry. For example, post 9/11 policies increased screening of student visa applicants, leading to longer wait times for visas. See Walfish (2002), Alberts (2007), and Urias & Yeakey (2009) for further background.



masters' degrees recipients, and between 60-70% of doctoral recipients graduated with a STEM degree. In comparison, the percent of H-1B recipients in STEM occupations has climbed from 48% to 75% over the 2003-2012 period (figure 2, right panel).

Additionally, foreign students and H-1B recipients are also similar in terms of where they come from. Figure 3 plots the distribution of foreign students (left panel) and H-1B recipients (right panel) across the 13 countries that appear among the 20 largest in both international enrollment and H-1B visa issuance in 2012. All other countries are combined in the "Other" category. Asian countries comprise the large majority of both international students and H-1B immigrants. The H-1B program is unique, however, in that one country (India) far dominates all others, while international students are more evenly distributed across Asian nations. China is the largest country group in terms of international enrollment, followed by India as a close second.

Despite starkly different policies towards international students and high skill foreign labor, the types of students and workers that ultimately arrive in the US appear rather similar. H-1B workers and international students tend to gravitate towards STEM fields and are predominantly selected from Asia. These descriptive statistics, therefore, provide support to the notion that H-1B policies that alter labor market openness may have consequences for international students. With these facts in mind, the next section turns to gravity regression analysis to examine the role between H-1B visa issuance and foreign enrollment.

### 3 Data and Empirical Analysis

Does labor market openness, as regulated by the H-1B visa program, attract international students to the US? One way to approach this question would be to measure how closely international enrollment from a country varies with that country's usage of the H-1B program. Prior research has adopted a similar approach, utilizing gravity regressions, to examine the association between international enrollment and various economic factors, such as GDP, exchange rates, and bilateral trade, (e.g. McMahon 1992, Rosenzweig 2006, Liu & Wang 2009, Jena & Reilly 2013, Bird & Turner 2014).<sup>7</sup> Using this framework I introduce a measure of the H-1B program, which controls labor market openness, as another possible determinant. I then include previously considered determinants in regressions to see if the relationship between H-1B visas and foreign enrollment remains.

The analysis uses the following general gravity regression model,

$$\log(E_{ct}) = \alpha + \beta \log(H1B_{ct-1}) + \log(X_{ct}) + \gamma_c + \gamma_t + \varepsilon_{ct} \quad (1)$$

In specification 1,  $E_{ct}$  represents the total number of international students from country  $c$  enrolled in US universities in year  $t$ . The number of H-1B visas issued in a given year to each country is denoted by  $H1B_c$ . Because many foreign students end up transferring to an H-1B visa in each year, I use H-1B issuances lagged one year ( $H1B_{ct-1}$ ) to help

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<sup>7</sup> The gravity method is also popularly used in related literature that attempts to identify determinants of international migration (e.g. Clark et al. 2007, Mayda 2010, Ortega & Peri 2013, 2014).

break this mechanical correlation. The key coefficient,  $\beta$ , measures the strength of the relationship between foreign enrollments and H-1B visa issuances.

Importantly, H-1B visa issuance is an imperfect measure of labor market openness, since, for example, changes in H-1B usage could be entirely driven by US labor demand or foreign labor supply and therefore not representative of policy openness. Therefore, the model includes a vector of control variables,  $X_{ct}$ . Importantly, to account for changes in labor supply or demand conditions in the sending country that push students abroad I include measures of home country push factors, such as the college age population, employment, and GDP per capita. To account for changes in US economic conditions that attract students from abroad, I include a proxy for foreign students' expected earnings from studying in the US: the average wages of college educated immigrants in the United States by country of origin. Additionally, I include imports, exports, and exchange rates to measure the strength of ties between foreign countries and the US, which may affect the extent of educational exchange. These controls appear in various prior studies, and thus allow the results from this analysis to be compared to previous findings.

Finally, specification 1 also includes country-fixed effects ( $\gamma_c$ ) to absorb time-invariant country-specific factors that may influence both international enrollment and H-1B issuances, such as distance, culture, and language. The inclusion of year dummies ( $\gamma_t$ ) helps account for global trends, such as rising worldwide GDP which might simultaneously increase the attractiveness of alternative study abroad destinations. The identifying variation, therefore, comes from changes in H-1B visa issuance within

countries and over time. As such, this methodology will be particularly vulnerable to other omitted factors that vary within countries over time. For example, multilateral factors, such as changes in the relationship between China and Canada, another popular destination for foreign students, may bias results if such changes are correlated with China-US relations (Bertoli & Moraga 2013).<sup>8</sup>

### 3.1 Data

The principal source of data on international student enrollment in the US comes from the Institute of International Education (IIE).<sup>9</sup> I compile undergraduate and graduate fall term enrollment counts by country of origin for the academic years 1998-1999 through 2010-2011 (e.g. Fall 1998 for the 1998-1999 academic year) from Open Doors reports (Open Doors 2012). I collect the count of H-1B visas issued by country over the same period from the US Department of State (Department of State 2012).

Data for control variables come from a variety of sources. Real GDP per capita by country is calculated by dividing real GDP by population, from the Penn World Tables (Feenstra et al. 2013). Specifically, I use expenditures-side real GDP, which better captures real living standards and is more suitable for analysis across countries and over time.<sup>10</sup> While increases in real GDP may reflect rising wages/demand conditions in the home country, and hence increasing opportunity costs of studying in the US, they might

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<sup>8</sup> Note that some multilateral factors, which Bertoli & Moraga (2013) label “multilateral resistance to migration”, will be accounted for when using time dummies. Only bilateral or “dyad” factors will be unaccounted for in the gravity approach.

<sup>9</sup> The IIE was founded in 1919 and has published yearly statistics of international students in US higher education in volumes called “Open Doors” since 1954. For more information see <http://www.iie.org/Research-and-Publications/Open-Doors>.

<sup>10</sup> Expenditure-side real GDP is calculated at chained Purchasing Power Parities (PPPs), to compare relative living standards across countries and over time. Using PPPs adjustments are important to capture the real costs of living which differ across countries. See Feenstra et al. (2013) for detailed description of this variable.

also represent rising income which could enable more students to afford studying in the US.

Exchange rates, denominated in home currency per USD, also come from the Penn World Tables. Holding other prices constant, fluctuations in exchange rates should raise or lower the cost of attending college in the US.<sup>11</sup> For example, an appreciation in the Euro/USD exchange rate raises the cost of attending college in the US for European students. Thus, exchange rates should be negatively correlated with foreign student enrollment.

As the focus of this analysis is on the *quantity* of foreign students, it is important to control for demographic shifts in sending countries that might affect the number of internationally mobile workers and students (Liu & Wang 2009; Bird & Turner 2014). All else equal, a country that experiences a particularly large birth cohort will mechanically have a larger number of individuals from that cohort applying and attending college. It is likely that some of this excess demand for higher education spills over to the US. To account for demographics I gather data on the population of tertiary education age (i.e. college age) individuals by sending country from UNESCOs Institute for Statistics.<sup>12</sup>

Trade linkages between countries may foster other types of interaction, including educational or labor exchange (McMahon 1992). I compile bilateral import and export values by Harmonized System (HS) code, US state, and partner country from US census

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<sup>11</sup> These costs may include tuition, living costs, transportation costs, and application fees.

<sup>12</sup> Tertiary age differs depending on the country, but generally cover individuals aged 18-30 who attend educational levels from undergraduate to graduate education in the US. See <http://www.uis.unesco.org/Education/Pages/international-standard-classification-of-education.aspx> for more information.

data.<sup>13</sup> These data are aggregated across states and HS codes to obtain total values of imports and exports between the US and each sending country.

