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Taxes on International Students: Demand and Supply Response for Post-Graduation Foreign Workers on Optional Practical Training

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Abstract

The US government has proposed various taxes on high-skill immigration. The effects of such taxes hinge on price elasticities of demand and supply that the literature has rarely measured. I estimate key elasticities to evaluate a $100,000 tax on Optional Practical Training (OPT) work permits for international graduates of US universities, the largest single channel of high-skill immigration to the US. Depending on the tax's incidence, evaluation requires the price elasticity of demand for US degrees with the OPT option, of universities' supply of OPT placements, or of employers' demand for OPT workers. In all incidence scenarios, OPT starts at a given level of international enrollment fall by roughly a third or more, and by four fifths under university or employer incidence in the central scenarios. The decline in OPT opportunities would cut international enrollment, costing universities hundreds of millions to over four billion dollars a year in net margin, before any compounding with taxes on work visas such as the H-1B. The need for better estimates will grow with the prevalence of immigration taxes.

JEL classification

F22, H22, I23, J61

Keywords

Optional Practical Training, H-1B, immigration, immigrant, labor, tax, fee, payment, duty, tariff, skill, talent, foreign, student, graduate, college, higher ed, university, demand, supply, elasticity, STEM

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Governments that seek to limit imports rely on a mix of quotas (quantity-based) and taxes (price-based). Governments that seek to limit immigration have overwhelmingly used quotas alone.[1] This is changing in the United States, the world's leading destination country for international migrants. The US government has recently proposed and explored various immigration taxes, focused to date on taxing the employers of high-skill foreign workers.[2] Policy analysis of such taxes is hindered by the fact that, precisely because high-skill immigration taxes have been so rare, the economic research literature on such taxes is extremely limited.

In this paper I propose straightforward methods to evaluate selected plausible taxes on US high-skill immigration. I focus on taxes on Optional Practical Training (OPT), a post-graduation work authorization for international graduates of US universities that constitutes the largest single employment-based channel of high-skill foreign labor supply into the US market. I then apply those methods to estimate or bound selected partial-equilibrium impacts on high-skill migrants, universities, and employers.

For any tax, impacts depend crucially on the behavioral response by economic actors. This behavioral response has been little studied for taxes levied on the high-skill immigration pipeline, taxes that could be incident upon migrants, universities, or employers. I thus begin by measuring the price elasticity of demand for US education by international students, the price elasticity of supply of international student graduates by US universities, and the price elasticity of demand for high skill foreign workers by US employers. For all three, the literature contains useful methods but very few direct estimates. Here I focus on bachelor's and master's graduates because

[1] Economists who have considered a shift toward price-based immigration regulation include Becker (1987), Freeman (2006), Peri (2012, 17), and Sharma and Sparber (2024). A related strand of research considers auction-based or tradeable permit-based mechanisms for visa allocation (DeVoretz 2008; Chiswick 2009; Orrenius and Zavodny 2010; Orrenius et al. 2013; Fernández-Huertas Moraga and Rapoport 2014; Casella and Cox 2018; Orrenius and Zavodny 2020; Lokshin and Ravallion 2022). Stark et al. (2017), Guerreiro et al. (2020), and Auriol and Mesnard (2016); Auriol et al. (2023) consider the theoretically optimal mix of quotas and taxes in immigration regulation.

[2] The best-known of these is a proposed \$100,000 tax on H-1B high-skill nonimmigrant workers (Proclamation 10973 of Sep. 19, 2025: Executive Office of the President, "Restriction on Entry of Certain Nonimmigrant Workers", 90 *Fed. Reg.* 46027, September 24, 2025). The stated goal of the tax is to "impose higher costs on companies seeking to use the H-1B program" to prevent the "large-scale replacement of American workers". The proposed tax is incident directly on employers: "Employers shall, prior to filing an H-1B petition on behalf of an alien outside the United States, obtain and retain documentation showing that the payment …has been made. The Secretary of State shall verify receipt of payment …and shall approve only those visa petitions for which the filing employer has made the payment" (§2). For a proposed tax on high-skill work by nonresident aliens who have recently graduated from US universities ('Optional Practical Training'), see: Michelle Hackman, "U.S. Weighs \$100,000 Fee for Foreign Students Wanting to Work After Graduation", *Wall Street Journal*, July 30, 2026.

the financing of doctoral education for international students is fundamentally different (more university- and grant-based) and because doctoral graduates have a wider range of employment-based pathways (such as J-1 or O-1 nonimmigrant visas and EB-1 immigrant visas).

I apply those tools to taxes on international students and high-skill foreign workers, illustrating how to estimate effects on workers, universities, and firms. I estimate the impact of various OPT taxes on the number of OPT starts at a given level of international student enrollment. *For a tax on students:* I find that the nationwide count of international students demanding US degrees responds to price with an elasticity of roughly −0.5 to −0.6, and show that this establishes a lower bound on the magnitude of a decline in OPT starts caused by a tax on international students entering OPT, implying that a $100,000 tax incident on OPT workers would cut OPT starts by more than a third among bachelor's and master's graduates collectively.[3] *For a tax on universities:* Using novel estimates of universities' net margin from international student enrollment, I simulate that a $100,000 tax incident paid by universities on OPT placements yields a decline of about four fifths in OPT starts, equivalent to a price elasticity of OPT placement supply of approximately +0.5. *For a tax on employers:* Employers' demand for OPT workers would fall by roughly half to more than nine tenths at a $100,000 tax incident on OPT employers, at demand elasticities between −4, motivated by simulation estimates in the small literature on H-1B demand, and −16, implied by the short-term collapse in petitions for new H-1B workers from abroad under the $100,000 H-1B tax proclaimed in September 2025. The declines assume a constant-elasticity demand response, a conservative form in which the tax never exhausts employers' willingness to pay for the foreign hire.

The estimates do not account for any compounding effects of taxes on high-skill work visas such as the H-1B visa. And all of these predicted effects hinge on demand and supply responses that the literature has rarely measured, and values within the currently plausible range of each parameter produce predictions that vary greatly, a gap that grows more urgent as high-skill immigration taxes proliferate. These estimates are a first step in a very small literature, not a comprehensive accounting of the effects of such taxes.

[3] These demand elasticity estimates are weighted by the number of international students at each institution, so that the estimates are informative about international students as an aggregate. I also find that the demand elasticity is roughly −0.2 to −0.3 at the average university × major program, unweighted (regardless of international enrollment). The weighted estimates must be used because the estimand of interest is the decline in overall quantities due to the tax, about which responses at institutions with low foreign enrollment provide little information.

The paper proceeds as follows. Section 1 sets out the dependence of high-skill immigration tax effects on key response elasticities depending on incidence. Section 2 estimates the price elasticity of demand by international students for US education with the OPT option, and uses it to place a lower bound on the magnitude of the decline in OPT starts caused by an OPT tax incident on students. Section 3 estimates the price elasticity of supply of OPT placements by US universities, and thus the effect of an OPT tax paid by universities. Section 4 considers the effects of an OPT tax incident on employers in light of OPT labor demand estimates consistent with prior research. Section 5 considers the effects on university revenue from deterring international enrollment via reductions in OPT opportunities. Finally, Section 6 concludes.

1 Three scenarios of tax incidence: students, schools, and firms

Taxes on high skill immigration can take various forms. One of the largest channels of high-skill immigration to the United States is international graduates of US universities who remain to work (Glennon 2024; Clemens et al. 2025). This occurs mostly through a limited post-graduation work permit, called Optional Practical Training (OPT), that can be attached to student visas. A second major channel is temporary employment-based visas, particularly the H-1B high-skill work visa, both for graduates of US and foreign universities (Amuedo-Dorantes et al. 2019; Demirci 2019; Amuedo-Dorantes et al. 2023).

The form of this pipeline for high-skill immigration creates several opportunities for a government seeking to restrict high-skill immigration by taxing the flow through the pipeline. For example, it can tax international students graduating from US universities who choose to supply labor in the US, it can tax the universities they graduate from, or it can tax the employers of high-skill immigrants, whether US-trained or foreign trained. These different forms of tax incidence could yield different effects.

1.1 A tax incident on graduates

Let I denote the number of OPT starts from a given enrolled cohort of international students, and I_0 its value absent any tax. Let P be the opportunity cost of working in the United States on

OPT relative to the reserve option (such as returning home), and let τ_s be the dollar amount of a tax charged to the student. The effect of the tax on student demand for OPT starts hinges on the elasticity of that demand, $\varepsilon_s < 0$. Students' demand is

$$I^s(\tau_s) \;=\; I_0\left(\frac{P+\tau_s}{P}\right)^{\varepsilon_s}. \tag{1}$$

Some students facing a tax-induced price increase in equation (1) no longer find OPT worthwhile, conditional on having completed the degree. Whether the degree alone remains worthwhile under reduced access to OPT is a separate margin, considered later.

1.2 A tax incident on universities

A tax on universities whose graduates use OPT, of dollar-value τ_u, cuts the price the university receives from P to $P - \tau_u$. Let MC_i be university i's cost of educating the marginal student, cumulated over the degree. The university remains able to enroll and graduate students who work on OPT after graduation as long as the received price covers its cost, so

$$I^u(\tau_u) \;=\; I_0\left(\frac{P-\tau_u}{P}\right)^{\varepsilon_u}, \qquad \text{seats supplied iff } MC_i \;\le\; P_i - \tau_u, \tag{2}$$

where $\varepsilon_u > 0$ is the university's price elasticity of seat supply. With heterogeneous costs, the supply curve is the distribution of MC across schools: supply is elastic where many margins $P - MC$ sit just above zero, inelastic where margins are large.

1.3 A tax incident on employers

Alternatively, a tax could be charged to US employers of OPT workers. An employer-incident tax of dollar-value τ_e, per year of OPT work, raises the annual price of one hire from $b\overline{w}$ to $b\overline{w} + \tau_e$, where $\overline{w}$ is the mean annual wage and $b \geqslant 1$ is the ratio of full labor cost (including benefits) to the wage. Demand falls at constant elasticity $\varepsilon_e < 0$:

$$I^e(\tau_e) \;=\; I_0\left(\frac{b\,\overline{w}+\tau_e}{b\,\overline{w}}\right)^{\varepsilon_e}, \tag{3}$$

the same constant-elasticity form as equations (1) and (2).[4] An equivalent demand curve could be used to analyze the behavioral response to an employer-incident tax on workers who are foreign-trained.

Clearly, the impact of a similar dollar-value tax could be quite different in equations (1) to (3). Analysis of the impact of high-skill immigration taxes must begin, then, with a specific incidence and an estimate of the corresponding price elasticity. The next three sections proceed to estimate, for different tax incidence scenarios, the relevant price elasticity and selected impacts that it implies.

A note on terminology: The policy instruments τ_s, τ_u, and τ_e are taxes. Some advocates of these taxes call them "fees", because taxes of this kind enacted by Executive branch agencies face potential legal jeopardy if the agencies collecting the taxes lack authority to levy taxes.[5] But Congress has directly limited by statute the "fees" the Executive branch can charge for either international student programs (8 USC §1372) or immigration adjudications generally (8 USC §1356(m)), restricted to the costs of carrying out student programs or the costs of providing such adjudication services. Furthermore, the word "fee" is defined in case law, administrative rulings, and the field of public finance generally to mean a payment that is charged to offset the cost of a government service provided for private benefit, such as a passport fee.[6] It bears no relation to the compulsory payments considered here, which are untethered to the cost of any government service provided to migrants or employers, and which are thus taxes.

[4]This form is conservative. The native substitute bounds the employer's willingness to pay for the foreign hire, so the true demand curve reaches zero at some finite tax. A linear demand curve with the same elasticity at a zero tax, for example, reaches that choke point at $\tau_e = b\overline{w}/|\varepsilon_e|$, within the range of proposed taxes in several of the scenarios below. Equation (3) assumes no choke point—complete substitution into native labor never occurs at any finite tax—and thus predicts smaller declines than a linear demand curve at every tax.

[5]See for example the US federal court ruling in California v. Mullin, No. 25-13829-LTS, 2026 WL 1649160 (D. Mass. June 8, 2026).

[6]"Taxes, the principal means of financing government expenditures, are compulsory payments that *do not necessarily bear any direct relationship to the benefits from government goods and services received*" (Hyman 2010, 21, emphasis added). "The legal distinction between fees and taxes is based on whether charges are levied for purely private benefits, or whether they confer public benefits that are independent of, rather than incidental to, private benefits" (Congressional Budget Office 1993, p. 15). This definition is consistent across US Internal Revenue Service rulings, *Black's Law Dictionary*, International Monetary Fund standards, and other authorities that I review in Appendix A2.8.

