Human Capital Investment under Immigration Policy: Evidence from STEM OPT

Marcia Ruiz Pulgar

Department of Economics, University of Michigan

April 24, 2026

Abstract

I study how work authorization policy shapes international students' human capital investment in STEM fields. Three expansions of the STEM Optional Practical Training (OPT) program, in 2008, 2011, and 2012, granted up to 29 additional months of post-graduation U.S. work authorization to graduates in newly eligible fields, creating staggered field-level variation in expected labor market opportunities. Using administrative student records from a Midwestern flagship university, I find that treated fields experienced sizable increases in international students' representation

at the undergraduate and master's levels, with larger and faster responses among master's students and no detectable effect among doctoral students. These gains appear to reflect selection at entry rather than changes in persistence or completion. I also examine changes in student composition and find evidence of broadening along some margins of observed preparation, but not a uniform decline across all available measures.

JEL Classification: I23, J15, J61, F22

Keywords: STEM OPT, international students, work authorization, field choice, human capital, immigration policy

1 Introduction

International students represent a growing share of graduate and undergraduate enrollment at American universities, particularly in science, technology, engineering, and mathematics. For these students, the returns to education depend not only on the skills and wages associated with a degree, but also on whether that degree provides access to work opportunities in the United States after graduation. Understanding their concentration in STEM therefore requires understanding not only the academic labor market but also the immigration policy environment in which students make educational investment decisions. In this paper, I study how work authorization policy shapes international students' human capital investment in STEM fields. I show that three expansions of the Optional Practical Training (OPT) program, in 2008, 2011, and 2012, substantially increased international students' representation in newly eligible fields at the undergraduate and master's levels, with no corresponding effect at the doctoral level, and that the gains reflect selection at entry rather than post-enrollment switching.

The OPT program gives international students on F-1 visas temporary authorization to work in the United States after graduation in a job directly related to their field of study. This authorization is especially important because, absent a separate work visa, international students generally cannot remain in the United States to work after completing their degree. OPT therefore increases the returns to education not only by allowing graduates to gain U.S. work experience, but also by giving them time to search for jobs and potentially transition to longer-term employer sponsorship. Prior to 2008, all OPT participants received a twelve-month authorization period. The 2008 expansion granted an additional seventeen months of authorization, a twenty-nine-month total, exclusively to graduates of fields newly designated as STEM-eligible. Subsequent expansions in 2011 and 2012 extended STEM eligibility to additional fields, creating staggered variation in treatment timing across degree programs and entry cohorts. This variation in the timing and scope of treatment is the basis for my identification strategy.

I study these policy changes using administrative student records from a Midwestern flagship university together with institution-level data from the Integrated

Postsecondary Education Data System (IPEDS). The administrative data allow me to follow international students from entry through graduation, observe their field of study and degree level, and characterize how the composition of student cohorts changes over time. IPEDS complements these records by allowing me to examine whether similar patterns appear more broadly across institutions and to study how universities adjust on the extensive and intensive margins. My empirical strategy exploits the staggered expansion of STEM OPT eligibility across fields in 2008, 2011, and 2012. Because these policy changes were determined by federal immigration policy rather than by university-level changes in program demand or student composition, they provide a useful source of variation for identifying how changes in expected U.S. labor-market access affect international students' educational investment decisions in STEM.

I find that STEM OPT eligibility increased international students' representation in treated fields in the pooled undergraduate and master's sample. On average, treated fields experienced a 3.2 percentage point increase in the international share of graduates over the post-treatment period, while log international graduate counts rose by about 0.24 log points, equivalent to roughly a 28 percent increase. Disaggregating by degree level shows that these effects are concentrated at the master's level, where treated fields experienced about a 10 percentage point increase in international share and a 0.37 log-point increase in international counts, or roughly 44 percent increase. Undergraduate effects are smaller but still positive, with an increase of about 2 percentage points in international share and 0.32 log points in international counts, or nearly 38 percent increase. By contrast, doctoral programs show no positive enrollment response, consistent with OPT being less central for students whose post-graduation paths more often run through cap-exempt academic and research employment.

I then examine two potential behavioral margins. On the entry versus switching margin, I find that the enrollment response operates primarily through selection at entry rather than through post-enrollment switching across fields. On the compositional margin, the evidence is more nuanced. Several measures move in a direction consistent with broadening of the international student pool: undergraduate SAT verbal scores decline, master's students' graduation GPA falls relative to their within-

major cohort, and the lower tail of the TOEFL distribution declines for doctoral entrants. At the same time, I do not find comparable declines across all observed measures, which suggests that STEM OPT changed the composition of students along particular dimensions of preparation rather than generating a uniform deterioration in quality. I corroborate the enrollment findings using national IPEDS data, where the response is concentrated at research universities.

I develop a Roy model of field choice under work authorization uncertainty that organizes these findings. The model predicts that STEM OPT lowers the threshold STEM-comparative-advantage for which enrollment is optimal, increasing total enrollment while reducing the average preparation of the entering cohort. A key prediction of the model is degree-level heterogeneity: doctoral students face lower work authorization uncertainty through cap-exempt pathways, implying a smaller enrollment response and a different compositional mechanism at the doctoral level.

This paper contributes to three strands of literature. First, it contributes to the literature on immigration policy and the supply of skilled workers. Prior work has documented the sensitivity of high-skilled immigration flows to visa and work authorization policy (Kerr and Lincoln 2010; Peri et al. 2015; Bound et al. 2017; Shih 2016). I extend this literature by showing that work authorization policy shapes human capital investment decisions prior to labor market entry, affecting not only where skilled workers go but also what they choose to study.

Second, I contribute to the literature on major and field choice in higher education (Wiswall and Zafar 2015; Stinebrickner and Stinebrickner 2014; Hastings et al. 2013; Arcidiacono 2004), providing evidence that immigration policy is a distinct margin of field selection for international students.

Third, the paper contributes to the emerging literature on STEM OPT and international student enrollment. Recent work shows that OPT reforms and STEM OPT extensions increased international student enrollment in eligible fields (Amuedo-Dorantes et al. 2023; Khoo 2025). More broadly, this contribution also relates to work on the determinants of international student enrollment (Amuedo-Dorantes and Furtado 2019; Bound et al. 2021; Kato and Sparber 2013). I add to these literatures in three ways. First, I exploit the staggered eligibility expansions across 2008, 2011, and 2012 using heterogeneous-treatment-effects-robust estimators (Sun

and Abraham 2021; Callaway and Sant'Anna 2021), whereas prior work focuses primarily on the 2008 reform using a single post-treatment indicator. Second, I use student-level administrative records that allow me to follow students from entry through graduation, directly decomposing the enrollment response into selection at entry versus post-enrollment field switching, a margin that prior work names but cannot separately identify. I find that virtually the entire response operates through field choice at enrollment, with no meaningful post-enrollment switching. Third, I observe pre-enrollment credentials alongside student's term GPA, measures unavailable in prior work. These direct measures show no post-treatment decline in entering cohort quality despite a 30–38 percent increase in master's enrollment. Fourth, I exploit country-of-origin variation to test the H-1B mechanism directly. Chinese students show large, growing enrollment responses while Indian students show essentially no response, consistent with India's binding per-country permanent-residence backlog attenuating the policy's value, a heterogeneity pattern neither prior paper estimates as a substantive test.

The rest of the paper proceeds as follows. Section 2 describes the STEM OPT program and its expansions. Section 3 presents the theoretical framework and testable predictions. Section 4 describes the data. Section 5 presents the empirical strategy. Section 6 presents the main results. Section 7 examines mechanisms by degree level. Section 8 presents national corroborating evidence. Section 9 concludes.

2 Institutional Background

2.1 The Optional Practical Training Program

Optional Practical Training (OPT) is a federal program that allows international students on F-1 visas to work in the United States in a position directly related to their field of study for a specified period following graduation. Under the rules in place prior to 2008, all OPT participants were eligible for twelve months of authorized employment. During this period, students maintain valid immigration status without requiring employer-sponsored visa sponsorship, making OPT a critical bridge between student visa status and longer-term work authorization under, for

example, the H-1B visa program.

OPT authorization is administered through the student's university. Students apply for OPT through their Designated School Official (DSO), typically at the university's international student office, and authorization is approved by US Citizenship and Immigration Services (USCIS). The twelve-month OPT period begins when the student's F-1 status ends, generally at graduation. The transition from OPT to a longer-term work visa depends primarily on the H-1B visa program, which is subject to an annual statutory cap and an oversubscribed lottery. International graduates who do not obtain H-1B sponsorship within the OPT window must leave the United States or transition to another valid status. This constraint makes the length of OPT authorization a directly consequential policy parameter for international students weighing a career in the United States.

An important exception applies to doctoral-level employment at universities, nonprofit research institutions, and government research agencies: these employers are exempt from the H-1B cap, allowing them to sponsor international researchers without going through the annual lottery. This cap-exemption substantially reduces the salience of OPT duration for doctoral students who intend to pursue academic or research careers, a distinction that turns out to be empirically important.

2.2 The STEM OPT Extensions: 2008, 2011, and 2012

In April 2008, the Department of Homeland Security (DHS) issued an interim final rule establishing a seventeen-month extension of OPT for graduates of programs classified under designated STEM fields, bringing total post-graduation work authorization to twenty-nine months for eligible graduates. The 2008 rule defined STEM eligibility using the Classification of Instructional Programs (CIP) taxonomy. Fields classified under DHS's initial STEM-designated list, including programs in engineering, computer science, physical sciences, mathematics, and select biological sciences, became treatment-eligible in 2008. The 2008 expansion was motivated by concerns about the competitiveness of the US STEM workforce and the loss of trained international graduates to other labor markets during the period of uncertainty between graduation and H-1B status. Employers of STEM OPT participants must

enroll in E-Verify, the federal employment eligibility verification system.

In 2011 and 2012, DHS expanded the list of STEM-eligible CIP codes, incorporating programs in additional scientific and technical fields not included in the initial 2008 designation. These successive expansions generated staggered treatment timing: programs on the 2008 list became eligible in 2008, while programs added in 2011 or 2012 became eligible in those years. I exploit this staggered eligibility as the identifying variation.