Finally, to proxy for US demand conditions I construct a measure of the expected US wage for students from each sending country by calculating the average annual wage of immigrants aged 25-40 with a bachelor's degree or higher by country of origin from the 2000 US Census and the 2001-2010 American Community Surveys.<sup>14</sup> Average wages are expressed in constant 2010 dollars and are only available for only 92 countries.

The resulting dataset comprises a panel of 140 countries from 1998-2010.<sup>15</sup> All variables are expressed in natural logarithms (logs) to mitigate the effect of scale bias. A very small number of country-year observations contain zeroes, in either foreign enrollment or H-1B visa issuance. Thus I use a standard transformation, adding 1 to these variables, to allow logs to be taken.<sup>16</sup> Because variables are specified in logs, the key coefficient ( $\beta$ ) identifies the elasticity of international enrollment to lagged H-1B visa issuances. All specifications include country fixed effects and year effects. Standard errors are clustered at the country level to mitigate serial correlation in residuals.

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<sup>13</sup> These data were kindly made publicly available by Peter Schott See Schott (2008) for more details.

<sup>14</sup> Immigrants are defined as individuals not born in the US and who are not born abroad to US citizen parents. The sample is limited to immigrants who worked a positive number of weeks in the previous year, reported earning positive wage/salary income, and have a bachelor's degree or higher. Unfortunately, no surveys are available in 1998 or 1999 that provide enough observations to accurately estimate average wages of immigrants by country of origin.

<sup>15</sup> I drop one outlier country—Iraq—from the analysis, as it was one of the countries that was most largely affected by post 9/11 security measures, and thus saw huge declines in international students and H-1B visas.

<sup>16</sup> Thus, the dependent variable is  $\log(1 + E_{ct})$ , and the H-1B measure is  $\log(1 + H1B_{ct-1})$ . Results are very similar when dropping countries with zeroes from the panel, and are available upon request.

## 3.2 Empirical Analysis

Table 1 presents regression results of specification 1 on 140 countries from 1998-2010. The specification used in column 1 regresses total international enrollment on 1-year lags of H-1B visa issuance, controlling for country fixed effects and year effects. Column 2 adds home country push factors—GDP per capita, college age population, and employment—as controls. Column 3 further includes exchange rates, imports, and exports to account for economic ties with the US. Column 4 adds the measure of expected US wages to control for US pull factors.<sup>17</sup>

A strong and significant association between H-1B visa issuance and international enrollment is apparent in columns 1-4. Estimates range between 0.16 and 0.20, and are significant at the 1% level in all specifications. Taken literally, the estimate in column 4 implies that a 1% rise in H-1B visa issuance to a country leads to a 0.2% increase in international enrollment in the following year.

Aggregating over all foreign students in higher education could mask different responses to H-1B issuances. For example, undergraduate students might be myopic in deciding where to go to college, and place a small weight on labor market openness. In contrast, graduate students may be more concerned with the labor market openness of the destination country. Columns 5 and 6 of table 1 separately examine the relationship for foreign undergraduate and graduate students. The results show positive, similarly-

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<sup>17</sup> Notice the drop in sample size when adding expected US college wages. This is due to the fact that wages are only available for 92 countries and only from 2000-2010.

sized, and statistically significant relationships for both undergraduate and graduate students, suggesting evidence against differential responses.

Further, notice that among all control variables only college age population appears to have a consistently positive and significant association across the specifications. While the important relationship between demographics and international enrollment is not a new finding, it is interesting to see that it still remains when including H-1B visa issuance. The coefficients on college age population in columns 2-6 are always statistically significant, at least at the 10% level, and range between 0.50 and 0.89—on par with prior studies by Rosenzweig (2006) and Bird & Turner (2014).

Surprisingly, the other control variables that account for home country push factors, US pull factors, or bilateral linkages seem to have little association. This contrasts markedly with results from prior work using nearly identical regression frameworks. Bird & Turner (2014) find a significant positive association between foreign undergraduate enrollment and both GDP per capita and exchange rates (denominated in home currency per USD), with coefficients ranging between 0.6 to 0.7 and 0.3 to 1.2, respectively. Rosenzweig (2006) finds positive and significant coefficients on GDP per capita (estimates between 0.6-0.7), while Jena & Reilly (2013) find significant negative relationships between exchange rates and international students in the United Kingdom (estimates range from -0.7 to -1.6).<sup>18</sup> This analysis has shown that H-1B visa issuance

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<sup>18</sup> In highly related work, Grogger & Hanson (2013) find that home country GDP decreases the proportion of international PhD students who stay in the US after graduating, while US GDP increases that proportion.



has a very strong relationship with foreign enrollment, and reduces the significant effects on other potential factors when included in gravity regressions.

### 3.3 Timing of the H-1B Effect

Do international students only respond to 1-year lags of H-1B issuance? The analysis thus far has used 1-year lags of H-1B issuance to mitigate a mechanical correlation that arises because each year a portion of students that are enrolled will graduate and receive H-1B visas to work in the US. If students are highly forward-looking, H-1B admissions levels measured before students are college-eligible may be the relevant signal.

Alternatively, because college takes time to complete, students enrolled today may respond more to future admissions levels (Ryoo and Rosen 2004). However, using future H-1B admissions levels may lead to upward biased estimates because of the additional mechanical correlation described earlier.

Table 2 analyzes the timing of the relationship by varying H-1B issuances from 3 year lags to 3 year leads. The coefficient on the H-1B variable is displayed for total international enrollment (row 1), undergraduates (row 2), and graduate students (row 3). All specifications are identical to column 4 of table 1—they include all controls, country fixed effects and year dummies. The estimates in column 3 of table 2 uses 1-year lags of H-1B visas and thus is identical to the row 1 estimates in columns 4-6 of table 1.

Notice first that all results, except for row 1 column 1, are positive and always statistically significant at the 5% level, and at the 1% level in the majority of cases.<sup>19</sup> Additionally, the size of the point estimates increase when moving from 3 year lags to 3 year leads. The estimates in column 1 suggests that international students respond to H-1B issuance even 3 years prior. The estimate grows larger as the specifications use successively shorter lags. Coefficients continue to grow when using contemporaneous H-1B issuances and even leads of the H-1B variable. The fact that point estimates continue to grow when using leads is consistent with the problem of upward bias due to mechanical correlation from foreign students transferring to H-1B status after graduating.

### 3.4 Robustness

Gravity regressions of specification 1 are particularly vulnerable to threats from omitted variables that vary within countries and over time. To partially assess the extent of this bias, I implement a robustness check that includes country-specific linear trends, which absorb factors that evolve linearly within countries. Identification is driven by deviations in H-1B issuance from country trends over time.<sup>20</sup>

Columns 1-3 of table 3 display the results when including country-specific trends. The specifications also include all control variables, year dummies, and country fixed

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<sup>19</sup> The estimate using 3-year lags on total enrollment is not statistically significant, while the estimates for graduate and undergraduate enrollment are statistically significant. This is likely due to measurement error when using total foreign enrollment since survey respondents first report total enrollment and then report enrollment by academic level, which includes graduate students, undergraduates, non-degree students, etc. Respondents use a residual “unknown” group that allows the sum across academic levels to equal the reported total enrollment. Thus, total enrollment may be measured with greater error than undergraduate and graduate enrollments.

<sup>20</sup> Note that this specification is more demanding than those used in prior studies, which at most control for year dummies and country fixed effects. Additionally, results are robust to checks that drop the largest sending nations (China and India) from the analysis. These are available from the author upon request.

effects. Column 1 uses total enrollment as the dependent variable, while columns 2 and 3 repeat this check for undergraduates and graduate students, respectively. Estimated coefficients on H-1B issuance are around 0.10 when controlling for country-specific trends, slightly lower than the point estimates without country trends in table 1, which range from 0.16-0.20. The decrease in the point estimate suggests that country-trends do account for some endogenous variation coming through linearly-evolving omitted factors. Importantly, the positive result remains statistically significant at the 1% level.