2 A tax on students: The demand for Optional Practical Training

Consider the case of a high-skill immigration tax incident directly on international students graduating from US universities who choose to remain for work in the United States. By far the largest single pathway for such students to remain for work is Optional Practical Training (OPT), a work authorization that allows employment on a student visa for up to three years by graduates in science, technology, engineering, and mathematics (STEM), or one year otherwise. 64 percent of all international STEM graduates exercise the OPT option, and of international STEM grads who remain for work on either OPT or directly to an H-1B visa, 82 percent do so via OPT (Clemens et al. 2025).

Here I propose a way to place a conservative but informative bound on the response of international student demand for OPT to an OPT tax, by using information contained in their response on a different behavioral margin: the response of international student enrollment to increases in the cost of US degrees. I then estimate those bounds by replicating and then applying an existing method of isolating exogenous variation in US degree costs (Beine et al. 2023) to estimate international students' price elasticity of demand for US degrees.

2.1 Bounding students' demand response to an OPT tax

The price elasticity of demand for degrees can bound the response of OPT usage to an OPT tax because the enrollment decision and the OPT-start decision weigh the same tax against different amounts of surplus, in a direction whose sign is determined. A prospective student weighs the price of the degree against the combined value of the bundle: the degree itself and the work option attached to it. A graduate deciding whether to exercise the option holds the degree already, having paid that sunk cost, and only the value of the option itself stands against the tax. A given dollar amount therefore produces more response at the exercise of the option than the same amount folded into the up-front price of the degree-OPT bundle, provided the degree alone was worth its price. Any graduate whom the costlier bundle would have turned away ex-ante will decline to pay the same sum for the option alone.

A minimal proof of this idea needs four quantities: Each graduate among currently enrolled students 1) values the US degree alone at D, 2) holds an incremental value $O \geq 0$ of exercising the OPT option (the US work and the later options it opens, net of the reserve option of leaving), and 3) paid the whole-degree price P, sunk at graduation. 4) Let τ be a tax due when the OPT option is exercised. The graduate remains on OPT iff $O \geq \tau$. The same graduate would have enrolled at a whole-degree price of $P+\tau$ if and only if $D+O \geq P+\tau$. Considering only the margin of demand response for those already enrolled, in other words separate from any enrollment response to the OPT option (considered later), the degree must be worthwhile even without the OPT option by definition ($D \geq P$). Then

$$D + O \ < \ P + \tau \quad \Longrightarrow \quad O \ < \ \tau. \tag{4}$$

Ex ante the tax must exhaust the surplus on both parts of the bundle, $(D-P)+O$, while at exercise of the option it need only exhaust O. Every graduate deterred ex ante is deterred at exercise. The converse fails, so the bound is strict: a graduate with $O < \tau$ but $D-P \geq \tau - O$ would have bought the costlier bundle, but declines the taxed option. Each already-enrolled student's response of OPT demand to an OPT tax, conditional on enrolling and graduating, is at least as great as the response of *enrollment* demand to an increase in the price of enrollment.

A more formal demand bound follows by aggregation. Let $\Delta(\tau) = \Pr(O < \tau \mid O \geq 0)$ be the share of the stock that the tax removes from OPT, and let $B(\tau) = \Pr(D+O < P+\tau \mid D+O \geq P,\ O \geq 0)$ be the share that would have declined the bundle at the higher price. By (4), $\Delta(\tau) \geq B(\tau)$. If the ex-ante bundle surplus of the OPT-bound is distributed as the constant-elasticity demand curve estimated below implies, then

$$\Delta(\tau) \ \geq \ B(\tau) \ = \ 1 - \left(\frac{P+\tau}{P}\right)^{\varepsilon_I}, \tag{5}$$

the demand response of enrollment to the degree price, evaluated at the tax. Equivalently, OPT starts from the stock cannot exceed $I_0\,((P+\tau)/P)^{\varepsilon_I}$, because per dollar of tax, the demand for OPT in equation (1) responds at least as strongly as the demand for degrees, so the elasticity ε_S is at least ε_I in magnitude. The estimated degree-demand elasticity is a floor on lost OPT starts.[7]

[7] Again, this holds for the partial-equilibrium margin at a given level of international student enrollment, that is, assuming $D \geq P$. Analysis below, in Section 5, considers the case in which reduced OPT opportunities reduce demand to come to the US for higher education in the first place. For cohorts not yet enrolled, the same estimate bounds a

2.2 Replication and adjustment of the Beine et al. method

Assessing the price elasticity of demand by international students for a US university education, in the bounding equation (5), faces a clear endogeneity problem. Positive shocks to demand for US degrees could lead higher education institutions to raise the price, and cuts to university financing can cause them to both recruit more international students and charge them higher tuition (Bound et al. 2020). Either of these can attenuate or even reverse the sign of the simple observed correlation between price and demand. Careful estimation requires a source of exogenous variation in tuition.

The price elasticity of international students' demand for higher education has been estimated for a handful of other important destination countries. The estimated elasticities range from approximately −0.3 on impact in the United Kingdom, where the cumulative response over time is larger (Conlon et al. 2017), to −0.5 in Italy (Beine et al. 2020). This suggests a reasonable prior that in the United States, too, a 10 percent increase in costs would cause a 3 to 5 percent decline in international enrollment. But I am not aware of a quasi-experimental estimate of this elasticity for the United States in prior research.

Beine et al. (2023) offer a peer-reviewed method to isolate plausibly exogenous variation in US public universities' full-price (out-of-state) tuition, the rate that is charged to the overwhelming majority of international students. They do not calculate a price elasticity of demand for US degrees, but use that identifying variation for a different purpose (estimating the average US retention rate of international students after graduation). I replicate their method, extend the dataset for seven additional years (to 2024), and use it to estimate international students' price elasticity of demand for US degrees—that is, the bundle of a US degree and the option to work on OPT.

Beine et al. (2023) regress each public university's out-of-state tuition on its in-state tuition and a rich set of fundamentals that plausibly drive both pricing and attractiveness to students: state

different total. A tax due at exercise lowers the enrollment payoff only of students who expect to use OPT, so the enrollees it deters are drawn from *would-be* OPT users. Their number is the demand response at the bundle margin, the right side of (5). Students who enroll regardless and then decline the option ($O < \tau$) subtract further OPT starts that no enrollment count registers. For future cohorts the estimated response is therefore a floor on the combined effect, enrollment plus exercise, and no assumption on D is required. The second margin only includes further losses.

budget appropriations, lagged enrollment and graduation counts, endowment, expenditure, and faculty per student. The residual is variation in the price paid by international students arising from idiosyncratic administrative decisions. The lag of that residual then instruments for the price in enrollment regressions, on the identifying assumption that this leftover variation in what universities happen to charge nonresidents is uncorrelated with unobserved shocks to international students' demand for the university, so the enrollment response it traces is a movement along the demand curve rather than a shift of it. The first stage is

$$T_{ut} = \gamma\, T_{ut}^{in} + X_{ut}'\beta + \mu_{s(u)\times c(u)} + \delta_t + v_{ut}, \tag{6}$$

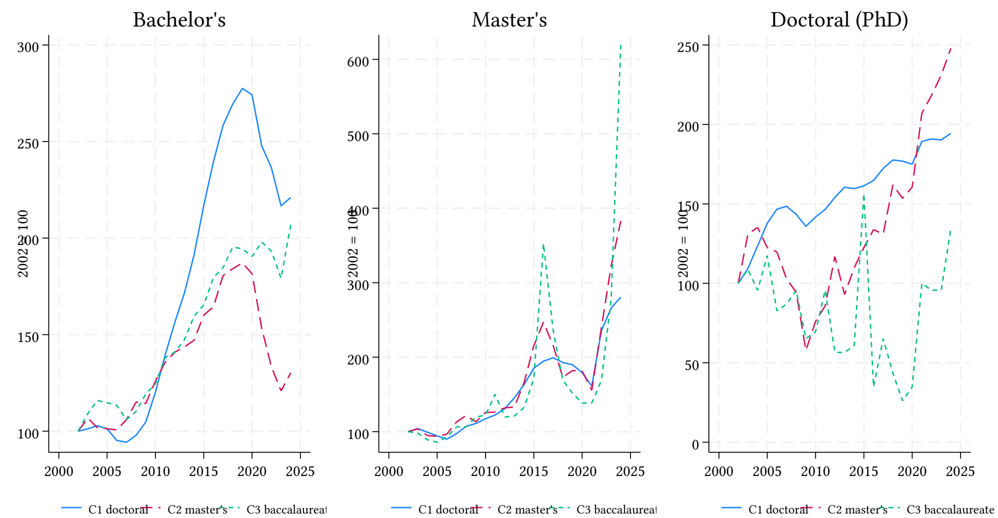
where X_{ut} holds state appropriations, lagged enrollment and graduation counts, endowment, expenditure, and faculty per student, and $\mu_{s(u)\times c(u)}$ are state × Carnegie-classification-group effects (explained below). The residual $\hat{v}_{ut}$ is the portion of out-of-state fees unexplained by fundamentals, and its lag $\hat{v}_{u,t-1}$ serves as the instrument for price. Estimated on the present sample for the overlapping years, equation (6) and its reduced form reproduce the published estimates closely.[8]

The Carnegie classification separates different classes of institutions in US higher education by the highest degrees they confer in substantial numbers, a standard and widely-used classification that recurs throughout the analysis to follow. It reflects the Carnegie Basic Classification, maintained by the Carnegie Foundation for the Advancement of Teaching and used here in the editions that preceded its 2025 revision. Doctoral universities (Basic codes 15–17) awarded at least twenty research doctorates a year, such as Harvard, the University of Michigan, and Ohio State. Master's colleges and universities (codes 18–20) awarded at least fifty master's degrees but fewer than twenty doctorates, such as most campuses of the California State University system. Baccalaureate colleges (codes 21–23) conferred degrees mainly at the bachelor's level, such as Williams and Amherst. This paper labels these as Carnegie doctoral (C1), Carnegie master's (C2), and Carnegie baccalaureate (C3) institutions. The Carnegie classification does not represent the only degrees awarded by each institution, and many schools in each class award a range of degrees.[9] Throughout the tables, degree words (bachelor's, master's, doctoral) refer to degrees, and

[8] Appendix A2.1 reports the replication tables.

[9] For example, roughly four fifths of the sample's international *master's* degree students study at C1 '*doctoral*' institutions rather than C2 '*master's*' institutions (Appendix Table A12).

Figure 1: International completions by degree and Carnegie group, 2002 = 100



National totals of degrees awarded to US-nonresident students, by degree and Carnegie group (C1 doctoral, C2 master's, C3 baccalaureate institutions), indexed to 2002 = 100. Sample as in Appendix Table A8.

C-labels refer to the institution's Carnegie group.

I make two modifications to the Beine et al. method. The first is that, in their second-stage regressions, they control for broad national trends with year fixed effects. This implicitly assumes common national trends for international enrollment across Carnegie classifications. I relax that assumption by including Carnegie classification × year fixed effects, allowing each Carnegie group to exhibit an idiosyncratic national trend. These are analogous to industry × year fixed effects, with the various types of universities experiencing different nationwide shocks to demand and supply during this period. This is important because international student enrollment trends differ sharply across Carnegie groups. Figure 1 shows how national totals of international completions, indexed to 2002, diverge across C1, C2, and C3 institutions by several percentage points of growth per year at every degree level.[10] A specification with plain year effects forces this heterogeneity into the error term, correlated with segment-specific trends in prices and enrollment.

The second adjustment is to link standard degree-completion and university finance data from

[10]More detail in Appendix A2.4.

the Integrated Postsecondary Education Data System (IPEDS), 2002–2024, to the number of students by school and year exercising their option to work on OPT from 2006 to 2022, taken from an extract from the US government's Student and Exchange Visitor Information System (SEVIS) obtained under the Freedom of Information Act and made available by Buxton-Walsh and Neufeld (2025). The sample is degree-granting four-year public and private nonprofit institutions in the fifty states and DC. Year t denotes the fall of the academic year throughout (details in Appendix A1).