A central institutional detail is that STEM OPT eligibility is tied not to a university's own department labels, but to the federal CIP taxonomy. Universities do report CIP codes for their degree programs, but this assignment is not unconstrained: National Center for Education Statistics defines CIP as a standardized classification system for instructional programs, and institutions are instructed to select the two-digit series and then the six-digit code that best matches the program's instructional content, using cross-references when a field could plausibly fit more than one category. STEM OPT eligibility is then determined by DHS at the CIP-code level through the STEM Designated Degree Program List, which is updated federally rather than by individual universities. This structure makes it difficult for universities to simply relabel programs in response to OPT policy, since CIP codes are embedded in broader federal reporting requirements and are intended to reflect substantive program content rather than ad hoc administrative choice. While institutions retain some discretion in coding interdisciplinary programs, the relevant classifications are anchored in a common federal taxonomy that extends well beyond OPT.

3 Theoretical Framework

3.1 A Roy Model of Field Choice under Work Authorization Uncertainty

I develop a Roy-style model of field choice in which international students face uncertainty about post-graduation work authorization in the United States. The model organizes the empirical evidence and generates testable predictions about enrollment and compositional effects across degree levels.

Let i index an international student with STEM comparative advantage $s_i \in \mathbb{R}$, where higher s_i indicates stronger relative productivity in STEM fields. Let w_S and w_N denote expected wage returns to STEM and non-STEM degrees in the US labor market, and let $\bar{w}$ denote the outside option, the expected value of employment in the student's home country upon graduation. A student who graduates from a STEM field and obtains US work authorization earns $w_S \cdot s_i$; if work authorization is not obtained, the student receives $\bar{w}$. Denote by $p \in (0,1)$ the probability of receiving post-graduation work authorization, which is determined by the OPT policy regime. The expected value of choosing STEM is:

$$V_S(s_i, p) = p \cdot w_S \cdot s_i + (1-p) \cdot \bar{w} \tag{1}$$

Similarly, the expected value of a non-STEM field is:

$$V_N(s_i, p) = p \cdot w_N \cdot (1-s_i) + (1-p) \cdot \bar{w} \tag{2}$$

The student chooses STEM if $V_S(s_i, p) \geq V_N(s_i, p)$, which simplifies to:

$$s_i \geq s^*(p) \equiv \frac{p \cdot w_N}{p \cdot (w_S + w_N)} \tag{3}$$

The threshold $s^*(p)$ is decreasing in p: as the probability of US work authorization rises, the set of students for whom STEM enrollment is optimal expands. The STEM OPT extension raises p for graduates of designated fields, shifting $s^*(p)$ downward and drawing in students with weaker STEM comparative advantage. Students newly enrolled in STEM, those with $s_i \in [s^*(p'), s^*(p)]$ where $p' < p$ is the pre-OPT authorization probability, have weaker STEM ability on average than the inframarginal students. The model therefore predicts both an enrollment increase and a compositional shift toward weaker average preparation in the entering cohort.

The model applies most directly to undergraduate and master's degree programs, where post-graduation employment in the US private sector is the primary career path and OPT authorization is therefore central to the investment decision. For doctoral students, the relevant p is higher because cap-exempt H-1B sponsorship through universities and research institutions provides an alternative path to US

employment. The model therefore predicts a smaller enrollment response at the doctoral level, with a different compositional mechanism operating through changes in the applicant pool rather than through a direct incentive to enroll.

3.2 Testable Predictions

The model generates five testable predictions that I examine in Sections 6 and 7.

P1 (Enrollment, undergrad and master's). International enrollment in STEM OPT-eligible fields increases after designation at the undergraduate and master's levels, reflecting an expanded pool of students for whom STEM enrollment is optimal.

P2 (Domestic neutrality). Domestic student enrollment is unaffected. STEM OPT changes p only for international students; domestic students face no work authorization constraint.

P3 (Entry margin). The enrollment response operates at the point of entry, not through post-enrollment field switching. Switching into a STEM field mid-program is costly (prerequisite coursework, delayed graduation) and does not generate the same return as entering STEM from the outset.

P4 (Composition). The entering cohort's average STEM comparative advantage falls. This compositional change is visible in pre-enrollment quality measures (TOEFL, GRE) and graduation outcomes (GPA). The decline should be broad rather than tail-specific, since the policy lowers the enrollment threshold for all types above $s^*(p')$.

P5 (Doctoral null and diversion). International enrollment in doctoral programs shows no positive response, because cap-exempt employment pathways reduce the marginal value of STEM OPT for doctoral students. However, if STEM OPT induces a reallocation of high-ability students from doctoral programs toward master's tracks, the composition of doctoral applicants may deteriorate even as aggregate doctoral enrollment is unchanged.

4 Data

4.1 Administrative University Records

The primary data source is an administrative student-level panel from a Midwestern flagship university, covering academic years 2000 through 2016.[1] The data contain the universe of students enrolled in degree-granting programs during this period and allow me to follow students from entry through graduation. They include detailed information on each student's degree program, field of study (identified at the six-digit CIP code level), degree level (bachelor's, master's, doctoral), entry term, graduation year, semester-by-semester enrollment and coursework, semester GPA, cumulative GPA, and demographic characteristics. Students are identified as domestic or international based on their visa status at enrollment. I focus on undergraduate, master's, and doctoral degree programs.

The records also contain pre-enrollment academic credentials used in the mechanisms analysis. For master's and doctoral applicants, I observe Test of English as a Foreign Language (TOEFL) scores and Graduate Record Examination (GRE) scores reported at the time of application. For undergraduate students, I observe TOEFL and SAT scores. Reporting requirements differ across degree levels and applicant groups, so the availability of these measures varies across tests and samples. I therefore use them as pre-matriculation measures of preparation where observed, while accounting for differences in coverage across groups.

Sample construction. I construct a field-by-graduation-year panel at the six-digit CIP level, separately for undergraduate, master's, and doctoral programs. For each field f and graduation year t, I compute the international share (S_{ft}) and the log number of international graduates ($\ln(N_{ft}^{\text{intl}} + 1)$). As robustness, I also consider the inverse hyperbolic sine transformation of international counts and Poisson specifications for count outcomes, which allow the results to be assessed without relying on the log-plus-one transformation. I assign treatment status based on whether a field's six-digit CIP code appears on DHS's STEM-designated list, matched to the appropriate policy wave (2008, 2011, or 2012). Fields never designated as STEM-eligible

[1] The specific institution is not identified to protect the confidentiality of the administrative records agreement.

serve as the control group. The undergraduate sample contains 2,331 field-year observations across 142 fields. The master's sample contains 2,003 field-year observations across 172 fields. The doctoral sample contains 2,535 field-year observations across 168 fields.

4.2 IPEDS Degree Completion Data

As a national validation exercise, I use degree-completion data from the Integrated Postsecondary Education Data System (IPEDS), compiled by the National Center for Education Statistics. IPEDS contains annual counts of degree completions by institution, CIP6 field, degree level, and student origin. I use the bachelor's completions sample, covering 3,330 institutions and 26,748,654 awards for academic years 2003 through 2018.

4.3 Descriptive Statistics

Table 1 presents summary statistics for the main analysis samples. Across all degree levels, treated fields are larger and more internationally concentrated than never-treated control fields, especially at the master's and doctoral levels. In the full sample, international students account for 8.9 percent of graduates in treated undergraduate fields, compared with 2.6 percent in control fields, and 30.4 percent of graduates in treated master's fields, compared with 19.9 percent in control fields. In the pre-treatment period, these differences are already visible: international students account for approximately 8.4 percent of undergraduate graduates and 30.3 percent of master's graduates in fields that will eventually receive STEM OPT eligibility, with higher shares than in never-treated control fields. Figure 1 shows the distribution of treatment cohorts by degree level.

Table 1: Summary Statistics

	Undergraduate		Master's		Doctoral	
	Treated	Control	Treated	Control	Treated	Control
Intl. share (%)	8.9	2.6	30.4	19.9	30.9	20.7
Total grads per cell	72.2	43.8	19.9	22.6	8.6	4.3
N fields	45	97	66	106	68	100

Notes: Pre-period defined as graduation years prior to first STEM OPT designation. Data from administrative university records.

Before turning to the event-study estimates, I provide descriptive evidence on the timing of treatment and on the evolution of international student representation in treated and control fields. Figure 1 shows the distribution of treatment cohorts by degree level. At all three degree levels, most treated fields enter in the 2008 cohort, with smaller additional waves in 2011 and 2012. Figure 2 then plots the average number of international graduates per field-year cell in treated and never-treated fields over time. Treated fields are more internationally concentrated throughout the sample, but the contrast is especially pronounced at the undergraduate and master's levels after the OPT expansions. In undergraduate treated fields, the average number of international graduates per field-year cell rises from 4.2 before 2008 to 8.2 afterward, compared with an increase from 1.3 to 2.3 in control fields. In master's treated fields, the corresponding increase is from 5.0 to 9.6, compared with 5.7 to 6.6 in control fields. By contrast, doctoral treated fields are already highly international before treatment, and the descriptive post-expansion change is more muted in international share, consistent with the weaker role of OPT duration for doctoral career paths.