Although the positive and statistically significant relationship between international enrollment and H-1B visas issuances is compelling, the empirical designs presented thus far are not without flaws. Many omitted factors, including multilateral factors (Bertoli & Moraga 2013), may bias the results. Crucially, the findings should be interpreted as strong associations rather than causal estimates. To better identify the causal impacts of labor market openness, I focus on a natural experiment that occurred in October 2003—the H-1B visa cap fell from 195,000 to 65,000, drastically reducing access to the US labor market. The next section analyzes this reduction in H-1B visas and estimates the impact on foreign enrollment.

## 4 The H-1B Policy Experiment

The H-1B program began in 1990 with a congressionally mandated cap of 65,000 visas per year. Since then the program has undergone various reforms, which have both restricted and relaxed entry. One such reform led to a fall in the cap in October 2003, providing a very good natural experiment to evaluate the impact of reduced labor market openness on foreign enrollment.

During the late 1990's legislation increased the cap from its original level of 65,000. The passage of the American Competitiveness and Workforce Improvement Act (ACWIA) in October 1998 raised the cap from 65,000 to 115,000 for fiscal years (FY) 1999 and 2000, and to 107,000 for FY 2001. These increases were temporary, however, as the act stated the cap would return to the original level of 65,000 for FY2002. The passage of the American Competitiveness in the 21<sup>st</sup> Century Act (AC21) in October 2000, however, extended this rising trend of openness, superseding ACWIA and further expanding the H-1B visa cap to 195,000 for FY 2001-2003. Again the increased cap was temporary—as written in AC21, the H-1B cap would return to 65,000 beginning in FY 2004 without further acts by Congress.

By October 2003 (the start of FY 2004) Congress failed to introduce new legislation that would extend the raised caps from AC21, as they did in October 2000 before the raised caps under ACWIA expired. The H-1B cap fell from 195,000 to 65,000, marking a dramatic decrease in labor market access for foreign students enrolling in the following academic year (i.e. September 2004 - June 2005).<sup>21</sup> It is unlikely (and later I show it not to be the case) that students reacted in anticipation of the expiration of the cap. The rising trend in openness and the previous extension and expansion of the H-1B caps set under ACWIA created uncertainty about whether the cap would actually fall or be extended again. Importantly, the expiration of legislation is arguably more exogenous than the passage of legislation, and any anticipatory effects are likely to bias results downward.

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<sup>21</sup> Note that the H-1B cap was not binding in 2003, making the expiration of raised caps all the more dramatic.

Interestingly, however, the fall in the cap in October 2003 did not necessarily signal lower labor market access to all students. By October 2003, four countries—Canada, Chile, Mexico, and Singapore—had signed trade agreements which included alternative visas for their skilled citizens to work in the US. In May 2005, the passage of a preferential trade agreement also created an alternative work visa for highly educated Australian nationals.<sup>22</sup> The availability of alternatives to the H-1B visa under these trade agreements proved crucial after the cap fell in 2004. As shown in figure 4, as the H-1B cap fell, these countries began substituting into the other visas. Notice the timing of substitution for Australia, which does not occur until the trade agreement was signed 2005, suggesting Australian students in 2004 were likely affected by the decreased H-1B caps. Overall, while prospective foreign students from most nations experienced a dramatic restriction in access to the US labor market (treated countries), students from countries with alternative visas (control countries) did not.

Kato & Sparber (2013) utilizes a difference-in-differences design to compare changes in SAT scores from applicants of treated countries against control countries.

Importantly, this difference-in-differences estimator hinges on the assumptions of parallel trends—foreign enrollment from treated and control countries would have evolved identically in absence of treatment. Replicating this strategy to examine effects on international student quantity is worrisome since differential trends in enrollment behavior across treated and control countries may exist. Additionally, having only 5

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<sup>22</sup> These various trade agreements created alternative visas which were very similar to the H-1B visa. TN visas were created in 1994 under the North American Free Trade agreement for citizens of Canada and Mexico. The H-1B1 visa program was enacted in September 2003 for citizens of Chile, and Singapore. Lastly, in May 2005 a bill was enacted establishing E-3 visas for Australian citizens. For further details regarding these policy changes see Kato & Sparber (2013).

control countries raises the concern of whether the small control group yields sufficient power to detect meaningful effects.

Interestingly, however, two other features of H-1B reforms provide a way around the restrictive assumption of parallel trends. First, in addition to raising the H-1B cap, AC21 also exempted foreign highly educated individuals hired by non-profit organizations and universities from counting against the cap. Second, the H-1B Reform Act of 2004 mandated that beginning in FY 2005 an additional 20,000 H-1B visas per year, not counted toward the cap of 65,000, was to be reserved for individuals that earned graduate degrees from US colleges and universities. Together this meant that the October 2003 fall in the cap reduced labor market access for foreign undergraduates much more than for foreign graduate students. Thus, comparing the enrollment behavior of foreign undergraduates relative to graduate students adds another dimension of plausibly exogenous variation to identify the causal impact of H-1B policy on foreign enrollment.

I utilize a differences-in-differences-in-differences (*DDD* or triple difference) regression framework to estimate the causal impact of the H-1B visa policy on international student enrollment. IIE data provides foreign student enrollment counts by academic level and country of origin. Under this design Canada, Mexico, Australia, Chile, and Singapore—countries with alternatives to the H-1B—are considered control countries, whereas all others are considered treated countries. Undergraduates are considered treated students, while graduates are considered control students.

I focus on the sample of 92 countries for which all control variables used in the gravity regression analyses of section 3.2 are available. I center the analysis on enrollments over the 7 year window from fall 2001 - fall 2007, which remained relatively free from other H-1B related policy reforms that might otherwise confound treatment effects.<sup>23</sup> Pre- and post-treatment periods cover fall 2001 - fall 2003 and fall 2005 - fall 2007, respectively. I remove fall 2004 from the analysis as the extra 20,000 visas for graduate students was not enacted until December 2004. This demarcation will introduce a slight bias towards finding no effect as Australia, denominated as a control country throughout the sample, did not have an alternative to the H-1B until December 2005—students from Australia enrolling in fall 2004 were actually treated.<sup>24</sup> Robustness checks correct for this issue by dropping both fall 2004 and fall 2005 from the analysis.

Importantly, this methodology overcomes the concern of parallel trends because it requires a much weaker assumption: no other coincident factors differentially affected undergraduates from treated countries. Graduate students, who are less restricted by the fall in the H-1B cap, proxy for how undergraduate enrollment would have trended in the absence of treatment. Thus, differential trends should be differenced out when comparing the evolution of undergraduate and graduate enrollment, across treated and control countries. Empirically, the triple difference estimator also removes differential trends across academic levels. Furthermore, this strategy allows for visual inspection of whether differential trends are in fact removed—there should not be any apparent pre-

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<sup>23</sup> For example, including fall 2000 might confound estimates because AC21, which raised the H-1B visa cap, was passed between fall 2000 and fall 2001. Similarly, including fall 2008 would be worrisome since an interim final rule was passed in April 2008 that extended the period of Optional Practical Training to 17 months for F-1 students pursuing STEM degrees.

<sup>24</sup> The bias towards zero arises since we would be comparing enrollments from treated countries to those from a control country that is actually treated in two years of the post period (fall 2004 and fall 2005). To the extent treatment effects are identical across countries, this will induce a bias towards 0.

trends between treated and control countries, when plotting differences in enrollment between foreign undergraduates and graduate students.