2.3 Student demand elasticity estimates

The elasticity specifications re-express the Beine et al. (2023) design in logs, so that the coefficient reads directly as a percent change in students per percent change in price, in the tradition of the student price-response literature (Leslie and Brinkman 1987). Degrees respond at the university × major cell, the unit of Beine et al.. Enrollment by major is never observed in IPEDS, so graduates G in year t proxy the cohort that enrolled facing the tuition of its entry year:

$$\ln G_{umd,t} = \varepsilon_d \ln T_{u,t-k_d} + \alpha_{umd} + \delta_{g(u),t} + e_{umd,t}, \tag{7}$$

where the degree length $k_d \in \{4, 2, 5\}$ for bachelor's, master's, and doctoral degrees respectively. $T_{u,t-k_d}$ is the tuition of those who graduate in year t at the time that they enrolled at university u. Table 1 reports six estimators per degree: OLS, IV, and PPML and control-function IV-PPML (Santos Silva and Tenreyro 2022)—the latter two retaining zero cells and thus information on extensive-margin demand—with the IV and IV-PPML estimators each shown both unweighted and weighted by cell size (columns 3 and 6, with analytic weights equal to the cell's mean international completions). The two estimands differ, and the difference matters for the policy question. The unweighted regressions answer how the *average* university × major cell responds in percent, an estimand that gives a program with three international students the same voice as a program with three hundred. The weighted regressions answer how the *nationwide count* of international students responds—the response of students at the institutions where international students actually are—because the national percent change is the level-share-weighted average of cell percent changes, an aggregation identity that only level-share weights satisfy. The quantity of interest for the tax simulations below is the decline in the number of international students coming to the country overall, not the effect on the average college regardless of how few international students study there, so the size-weighted column-3 IV estimates (−0.49 bachelor's, −0.60 master's, −0.21 PhD) are the elasticities carried forward to the simulations. The unweighted column-2 estimates (−0.21, −0.29, −0.23) describe the average cell; the weighted IV-PPML estimate of column 6 is similar to column 3 for bachelor's and noisier for master's. The weak-IV robust Anderson-Rubin p-value implies rejection of the hypothesis of a null elasticity in the second stage at the five percent level in column 2 for all three degrees, and in column 3 for master's and doctoral degrees ($p = 0.061$ for bachelor's).[11] Figure 2 confirms that the results are not driven by a handful of influential observations, showing Angrist and Pischke's (2009, 138–144) "visual instrumental variables" (VIV) plot corresponding to column 2 in each panel of Table 1: a second-stage partial-residual binscatter (50 bins) whose fitted line has slope exactly equal to the 2SLS elasticity.[12]

2.4 Bounding the effects of a student tax on OPT starts

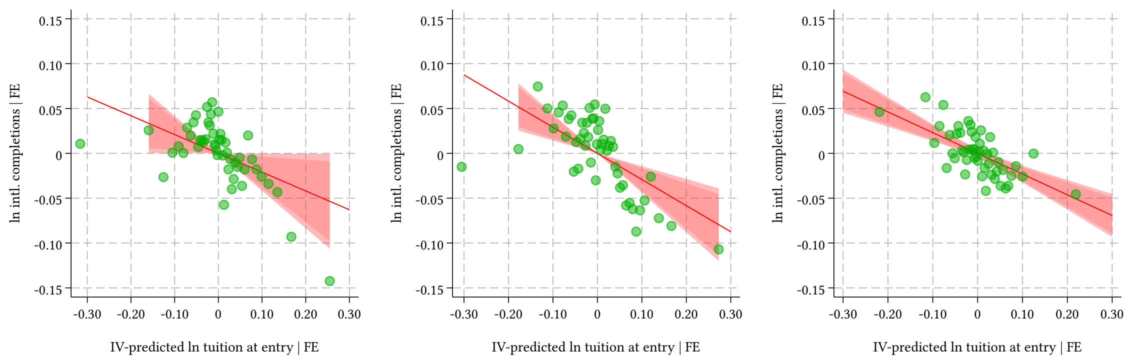
The above estimates of international students' price elasticity of demand for the US-degree-plus-OPT-option bundle allow estimated lower bounds on the magnitude of the decline in that demand under different dollar-amounts of tax: the true decline is at least as large as the declines estimated here. If the dollar amount varies by the extent of OPT, the total effect would correspond to the total across the full OPT period. For example, if there were a $70,000 tax on the first year of OPT and a $30,000 tax on the STEM extension for an additional two years, the effect on demand would correspond to a $100,000 tax on international students' demand for placement into three years of STEM-OPT.

[11] The plausibly exogenous residual moves tuition at entry strongly in the linear first stages behind the IV columns, with Kleibergen–Paap F statistics of 280 (BA), 67 (MA), and 17 (PhD) unweighted, and 141, 50, and 14 weighted. Appendix A2.2 reports the unweighted first stages on exactly the 2SLS estimation sample. The cell-size weights are held fixed over time (a time-varying outcome weight could itself respond to price) and apply to every regression of the weighted columns, including first stages, Anderson–Rubin reduced forms, and control functions; always-zero cells carry zero weight, and because the unweighted PPML is already implicitly tilted toward large cells, explicit weights move the OLS and IV columns most. The first-stage-residual rows report the control-function test of tuition's endogeneity, the Durbin–Wu–Hausman test. IV-PPML is the control-function form of IV: a PPML estimation that adds the first-stage residual of lagged ln tuition on the lagged instrument as a regressor, so the tuition coefficient uses instrumented variation only while zero counts stay in the sample. (In the linear model the same construction reproduces 2SLS exactly.) A significant positive residual indicates demand-type endogeneity biasing uninstrumented estimates toward zero, as expected.

[12] Fall-enrollment regressions at the coarser university × level unit tell the same story: graduate elasticities of −0.26 to −0.57 in the count models, with undergraduate responses smaller and imprecise (Appendix A2.3).

Figure 2: Visual IV: the second stage of the Table 1 linear IV regressions

(a) *Bachelor's* (b) *Master's* (c) *Doctoral*



Partial-residual binscatters (50 equal-count bins) of the second stage of equation (7) on the 2SLS estimation sample, after partialling the cell and Carnegie × year fixed effects out of every variable: the vertical axis is residualized ln international completions, the horizontal axis the IV-predicted residualized ln tuition at entry. The solid line is drawn from the underlying micro regression, so its slope equals the column-2 elasticity of Table 1 exactly. Shaded bands are 90 and 95 percent conventional confidence intervals on the conditional mean, centered on the 2SLS line and built from the dispersion of the bin means around it. Formal inference remains the table's cluster-robust SE. Axes are identical across panels.

When student cost rises, the school-level whole-degree price is $P_{il} = D_l T_{il}$, with $D_l = 4$ years of the school's own sticker out-of-state charges for a bachelor's degree and 2 for a master's. A tax of t is added once to that degree price. Under a constant elasticity ε_l the school-level loses the share $1 - ((P_{il} + t)/P_{il})^{\varepsilon_l}$ of its international graduates, which equals $|\varepsilon_l|\, t/P_{il}$ for small taxes and never extrapolates past 100 percent. Aggregating with graduate counts n_{il} as weights, the loss Λ is

$$\Lambda_l(t) = 100 \times \frac{\sum_i n_{il}\,[1 - ((P_{il} + t)/P_{il})^{\varepsilon_l}]}{\sum_i n_{il}}, \tag{8}$$

the percent of all international graduates lost at tax t. By the bounding argument of equation (5), $\Lambda_l(t)$ is a lower bound on the magnitude of the percent decline in OPT starts: the true decline is more negative. The degree-specific demand elasticities ε_l are the column-3 size-weighted IV estimates of Table 1—the elasticity of the nationwide count of international students, matching the quantity the simulation tracks, the decline in the number of international students coming to the country overall—and are lower bounds on (the absolute value of) the elasticity ε_s in equation (1). Table 2 reports $\Lambda_l(t)$ at taxes of \$0–\$100,000. Panel (a) weights by international degrees awarded.

Panel (b) reweights the same school-level percentages by OPT starts from SEVIS (Appendix A1.2).

This addresses the fact that the estimates in panel (a) could be biased if OPT starts concentrate at low-tuition schools where the tax causes a larger percent change in the price. But the estimates in panels (a) and (b) are similar.[13]

The estimates imply that, for example, a tax of $100,000 on OPT work would cause a decline in OPT usage of some amount greater than 35.0 percent for undergraduate and master's degree recipients collectively. Figure 3 plots the same lower-bound curves in tax-loss space: the tax, which raises the price students pay, rises up the vertical axis, and losses run leftward as negative percents, with the true losses lying to the left of (more negative than) the plotted bounds.

[13]The estimates proceed on the assumption that within a school-level the OPT-bound respond with the same elasticity as everyone else, a mild assumption given the very high prevalence of OPT. A $100,000 tax on the degree causes a reduction in OPT usage of no less than about a quarter of bachelor's graduates and two fifths of master's graduates. Doctorates are excluded throughout, as in the supply analysis to follow, because their systems of degree finance are more complex and often driven by university- or grant-funding even for international students.

Table 1: Elasticity of international degrees to tuition at entry: university × major cells, Carnegie-group × year fixed effects

(a) *Bachelor's (tuition 4 years before graduation)*

	(1) OLS	(2) IV	(3) IV wtd	(4) PPML	(5) IV-PPML	(6) IV-PPML wtd
Elasticity w.r.t. tuition at entry	-0.145^{***}	-0.210^{**}	-0.488^{*}	-0.301^{***}	-0.381^{**}	-0.529^{*}
	(0.045)	(0.102)	(0.254)	(0.102)	(0.150)	(0.280)
Cell-years	177,641	83,226	83,226	407,101	159,760	159,760
Universities	1,810	594	594	1,945	625	625
First-stage Kleibergen–Paap F		279.9	140.9			
Anderson–Rubin test p-value		0.048	0.061		0.079	0.075
First-stage residual (CF test)		−0.076	0.177		−0.048	0.318
		(0.156)	(0.391)		(0.216)	(0.421)

(b) *Master's (tuition 2 years before graduation)*

	(1) OLS	(2) IV	(3) IV wtd	(4) PPML	(5) IV-PPML	(6) IV-PPML wtd
Elasticity w.r.t. tuition at entry	-0.141^{***}	-0.291^{***}	-0.596^{***}	-0.234^{**}	-0.444^{***}	−0.425
	(0.040)	(0.087)	(0.226)	(0.092)	(0.161)	(0.318)
Cell-years	129,080	71,380	71,380	218,577	114,985	114,985
Universities	1,607	511	511	1,709	524	524
First-stage Kleibergen–Paap F		66.7	50.5			
Anderson–Rubin test p-value		0.000	0.005		0.004	0.234
First-stage residual (CF test)		0.216^{**}	0.701^{**}		0.581^{**}	0.954^{**}
		(0.093)	(0.312)		(0.241)	(0.388)

(c) *Doctoral (tuition 5 years before graduation)*

	(1) OLS	(2) IV	(3) IV wtd	(4) PPML	(5) IV-PPML	(6) IV-PPML wtd
Elasticity w.r.t. tuition at entry	−0.059	-0.231^{***}	-0.214^{**}	−0.041	-0.153^{*}	0.010
	(0.046)	(0.085)	(0.102)	(0.058)	(0.081)	(0.129)
Cell-years	43,939	27,073	27,073	64,449	38,413	38,413
Universities	540	253	253	619	273	273
First-stage Kleibergen–Paap F		17.4	14.3			
Anderson–Rubin test p-value		0.004	0.020		0.033	0.795
First-stage residual (CF test)		0.262^{**}	0.265^{**}		0.207^{**}	−0.113
		(0.102)	(0.119)		(0.096)	(0.211)

Cells: university × 2-digit-CIP major × degree; dependent variable: degrees awarded to US-nonresident students in the cell (logs; counts for PPML and IV-PPML), 2002–2024, with graduates in year t facing the tuition of their entry year, k years earlier. All columns: cell and Carnegie-group × year fixed effects; SEs clustered by university, the level at which tuition varies. OLS and PPML: public and private nonprofit 4-year universities; IV and IV-PPML: publics, with tuition at entry instrumented by the lagged equation (6) residual. PPML and IV-PPML retain cell-years with zero international degrees. The weighted ("wtd") columns 3 and 6 repeat the IV and IV-PPML estimators with analytic weights equal to the cell's mean international completions across its observed years, held fixed over time, in every regression of the column including its first stage, Anderson–Rubin reduced form, and control function: their coefficients are the elasticity of the *nationwide* count of international students rather than that of the average cell (see text). The below-the-line diagnostics are described in the text. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 2: Lower bounds on the share of OPT starts lost to a per-student tax through the demand response

(a) *Unweighted*

Tax per student	Bachelor's	Master's	Combined
USD 0	−0.0%	−0.0%	−0.0%
USD 10,000	−3.5%	−10.2%	−8.3%
USD 20,000	−6.6%	−17.6%	−14.5%
USD 30,000	−9.4%	−23.3%	−19.4%
USD 70,000	−18.0%	−38.2%	−32.5%
USD 100,000	−22.9%	−45.2%	−38.9%
Elasticity of demand w.r.t. the degree price	−0.49	−0.60	−0.57
	(0.25)	(0.23)	(0.18)

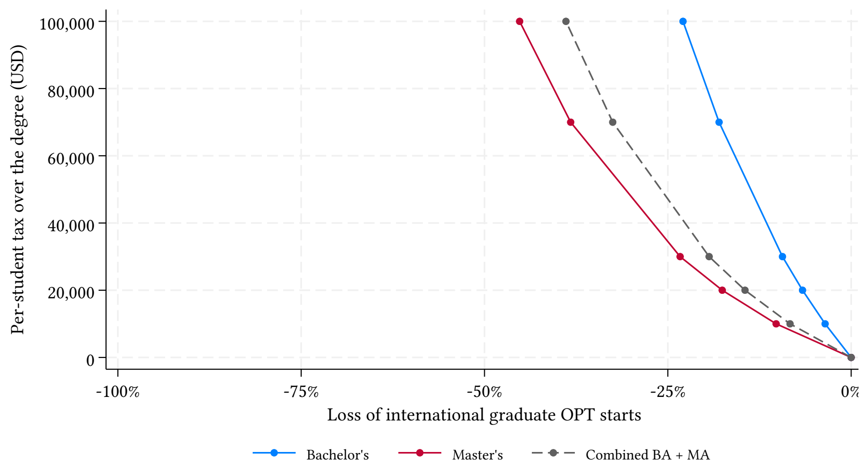
(b) *Weighted by the distribution of initial OPT starts across university-degrees*