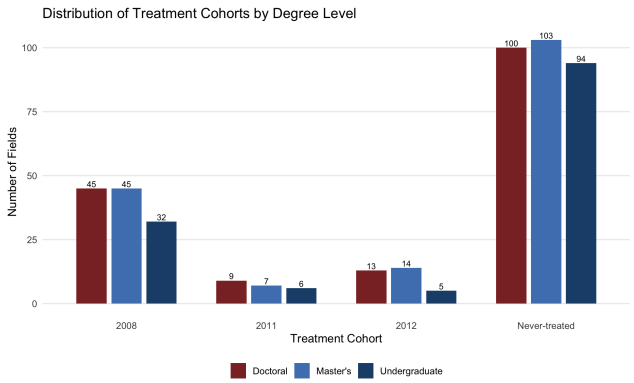


Figure 1: Distribution of Treatment Cohorts by Degree Level

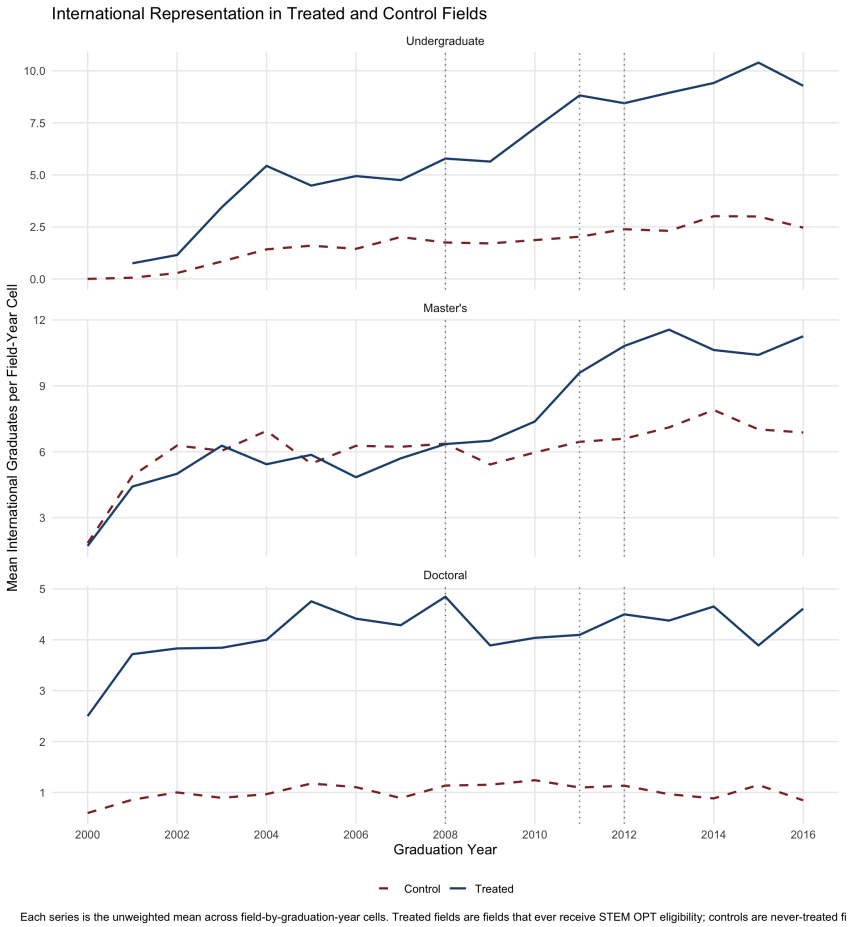


Figure 2: International Graduates in Treated and Control Fields by Degree Level

5 Empirical Strategy

5.1 Estimating Equation

To identify the causal effect of STEM OPT eligibility on international student enrollment, I exploit the staggered designation of academic fields to the STEM OPT list beginning in 2008. Fields are designated by CIP code and gain eligibility at different points in time, generating variation in both the cross-section (which fields are ever designated) and over time (when designation occurs). I estimate the following two-way fixed effects event-study specification at the field-by-year level:

$$Y_{ft} = \alpha_f + \gamma_t + \sum_{k \neq -1} \beta_k \cdot \mathbf{1}[t - E_f = k] + \varepsilon_{ft}, \tag{4}$$

where Y_{ft} is an outcome measured for field f in graduation year t; α_f are field fixed effects that absorb time-invariant differences across programs; γ_t are year fixed effects common to all fields; and E_f denotes the year in which field f first became STEM OPT eligible, so that $k = t - E_f$ is event time relative to designation. I omit $k = -1$ as the reference period. To avoid functional-form dependence on sparsely observed endpoint bins, I group event times $k \leq -7$ into a single pre-treatment indicator and $k \geq 8$ into a single post-treatment indicator; the displayed window runs from $\tau = -6$ to $\tau = +7$.[2] Standard errors are clustered at the field level throughout.

My primary outcomes are (i) the log count of international students graduating in field f and year t, and (ii) the international share of graduates. The log count specification captures extensive-margin growth in international enrollment, while the share specification abstracts from concurrent changes in overall field size and focuses on compositional shifts within treated fields. In the master's analysis, I weight observations by the field's average annual enrollment during 2000–2007, the pre-policy period. I do so because the master's sample contains many small and intermittently observed fields, so an unweighted specification places substantial influence on thin cells with noisy year-to-year variation. Using fixed pre-policy weights gives greater influence to fields that account for a larger share of baseline

[2] Results are robust to a narrower -4 to $+7$ display window (Figure **??**).

enrollment while avoiding endogeneity to post-treatment changes in field size.[3] By contrast, I present unweighted specifications as the main results in the undergraduate and pooled analyses, where field cells are larger and less sensitive to thin-cell noise. For a scalar summary of the average post-treatment effect, I report the simple average of $\hat{\beta}_k$ for $k \geq 0$. The sample covers graduation years 2000–2018 for undergraduates and 2000–2016 for master's students.

5.2 Identifying Assumption

Identification rests on a parallel trends assumption: absent STEM OPT designation, international enrollment in treated and never-treated fields would have evolved along parallel paths. I assess this assumption directly through the pre-treatment coefficients in equation (4). A joint F-test on the five estimated pre-treatment event-time indicators ($\tau = -6$ through $\tau = -2$) fails to reject the null of zero pre-trends: $\chi^2(5) = 6.00$, $p = 0.306$. Visual inspection of the event-study figures is consistent with this test: pre-period coefficients are small and centered near zero, with no systematic trend in treated relative to never-treated fields before designation.

The treatment timing is administratively determined: STEM OPT eligibility is assigned by the Department of Homeland Security at the CIP-code level and does not respond to field-level enrollment trends at individual universities. This institutional feature strengthens the plausibility of parallel trends, since the treatment assignment mechanism is external to the outcomes I study.

5.3 Threats to Identification and Supporting Evidence

Reallocation versus aggregate expansion. A potential concern is that the estimated treatment effect captures within-university reallocation rather than net expansion of international enrollment. Under this interpretation, a student who would have enrolled in a never-treated field instead enrolls in a treated field following the policy change; the DiD estimate grows even though total international enrollment at the

[3] These weights are computed from pre-policy enrollment and are therefore not affected by any post-treatment adjustment in field size. The unweighted estimates move in the same direction, but are less precisely estimated and yield fewer statistically significant post-treatment coefficients.

university is unchanged.

I address this concern with a university-wide decomposition of international students into three groups: those graduating from ever-treated fields, those graduating from never-treated fields, and the university-wide total (Appendix Figure A1). If the results were driven by reallocation, I would expect the university total to be roughly flat while treated-field counts increase and never-treated-field counts decline symmetrically. Instead, I observe the opposite: the university-wide total expands substantially after 2008, and never-treated fields show no systematic decline. The master's panel is particularly clean, treated fields grow sharply from 2008 onward, the never-treated series is flat, and the university total tracks treated-field growth closely. This pattern is inconsistent with pure reallocation and supports the interpretation that STEM OPT designation stimulated net inflows of international students into treated fields.

SUTVA and cross-field spillovers. A related concern involves violations of the Stable Unit Treatment Value Assumption (SUTVA). If students are on the margin between treated and never-treated fields, designation of one field may reduce enrollment in another. Never-treated fields would then be contaminated controls: their outcomes decline not because of parallel trends, but because treated-field designation pulled students away from them, causing the estimator to overstate the effect of STEM OPT eligibility.

To assess this possibility, I estimate a within-field triple-difference specification that does not rely on comparisons across treated and never-treated fields alone. I construct the outcome $\Delta_{ft} = \ln(\text{intl}_{ft} + 1) - \ln(\text{dom}_{ft} + 1)$ and apply the same interaction-weighted event-study estimator to this difference. Under this specification, shocks common to international and domestic students within a field net out, so identification comes from whether treated fields experience relatively faster international growth than domestic growth after STEM OPT designation. Appendix Table A1 reports the results. Using this specification, I find that the average post-treatment effect is positive and statistically significant, while the joint pre-trend tests do not reject. Taken together, these results support the interpretation that STEM OPT eligibility increased international enrollment in treated fields relative to domestic

enrollment within the same program, rather than merely reflecting differential trends across fields.

5.4 Robustness to Heterogeneous Treatment Effects

The TWFE estimator in equation (4) can be biased when treatment effects are heterogeneous across cohorts or over time, as emphasized by Goodman-Bacon (2021), Callaway and Sant'Anna (2021), and Sun and Abraham (2021). In staggered-adoption settings, a particular concern is that already-treated units may enter implicitly as controls for later-treated cohorts, generating contamination through negative-weight comparisons.

I therefore interpret the TWFE event-study estimates together with alternative estimators designed for staggered treatment timing. In particular, I report robustness checks using the interaction-weighted estimator of Sun and Abraham (2021), and the estimator of Callaway and Sant'Anna (2021). Both approaches restrict comparisons to never-treated or not-yet-treated units and avoid using already-treated fields as controls for later-treated cohorts. Across these alternative specifications, the post-treatment patterns are quantitatively similar to the TWFE estimates, indicating that the main results are not driven by the particular weighting or aggregation structure of the TWFE estimator.

6 Main Results

6.1 Pooled Results

Figure 3 presents Sun–Abraham interaction-weighted event-study estimates for the pooled undergraduate and master's sample, with log international graduate counts as the outcome. The pre-treatment coefficients are centered near zero throughout the window, with no systematic upward drift toward treatment. The one notable departure is a negative dip at $\tau = -6$ and $\tau = -5$, which carries a wide confidence interval and is isolated rather than part of a trend; it does not persist into the periods immediately before treatment. A joint F-test on the five pre-treatment event-time indicators

($\tau = -6$ through $\tau = -2$) fails to reject the null of zero pre-trends ($\chi^2(5) = 6.00$, $p = 0.306$).

Following STEM OPT designation, international graduate counts in treated fields rise persistently relative to never-treated fields. The effect is visible by $\tau = 0$, grows through the medium run, and remains large and statistically distinguishable from zero in seven of eight post-treatment periods. The domestic graduate series, shown alongside international in the same figure, is flat throughout the post-treatment window, none of the post-treatment domestic coefficients approach statistical significance, confirming that the response is specific to international students and does not reflect a general field-level demand shock.