The removal of differential trends across treatment and control countries can be more clearly seen in figure 5, which plots differences in log enrollment between undergraduates and graduates, separately for treated and control countries. The horizontal axis indicates time, in years, relative to the October 2003 reform. Fall 2003 is coded as 0 years relative to the October 2003 reform, fall 2004 is 1 year after the reform, etc. As can be seen, after differencing across academic levels there is no evident pre-trend in enrollments across the two types of countries. Furthermore, notice that the drop in undergraduate enrollment only occurs after treatment. This shows that students did not respond in anticipation of the cap expiring. It is likely that the rising trend of openness and the previous passage of AC21 which extended ACWIA created uncertainty over whether the cap would actually fall.<sup>25</sup> Given that the triple difference methodology appears to effectively remove problematic differential trends, the next section presents the findings.

#### 4.1 Comparison of means

The top panel of table 4 shows a simple comparison of average log undergraduate enrollment for treatment and control countries, before and after the October 2003 fall in the cap. The panel is divided into four cells by time (pre-treatment vs. post-treatment)

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<sup>25</sup> Note that graduate enrollments appear to fall slightly in treated countries relative to control countries after the drop in the cap. This may perhaps be due to an overall downward trend in international entry to the US after post-9/11 security measures came into effect. The triple difference estimator is still valid so long as the extent 9/11 policies did not differentially affect undergraduates in treated countries.



and country (treated vs. control). To simplify notation,  $TS$  will stand for “Treated Students” and  $CS$  will stand for “Control Students”. Standard errors, shown below the means in parenthesis, are clustered at the country level.

Average undergraduate enrollment fell by 7% for control countries, while falling 18.4% for treated countries. Thus, enrollment declined in treatment countries relative to control countries by 11.5%. This is equivalent to the difference-in-difference estimate only comparing changes between treated and control countries for undergraduates ( $DD_{TS}$ ). The validity of this difference-in-difference estimate requires that undergraduate enrollment in treatment and control countries would have trended similarly if the fall in the H-1B cap never occurred.

As stated earlier, by October 2003 several reforms had created alternative pathways for graduate students to gain access to the US labor market. Thus, the behavior of graduate students between treated and control countries should serve as a counterfactual for what would have happened to undergraduate enrollments in the absence of treatment. The bottom panel of table 4 shows similar mean comparisons of log graduate enrollment. The simple differences in means show that graduate enrollment declined by a statistically insignificant 3.5% for control countries, while declining by 5% in treated countries. Thus, the difference-in-difference estimate comparing treated to control countries for only graduate students ( $DD_{CS}$ ) suggests that the drop in the H-1B visa cap decreased enrollment by 1.5%. However, the  $DD_{CS}$  estimate is statistically indistinguishable from zero.

The triple difference (*DDD*) estimates are provided in the final row of table 4. The *DDD* estimate shows that the fall in the H-1B cap led to a 10% decline in international enrollment in the US. This estimate is statistically significant at the 5% level, with a p-value of 0.039. Importantly, the three-tiered differencing (pre vs. post, treated country vs. control country, and treated students vs. control students) removes trends within-country and within-academic level. The validity of the *DDD* estimate requires that there were no other shocks that coincided with the fall in the H-1B cap and also differentially affected undergraduates in treated countries.

## 4.2 Robustness

Table 5 displays results from robustness checks that estimate the triple-difference in a regression framework using the following specification:

$$\begin{aligned} \log(E_{lct}) = & \alpha + \gamma_c + \gamma_l + \gamma_t + \beta_1(P \times TC) + \beta_2(P \times TS) \\ & + \beta_3(TC \times TS) + \beta_4(P \times TC \times TS) + \delta \log(X_{ct}) + \epsilon_{lct} \end{aligned} \quad (2)$$

The dependent variable in specification 2 represents log enrollment, which varies by academic level ( $l$ ), country ( $c$ ) and year ( $t$ ). I control for academic level, country, and year effects ( $\gamma_l$ ,  $\gamma_c$ , and  $\gamma_t$ , respectively) and all two-way interactions of  $P$  (a dummy equal to 1 for all years after the drop in the H-1B cap),  $TC$  (a dummy equal to 1 for treated countries), and  $TS$  (a dummy equal to 1 for treated students—i.e. undergraduates). The coefficient on the triple interaction,  $\beta_4$ , gives the *DDD* estimate. To explore the robustness of  $\beta_4$ , I include various controls ( $X_{ct}$ ) representing other

potential determinants of foreign enrollment, which come from the analysis under section 3.2.

The first row of table 5 reports coefficient estimates of  $\beta_4$  from specification 2. Each column subsequently adds more controls. Column 1 replicates the triple difference estimate in the last row of table 4. Column 2 controls for population, employment, and real GDP per capita in sending countries. Because the control countries obtained alternatives to the H-1B visa through preferential trade agreements, it is crucial to control for trade flows to isolate the effect of a change in H-1B cap, above and beyond any changes in trade policies with the US. Column 3 performs this check by adding imports and exports. Additionally, column 3 also includes bilateral exchange rates. Column 4 further adds the expected US college wage. Column 5 performs a highly demanding specification which includes all controls in column 4 and adds country-specific linear time trends. Note that the inclusion of these controls hardly affects the *DDD* estimate, which remains statistically significant at the 5% level, with p-values ranging between 0.039 and 0.049.

As a last check, column 6 also drops fall 2005 from the analysis. Recall that Australia, though labeled a control country in regressions, was actually treated in fall 2004 and fall 2005. Australia only obtained an alternative to H-1B visas in December 2005, after students had already enrolled for the fall 2005 term. Therefore in fall 2004 and fall 2005, students from Australia perceived a large drop in access to the US labor market, which was only alleviated for students enrolling in fall 2006. As stated earlier, miscategorizing Australia as a control country in fall 2005 should bias the *DDD* estimate

towards zero. This is confirmed in column 6, which removes fall 2005 from the analysis entirely. The point estimate is slightly more negative than in all other specifications which retain fall 2005. However, the extent of this bias is small as the coefficient only changes by 0.03 log points.

Overall the triple difference estimates show that the fall in the H-1B cap reduced international enrollment by 10%. Furthermore, this finding is very robust and stable to the inclusion of various controls. This result confirms the positive association uncovered in the gravity regressions in section 3.2 and indicates that labor market openness is a strong and important determinant of international enrollment.

### 4.3 Mechanisms

Why does H-1B policy, and hence labor market openness, affect international enrollment? There are several plausible mechanisms through which this relationship may arise. For example, international enrollment may increase with expanded labor market openness if high skill immigrant workers transmit crucial information about educational opportunities to home countries. Such backward linkages could foster educational exchange as young relatives and friends of H-1B workers learn more about opportunities at American universities. Alternatively, the cultural climate of destination countries may be an important factor for foreign students. Increases in H-1B policy may signal a broader openness and warming to foreign students, which would encourage individuals from abroad to apply and enroll in US universities.

An altogether different explanation is that foreign students weigh the net return to studying in the US against studying at home (or another destination). Increases in labor

market openness may raise the anticipated return to studying in the states, because it also raises the probability of finding a job and earning a US wage after graduating. As the expected return to studying in the US rises relative to staying at home, more students enroll in American colleges and universities.

To test whether this latter mechanism prevails, I create measures of expected returns to studying in the US and studying at home. The expected earnings variable used as a control in earlier gravity regressions—i.e. average wages of college educated immigrants from each country of origin—proxies for the return to studying in the US. To proxy for the return to staying at home, I use average income per worker (GDP per capita). Skilled wages in each of the countries are not readily available, so instead home country GDP serves as a rough proxy.