Tax per student	Bachelor's	Master's	Combined
USD 0	−0.0%	−0.0%	−0.0%
USD 10,000	−3.6%	−8.8%	−6.8%
USD 20,000	−6.8%	−15.4%	−12.2%
USD 30,000	−9.6%	−20.8%	−16.6%
USD 70,000	−18.3%	−35.2%	−28.8%
USD 100,000	−23.2%	−42.2%	−35.0%
Elasticity of demand w.r.t. the degree price	−0.49	−0.60	−0.56
	(0.25)	(0.23)	(0.17)

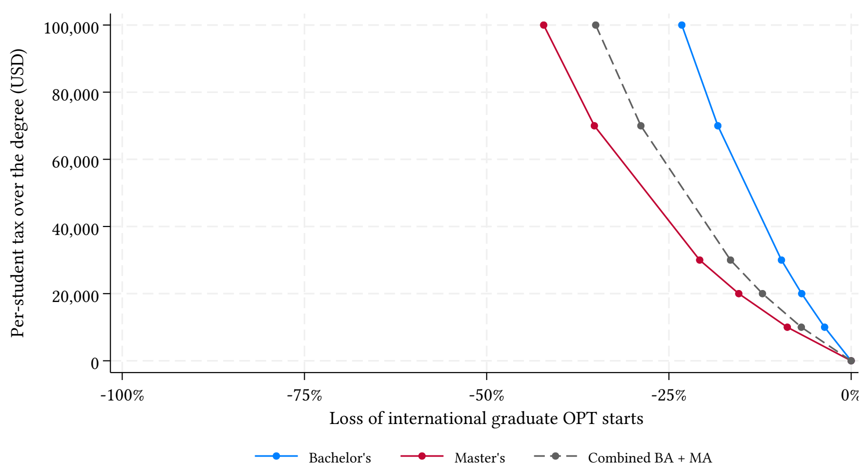
The changes in OPT starts in the table show lower bounds on the absolute value of the change; that is, the estimated change is more negative than the negative changes in the table. Each cell: the percent of international graduates lost at tax t per equation (8), aggregated over school-levels with graduate counts as weights; the zero-tax row is zero by construction. Whole-degree price: 4 years (bachelor's) or 2 (master's) of the school's own latest sticker out-of-state tuition & fees. Panel (a) weights by international degrees awarded; panel (b) by OPT starts in the school's most recent covered SEVIS cohort. Elasticity rows: the column-3 size-weighted IV estimates of Table 1—the elasticity of the nationwide count of international students, the quantity these simulations track—with cluster-robust SEs; the combined entry is the graduate-count-weighted average of the two, with a delta-method SE treating them as uncorrelated. See text for details.

Figure 3: Lower bounds on OPT demand response to a per-student tax

(a) *Unweighted*



(b) *Weighted by the distribution of OPT starts by university-degree*



The loss curves of Table 2, by degree level and combined. The horizontal axis is a lower bound on the absolute value of the percent loss, 0 at the right to -100 at the left. That is, the curves imply that the losses are more negative and lie to the left of the bound curves displayed. The vertical axis is the per-student tax over the degree, rising from \$0 to \$100,000.

3 A tax on universities: The supply of OPT placements

Policymakers might place taxes on another point in the same student-to-workforce pipeline. Every OPT placement at a US employer requires the graduating student's Designated School Official (DSO) to recommend that student for employment in a particular field (the student's field of study) within the Student and Exchange Visitor Information System (SEVIS) administered by the Student and Exchange Visitor Program that is part of Immigration and Customs Enforcement (ICE). US Citizenship and Immigration Services (USCIS), which must approve the application for OPT work authorization, must accept the DSO recommendation for it to proceed. Thus in principle, if either ICE or USCIS holds the legal authority to impose such a tax, it can demand payment of taxes by the recommending university either as a condition of recommending the OPT in SEVIS or at the time USCIS acts on the request for an employment authorization document. This section considers how such a tax, incident on the US universities that international students graduate from, would affect the supply of OPT recommendations by universities—and thus the *supply* of OPT starts available to international students for a given level of international enrollment.

The empirical strategy assumes that universities would be in general unwilling to give a net subsidy to international students who have already graduated in order to pay OPT taxes on their behalf. This implies an upper bound on the willingness of universities to pay such a subsidy: Universities would not pay a tax greater than the markup (or net margin) they earn from international students' full-degree cumulative tuition, after paying the marginal full-degree cost of training those students. Otherwise, the university would lose money on net from every international student who enrolled, graduated, and worked on OPT.

The key quantity to be estimated, then, is the marginal cost of training an international student at each university and degree level. I am not aware of any rigorous estimates of the marginal cost of training specifically international students in the economic research literature. The estimation thus begins by constructing those marginal cost estimates.

3.1 Costs and margins

Suppose the international student's university pays a tax on the student's usage of OPT. The university must pay the tax out of the net margin a student generates. The margin requires a marginal cost. Cost is estimated with the flexible fixed-cost quadratic (FFCQ) multiproduct cost function of Cohn et al. (1989), the literature-standard method for marginal cost estimation in higher education (Cohn and Cooper 2004), augmented with a faculty-salary input price in the spirit of de Groot et al. (1991):

$$C_{it} = \alpha_{it} + \sum_j \beta_j Q_{jit} + \frac{1}{2} \sum_j \sum_k \gamma_{jk} Q_{jit} Q_{kit} + \theta_1 w_{it} + \theta_2 w_{it}^2 + \sum_j \phi_j w_{it} Q_{jit} + \delta_t + e_{it}, \quad (9)$$

where at university i in year t the outputs Q (indexed by j or k) are undergraduate full-time equivalents (FTE), graduate FTE, and research spending; w is the average full-time faculty salary; and within the term $\alpha_{it} \equiv \alpha_0 + \sum_j \alpha_j D_{jit}$, where $D_{jit} \equiv \mathbb{1}[Q_{jit} > 0]$, the specification adds output-presence dummies (indicators for nonzero production of basic research or graduate education), a PhD-share shifter of graduate costs, and controls for the presence of a university hospital. These absorb fixed costs so that each marginal cost is identified from the institutions that actually produce that output. Marginal cost is the derivative $MC_j \equiv \frac{\partial C_{it}}{\partial Q_{jit}} = \beta_j + \sum_k \gamma_{jk} \overline{Q}_k + \phi_j \overline{w}$, evaluated at sample means.

Table 3 reports estimates of the regression (9) separately for publics and privates and for a broad cost concept (instruction, academic support, student services, institutional support) and a narrow one (instruction only), with six marginal-cost rows: each degree level evaluated on the whole sample and re-estimated on the Carnegie subsample that specializes in it.[14]

Table 4 assembles the implied markups (net margins): the mean FY2023 out-of-state sticker price at the student's level, the marginal cost from Table 3, and the difference $P - MC$, in three weightings (unweighted, weighted by each university's international students, and weighted by its OPT graduates). Positive margins on some students fund losses on others, and this cross-subsidy structure is a standard feature of university finance (James 1978; Rothschild and White 1995; Winston 1999), and universities have leaned on out-of-state and international tuition when other revenue falls (Bound et al. 2020; Shih 2017). Costs also differ widely across programs and levels (Altonji and Zimmerman 2019). Each level's marginal cost is therefore re-estimated on its particular Carnegie-classification subsample.

[14]Because IPEDS only reports official derived cost estimates for the last few years, I construct them manually from the raw IPEDS data, then check for match at the overlap. The constructed expense aggregates match IPEDS' own official derived files within a few percent in every overlap year (Appendix A2.5), and Appendix A2.6 reports summary statistics for both estimation samples. Cost responses estimated in 5- and 10-year long differences climb with the horizon toward the levels estimates, supporting the long-run reading of (9). Appendix A3.1 reports the check.

Table 3: The long-run cost function (Cohn–Rhine–Santos FFCQ): separate public and private equations, with subsample marginal costs (2024 USD)

	(1) Public broad	(2) Private broad	(3) Public narrow	(4) Private narrow
UG FTE (000)	7.676**	1.740	4.184*	0.494
	(3.700)	(4.730)	(2.509)	(5.649)
UG^2	−0.037	−0.140***	−0.011	−0.063**
	(0.067)	(0.038)	(0.042)	(0.025)
Grad FTE (000)	−7.182	−53.808***	−3.276	−37.501**
	(17.808)	(15.801)	(10.547)	(15.905)
Grad^2	−1.420	−0.565**	−1.299*	−0.033
	(1.171)	(0.269)	(0.786)	(0.265)
UG × Grad	0.091	0.488**	−0.041	0.117
	(0.435)	(0.210)	(0.293)	(0.167)
Research (USD millions)	0.264	1.001*	−0.035	1.452*
	(0.501)	(0.607)	(0.351)	(0.806)
PhD share × Grad FTE (000)	7.167	43.912*	20.401	4.489
	(22.617)	(22.871)	(16.316)	(21.835)
Avg faculty salary (USD 000)	2.021***	1.195***	1.005***	0.536**
	(0.435)	(0.296)	(0.302)	(0.245)
Medical/hospital dummy	114.781***	−14.106	83.467***	15.402
	(31.327)	(46.375)	(20.345)	(36.527)
MC at means: UG, whole sample (USD)	10,194	14,993	5,132	7,132
MC at means: UG, C3 baccalaureate insts (USD)	11,706	15,487	7,064	7,359
MC at means: master's, whole sample (USD)	22,930	4,774	16,360	1,557
MC at means: master's, C2 master's insts (USD)	7,491	152	5,139	-2,043
MC at means: doctoral, whole sample (USD)	30,097	48,687	36,762	6,045
MC at means: doctoral, C1 doctoral insts (USD)	8,301	33,980	19,928	-3,669
University-years	14,057	31,845	14,057	31,845
Universities	803	1,820	803	1,820

Cost in millions of 2024 USD, 'narrow' costs include instruction only. Enrollment in thousands of FTE. FFCQ: quadratics and interactions in UG FTE, graduate FTE, and research spending; output-presence dummies; hospital spending and medical dummy; faculty-salary input price with quadratic and wage-output interactions; year dummies; SEs clustered by university. Whole-sample MC rows evaluate the displayed regression at its sample means; the C3 baccalaureate, C2 master's, and C1 doctoral institution rows re-estimate the same FFCQ on that Carnegie subsample and evaluate it at the subsample means. Doctoral MC = graduate derivative + the PhD-share term. The sample is restricted to institution-years whose education-and-related spending per weighted FTE student—direct instruction and student services, grossed up by overhead allocated in proportion to direct costs, over full-time-equivalent enrollment counting a master's student as 1.5 and a doctoral student as 2.5 undergraduates—falls between \$2,000 and \$200,000; observations without the SAL salary survey drop. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Weighting matters because international students concentrate at high-price universities: the international-student-weighted bachelor's margin is roughly \$20,000–\$44,000 per student-year against \$9,000–\$18,000 unweighted. Panel C of Table 4 weights by each school's OPT starts instead, so it is more informative about the net margin at the universities whose graduates actually take OPT jobs.[15] OPT starts divide almost evenly between public and private nonprofit universities, 49.5 and 50.5 percent, but they concentrate overwhelmingly at C1 doctoral institutions, which host 81.1 percent of them against 11.9 percent at C2 master's and 3.7 percent at C3 bac-

[15] The margins are broadly robust to estimating the cost function on the most recent five years of data alone: bachelor's margins barely move, and the weighted master's and doctoral margins mostly widen, so the whole-period estimates are the cautious ones (Appendix A3.2).