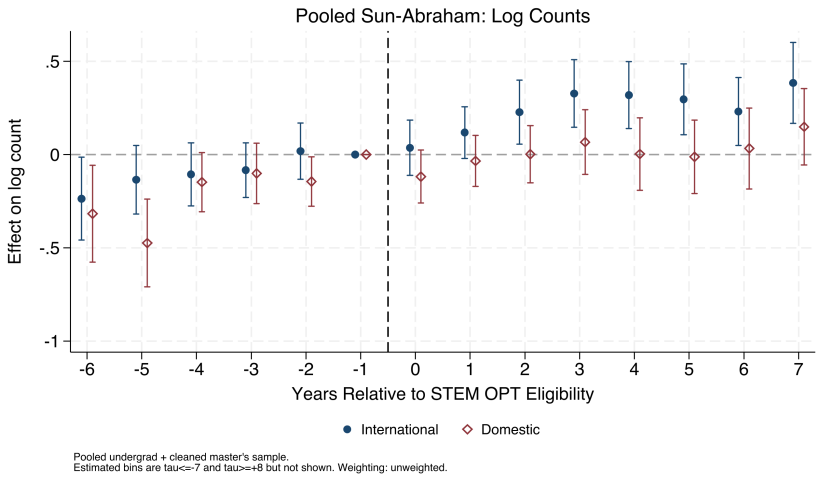


Figure 3: Effect of STEM OPT on International Graduates in Treated Fields

Table 2 summarizes the Sun–Abraham estimates in three windows. The average pre-treatment coefficient ($\tau = -6$ to -2) is close to zero for all three outcomes, consistent with parallel pre-trends. In the short run ($\tau = 0$ to 2), international log counts in treated fields are on average 0.26 log points higher than in never-treated fields, implying roughly a 30 percent increase relative to the pre-treatment mean.[4] The medium-run effect ($\tau = 3$ to 7) is larger, averaging 0.32 log points. For international share, the short-run average effect is 2.4 percentage points, rising to

[4]Calculated as $\exp(0.261) - 1 \approx 0.30$. The baseline mean of log international counts in treated fields in the pre-treatment period is 1.083.

4.5 percentage points in the medium run. The asinh estimates show the same pattern, with positive effects in the short run that grow over time, indicating a persistent increase in international enrollment in treated fields after STEM OPT designation.[5]

Table 2: Effect of STEM OPT Eligibility on International Graduate Enrollment: Pooled Sample

	(1) Log intl. count	(2) Intl. share	(3) Asinh intl.
Sun–Abraham Interaction-Weighted (SA-IW)			
Years -6 to -2	-0.060	0.006	-0.074
	(0.044)	(0.005)	(0.053)
Years 0 to 2	0.261^{***}	0.024^{***}	0.288^{***}
	(0.055)	(0.006)	(0.063)
Years 3 to 7	0.315^{***}	0.045^{***}	0.326^{***}
	(0.057)	(0.007)	(0.066)
Baseline mean	1.083	0.202	1.367
Field $\times$ degree FE	Yes	Yes	Yes
Degree-group $\times$ year FE	Yes	Yes	Yes
Observations	4296	4296	4296

Notes: Pooled undergraduate and master's sample; unit of observation is the field-by-degree-group-by-year cell. Effect at $\tau = -1$ is normalized to zero. Baseline mean is the mean of the outcome at $\tau = -1$ across treated field-degree cells. "Years -6 to -2" is the average of event-study coefficients for $\tau \in \{-6, \ldots, -2\}$; "Years 0 to 2" and "Years 3 to 7" are the post-treatment averages for the respective windows. Standard errors in parentheses clustered at the field level, computed from the full covariance matrix via `lincom`. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

[5]Appendix Figure A2 reports Callaway–Sant'Anna (2021) estimates using never-treated fields as the control cohort. Appendix Figure A3 shows the analogous estimates using not-yet-treated fields as the control group; the results are qualitatively unchanged, suggesting that already-treated fields do not contaminate the comparison. Appendix Figure A4 reports Poisson quasi-maximum likelihood estimates, which treat the raw count of international graduates as the outcome and are robust to the log-of-zero problem that motivates the log(count + 1) transformation in the main specification (Santos Silva and Tenreyro 2006). Taken together, the SA, Callaway–Sant'Anna, and Poisson estimates tell a consistent story: STEM OPT eligibility produced a persistent, international-student-specific increase in graduate counts in treated fields, with no evidence of a corresponding domestic response.

The pooled estimates mask substantial heterogeneity by degree level. Effects are largest and cleanest at the master's level, present but less precisely identified at the undergraduate level, and absent at the doctoral level. I discuss each in turn; doctoral results are reported in Appendix A.1.

6.2 Master's Results

Figure 5 presents Sun–Abraham event-study estimates for the master's sample. Pre-treatment coefficients are tight around zero throughout the pre-period, and a joint test on $\tau = -5$ through $\tau = -2$ provides no evidence against parallel pre-trends: $\chi^2(4) = 5.22$, $p = 0.265$ for log international counts and $\chi^2(4) = 3.11$, $p = 0.540$ for international share. The domestic graduate series is flat in both the pre- and post-treatment periods, consistent with a field-specific international response rather than a general enrollment shock.

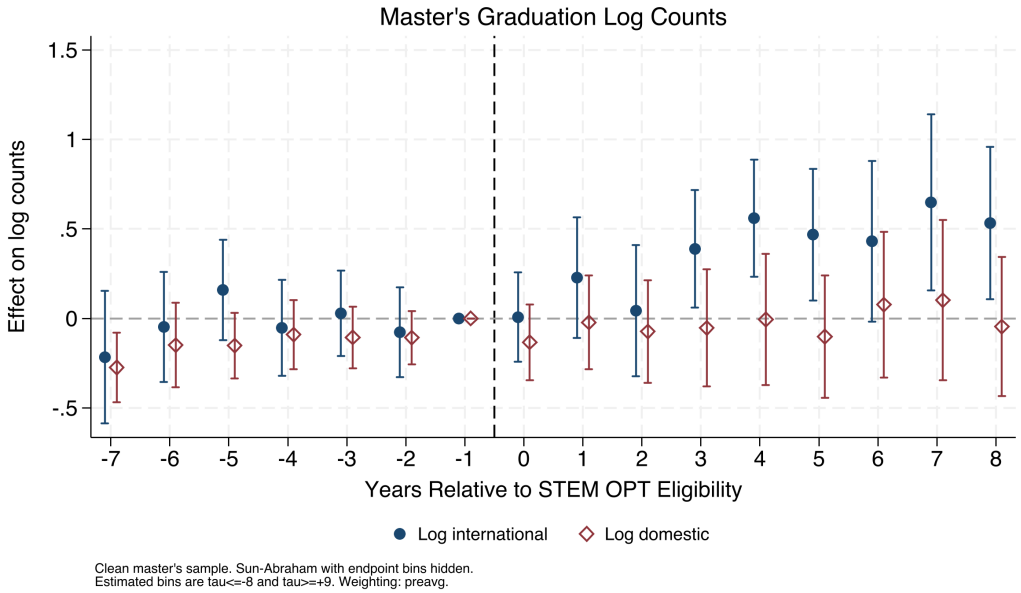


Figure 4: Effect of STEM OPT on Master's International Enrollment

Notes: Sun–Abraham interaction-weighted event-study estimates for the master's sample. Outcome: log international graduate count (navy circles) and log domestic graduate count (red diamonds). Never-treated fields are the control cohort. Pre-period average enrollment weights (2000–2007). Event-time window displayed: $\tau \in [-7, +8]$; endpoint bins estimated but not shown. Standard errors clustered at the field level. Shaded bands: 95% confidence intervals.

Following STEM OPT designation, international graduate counts in treated master's fields rise persistently and substantially. The effect is modest at $\tau = 0$, becomes clearly positive by $\tau = 3$, and continues to grow through the medium run. By $\tau = 4$, log international counts are about 0.56 log points higher, which corresponds to roughly a 75 percent increase in counts relative to the pre-treatment baseline, and the effect peaks at about 0.65 log points around $\tau = 7$, or roughly a 90 percent increase.[6] Averaging across post-treatment periods, the effect is about 0.37 log points, equivalent to roughly a 44 percent increase. The international share of master's graduates in treated fields also rises substantially after designation. By contrast, the domestic series remains close to zero throughout the post-treatment window, providing no evidence that treated master's fields expanded by crowding

[6] A coefficient of x log points corresponds approximately to a $\exp(x) - 1$ proportional change. Thus, 0.56 log points implies $\exp(0.56) - 1 \approx 0.75$, and 0.65 log points implies $\exp(0.65) - 1 \approx 0.91$.

out domestic students.

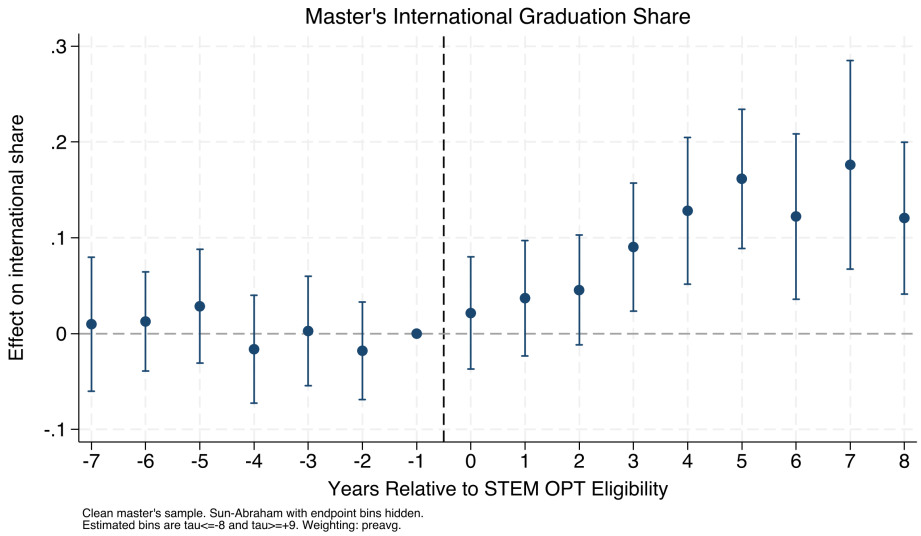


Figure 5: Effect of STEM OPT on Master's International Share

Notes: Sun–Abraham interaction-weighted event-study estimates for the master's sample. Outcome: log international graduate count (navy circles) and log domestic graduate count (red diamonds). Never-treated fields are the control cohort. Pre-period average enrollment weights (2000–2007). Event-time window displayed: $\tau \in [-7, +8]$; endpoint bins estimated but not shown. Standard errors clustered at the field level. Shaded bands: 95% confidence intervals.