For each country I use these two measures to construct the relative return—log expected US wages minus log home country GDP. Treatment countries are then divided into terciles based on the distribution of this relative return. The triple difference regressions are separately estimated for each tercile of the distribution of relative returns using the same specification as in column 4 of table 5.

The results of this exercise is shown in table 6. Column 1 shows results for the first tercile (countries with very small relative returns), column 2 for the second tercile (countries with moderate returns), and column 3 for the third tercile (countries with large returns). The negative impact of the fall in the H-1B cap is largest in the third tercile—those countries with the most to gain from studying in the US. Reducing labor market access by decreasing the number of available visas lowers the expected return

from studying in the US. In contrast, students in the 1<sup>st</sup> and 2<sup>nd</sup> tercile of relative returns have smaller effects which are statistically insignificant.

Interestingly, the results from this exercise also reveal that the impact of H-1B policy on foreign students appears heterogeneous across countries depending on the expected return to studying in the states relative to remaining at home. This is a crucial finding for both educators and policy makers. Shocks that affect labor market openness will likely have disproportionate impacts on students who have more to gain by studying in the US.

## 5 Conclusion

This paper provides an empirical analysis of the effect of labor market openness on the quantity of international students in the US. In the US, labor market access for college educated foreign workers is largely controlled by the H-1B visa program. Gravity regressions on country-level panel data reveal that H-1B visa issuances have a strong positive association with international enrollment, even after controlling for other possible factors including exchange rates, trade, home country population, and expected US college wages.

While such correlations are enlightening, I estimate causal effects by focusing on a large reduction in the H-1B visa cap (from 195,000 to 65,000 per year) that occurred in October 2003. Importantly, this reform created a natural experiment that restricted labor market access to some countries, but not others. Additionally, access was restricted only for some students (undergraduates), but not others (graduate students). I

utilize a triple difference framework to evaluate the fall in the H-1B cap, comparing differences across treated and control countries, for graduate and undergraduate enrollment.

Triple difference estimates reveal that the fall in the H-1B cap reduced international enrollment by 10%. Importantly, these reductions appear to be driven by the fact that lower labor market openness reduces the expected return to studying in the US. Students from countries with larger expected returns appear to respond more strongly than students from countries with little or nothing to gain by studying in the US.

Understanding the determinants of international enrollment in the US is an important agenda. It is worth reiterating that the focus of this paper has been on the quantity of foreign students in the US and the economic forces that lead to changes in scale. Jointly understanding adjustments that take place on both the quality and quantity margins are important to elucidate how various international economic factors influence US higher education. Additionally, future work that identifies how such factors affect the mix of foreign students across different fields of study will also be useful for education administrators and policymakers alike.

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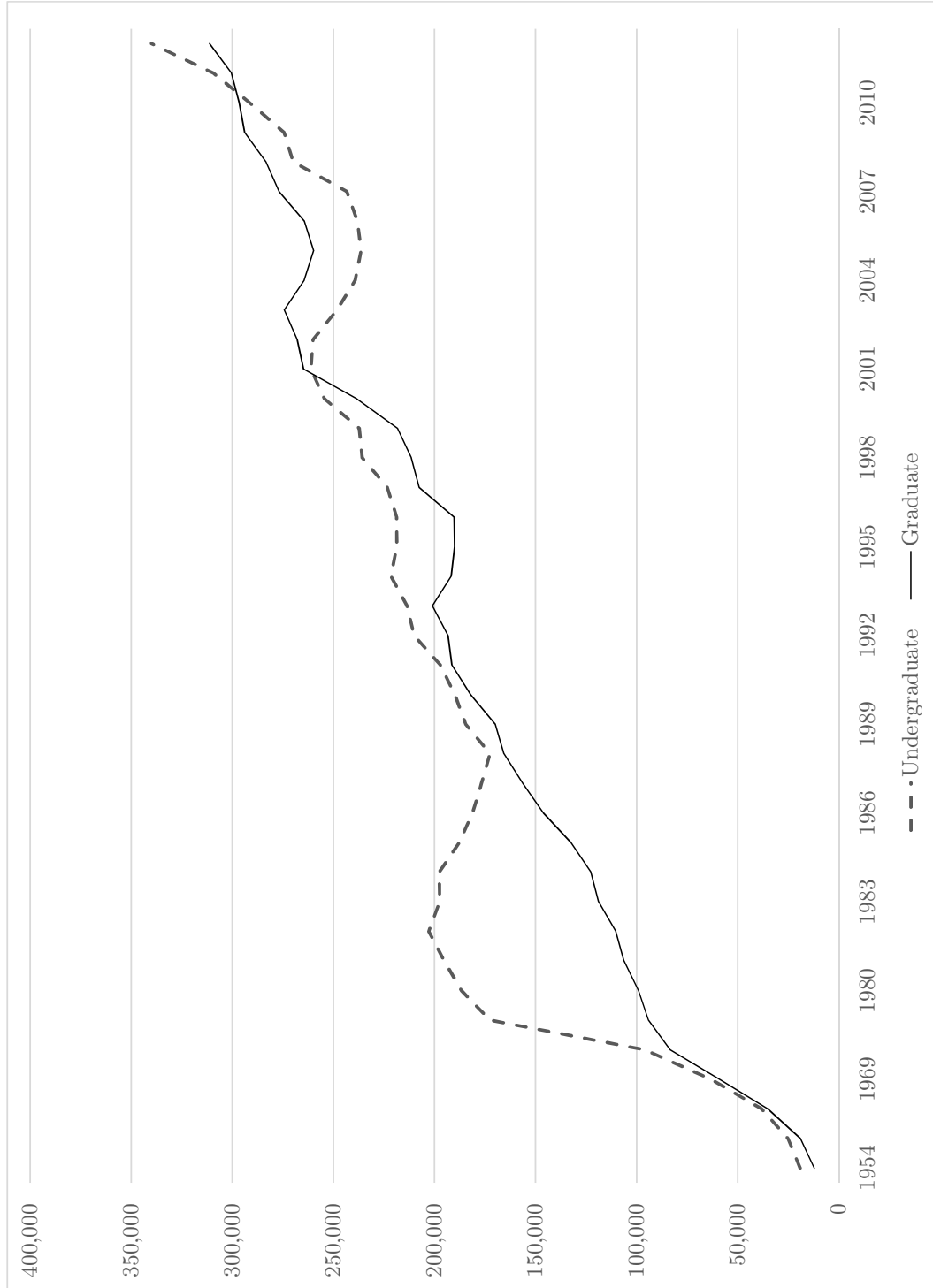
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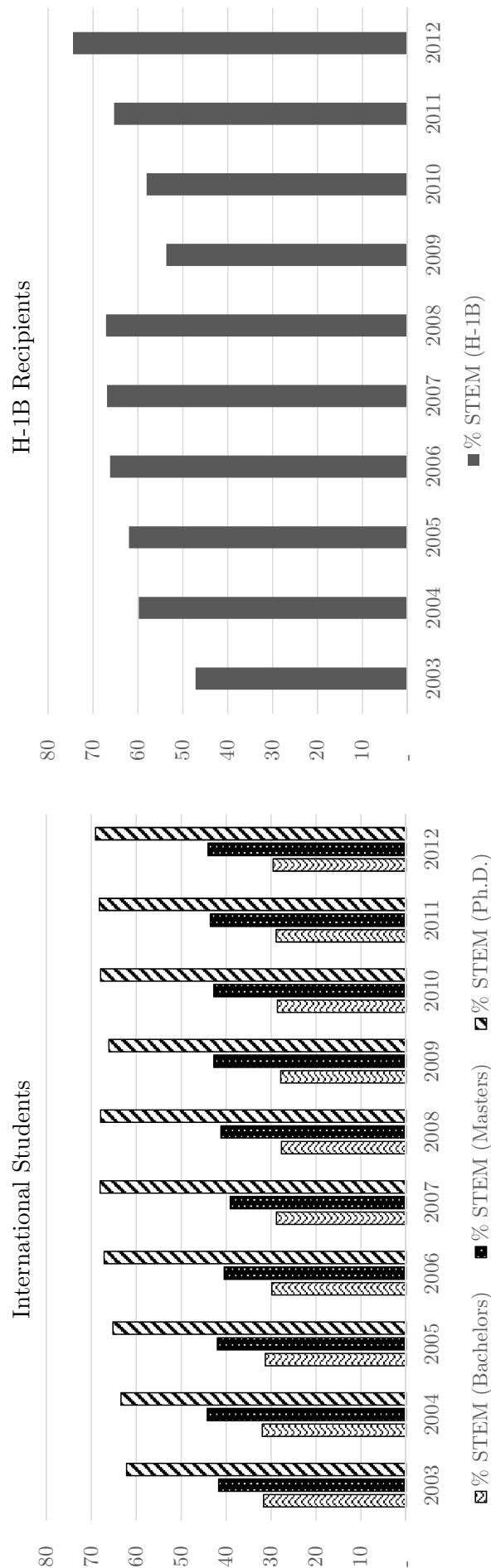
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Figure 1: Trends in International Postsecondary Enrollment in the US, 1954-2012