Table 4: Per-student-year sticker price, long-run marginal cost at the means, and net margin, broad cost concept (2024 USD)

(a) *Unweighted*

	Public			Private nonprofit			Combined
	Price	MC	P−MC	Price	MC	P−MC	P−MC
Bachelor's (whole sample)	19,616	10,194	9,422	33,227	14,993	18,234	13,090
	(368)	(1,115)	(1,174)	(490)	(2,267)	(2,319)	(1,184)
Bachelor's (C3 baccalaureate insts)	17,077	11,706	5,372	36,710	15,487	21,223	17,468
	(844)	(1,276)	(1,529)	(907)	(1,895)	(2,101)	(1,643)
Master's (whole sample)	21,302	22,930	-1,628	21,478	4,774	16,704	7,301
	(367)	(5,234)	(5,247)	(414)	(5,534)	(5,550)	(3,814)
Master's (C2 master's insts)	18,074	7,491	10,582	17,696	152	17,544	14,606
	(385)	(3,342)	(3,364)	(511)	(4,789)	(4,816)	(3,125)
Doctoral (whole sample)	21,302	30,097	-8,795	21,478	48,687	-27,209	-15,932
	(367)	(21,082)	(21,085)	(414)	(21,250)	(21,254)	(15,317)
Doctoral (C1 doctoral insts)	25,379	8,301	17,079	28,470	33,980	-5,510	8,676
	(556)	(22,499)	(22,506)	(1,131)	(22,507)	(22,535)	(16,433)

(b) *Weighted by each university's share of international students*

	Public			Private nonprofit			Combined
	Price	MC	P−MC	Price	MC	P−MC	P−MC
Bachelor's (whole sample)	28,899	9,204	19,694	53,740	9,272	44,468	30,007
	(450)	(3,377)	(3,406)	(507)	(6,437)	(6,457)	(3,343)
Bachelor's (C3 baccalaureate insts)	13,671	10,202	3,470	45,233	11,404	33,829	26,638
	(642)	(1,652)	(1,772)	(1,112)	(1,326)	(1,731)	(1,386)
Master's (whole sample)	27,767	19,298	8,469	39,790	5,450	34,340	21,070
	(401)	(14,683)	(14,688)	(610)	(11,904)	(11,920)	(9,512)
Master's (C2 master's insts)	18,040	9,779	8,261	21,495	-4,511	26,007	18,516
	(359)	(3,724)	(3,742)	(736)	(6,485)	(6,527)	(4,089)
Doctoral (whole sample)	27,767	-3,720	31,487	39,790	52,652	-12,862	14,299
	(401)	(33,613)	(33,615)	(610)	(29,914)	(29,920)	(23,628)
Doctoral (C1 doctoral insts)	29,322	-5,702	35,024	45,995	70,839	-24,844	12,753
	(588)	(35,057)	(35,062)	(1,170)	(33,553)	(33,574)	(25,314)

(c) *Weighted by each university's OPT graduates*

	Public			Private nonprofit			Combined
	Price	MC	P−MC	Price	MC	P−MC	P−MC
Bachelor's (whole sample)	30,585	8,454	22,131	57,821	9,984	47,838	34,271
	(468)	(3,612)	(3,642)	(471)	(6,816)	(6,832)	(3,755)
Bachelor's (C3 baccalaureate insts)	17,172	6,499	10,673	47,979	11,528	36,452	34,351
	(839)	(1,139)	(1,414)	(1,159)	(1,541)	(1,928)	(1,775)
Master's (whole sample)	27,792	18,053	9,740	44,262	6,406	37,856	25,785
	(425)	(16,031)	(16,037)	(597)	(14,637)	(14,649)	(10,830)
Master's (C2 master's insts)	17,575	4,991	12,584	25,770	3,429	22,341	17,592
	(396)	(4,837)	(4,853)	(861)	(6,433)	(6,491)	(4,084)
Doctoral (whole sample)	27,792	-132	27,924	44,262	61,122	-16,860	13,825
	(425)	(36,904)	(36,906)	(597)	(31,308)	(31,314)	(27,141)
Doctoral (C1 doctoral insts)	29,209	-2,127	31,336	47,996	80,608	-32,612	12,301
	(594)	(37,470)	(37,475)	(1,135)	(32,771)	(32,791)	(28,072)

Rows match the six marginal-cost estimates of Table 3: whole-sample rows use the control-wide FFCQ; C1/C2/C3 rows re-estimate it on that Carnegie subsample. Price: FY2023 mean annual out-of-state sticker charges at the student's level, on the same sample as the row's MC (graduate charges price MA and PhD). Margin SE treats price and MC as independent. Combined column: P−MC averaged across controls, weighted by the level-specific public/private split of international students. Panel B weights prices and regressions by FY2023 international enrollment; Panel C by the school's OPT starts in its most recent covered SEVIS cohort, held fixed over time. Broad cost concept; 2024 dollars.

calaureate institutions. That concentration holds at every degree level: C1 institutions account for 20.4 of the 30.7 percent of starts that follow a bachelor's degree, 45.9 of 53.7 at the master's level, and 14.9 of 15.5 at the doctoral (Table A14). International students are 3.7 percent of undergraduate and 17.7 percent of master's enrollment overall, and three-quarters of them attend C1 doctoral institutions.[16]

3.2 Effect of a tax charged to universities on OPT starts

Under university incidence, a school retains a student only while the whole-degree margin covers the tax. Each school-degree level's margin is

$$M_{il} = D_l \left(P_{il} - MC_{c(i),l}\right), \tag{10}$$

the degree length times the school's own FY2023 sticker price minus the international-student-weighted FFCQ marginal cost of its control × Carnegie cell. The exposure at tax t is the raw share of students at school-degree levels whose margin falls below it,

$$F_l(t) = 100 \times \frac{\sum_i n_{il}\, \mathbb{1}\{M_{il} < t\}}{\sum_i n_{il}}, \tag{11}$$

with the zero-tax point set to zero by assumption, since current enrollment is the status quo. This estimates the fraction of students for whom the university would require taking a net loss on the student's entire course of study, from enrollment through graduation, if the student were to work on post-completion OPT.

Table 5 reports $F_l(t)$: panel (a) counts international students, panel (b) OPT graduates. The implied summary elasticity of seat supply to the degree price is the slope of $\ln(100 - F_l)$ on $\ln(\overline{P}_l - t)$, with bootstrapped standard errors over universities, approximately +0.5 for bachelor's and masters' students collectively.[17] The exercise assumes a university sheds exactly the students whose degree margin no longer covers the tax. The effects are thus likely to be con-

[16]The underlying distribution and prevalence tables, for international students and for OPT starts alike, are in Appendix A2.7. Appendix A1.1 details the finance data.

[17]The bootstrap redraws schools with replacement and recomputes the entire loss curve and slope each time, holding the cell marginal costs fixed, so the standard errors reflect sampling of the school composition rather than cost-function estimation error.

Table 5: Students lost to a per-student tax, and the implied supply elasticities (FY2023)

(a) *Percent of international students lost*

Tax per student	Bachelor's	Master's	Combined
USD 0	−0.0%	−0.0%	−0.0%
USD 10,000	−14.8%	−31.8%	−23.8%
USD 20,000	−17.9%	−50.5%	−35.2%
USD 30,000	−22.6%	−63.0%	−44.0%
USD 70,000	−39.4%	−87.7%	−65.1%
USD 100,000	−53.3%	−99.1%	−77.6%
Elasticity of seat supply to the degree price	0.60	1.66	0.40
	(0.04)	(0.47)	(0.16)

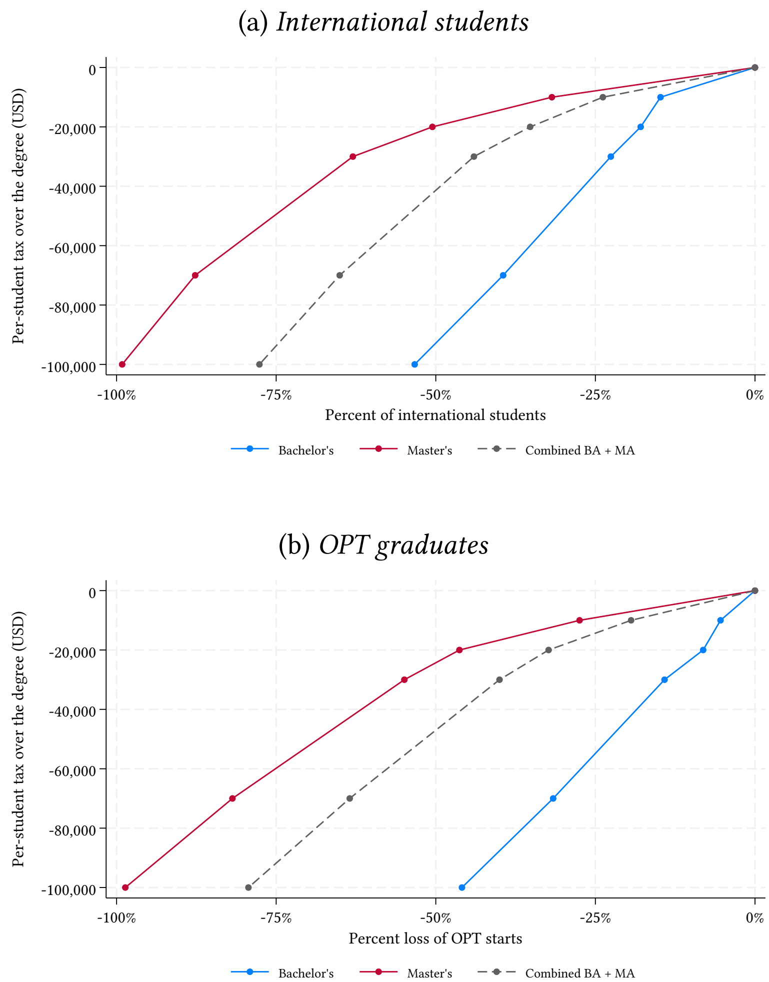
(b) *Percent of OPT graduates lost*

Tax per student	Bachelor's	Master's	Combined
USD 0	−0.0%	−0.0%	−0.0%
USD 10,000	−5.4%	−27.5%	−19.4%
USD 20,000	−8.1%	−46.3%	−32.3%
USD 30,000	−14.2%	−54.9%	−40.0%
USD 70,000	−31.6%	−81.8%	−63.5%
USD 100,000	−45.9%	−98.6%	−79.3%
Elasticity of seat supply to the degree price	0.63	0.56	0.53
	(0.04)	(0.33)	(0.09)

Loss rows: the percent of the level's students at universities whose whole-degree margin, equation (10), falls below the tax: degree length times the school's own FY2023 out-of-state sticker price minus the international-student-weighted FFCQ marginal cost of its control × Carnegie cell. Schools with negative zero-tax margins are included; the zero-tax row is zero by assumption. Panel (a) counts FY2023 international enrollment (graduate headcount split MA/PhD by the completions stock); panel (b) counts OPT starts in each school's most recent covered SEVIS cohort. Elasticity rows: the slope of ln(percent remaining) on $\ln(P - t)$, with P the count-weighted mean whole-degree sticker price; bootstrap SEs over universities. Construction and caveats: see text. 2024 dollars.

servatively low in a particular sense: Universities would realistically begin to hesitate to supply OPT recommendations before the net margin, inclusive of the tax, actually reached zero. Master's exposure is severe (a $30,000 tax already exceeds the margin on 55 percent of the OPT-bound master's pipeline) because master's margins are thinner than bachelor's at the schools international students attend. Figure 4 plots the supply curves in tax-loss space: the tax cuts the price the university receives, so greater values of the tax correspond to lower values on the vertical axis, giving these supply curves the familiar upward slope.

Figure 4: The supply response to a per-student tax on universities



The exposure curves of Table 5, by degree level and combined. The vertical axis is the per-student tax over the degree, from \$0 at the top to −\$100,000 at the bottom: the tax reduces the price the supplier receives. The horizontal axis is the percent decline in students for whom the university could recommend OPT without taking a financial loss on the marginal student, expressed as a fraction of international students (panel a) or as a fraction of OPT starts (panel b), 0 at the right to −100% at the left.

4 A tax on employers: Demand for OPT workers

The third incidence scenario considers a tax on OPT workers that is charged to their employers. The key assumption is that the employer demand curve for OPT workers is similar to the demand curve for H-1B workers. This appears reasonable for workers on OPT-STEM, who are the large majority of people working on OPT at a given moment, given that the OPT-STEM extension was explicitly designed as a channel for hiring workers similar to H-1B workers. The chairman of Microsoft addressed the US Congress in March of 2008 to recommend, "Extending OPT from 12 to 29 months would help to alleviate the crisis employers are facing due to the current H-1B visa shortage" (Gates 2008). The George W. Bush administration extended OPT from 12 to 29 months for STEM workers the next month.

The key parameter for these estimates is employers' elasticity of demand for OPT or H-1B workers. One source of evidence is the finding of Borjas (2026, 25) that, at a tax of $100,000 on H-1B hiring, "[b]etween 45 and 64 percent of the H-1Bs hired between 2021 and 2024 would still be hired", with a central estimate of 55 percent. These correspond to demand elasticities between −2.9 and −5.3 with a central value of −3.9.[18] This range overlaps with the range of demand elasticities for computer science workers in general (up to −4) used by Bound et al. (2018, 2015), though these values, which those authors benchmark against the engineer estimates of Ryoo and Rosen (2004), may understate the absolute value of the elasticity because they were not explicitly calculated to take into account firms' capacity to substitute for computer science workers on all margins including outsourcing.