6.3 Undergraduate Results

Figure 6 presents the corresponding estimates for the undergraduate sample. A joint pre-trend test on $\tau = -6$ through $\tau = -2$ yields $\chi^2(5) = 12.32$, $p = 0.031$ for log international counts and $\chi^2(5) = 9.54$, $p = 0.089$ for international share, indicating that pre-treatment trends are not fully parallel for this sample. As visible in the figure, both the international and domestic series show negative departures in the far pre-period ($\tau = -7$ to $\tau = -5$), suggesting pre-existing field-level dynamics that affect both groups before the policy change. I therefore interpret the undergraduate results as suggestive rather than causal evidence of a policy effect.

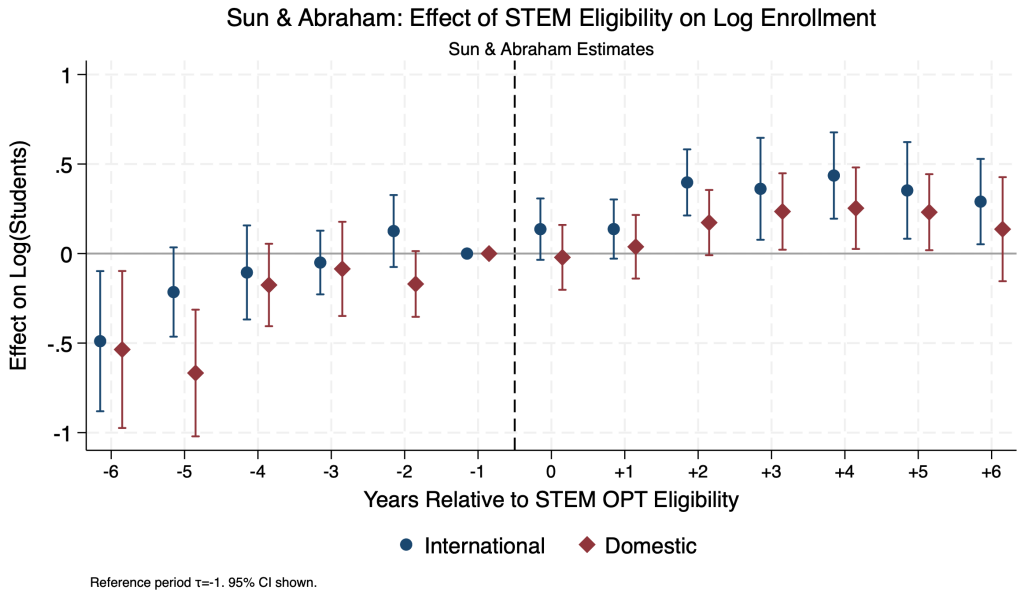


Figure 6: Event Study: Undergraduate International Enrollment (Sun–Abraham, Unweighted)

Notes: Sun–Abraham event-study estimates for the undergraduate sample. Outcome: log international graduate count (navy circles) and log domestic graduate count (red diamonds). Never-treated fields are the control cohort. Unweighted. Event-time window displayed: $\tau \in [-7, +8]$; endpoint bins estimated but not shown. Standard errors clustered at the field level. Shaded bands: 95% confidence intervals.

With this caveat, the post-treatment pattern for international graduates is positive and growing, with several coefficients statistically significant by $\tau = 2$ onward. The average post-treatment effect is approximately 0.28 log points. The domestic series also rises modestly in the post-treatment period, but the increase is substantially smaller and less precisely estimated than for international students, providing little evidence that the international response primarily reflects displacement of domestic undergraduates from treated fields.

7 Mechanisms

This section examines the mechanisms behind the enrollment response along three related dimensions. First, I study whether STEM OPT eligibility changed the compo-

sition of international students entering treated fields, using pre-enrollment test scores and post-enrollment academic performance. Second, I discuss the economic channel through which OPT operates, namely the increase in expected post-graduation labor-market returns in the United States. Third, I examine whether the rise in treated-field graduates reflects selection into STEM at entry or switching into STEM after beginning in a different field. Taken together, these exercises help distinguish whether OPT changed who enrolls, why treated fields became more attractive, and at what point in the educational trajectory the response occurs.

7.1 Composition and Selection

The composition evidence points to some broadening of the international student pool, but not to a uniform deterioration in preparation across all margins. The administrative records are especially useful here because they contain several pre-enrollment credentials and complete post-enrollment GPA records. Coverage differs across measures. For international entrants in treated master's fields, TOEFL scores are observed for about 81 percent both before and after 2008, and GRE scores for about 82 percent before 2008 and 86 percent after 2008. For international entrants in treated doctoral fields, TOEFL coverage is about 77 to 79 percent, and GRE coverage rises from roughly 82 percent to 94 percent. For undergraduates, SAT verbal and SAT math scores are available for a thinner subset: overall coverage among international students is about 63 percent, and about 52 percent in treated entry fields.

Across these measures, the clearest evidence of compositional change appears in verbal or English-related outcomes. Among doctoral entrants, the lower tail of the TOEFL distribution declines after treatment: the 25th percentile falls materially in the post-treatment period, consistent with a weakening of the lower tail of observed English proficiency. Among undergraduates, mean SAT verbal scores for international students also move downward after treatment, while the domestic series is comparatively flat. At the master's level, the clearest shift appears not in pre-enrollment test scores but in realized academic performance: international students' graduation GPA falls relative to their within-major, within-graduation-cohort distri-

bution, while domestic GPA does not show a comparable decline. Appendix A.2 report the corresponding event-study estimates for these composition outcomes.

At the same time, these patterns should not be interpreted as evidence of uniform negative selection. I do not find comparable evidence of a decline in master's GRE quantitative scores, and the undergraduate evidence does not show the same pattern for all available measures. More broadly, the observed changes are concentrated in some dimensions of preparation and are noisier or absent in others. This is important because the OPT expansions may have changed not only the average level of preparation, but also the composition of students along specific margins, such as English proficiency or field-specific fit.

One reason to be cautious is that part of the compositional response may reflect changes in sending-country mix rather than a pure decline in student quality. This pattern could also be consistent with the possibility that some of the score changes reflect shifts in the countries from which treated fields recruit international students. More broadly, changes in observed test scores need not arise solely from changes in student demand: they may also reflect institutional responses on the admissions margin, such as programs becoming more willing to admit international applicants with lower verbal or English-language scores once STEM OPT increases the expected returns to enrollment in treated fields.

7.2 Labor Market Returns: The Post-Graduation Work Authorization Channel

The most direct mechanism linking STEM OPT eligibility to enrollment is the increase in expected post-graduation labor market returns for international students. Prior to the 2008 extension, STEM graduates received a 12-month OPT period, during which they could work for any employer in their field of study. The 17-month extension (later expanded to 24 months) tripled the window from one to nearly three years.

This extension increases expected returns through two reinforcing channels. First, it provides substantially more US work experience, which raises human capital and employer-specific match quality. Second, and more importantly, it gives students

multiple attempts at the annual H-1B visa lottery. The H-1B cap is 65,000 per year (plus 20,000 for US master's degree holders), and typical oversubscription ratios since the mid-2000s have meant that any single year's odds of winning the lottery are well below one. An extended OPT period allows students to submit H-1B petitions in two or three consecutive lottery cycles, substantially raising the probability of obtaining work authorization before OPT expires. For an employer sponsoring an international student, the extension reduces the uncertainty and cost associated with early H-1B filing, making international hires more attractive.

A test of this mechanism comes from heterogeneity by country of origin. India faces the most binding per-country H-1B numerical cap: Indian-born workers have faced backlogs of decades for employment-based green cards since the early 2000s, and this uncertainty persists regardless of how many H-1B lottery chances a student receives. Chinese-born workers face less extreme caps, making the bridge from OPT to H-1B employment more feasible. If the labor market channel operates primarily through improved H-1B access, we would expect a stronger enrollment response among Chinese students relative to Indian students.

Figure A9 presents Sun-Abraham event-study estimates separately for students from China and India. The response of Chinese master's enrollment is large and growing, reaching approximately 1.0–1.25 log points by $\tau = 5$–7. By contrast, Indian master's enrollment shows no detectable positive response. This pattern is consistent with the hypothesis that the extension's value is mediated by H-1B accessibility: for students from countries facing extreme permanent-residence backlogs, the incremental value of additional OPT time is attenuated by the broader uncertainty of the immigration pathway.

7.3 Entry vs. Switching

The increase in STEM graduates could arise either because more students select into STEM at entry or because students who begin in non-STEM fields later switch into STEM. To distinguish between these margins, I use the individual-level administrative records to compare each student's field at first enrollment with the field in which the student eventually graduates.

Figure A10 presents this decomposition for the master's sample. Each bar shows the total number of STEM graduates in a given graduation year, partitioned into students who entered their program in a STEM field and students who switched into STEM after beginning in a non-STEM field. The figure shows that the post-2008 increase in international master's STEM graduates is driven overwhelmingly by the entry margin. Before 2008, international master's STEM graduates number about 1,176, of whom 1,082 entered STEM and 94 switched in from non-STEM fields. After 2008, the total rises to 3,547, with 3,347 entering STEM and only 200 arriving through switching. Thus, nearly all of the increase reflects more students choosing STEM at the outset rather than greater movement into STEM after enrollment.

The domestic series shows a similar compositional pattern: most domestic STEM graduates also entered STEM directly, while the switching component remains comparatively small throughout the period. This is useful for interpretation because it suggests that the post-OPT growth in international STEM graduates does not primarily reflect within-university reshuffling across majors. Instead, the dominant behavioral response is that international students are more likely to begin their studies in treated STEM programs when those programs offer better post-graduation work opportunities.