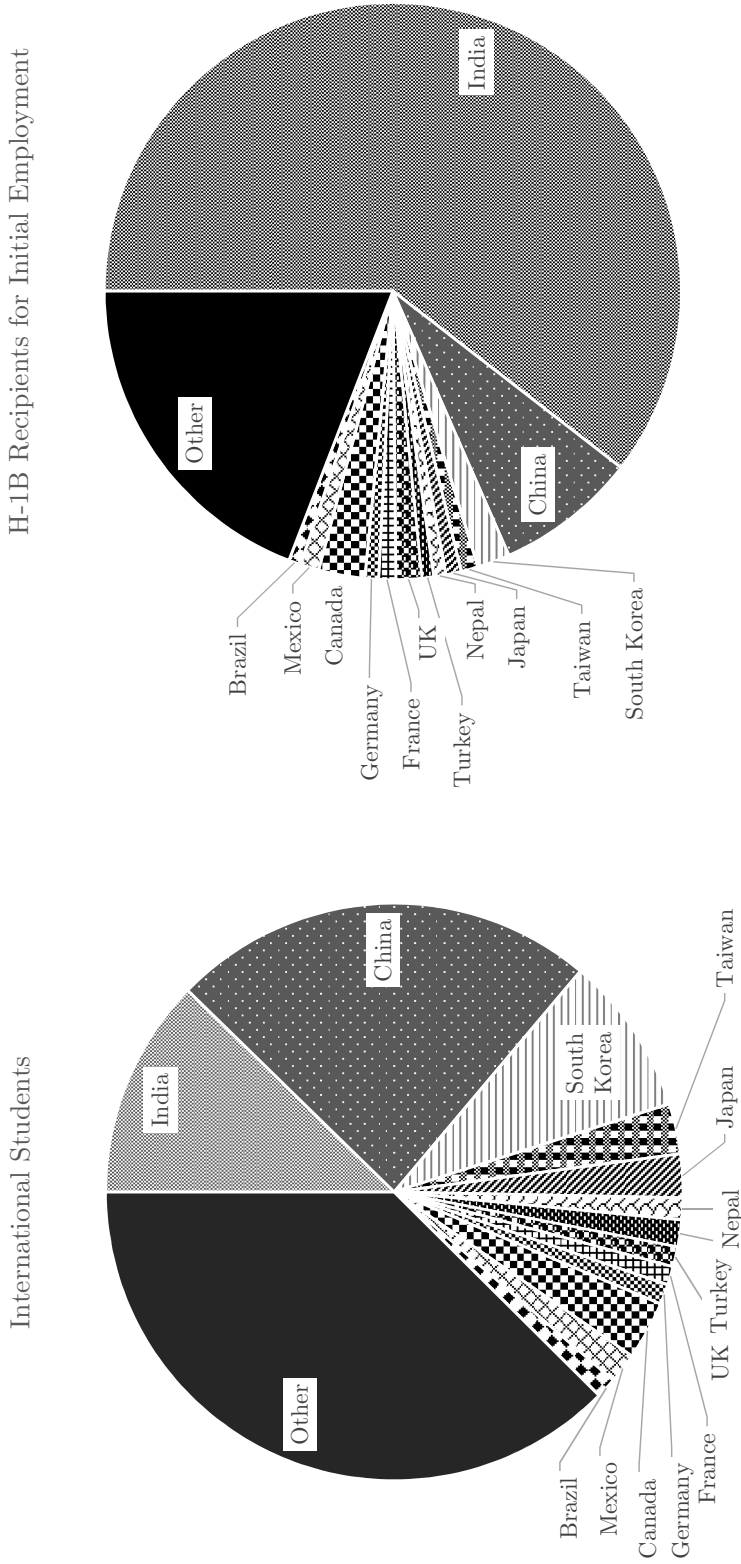
Note: This figure represents graduate and undergraduate enrollment of foreign students in the US. The left panel shows graduates and the right panel shows undergraduates. Data comes from the Institute of International Education, publicly available at: <http://www.iie.org/research-and-publications/open-doors/data>.