There are several signs that the true elasticity is greater in absolute value. Clemens (2026) raises several concerns about the Borjas analysis, all of which imply that the elasticity of H-1B demand is more negative than −3.9. A small survey of nine US firms that are among the largest users of the H-1B program in June and July of 2026 asked how they would adjust their petitions for H-1B workers if there were a $100,000 tax on each hire regardless of their prior visa status. The median response was a reduction of 77.5 percent, implying a demand elasticity of −9.8.[19]

[18] A one-time $100,000 tax raises the discounted cost of employing the average H-1B worker over the visa term by the wedge $\tau^w = \ln\left(1 + \frac{100{,}000}{112{,}600 \times 5.42}\right) = \ln 1.164 = 0.152$, where $112,600 is the mean H-1B salary and 5.42 the discounted years of a six-year visa term at 3 percent, both from Borjas (2026, 38). The tax is, in effect, a 16 percent tax on the wage. The quantity response is the simulated decline in hiring, from a rate of one at a zero tax to p at the tax, so the implied arc elasticity is the ratio of log changes, $\varepsilon_e = \frac{\ln p}{\tau^w}$. The hiring rates that Borjas (2026) reports at the $100,000 tax span $p \in [0.45, 0.64]$, giving ε_e between −5.3 and −2.9, and the central case, a hiring rate near 0.55, implies $\varepsilon_e \approx -3.9$.

[19] The survey by IFP (2026) contacted high-ranking officials directly involved with H-1B petitioning at 17 companies including many of the largest US-based users of the H-1B program. 9 of the 17 responded. The survey concerned a hypothetical policy of an H-1B tax on all initial H-1B petitions, not a tax exempting workers already present in the US and changing status to an H-1B visa. This is desirable for the purpose of gathering information about the effect of an OPT hiring tax that would likewise apply to all initial hires. $\frac{\ln(1-0.775)}{\ln\left(1+\frac{100{,}000}{112{,}600 \times 5.42}\right)} = -9.83$.

Table 6: Decline in employer demand for OPT workers under a tax on employers (zero H-1B tax)

Year-1 tax	Years-2–3 tax	Implied annual tax	Tax as percent of wage: Elasticity of demand −4	−10	−16	Tax as percent of labor cost: Elasticity of demand −4	−10	−16
USD 20,000	USD 10,000	USD 10,000	−28.8%	−57.3%	−74.4%	−21.2%	−44.8%	−61.4%
USD 40,000	USD 20,000	USD 20,000	−48.0%	−80.5%	−92.7%	−37.0%	−68.5%	−84.3%
USD 70,000	USD 30,000	USD 33,333	−64.6%	−92.5%	−98.4%	−52.4%	−84.4%	−94.9%

The year-1 tax covers the initial 12-month OPT period and the years-2–3 tax the two STEM-extension years, so the implied annual tax is the three-year total divided by three. Each cell: the constant-elasticity response of (3), a decline of $100 \times [1 - (1+\tau/b\overline{w})^{\varepsilon}]$ percent at annual tax τ, on each basis (wage USD 112,600; labor cost 1.45 × wage). The outer elasticities bracket the plausible range: −4 is motivated by the estimates of Borjas (2026) and is likely conservative, while −16 is implied by the short-term response of employers to the 2025 proclamation tax on H-1B workers (U.S. Department of Homeland Security 2026) and may overstate the long-run response; −10 is their midpoint (see text). Constant elasticity admits no choke point: demand approaches but never reaches a 100 percent decline at any finite tax. The implied demand curves are plotted in Figure 5.

Direct evidence on this elasticity has since emerged from the \$100,000 tax on new H-1B workers imposed by presidential proclamation in September 2025. In the Technical Appendix to a subsequent proposed rule on H-1B fees, the Department of Homeland Security (DHS) disclosed the short-term response of employers to that tax (U.S. Department of Homeland Security 2026): in the first 245 days with the tax in force, employers filed 1,212 initial petitions for H-1B workers outside the United States—the workers covered by the tax—against 13,823 in the same window a year earlier, a decline of 91.2 percent, implying an elasticity of −16.[20] This value, reflecting a short-term response, may overstate the elasticity relevant to a lasting tax.[21]

The analysis below therefore uses two elasticities to bracket the plausible range: −4, motivated by the central value of −3.9 implied by the Borjas estimates and likely too small in absolute value, and −16, the short-term proclamation response, which may be too large in absolute value. Their midpoint of −10 is the middle scenario, and lies close to the small-N survey-based value of −9.8.

[20] The same log-change mapping used above to extract elasticities from the Borjas simulations converts this response into a demand elasticity: $\ln(1{,}212/13{,}823) \,/\, \ln\!\left(1 + \frac{100{,}000}{112{,}600\times 5.42}\right) = -16.0$. U.S. Department of Homeland Security (2026, Table A.7), an appendix to the proposed rule at 91 *Fed. Reg.* 54817, Docket No. USCIS-2026-0298 (RIN 1615-AD02). The count is of initial Form I-129 H-1B petitions requesting consular notification, that is, petitions for beneficiaries outside the United States, to whom the proclamation tax applies. Because cap-subject petitions are filed in a narrow window after the March registration lottery, the petitions filed year-round in this count come disproportionately from cap-exempt employers; cap-subject employers showed a parallel response in registrations for the fiscal year 2027 lottery (U.S. Department of Homeland Security 2026, Table A.6).

[21] DHS describes the response as a short-term shock to a payment that employers "did not have time to absorb", and some of the missing petitions may return as employers adjust, including by hiring workers already in the United States, to whom the proclamation tax does not apply.

In the scenarios to follow, employers are charged τ_1 for the initial 12-month OPT period and τ_{23} for the two STEM-extension years, with the heavier charge on the initial year. The implied annual tax over a full three-year STEM course is $\tau = (\tau_1 + \tau_{23})/3$. The annual tax is a percent increase in the price of an OPT hire on two bases b, the wage itself (for consistency with Borjas 2026) and full labor cost at 1.45 times the wage, the ratio in the US Bureau of Labor Statistics Employer Costs for Employee Compensation survey for management and professional occupations (Appendix A1.3). Demand declines with constant elasticity, per equation (3):

$$\Delta(\tau; b, \varepsilon) = 100 \times \left[1 - \left(1 + \frac{\tau}{b\,\overline{w}}\right)^{\varepsilon}\right], \qquad b \in \{1.0, 1.45\}, \qquad \overline{w} = \$112{,}600, \tag{12}$$

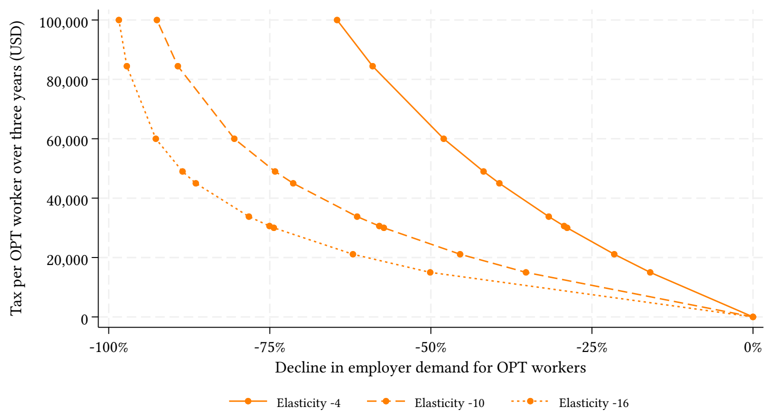
at the elasticities $\varepsilon \in \{-4, -10, -16\}$. This is the same log-change mapping used above to extract the demand elasticities from the Borjas tax simulations and the proclamation response, now applied to the OPT tax. The predicted declines are conservative in the sense that constant elasticity admits no choke point, so demand approaches but never reaches zero at a finite tax.

Table 6 reports the declines in OPT hiring predicted at each level of tax, assuming full employer incidence: at the \$100,000 three-year tax, hiring falls by 65 to 98 percent measured against the wage and by 52 to 95 percent measured against full labor cost (92.5 and 84.4 percent at the midpoint elasticity −10). Figure 5 plots the demand curves, which bend away from the −100 percent boundary rather than reaching it. Demand for OPT workers at the same dollar value of tax falls more than demand for H-1B workers, for the simple reason that employers of OPT workers have a shorter period ($\leqslant$ 3 years) to recoup the cost of the tax.

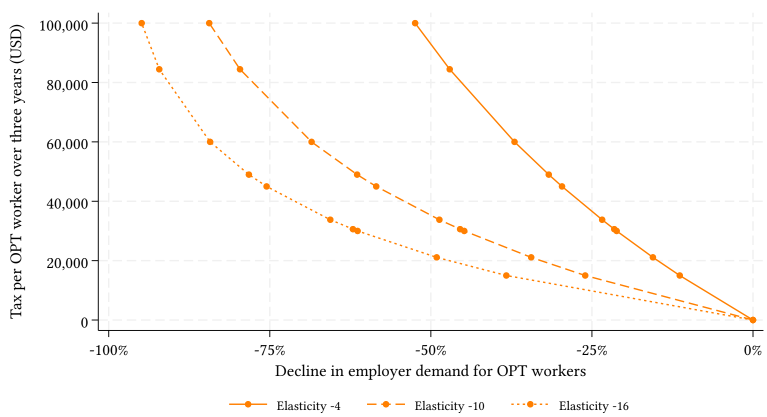
These estimates of the effects of an OPT tax are also conservative in the sense that they assume the absence of an H-1B tax. Because many employers hire OPT workers in the hopes of later sponsoring them for an H-1B visa, and about half of OPT-STEM workers do transition to an H-1B (Clemens et al. 2025), the total tax burden on the employer for hiring such a worker would rise to the composed effect of both taxes. It is thus likely that the effect of a given OPT tax on hiring would be larger when combined with an H-1B tax.

Figure 5: Employer demand for OPT workers under a per-worker tax (zero H-1B tax)

(a) *Tax relative to the wage*



(b) *Tax relative to labor cost*



The constant-elasticity demand responses of equation (12) at $\varepsilon = -4$, -10, and -16 (see text). The vertical axis is the three-year tax, rising from \$0 to \$100,000: the tax raises the price employers pay for labor. The horizontal axis is the decline in employer demand, 0 at the right to -100 percent at the left. No curve reaches the -100 percent boundary: constant elasticity implies that the tax never fully eliminates demand, and at the \$100,000 tax the declines run from 64.6 to 98.4 percent on the wage basis (panel a) and from 52.4 to 94.9 percent on the labor-cost basis (panel b).

5 Indirect costs to higher education institutions

Access to work after graduation is itself a determinant of international students' demand for US study. Past extensions and expansions of STEM-OPT raised international bachelor's enrollments by about 18 percent and master's enrollments by about 30 percent against a roughly 142 percent rise in expected months of post-study work authorization (Amuedo-Dorantes et al. 2023, 2019) and raised completions by 0.22–0.24 log points (Amuedo-Dorantes and Shih 2026). Conversely, the 2003 collapse of the H-1B cap, a 67 percent cut in post-study work slots, lowered foreign enrollment by 10 percent (Shih 2016).[22] These estimates bracket an elasticity of US-study demand to OPT opportunities of $\eta \in [0.10, 0.20]$, centered near the 0.15 implied by Shih (2016).

This can be used to translate the reduction in OPT opportunities, in each tax scenario above, into an implied reduction in enrollment by international students. Incidence scenario j reduces OPT starts at level l by $X_{jl}(\tau)$ percent (Table 2, Table 5, and Table 6). International enrollment falls by $100\,[1-(1-X_{jl}/100)^{\eta}]$ percent—the constant-elasticity response to the loss of OPT opportunities, the same functional form used for every demand response in this paper—and each lost student costs the university the school-specific annual surplus s_l, the same price-minus-marginal-cost margin behind Figure 4, per student-year. The annual loss to all universities is

$$L_j(\tau) = \sum_l N_l \times \left[1 - \left(1 - \frac{X_{jl}(\tau)}{100}\right)^{\eta}\right] \times s_l, \tag{13}$$

with N_l the FY2023 international enrollment stock. The declines X_{jl} come from panel (b) of Table 2 under student incidence (lower bounds on the magnitude of the decline, so the student-incidence dollar losses that follow are likewise lower bounds on the true losses), panel (b) of Table 5 under university incidence, and the labor-cost series of Table 6 at elasticity −10, the midpoint of the two elasticities of Section 4, applied to both levels, under employer incidence. The total tax is charged over the degree in the first two cases and over up to three OPT years in the third.[23]

Table 7 reports the implied enrollment losses at total taxes of \$30,000 and \$100,000 per person. At the larger tax the annual loss runs from an amount greater than \$0.5–\$1.0 billion under student incidence (a lower bound: the true loss is larger) to \$2.4–\$4.3 billion under employer incidence and \$2.5–\$4.2 billion under university incidence, depending on η.