8 National Evidence

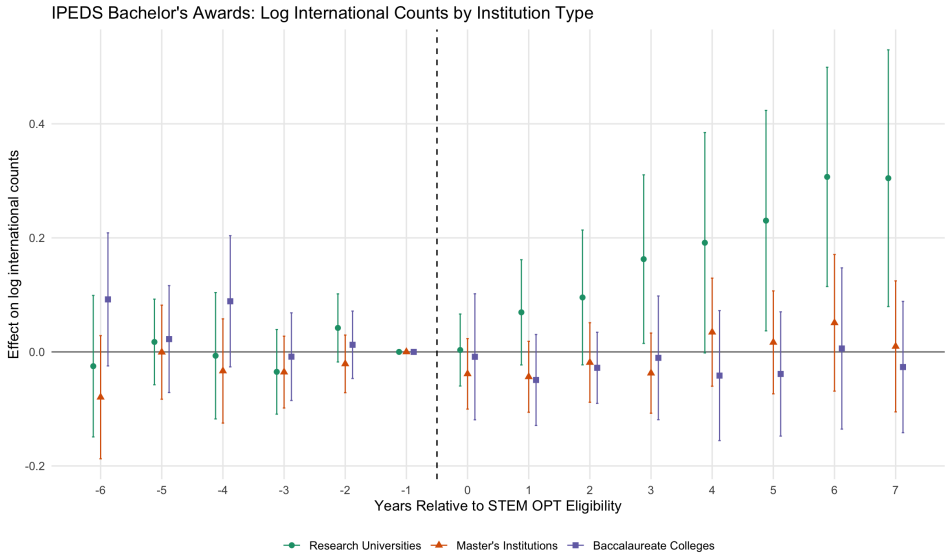
The institutional results establish that STEM OPT expanded international student graduation in treated undergraduate and master's fields at a single Midwestern flagship university. In this section, I use national IPEDS data on bachelor's degree completions to assess whether this pattern generalizes across the US higher education landscape.

The IPEDS analysis uses institution-by-CIP6-by-year cells as the unit of observation. The main outcome is the international share of bachelor's completions. I estimate a weighted TWFE regression with institution-by-CIP6 fixed effects, year fixed effects, and CIP2-by-year fixed effects. The CIP2-by-year fixed effects absorb time-varying shocks common to broad disciplinary groupings, providing a tighter control for differential field-level trends. Observations are weighted by total awards

in each cell, and standard errors are clustered at the institution-by-CIP6 level.

The IPEDS results confirm the institutional findings: treated fields experienced a positive and statistically significant increase in international students' share of completions. Figure 7 presents results by institution type. The enrollment response is concentrated at research universities. This pattern is consistent with the hypothesis that STEM OPT's impact is largest where international student infrastructure, dedicated OPT advising offices, employer networks, and established connections to H-1B sponsors, is most developed. The concentration at research universities also rules out a purely mechanical interpretation in which STEM OPT designation signals field quality; if the effect were driven by signaling alone, it should not be concentrated at any particular institutional type.

Figure 7: IPEDS Results by Institution Type



Notes: TWFE estimates with institution-by-CIP6, year, and CIP2-by-year fixed effects. Institution types follow Carnegie Classification definitions. Standard errors clustered at the institution-CIP6 level.

9 Conclusion

This paper studies how work authorization policy shapes international students' human capital investment in STEM. Using administrative student records from a Midwestern flagship university and three waves of STEM OPT expansions as a source of staggered field-level variation, I find that STEM OPT designation increased international student representation at the undergraduate and master's levels, with the largest response in master's programs and no effect at the doctoral level. The degree-level pattern is consistent with a Roy model in which the value of OPT authorization is lower when cap-exempt employment pathways are available, as they are for doctoral-level positions at research institutions.

The enrollment gains at the undergraduate and master's levels operate through selection at entry rather than post-enrollment switching. On the compositional margin, the evidence points to broadening along some dimensions of observed preparation, but not to a uniform decline across all available measures. Undergraduate SAT verbal scores move downward after treatment, master's students' graduation GPA declines relative to their within-major cohort, and the lower tail of the TOEFL distribution falls for doctoral entrants. At the same time, other measures show weaker or less systematic changes, suggesting that STEM OPT altered who enrolls along specific margins rather than shifting all dimensions of preparation in the same way.

The results have implications for the design and evaluation of immigration policy affecting high-skilled workers. STEM OPT operates primarily through the entry margin, changing who chooses STEM rather than how enrolled students behave after arrival. This has consequences for interpreting the downstream outcomes of international STEM graduates and for understanding the distributional effects of the policy across degree levels. A policy that raises the attractiveness of master's programs may also reshape the composition of applicants and entrants elsewhere in the higher-education system, including doctoral programs, even when aggregate doctoral enrollment does not change.

More broadly, the paper illustrates that immigration policy is a margin of human capital investment. The decision to study STEM, and at which level, is shaped not only by academic aptitude and expected earnings but also by the legal framework

governing post-graduation employment. Understanding this interaction is important for both forecasting the supply of STEM workers and for designing immigration policy that achieves its intended goals.

References

Amuedo-Dorantes, Catalina and Delia Furtado, "Settling for Academia? H-1B Visas and the Career Choices of International Students in the United States," *Journal of Human Resources*, 2019, *54* (2), 401–429.

_ , Kevin Shih, and Xing Xu, "The Implications of Optional Practical Training Reforms on International Students," *Economic Inquiry*, 2023, *61* (2), 253–281.

Arcidiacono, Peter, "Ability Sorting and the Returns to College Major," *Journal of Econometrics*, 2004, *121* (1–2), 343–375.

Bound, John, Breno Braga, Gaurav Khanna, and Sarah Turner, "A Passage to America: University Funding and International Students," *American Economic Journal: Economic Policy*, 2021, *13* (3), 97–131.

_ , Gaurav Khanna, and Nicolas Morales, "Understanding the Economic Impact of the H-1B Program on the United States," in Gordon H. Hanson, William R. Kerr, and Sarah Turner, eds., *High-Skilled Migration to the United States and Its Economic Consequences*, University of Chicago Press, 2017, pp. 109–175.

Callaway, Brantly and Pedro H. C. Sant'Anna, "Difference-in-Differences with Multiple Time Periods," *Journal of Econometrics*, 2021, *225* (2), 200–230.

Goodman-Bacon, Andrew, "Difference-in-Differences with Variation in Treatment Timing," *Journal of Econometrics*, 2021, *225* (2), 254–277.

Hastings, Justine S., Christopher A. Neilson, and Seth D. Zimmerman, "Are Some Degrees Worth More than Others? Evidence from College Admission Cutoffs in Chile," *NBER Working Paper*, 2013, (19241).

Kato, Takao and Chad Sparber, "Quotas and Quality: The Effect of H-1B Visa Restrictions on the Pool of Prospective Undergraduate Students from Abroad," *Review of Economics and Statistics*, 2013, *95* (1), 109–126.

Kerr, William R. and William F. Lincoln, "The Supply Side of Innovation: H-1B Visa Reforms and U.S. Ethnic Invention," *Journal of Labor Economics*, 2010, *28* (3), 473–508.

Khoo, Pauline, "If You Extend It, They Will Come: The Effects of the STEM OPT Extension," *Applied Economics*, 2025.

Peri, Giovanni, Kevin Shih, and Chad Sparber, "STEM Workers, H-1B Visas, and Productivity in US Cities," *Journal of Labor Economics*, 2015, *33* (S1), S225–S255.

Shih, Kevin, "Labor Market Openness, H-1B Visa Policy, and the Decision to Study Science and Engineering," *Journal of Human Resources*, 2016, *51* (3), 725–759.

Silva, Joao M.C. Santos and Silvana Tenreyro, "The Log of Gravity," *Review of Economics and Statistics*, 2006, *88* (4), 641–658.

Stinebrickner, Todd R. and Ralph Stinebrickner, "A Major in Science? Initial Beliefs and Final Outcomes for College Major and Dropout," *Review of Economic Studies*, 2014, *81* (1), 426–472.

Sun, Liyang and Sarah Abraham, "Estimating Dynamic Treatment Effects in Event Studies with Heterogeneous Treatment Effects," *Journal of Econometrics*, 2021, *225* (2), 175–199.

Wiswall, Matthew and Basit Zafar, "Determinants of College Major Choice: Identification Using an Information Experiment," *Review of Economic Studies*, 2015, *82* (2), 791–824.

A Additional Figures

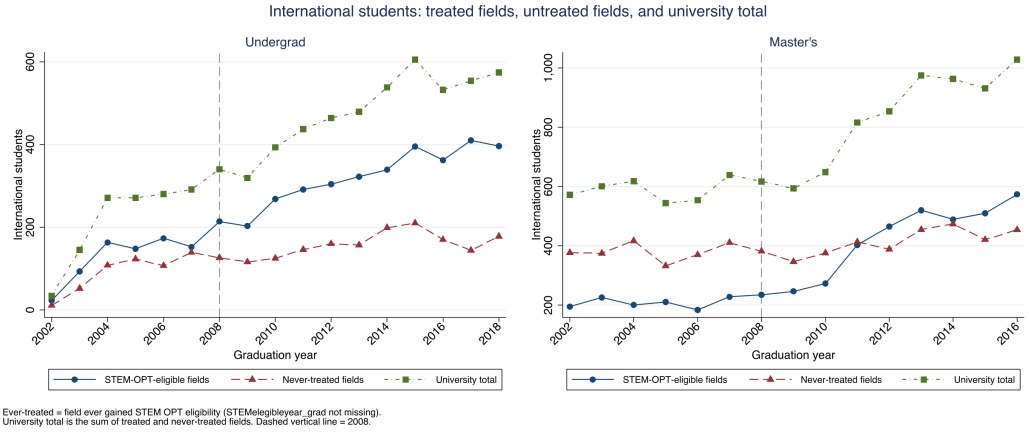


Figure A1: International Graduates in Treated Fields, Never-Treated Fields, and University Total

Table A1: Within-Field Triple-Difference Results

Avg. post-treatment effect	SE	p-value	Pretrend p (full)	Pretrend p (tight)
0.207	0.100	0.039	0.190	0.126

Notes: The outcome is $\Delta_{ft} = \ln(\text{intl}_{ft}+1) - \ln(\text{dom}_{ft}+1)$. Entries report the simple average of the post-treatment interaction-weighted event-study coefficients. "Pretrend p (full)" reports the joint test for leads $\tau \leq -7, -6, \ldots, -2$; "Pretrend p (tight)" reports the joint test for leads $\tau = -6, \ldots, -2$.