Figure 2: Percentage of International Students and H-1B recipients in STEM



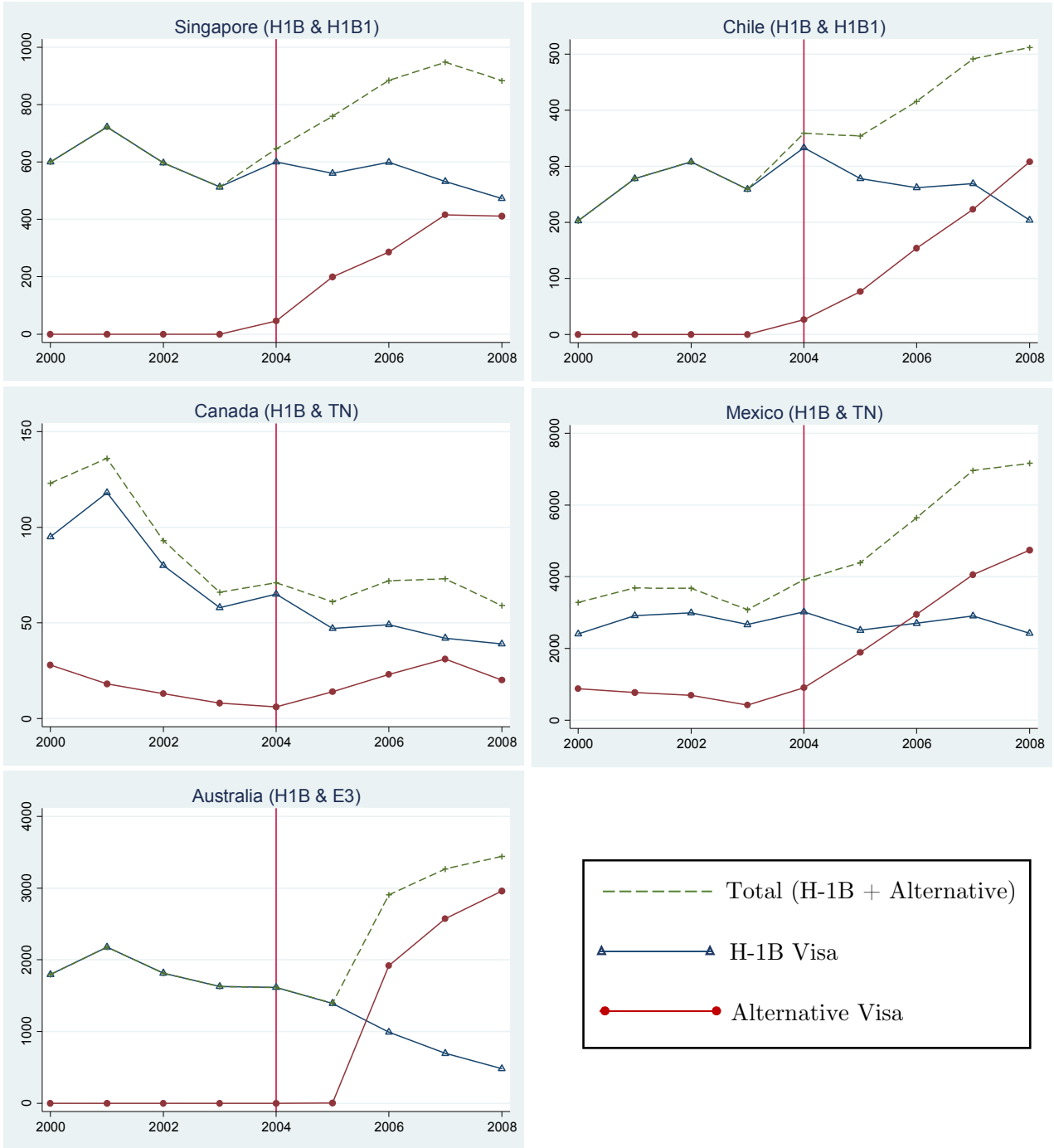
Note: The figure on the left displays the percentage of STEM bachelors, masters, and doctoral degrees awarded to international students by US colleges and universities. The figure on the right represents the percentage of all H-1B visa recipients for initial employment in STEM occupations. Data on H-1B recipients by occupation comes from Department of Homeland Security reports (USCIS 2012). Data on STEM degrees awarded to international students comes from the Open Doors reports of the Institute of International Education (Open Doors 2012).

Figure 3: Distribution of International Students and H-1B recipients by Country in 2012



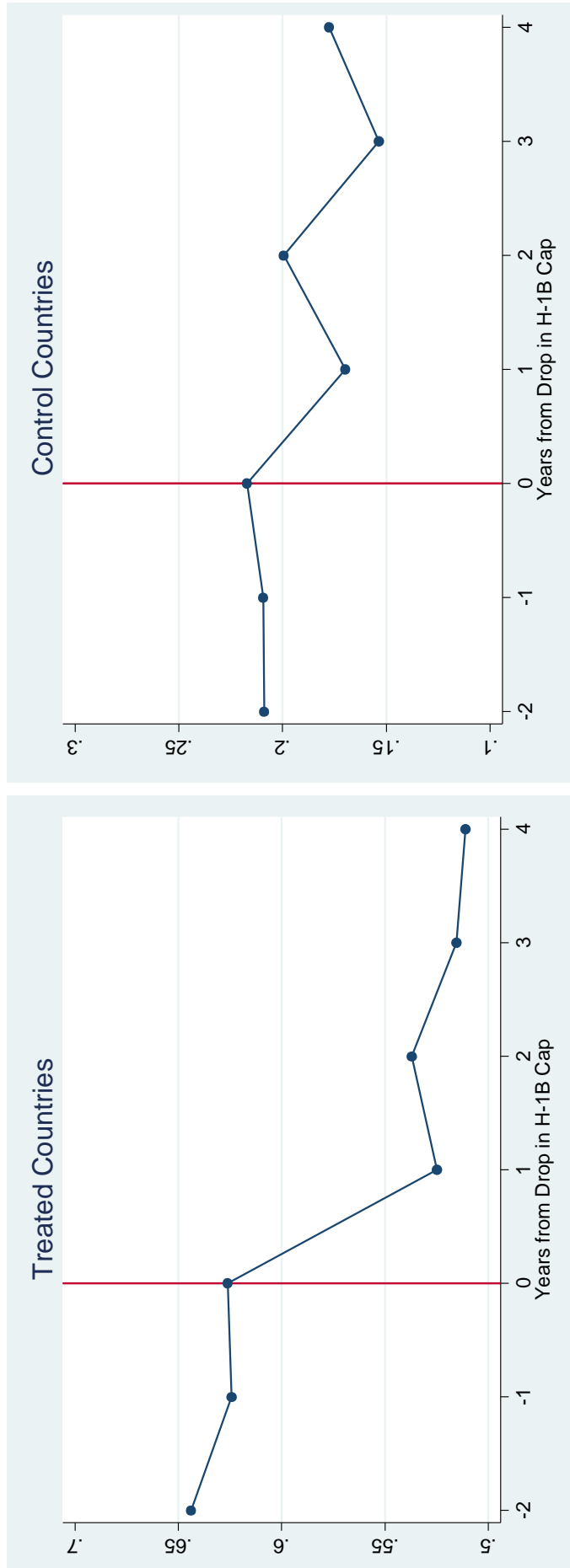
Note: Figures represent the distribution of international students (left figure) and H-1B visa recipients (right figure) across countries of origin. Data on international students by country come from the Open Doors reports of the Institute of International Education (Open Doors 2012). H-1B visa issuances by country of origin come from the Department of Homeland Security Report: “Characteristics of Specialty Occupation Workers (H-1B): FY 2012” (USCIS 2012). Figures reflect H-1B visa issuances for initial employment.

Figure 4: H-1B Usage by Control Countries



Note: The above set of figures displays H-1B visa usage, measured by visas issued to that country group, from 2000-2008. Also displayed is visa usage of alternative visa classes for high skilled immigrants. These include the H-1B1 visa for Singaporeans and Chileans, the TN visa for Canadians and Mexicans, and the E3 visa for Australians. Data comes from the Department of State's Non-immigrant Visa Statistics (Department of State 2012).

Figure 5: Enrollment from Treatment vs. Control Countries



Note: Figures plot differences in log international enrollment between undergraduate and graduate students. The left figure plots the mean for treated countries—i.e. nations without alternatives to the H-1B visa. The right figure shows the mean for control countries with alternatives to the H-1B visa. Control countries are Australia, Canada, Chile, Mexico, and Singapore. The horizontal axis indicates years relative to the drop in the H-1B cap in October 2003.

Table 1: Gravity Regressions of International Enrollment on H-1B Visa Issuance

Dep. Var:	(1)	(2)	(3)	(4)	(5)	(6)
International Enrollment	Total	Total	Total	Total	Undergraduate	Graduate
H-1B	0.19*** (0.04)	0.16*** (0.04)	0.16*** (0.04)	0.20*** (0.07)	0.26*** (0.08)	0.25*** (0.06)
GDP per capita		0.17 (0.11)	0.15 (0.12)	0.03 (0.12)	0.08 (0.14)	0.03 (0.10)
College Age Population		0.89*** (0.20)	0.87*** (0.20)	0.51** (0.25)	0.74* (0.39)	0.50** (0.21)
Employment		-0.21 (0.19)	-0.22 (0.19)	0.40 (0.32)	0.19 (0.40)	0.42* (0.23)
Exchange Rate			-0.07 (0.05)	-0.03 (0.07)	-0.04 (0.09)	0.03 (0.08)
Imports			-0.02 (0.02)	0.03 (0.04)	0.06 (0.04)	-0.00 (0.04)
Exports			0.07*** (0.03)	0.02 (0.05)	-0.03 (0.04)	0.05 (0.05)
Avg. U.S. Wage, College Immigrant				0.07 (0.04)	0.06 (0.06)	0.02 (0.04)
N	1,820	1,820	1,820	1,012	1,012	1,012
Countries	140	140	140	92	92	92

Note: \*, \*\*, \*\*\* denote significance at the 10%, 5%, and 1% levels, respectively. Table represents results from regressions of international student enrollment on U.S. labor market openness, as proxied by H-1B visa issuance. All variables are expressed in natural logarithms, unless explicitly stated otherwise. Standard errors are displayed in parenthesis and are clustered at the country-level to account for serial correlation in residuals within countries.