[22]Related evidence points the same way: cutting H-1B access reduced the quality of the prospective foreign applicant pool (Kato and Sparber 2013), visa restrictiveness shifts who attends US colleges (Chen et al. 2023), and the OPT extensions lengthened graduates' stays (Demirci 2019).

[23]The surplus is s_l = \$22,969 per student-year at the bachelor's level and \$13,735 at the master's level, on stocks N_l of 363,226 and 410,779. Schools where tuition lies below the estimated degree × Carnegie group specific marginal cost are included, because the estimated group marginal cost measures school-specific marginal costs with error and it is rare for real schools to systematically lose money on international students. The losses are steady-state annual flows. Because the percent decline is uniform within a level, using the enrollment-weighted average surplus in (13) recovers the sum of school-specific losses exactly.

Table 7: Annual cost to US universities of an OPT tax, by incidence (FY2023)

(a) *Total tax of USD 30,000 per person*

	Decline in OPT		Enrollment ($\eta = 0.1$)		Enrollment ($\eta = 0.2$)		Loss (USD mil.)	
Incidence of the tax	Bach.	Mast.	Bach.	Mast.	Bach.	Mast.	$\eta = 0.1$	$\eta = 0.2$
On students	−9.6%	−20.8%	−1.0%	−2.3%	−2.0%	−4.6%	>213	>423
On universities	−14.2%	−54.9%	−1.5%	−7.7%	−3.0%	−14.7%	559	1,082
On employers	−44.8%	−44.8%	−5.8%	−5.8%	−11.2%	−11.2%	807	1,568

(b) *Total tax of USD 100,000 per person*

	Decline in OPT		Enrollment ($\eta = 0.1$)		Enrollment ($\eta = 0.2$)		Loss (USD mil.)	
Incidence of the tax	Bach.	Mast.	Bach.	Mast.	Bach.	Mast.	$\eta = 0.1$	$\eta = 0.2$
On students	−23.2%	−42.2%	−2.6%	−5.3%	−5.1%	−10.4%	>518	>1,015
On universities	−45.9%	−98.6%	−6.0%	−34.9%	−11.6%	−57.6%	2,464	4,213
On employers	−84.4%	−84.4%	−17.0%	−17.0%	−31.0%	−31.0%	2,371	4,340

Each row translates one incidence scenario into an annual dollar cost via (13): the tax reduces realized OPT starts (first column pair); fewer OPT opportunities reduce demand to study in the US with constant elasticity η, so a decline of X percent in OPT starts reduces enrollment by $100\,[1-(1-X/100)^{\eta}]$ percent (remaining pairs); and each lost student costs the university the school-specific annual surplus per student-year, in 2024 USD. Applying η linearly instead (ηX) would give weakly smaller losses at every decline, markedly so where OPT opportunities nearly vanish. The student-incidence OPT declines are those of panel (b) of Table 2, built on the column-3 size-weighted IV elasticities of Table 1; the employer-incidence declines are the labor-cost series of Table 6 at elasticity −10, the midpoint of the outer two values in that table (see text). The economic losses for the scenario of a tax levied "on students" are marked with the inequality sign (>) because the decline in OPT usage from Table 2 is a lower bound on the magnitude of the decline, thus the cost estimate for that row of the table is a lower bound on the implied cost. For details see text.

6 Conclusion

Two lessons of the analysis reach beyond the specific estimates. First, a tax fixed in dollars is, *ad valorem*, not one tax but many. The same $100,000 is a fraction of the whole-degree price a bachelor's student pays at a high-tuition university, several times the margin a typical master's program earns on an international student, and, because the employer has at most three years of OPT work in which to recoup it, roughly twice the effective annual cost shock that the same tax imposes on an H-1B hire. A uniform dollar tax therefore falls hardest on master's programs, where net margins are thin, and on OPT hiring, where the employer's horizon to recoup the tax is short. These absorb the largest predicted losses. Second, statutory incidence does not determine a tax's effects. Access to post-graduation work is itself a determinant of international students' demand for US study, so a tax collected from students or from employers reaches universities through reduced enrollment: on the estimates here, US universities would lose on the order of \$0.5 to \$4.3 billion a year under a \$100,000 tax—the smaller figure itself a lower bound, because the student-incidence estimates understate the magnitude of the true decline—whoever the statute names as the payer.

The estimates above depend on a small set of behavioral parameters that the literature has very rarely measured. The price elasticity of international students' demand for US degrees estimated here appears to be one of the first quasi-experimental estimates for the United States. Universities' net margin from training international students may not have been systematically estimated in prior literature. And the elasticity of employer demand for high-skill foreign workers rests on a handful of estimates that require further scrutiny. As key governments examine substituting price-based taxes for quotas in regulating high-skill migration, pinning down these elasticities is a first-order task for research. ■

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Online Appendix

“Taxes on International Students: Demand and Supply Response for Post-Graduation Foreign Workers on Optional Practical Training”

Michael A. Clemens — September 2026

This Appendix serves three purposes. Section A1 documents every data source, with the file names, years, variables, and construction rules needed to reproduce the database and, from it, every exhibit in the paper. Section A2 collects auxiliary tables and figures that support the analysis in the paper. Section A3 reports robustness checks.

Contents

A1 Data sources

A1.1 IPEDS complete data files

All university-level data come from the complete data files of the Integrated Postsecondary Education Data System (IPEDS), National Center for Education Statistics, downloadable at https://nces.ed.gov/ipeds/datacenter/DataFiles.aspx. The analysis reads the raw survey files directly. Year t denotes the fall of the academic year: year-2024 tuition means charges for AY 2024–25, year-2024 enrollment means the fall 2024 headcount, and year-2024 completions mean degrees awarded in AY 2024–25. Where a survey-year folder holds both an original and a revised ("rv") file, the revised file is used. The sample throughout is degree-granting four-year institutions in the fifty states and DC, public (IPEDS control 1) and private nonprofit (control 2); for-profits are excluded. Carnegie Basic classifications are held time-invariant at each institution's newest reported vintage and grouped as C1 doctoral (codes 15–17), C2 master's (18–20), C3 baccalaureate (21–23), and other; Section 2 defines the C1/C2/C3 nomenclature.

Tuition and required fees. Files `ic2002_ay` through `ic2023_ay` and `cost1_2024`, years 2002–2024. The price at each level of study is tuition plus required fees: TUITION2+FEE2 (in-state undergraduate), TUITION3+FEE3 (out-of-state undergraduate), TUITION6+FEE6 (in-state graduate), TUITION7+FEE7 (out-of-state graduate). The variable names are unchanged across the 2024 move of these items from the IC survey to the new cost component.

Fall enrollment. Files `ef2002a` through `ef2024a`. Undergraduate enrollment is EFALEVEL = 2; graduate enrollment is derived as all students minus undergraduates, a definition that is continuous across the 2010 folding of first-professional students into the graduate category, so graduate enrollment includes professional-school students (MD, JD) in every year. Counts of US-nonresident ("international") students use EFNRALT where it exists (2008 onward) and EFRACE01+EFRACE02 before that.

Completions. Files `c2002_a` through `c2025_a`. The file year is the end of the academic year, so C2025_A holds AY 2024–25 degrees and is dated $t = 2024$. University × degree counts use the CIPCODE 99 totals; the cell panel uses 2-digit CIP majors. Award levels: bachelor's AWLEVEL 5, master's 7, doctorate 17 (code 9 before 2010). Doctoral counts therefore cover research and scholarship doctorates only: professional-practice degrees such as the MD, JD, and PharmD (AWLEVEL 18 from 2010, the first-professional award levels before) are excluded from the degree counts throughout the pipeline, from the university × degree panels through the cell elasticities to every simulation stated per degree. Students in those programs still appear in fall enrollment, where the graduate category includes professional schools; enrollment-based tables count them, degree-based tables do not. Nonresident counts use CNRALT, back-filled with CRACE01+CRACE02. In the cell panel, internal gap years of active programs (years between a cell's first and last observed year with no reported degrees) are filled with true zeros for the count models; years before a program existed or after it closed are not invented.

Finance. Files `f0203` through `f2324`, forms F1A (GASB, mostly publics) and F2 (FASB, mostly privates); F0203 is FY 2002–03 and is dated $t = 2002$. FY 2024–25 was unpublished at this writing, so the equation (6) residuals end at 2023 and the instrument is lagged. The cost analysis re-imports the full functional expense grid (instruction, academic support, student services, institutional support, research, hospital), the parent/child reporting flags (FLAGS2015–FLAGS2023), and the official derived files DRVF2021–DRVF2024 (per-FTE expenses by function, used for the validation in Table A9) and DRVEF12 2024–25 (12-month FTE, used to calibrate fall headcounts to FTE). Reporting conventions follow the IPEDS finance data user guide (https://nces.ed.gov/ipeds/use-the-data/finance-data-resources).

Instructional staff. Files `sal2002_a`–`sal2011_a` and `sal2012_is`–`sal2024_is`. A format break is handled directly: through 2011 the full-time instructional count is EMPCNTT at rank 7, contracts 1 and 2; from 2012 it is SATOTLT at rank 7. Average faculty salary is the outlay total over the count.

Directory. Files hd2002 through hd2025: control, sector, institutional level, and state by year; the Carnegie Basic code as above.

Distance education. The EF A_DIST files, fall 2012 onward, give the share of enrollment exclusively in distance education by level. These enter the database but not the headline tables.

A1.2 SEVIS–IPEDS crosswalk

OPT starts and F-1 graduates by school and degree level come from a single file, the SEVIS–IPEDS crosswalk with degree, fiscal years 2006–2022, from the OPT Observatory (https://optobservatory.org), constructed from SEVIS records released under the Freedom of Information Act. Each row is a SEVIS campus × fiscal year × degree level (bachelor's, master's, doctorate) with counts of F-1 graduates and of OPT starts. Because several SEVIS campuses map to one IPEDS UNITID, counts are summed by UNITID × year × level; rows without a UNITID match are dropped, and the matched rows cover 99.3 percent of F-1 graduates and 99.6 percent of OPT starts. FY f graduates are overwhelmingly the spring-f degree cohort, and the completions convention dates spring $t+1$ degrees as year t, so project year = fiscal year − 1; coverage is project years 2005–2021. A covered school-year with no row at a level is a true zero at that level.

A1.3 Deflators and auxiliary series

Dollar conversions use annual averages of the CPI-U (BLS series CUUR0000SA0); the finance panel of Section 3 is converted to 2024 dollars with this series. The labor-cost multiplier of 1.45 in Table 6 comes from the BLS Employer Costs for Employee Compensation release, table 4 (https://www.bls.gov/news.release/ecec.t04.htm): wages and salaries are 68.5 percent of total compensation in management, professional, and related occupations ($1/0.685 = 1.46$) and 69.9 percent in all private industry ($1/0.699 = 1.43$).

A1.4 Simulation parameters and their sources

The simulations use the following parameters, each recorded here with its source—a prior study, an estimate from this paper, or a stated assumption—and the place it enters.

Demand elasticities for degrees (ε_l, Table 2): the column-3 size-weighted IV estimates of Table 1, estimated in this paper—the elasticity of the nationwide count of international students, rather than that of the average university × major cell.

Employer demand elasticities (ε): −4, −10, and −16 for the OPT simulations of Table 6; the middle value, the midpoint of the outer two, is the one carried into the employer scenario of Table 7. The value −4 is motivated by the tax simulations of Borjas (2026), which imply −2.9 to −5.3 for H-1B workers with a central value of −3.9, as explained in the main text; Bound et al. (2018) calibrate occupation-level relative demand elasticities for computer scientists of 1.02, 1.99, and 3.98, citing the engineer estimates of 1.2–2.2 in Ryoo and Rosen (2004), but these are not elasticities estimated specifically for H-1B workers. The value −16 is implied by the short-term decline of 91.2 percent in initial consular H-1B petitions under the 2025 proclamation tax (U.S. Department of Homeland Security 2026, Table A.7). Throughout, the demand response to the tax is the constant-elasticity form of equation (3), the same log-change mapping used to extract those elasticities.

H-1B wage and visa term (Table 6): the \$112,600 mean annual salary of H-1B workers and the 5.42 discounted years of a six-year visa term at 3 percent, both from Borjas (2026, 38).