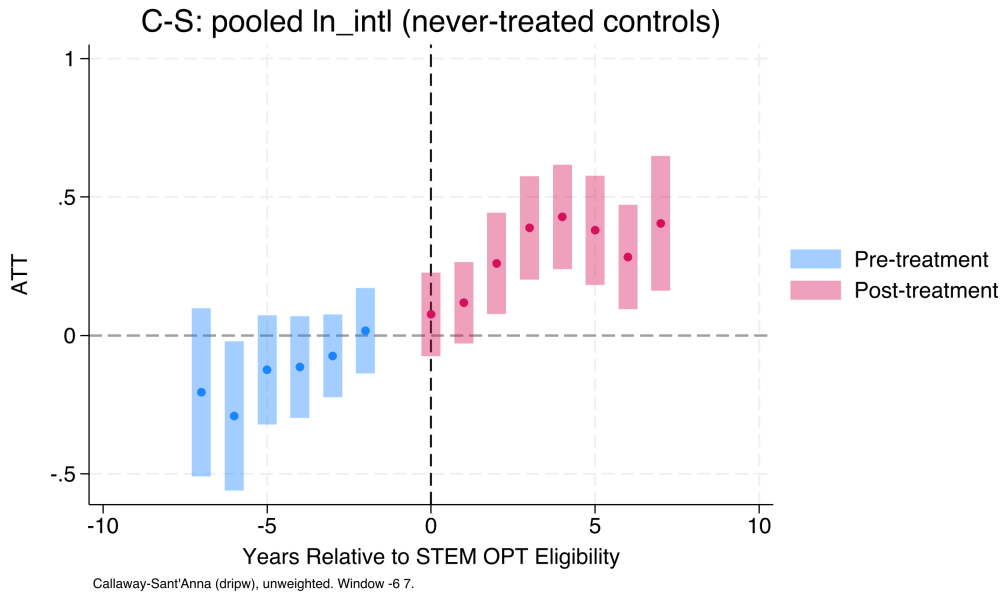


Figure A2: Effect of STEM OPT on International Students (CS never-treated)

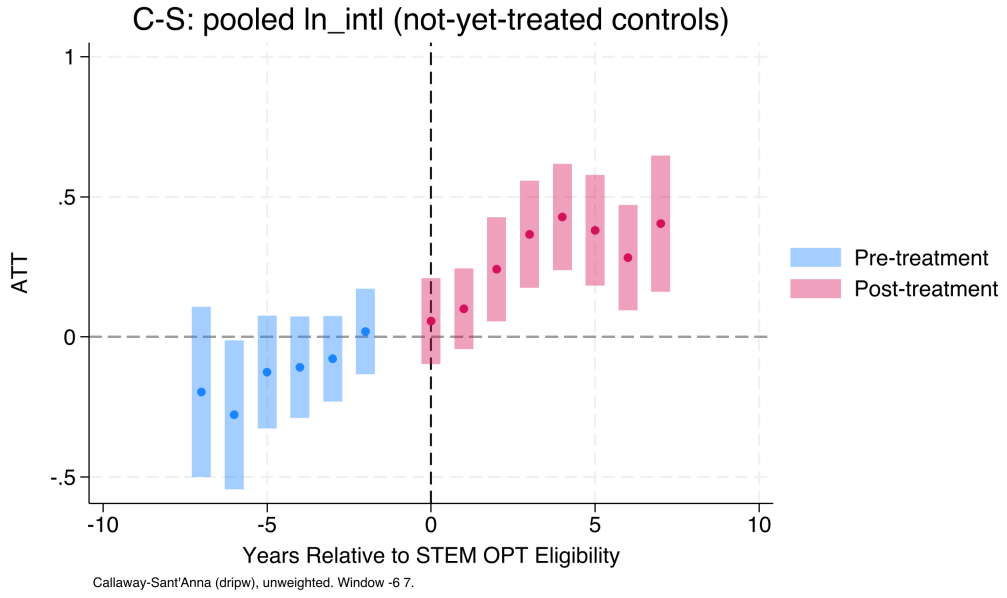


Figure A3: Effect of STEM OPT on International Students (CS not-yet-treated)

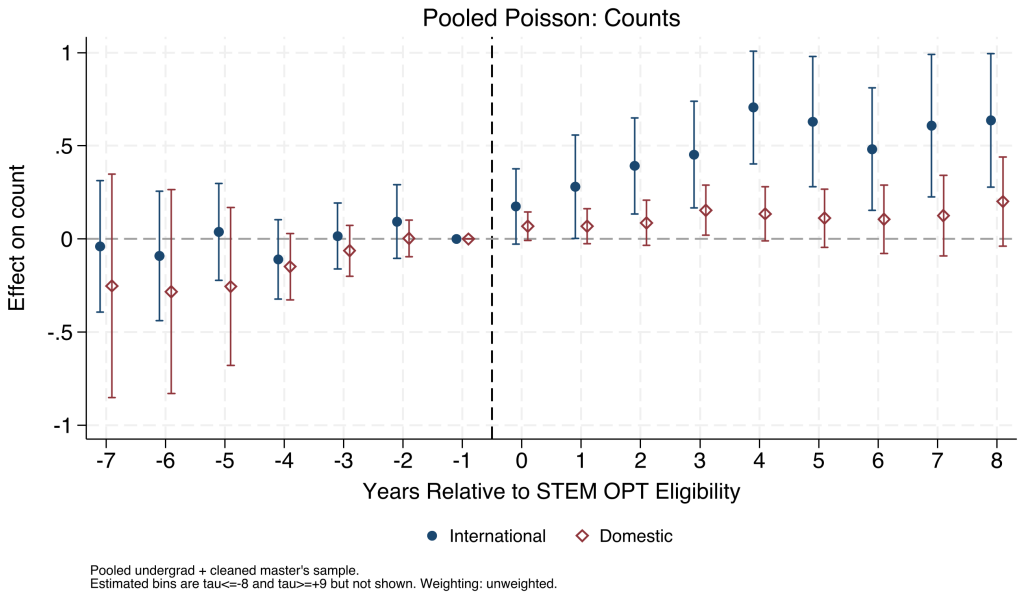


Figure A4: Effect of STEM OPT on International Students (Poisson)

A.1 Doctoral Results

In contrast to the master's and undergraduate findings, post-treatment coefficients for international doctoral graduates are uniformly near zero and statistically indistinguishable from zero across the event-study window. This null result is consistent with the institutional context: doctoral students have access to cap-exempt H-1B sponsorship through universities and research institutions, reducing the marginal value of an extended OPT period.

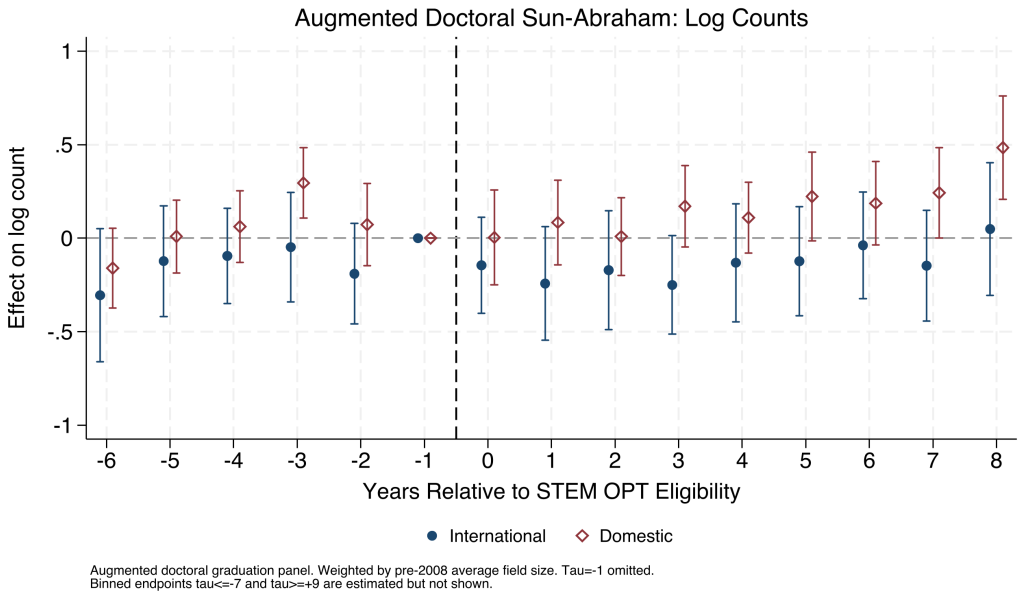


Figure A5: Effect of STEM OPT on International Doctoral Students

A.2 Composition and Selection

These appendix figures provide additional evidence on the composition of the international student pool after STEM OPT expansion. Figure A6 shows that mean SAT verbal scores among international undergraduates decline after treatment, while the corresponding domestic series remains comparatively stable. Figure A7 shows a decline in the lower tail of the TOEFL distribution for international doctoral entrants, consistent with a weakening of observed English proficiency at the bottom of the distribution. Figure A8 shows that international master's students experience a decline in graduation GPA relative to their within-major cohort, while domestic students do not show a comparable pattern. Taken together, these figures support the view that the OPT expansions broadened the international student pool along some dimensions of observed preparation, though the relevant margins differ across degree levels.

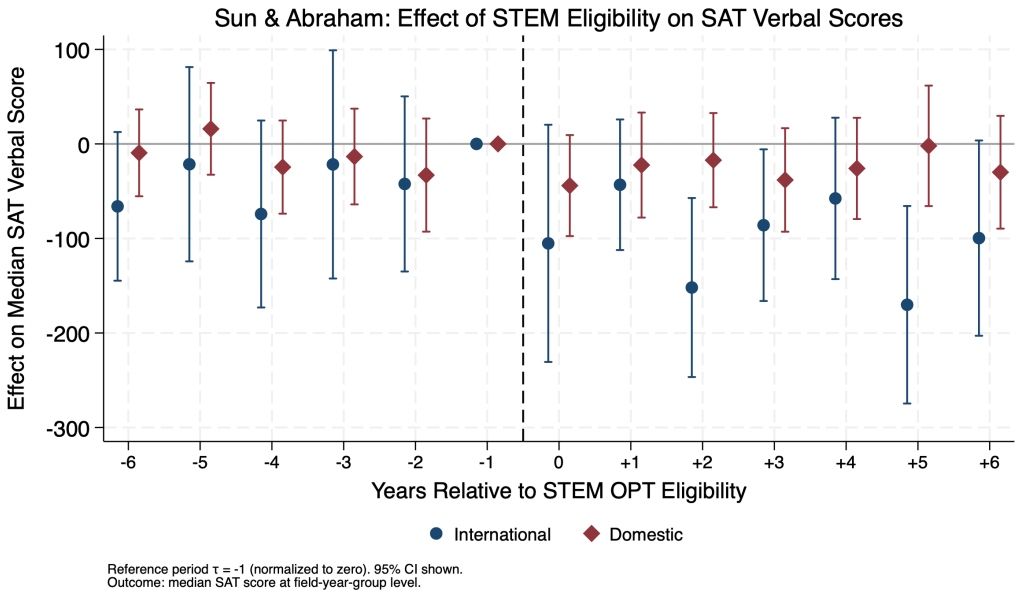


Figure A6: Undergraduate Entry SAT Verbal Scores

Notes: Sun–Abraham event-study estimates for mean SAT verbal scores in undergraduate entry fields, shown separately for international and domestic students. The international series declines after STEM OPT designation, while the domestic series remains comparatively stable, consistent with some broadening of the international undergraduate pool along verbal-preparation margins. Because SAT coverage is incomplete for international undergraduates, these estimates should be interpreted as suggestive.