**Table 2: Gravity Regressions with Leads and Lags of H-1B Visa Issuance**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Lead/lag of independent variable:	t-3	t-2	t-1	t	t+1	t+2	t+3
H-1B visa issuance							
Total	0.11 (0.07)	0.16** (0.07)	0.20*** (0.07)	0.23*** (0.08)	0.27*** (0.10)	0.31*** (0.09)	0.30*** (0.09)
Undergraduate	0.17** (0.08)	0.23*** (0.08)	0.26*** (0.08)	0.28*** (0.09)	0.31*** (0.11)	0.32*** (0.10)	0.32*** (0.10)
Graduate	0.17*** (0.06)	0.21*** (0.06)	0.25*** (0.06)	0.24*** (0.08)	0.26*** (0.09)	0.34*** (0.07)	0.33*** (0.07)
N	1,012	1,012	1,012	1,012	1,012	1,012	920
Countries	92	92	92	92	92	92	92

Note: \*, \*\*, \*\*\* denote significance at the 10%, 5%, and 1% levels, respectively. Table represents results from regressions of international student enrollment on leads and lags of U.S. labor market openness, as proxied by H-1B visa issuance. "t" indicates international enrollment is regressed on contemporaneous H-1B visa issuance. "t-1" indicates that H-1B issuance in the year prior is used instead. All variables are expressed in natural logarithms, unless explicitly stated otherwise. All models control for GDP per capita, employment, and the college age population in the sending country; exports, imports, and exchange rates with the U.S.; the average wages of college immigrants in the U.S. from the sending country; country fixed effects and year effects. Standard errors are displayed in parenthesis and are clustered at the country-level to account for serial correlation in residuals within countries.

**Table 3: Robustness of H-1B Visas w/ country-specific trends**

	(1)	(2)	(3)
Dep. Var:			
International Enrollment	Total	Undergraduate	Graduate
H-1B	0.10*** (0.02)	0.12*** (0.04)	0.09*** (0.03)
GDP per capita	-0.01 (0.02)	-0.01 (0.03)	-0.04 (0.03)
College Age Population	-0.16 (0.12)	-0.12 (0.16)	-0.13 (0.12)
Employment	0.01 (0.07)	0.10 (0.09)	-0.13* (0.08)
Exchange Rate	0.62* (0.32)	0.96*** (0.28)	0.53 (0.41)
Imports	-0.31 (0.30)	-0.29 (0.34)	-0.50 (0.35)
Exports	0.01 (0.02)	0.01 (0.03)	0.00 (0.03)
Avg. U.S. Wage, College Immigrant	0.03 (0.03)	0.06* (0.04)	-0.04 (0.04)
N	1012	1012	1012
Countries	92	92	92

Note: \*, \*\*, \*\*\* denote significance at the 10%, 5%, and 1% levels, respectively. Table represents results from regressions of international student enrollment on U.S. labor market openness, as proxied by H-1B visa issuance. All variables are expressed in natural logarithms, unless explicitly stated otherwise. Standard errors are displayed in parenthesis and are clustered at the country-level to account for serial correlation in residuals within countries.

**Table 4: Triple Difference Estimate of H-1B Policy**

	Pre (2000-2003)	Post (2005-2008)	Post - Pre
Undergraduates	Treated Countries [N=348]	6.684 (0.143)	-0.184 (0.029)
	Control Countries [N=20]	7.914 (0.612)	-0.069 (0.047)
<i>DD<sub>TS</sub></i>			
Graduates	Treated Countries [N=348]	6.334 (0.165)	-0.050 (0.025)
	Control Countries [N=20]	7.737 (0.513)	-0.035 (0.035)
<i>DD<sub>CS</sub></i>			
<i>DDD</i>			
<i>-0.100</i> <i>(0.046)</i>			

Note: Table displays cross-tabulated mean log enrollments by country (treatment vs. control countries) and time (pre-treatment vs. post-treatment). These means are separately calculated for undergraduate and graduate levels. Standard errors are reported in parenthesis and are clustered at the country level.

**Table 5: Robustness Checks of Triple Difference Estimate**

	(1)	(2)	(3)	(4)	(5)	(6)
DDD	-0.100** (0.048)	-0.100** (0.048)	-0.100** (0.048)	-0.100** (0.048)	-0.100** (0.050)	-0.103* (0.056)
[ <i>p-value</i> ]	[0.039]	[0.039]	[0.039]	[0.040]	[0.049]	[0.070]
P X TC	-0.015 (0.042)	-0.005 (0.047)	-0.010 (0.041)	-0.011 (0.042)	0.064 (0.041)	-0.004 (0.051)
P X TS	-0.035 (0.036)	-0.035 (0.036)	-0.035 (0.036)	-0.035 (0.036)	-0.035 (0.038)	-0.046 (0.044)
TC X TS	0.274 (0.196)	0.274 (0.197)	0.274 (0.197)	0.274 (0.197)	0.274 (0.207)	0.274 (0.199)
College Age Population		0.430 (0.271)	0.394 (0.283)	0.395 (0.283)	0.909** (0.409)	0.406 (0.292)
Employment		0.027 (0.199)	-0.022 (0.199)	-0.020 (0.197)	-0.684** (0.327)	0.091 (0.249)
GDP per capita		0.033 (0.132)	0.030 (0.132)	0.027 (0.132)	-0.141 (0.117)	0.055 (0.137)
Exchange Rates			0.062 (0.072)	0.065 (0.071)	0.069 (0.066)	0.061 (0.073)
Trade Share of GDP			0.387 (0.531)	0.364 (0.548)	-0.234 (0.631)	0.376 (0.641)
Avg. U.S. Wage, College Immigrant				0.037 (0.046)	-0.012 (0.038)	0.057 (0.052)
Country-specific trends Omit Fall 2005					x	x
Countries	92	92	92	92	92	92

Note: \*, \*\*, \*\*\* denote significance at the 10%, 5%, and 1% levels, respectively. Table displays triple difference regression estimates of the impact of H-1B policy on foreign student enrollment. All variables are specified in natural logarithms, unless explicitly stated otherwise. Standard errors are reported in parenthesis and are clustered at the country level.

**Table 6: Heterogeneous Impacts of H-1B Policy**

	(1)	(2)	(3)
	1st Tercile	2nd Tercile	3rd Tercile
DDD	-0.036	-0.102	-0.162**
	(0.059)	(0.069)	(0.070)
[ <i>p-value</i> ]	[0.545]	[0.152]	[0.027]
N	408	408	408
Countries	34	34	34

Note: \*, \*\*, \*\*\* denote significance at the 10%, 5%, and 1% levels, respectively. Table displays triple difference estimates, stratifying countries by tercile of the distribution of net returns from studying in the U.S. Net returns for each country are measured as the difference in log average U.S. wages paid to college educated immigrants from that country and the log GDP per capita of the country. Thus, countries in the 1st, 2nd, and 3rd terciles are generally high, middle, and low income countries, respectively. Standard errors are reported in parenthesis and are clustered at the country level.