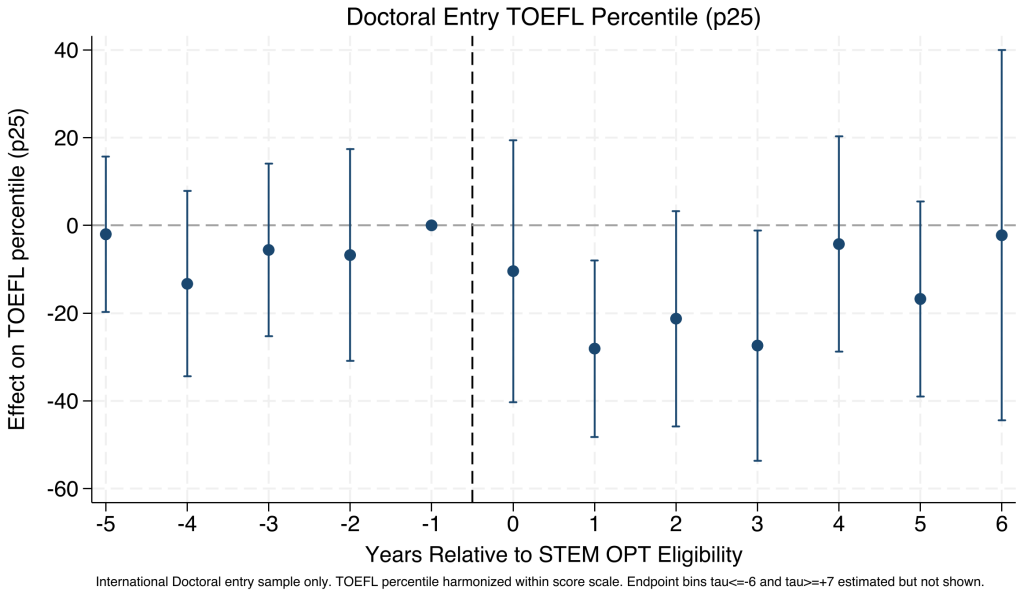


Figure A7: Doctoral Entry TOEFL Scores: Lower Tail

Notes: Sun–Abraham event-study estimates for the 25th percentile of TOEFL scores among international doctoral entrants. The post-treatment coefficients are generally negative, indicating a decline in the lower tail of observed English proficiency after STEM OPT designation. This pattern is consistent with compositional broadening at the doctoral level, though it may also reflect changes in country mix or admissions thresholds.

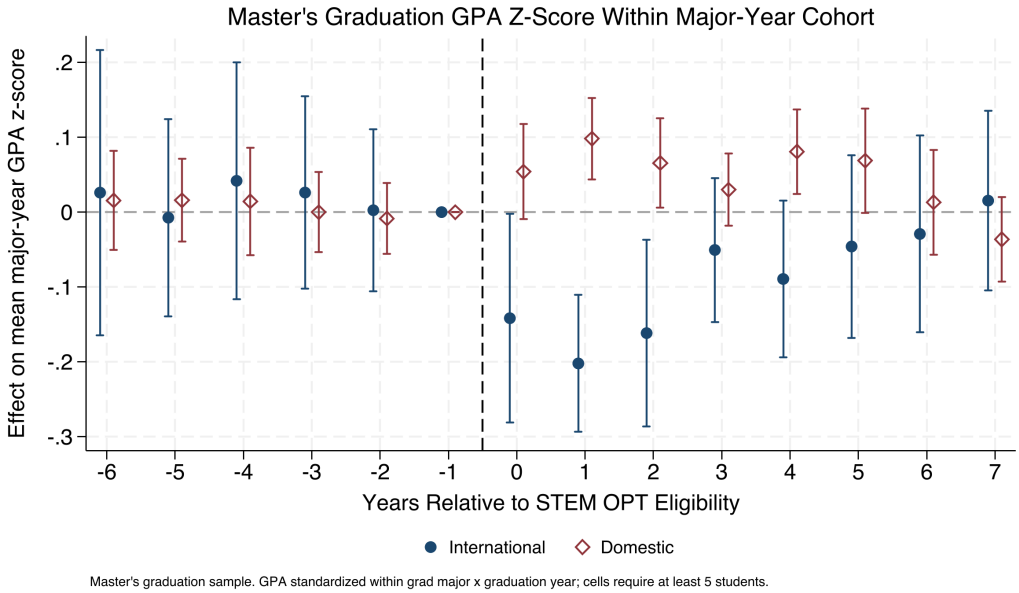
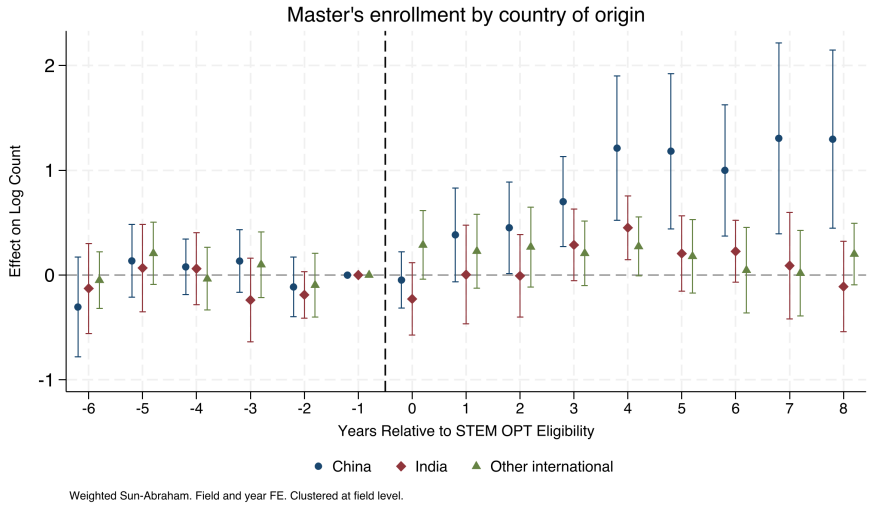


Figure A8: Master's Graduation GPA Within Major Cohort

Notes: Sun–Abraham event-study estimates for mean cumulative GPA, standardized within graduating major and graduation cohort, shown separately for international and domestic master's students. The international series declines after treatment, while the domestic series does not show a comparable deterioration. This pattern is consistent with some broadening of the international master's pool in realized academic performance at graduation.

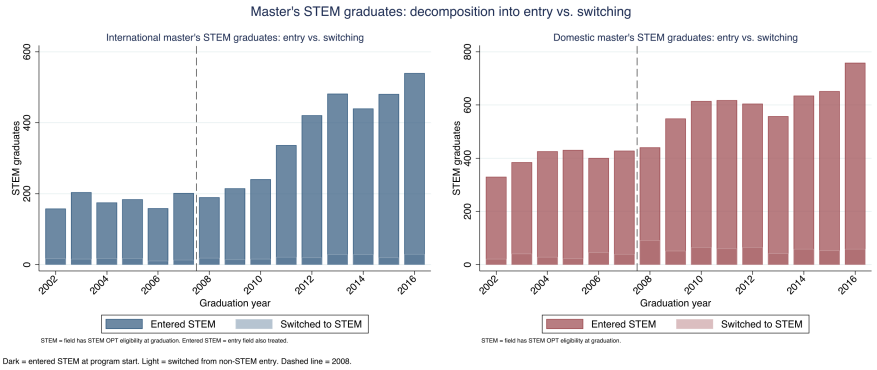
A.3 Entry, Switching, and Persistence

Figure A9: Master's Enrollment by Country of Origin: China vs. India



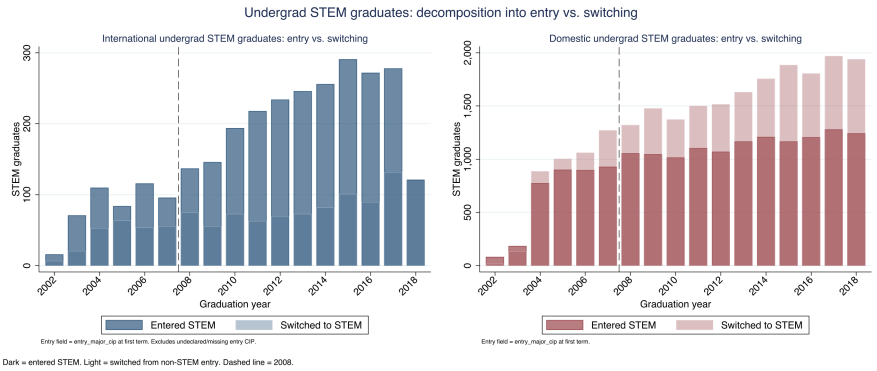
Notes: Sun-Abraham IW estimates. Outcome: log international master's enrollment. Estimated separately for students from China (circles) and India (diamonds). Field and year fixed effects; standard errors clustered at the field level. Control group: non-STEM fields. Variation from 2008/2011/2012 cohorts.

Figure A10: STEM Graduates by Entry Path: International vs. Domestic Master's



Notes: Count of master's graduates in STEM fields by graduation year. Each bar is decomposed into graduates who entered a STEM program (dark) versus those who switched into STEM after entry in a non-STEM program (light). Left panel: international students. Right panel: domestic students. Dashed vertical line marks 2008. Roughly 90–95% of international STEM master's graduates entered STEM at the start of their program.

Figure A11: STEM Graduates by Entry Path: International vs. Domestic Undergrad



Notes: Count of undergraduate graduates in STEM fields by graduation year. Each bar is decomposed into graduates who entered a STEM program (dark) versus those who switched into STEM after entry in a non-STEM program (light). Left panel: international students. Right panel: domestic students. Dashed vertical line marks 2008.