Elasticity of US-study demand to OPT opportunities (η, Table 7): 0.10 and 0.20. Amuedo-Dorantes et al. (2023) find that the STEM-OPT extensions raised international bachelor's enrollments about 18 percent and master's about 30 percent against a roughly 142 percent rise in expected OPT months; Amuedo-

Appendix Table A1: DETERMINANTS OF OUT-OF-STATE TUITION & FEES, PUBLIC UNIVERSITIES (BEINE ET AL. EQ. 2 ANALOG)

	(1) Undergraduate (BA)	(2) Graduate (MA)
In-state tuition & fees	1.5931***	1.5011***
	(0.1189)	(0.0937)
State appropriations (USD m)	7.4685***	3.0296
	(2.6516)	(2.5024)
Intl. enrollees, $t-1$	0.3447	0.0281
	(0.2777)	(0.5450)
Native enrollees, $t-1$	−0.0490**	0.2788
	(0.0195)	(0.1881)
Intl. graduates, $t-2$	1.2285	0.0446
	(1.2601)	(1.2395)
Native graduates, $t-2$	0.3084*	−0.5553
	(0.1594)	(0.5680)
Endowment per student	0.0322***	−0.0073
	(0.0068)	(0.0081)
Faculty per student	2.54×10^{4}*	7539.2868
	(1.42×10^{4})	(1.46×10^{4})
Expenditure per student	−0.0062	0.0016
	(0.0038)	(0.0032)
Constant	3416.2508***	3428.8376***
	(1045.4959)	(1096.3617)
Observations	3,501	2,916
R^2	0.915	0.900

Dependent variable: out-of-state tuition & fees in dollars, at the level of study shown, public four-year universities. State × Carnegie and year fixed effects; standard errors in parentheses, clustered by university. Beine et al. (2023), Table A1, report in-state slopes of 1.503 (BA) and 1.280 (MA) on their university × major cells. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Dorantes and Shih (2026) find completions responses of 0.24 (BA) and 0.22 (MA) log points; Shih (2016) finds the 2003 H-1B cap cut of 67 percent lowered foreign enrollment 10 percent, or $\eta = 0.15$ in the count metric. The elasticity enters equation (13) as a constant elasticity: a decline of X percent in OPT opportunities reduces enrollment by $100\,[1-(1-X/100)^{\eta}]$ percent. A linear application, ηX, would give weakly smaller losses at every decline, markedly so where OPT opportunities nearly vanish.

A2 Auxiliary tables and figures

A2.1 Replication of Beine, Peri, and Raux

Table A1 reports equation (6) estimated on the present sample: the in-state slope of 1.59 (BA) and 1.50 (MA) is near the 1.50 and 1.28 that Beine et al. (2023) report. Table A2 reproduces their Table A2 step: international enrollment falls with the lagged residual, with point estimates of −0.0015 (UG) and −0.0030 (grad) against their −0.0016 and −0.0030. Table A3 places the two designs side by side, for the years where the Beine et al. dataset and the present dataset overlap.

Appendix Table A2: International enrollment and lagged quasi-random tuition, public universities (Beine et al. Table A2 analog)

	(1) UG count	(2) UG log	(3) Grad count	(4) Grad log
$\hat{v}_{t-1}$ (USD)	−0.0015		−0.0030	
	(0.0026)		(0.0037)	
$\hat{v}_{t-1}$ (USD 1,000)		−0.0083		−0.0154
		(0.0078)		(0.0119)
Constant	428.1174***	4.9635***	429.2308***	4.5577***
	(0.0071)	(0.0001)	(0.0038)	(0.0002)
Observations	2,889	2,798	2,415	2,275
R^2	0.981	0.972	0.986	0.975

University and year fixed effects; standard errors in parentheses, clustered by university. Beine et al. (2023), Table A2, find −0.0016 (BA) and −0.0030 (MA) on university × major cells; the cells here are whole universities, so magnitudes are not comparable, signs and significance are. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Appendix Table A3: Replication check against Beine et al. (2023)

	Bachelor's / UG		Master's / Grad	
	Beine et al.	This paper	Beine et al.	This paper
Eq. (2): slope on in-state fees	1.5026	1.5931	1.2801	1.5011
	(0.0120)	(0.1189)	(0.0108)	(0.0937)
Step 2: intl. enrollment on $\hat{v}_{t-1}$	−0.0016	−0.0015	−0.0030	−0.0030
	(0.0006)	(0.0026)	(0.0006)	(0.0037)

Beine et al. (2023) estimate on university × major cells (their Tables A1 and A2, 2003–2017); the present analysis estimates on university × level cells, 2010–2017 (their pre-2010 years fall outside the present sample). The eq. (2) in-state slope is dollar-on-dollar and directly comparable; the step-2 coefficient is per cell, so only its sign and significance are comparable across designs.

A2.2 First stages of the cell IV regressions

Table A4 reports the linear first-stage regressions underlying the unweighted IV column (column 2) of each panel of Table 1: lagged ln out-of-state tuition on the lagged plausibly exogenous residual of equation (6), with the same fixed effects, sample, and clustering as the 2SLS, on its exact estimation sample. The residual moves tuition strongly at every degree level, and with a single instrument the Kleibergen–Paap F equals the cluster-robust F on the excluded instrument, so the 279.9, 66.7, and 17.4 here match the unweighted entries of the first-stage F row in Table 1; the weighted-column entries there (140.9, 50.5, 14.3) come from the same first stages run with the column-3 analytic weights. In these units, the bachelor's coefficient of 0.0503 means that a USD 1,000 increase in out-of-state charges raises tuition at entry by about 5 percent.

A2.3 Enrollment elasticities at the university level

Fall enrollment responds at the university × level of study, a coarser unit than the cells of Table 1. The estimating equation is

$$\ln E_{ul,t} = \varepsilon \ln T_{ul,t} + \alpha_{ul} + \delta_{g(u),t} + e_{ul,t}, \tag{A.1}$$

with university effects α_{ul} and Carnegie-group × year effects $\delta_{g(u),t}$; the IV columns instrument $\ln T$ with $\hat{v}_{u,t-1}$ on public universities, and the PPML columns keep the university-years with zero international

Appendix Table A4: First stages of the cell IV regressions: tuition at entry on the quasi-random residual

	(1) Bachelor's	(2) Master's	(3) Doctoral
Quasi-random tuition residual at entry (USD 1,000)	0.0503***	0.0497***	0.0399***
	(0.0030)	(0.0061)	(0.0096)
Cell-years	83,226	71,380	27,073
Universities	594	511	253
First-stage F (KP)	279.9	66.7	17.4
R^2 (within)	0.591	0.562	0.471

Dependent variable: ln out-of-state tuition at entry, lagged 4, 2, and 5 years before graduation for bachelor's, master's, and doctoral degrees; regressor: the equation (6) quasi-random residual at the same lag, in USD 1,000 units. Cell and Carnegie-group × year fixed effects; publics; SEs clustered by university; each column on the exact 2SLS estimation sample of the corresponding panel of Table 1. The Kleibergen–Paap F is that of the 2SLS itself. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

students that the log drops. Table A5 reports the results by level. The graduate elasticities are negative and significant across specifications (−0.26 to −0.57 in the count models); the undergraduate elasticities are smaller and imprecise. Column construction parallels Table 1: the IV-PPML column is the control-function form, PPML plus the first-stage residual of ln tuition on the instrument, so the tuition coefficient uses instrumented variation only while zero counts stay in the sample; its residual row and the IV column's endogeneity-test p-value are the Durbin–Wu–Hausman test in control-function and χ^2 form.

A2.4 Heterogeneous trends across Carnegie groups

Table A6 documents that nominal out-of-state price trends differ across Carnegie groups at the undergraduate level ($p < 0.001$). Table A7 runs, for each outcome, a within-university regression of the log outcome on university effects, year effects, and Carnegie-group-specific linear trends; the joint test rejects a common trend for four of five outcomes. Table A8 shows the divergence descriptively: national totals of international students grew at annualized rates that differ by several percentage points per year across groups. Figure A1 displays the indexed enrollment totals, and Figure A2 plots the completions series of main-text Figure 1 in log absolute levels, so slopes are growth rates and vertical gaps are size differences. A specification with plain year effects, as in Beine et al. (2023), would force this heterogeneity into the error term, correlated with segment-specific price trends; the Carnegie-group × year effects used throughout the paper absorb this heterogeneity without imposing a linear form.

A2.5 Validation of the constructed finance aggregates

Table A9 compares the expense aggregates per FTE constructed from the raw finance forms against IPEDS' own official derived files in every overlap year: ratios sit within a few percent of one for both cost concepts and both controls, so the cost panel entering equation (9) reproduces the official accounting.

A2.6 Summary statistics for the cost samples

Table A10 reports summary statistics for the two estimation samples of the cost analysis: the levels sample behind Table 3 and the 5-year-difference sample behind the long-difference check of Appendix A3.1. The output and input-price means locate the point at which the marginal costs are evaluated.

A2.7 Where international students enroll and where they use OPT

Table A11 reports international students as a percent of each cell's fall enrollment, by control, degree level, and Carnegie category; Table A12 reports their distribution across the same cells, with one grand

Appendix Table A5: International enrollment elasticities with Carnegie-group × year fixed effects, 2002–2024

(a) *Undergraduate*

	(1) OLS	(2) OLS $t-1$	(3) IV	(4) PPML	(5) IV-PPML
Elasticity w.r.t. out-of-state tuition	0.032	−0.013	−0.244	−0.112	−0.232
	(0.060)	(0.060)	(0.149)	(0.084)	(0.159)
First-stage residual (CF test)					0.008
					(0.194)
Observations	39,701	37,664	11,733	44,468	12,115
First-stage F (KP)			539.2		
Endogeneity test p-value			0.765		

(b) *Graduate*

	(1) OLS	(2) OLS $t-1$	(3) IV	(4) PPML	(5) IV-PPML
Elasticity w.r.t. out-of-state tuition	−0.073	-0.085^{*}	-0.379^{**}	-0.261^{***}	-0.571^{***}
	(0.051)	(0.051)	(0.150)	(0.079)	(0.193)
First-stage residual (CF test)					0.680^{***}
					(0.244)
Observations	30,831	29,363	9,631	36,957	10,096
First-stage F (KP)			215.9		
Endogeneity test p-value			0.082		

Dependent variable: fall enrollment of US-nonresident students (logs; counts for PPML and IV-PPML), 2002–2024. All columns: university fixed effects and Carnegie-group × year fixed effects; SEs clustered by university. OLS and PPML: public and private nonprofit 4-year universities; IV and IV-PPML: publics, with ln tuition instrumented by the lagged equation (6) residual. The IV-PPML control-function construction and the endogeneity tests parallel Table 1, described in the text. $^{*}\ p < 0.10$, $^{**}\ p < 0.05$, $^{***}\ p < 0.01$.

denominator so cells are additive. These are the source of the concentration facts used in Section 3: international students are 3.7 percent of undergraduate and 17.7 percent of master's enrollment, and three-quarters of them attend C1 doctoral institutions.

Table A13 is the OPT counterpart of Table A11: it reports OPT starts as a percent of all degrees awarded in each cell, so it measures the prevalence of OPT in a graduating cohort rather than in an enrollment stock. The gradient runs steeply with degree level, from 1.8 percent of bachelor's graduates to 7.2 percent of master's and 23.3 percent of doctoral, and it runs with research intensity: 4.9 percent of all degrees at C1 doctoral institutions against 2.5 and 1.7 percent at C3 baccalaureate and C2 master's institutions. Table A14 completes the set, giving the distribution of OPT starts rather than their prevalence: the same cells, measured against one grand denominator, so they are additive. Institutions outside the three named Carnegie categories host the remaining 3.2 percent of starts. Between them, these two tables explain why the OPT-weighted margins of Table 4 differ from the unweighted ones: OPT starts concentrate at a distinct set of universities, whose prices and costs differ from the sector average.

A2.8 The payments studied are taxes

The payments studied in this paper are taxes. They are not fees, and they are not "payments," the term the proclamation uses for the $100,000 it demands from initial H-1B entrants (The White House 2025).

Appendix Table A6: Average annualized growth of nominal out-of-state tuition & fees, 2002–2024, by Carnegie group

	Undergraduate charges		Graduate charges	
	Growth (% / yr)	Universities	Growth (% / yr)	Universities
C1 doctoral institutions	4.04	441	3.58	447
C2 master's institutions	3.67	627	3.36	639
C3 baccalaureate institutions	3.72	584	3.88	272
Other institutions	3.63	388	3.47	425
All	3.76	2,040	3.52	1,783
p-value, equal means across groups: <0.000 (UG), 0.275 (graduate)				

Each university's annualized log growth of nominal sticker out-of-state tuition & fees between its first and last observed year (span of at least 10 years required), averaged within Carnegie group. Sample: public and private nonprofit 4-year universities. Equality of group means is tested by OLS of the growth rate on group indicators with robust SEs. The heterogeneity documented here motivates the Carnegie × year fixed effects used throughout.

Appendix Table A7: Differential outcome trends across Carnegie groups (approx. percent per year, relative to Carnegie doctoral (C1) institutions)

	Intl. completions (by degree)			Intl. fall enrollment	
	(1) BA	(2) MA	(3) PhD	(4) UG	(5) Grad
C1 doctoral-group trend (base level)	2.04***	0.72	3.40***	2.22***	2.06***
	(0.67)	(0.51)	(0.58)	(0.56)	(0.46)
C2 master's group × trend	0.02	0.58	0.94	0.82	2.47***
	(0.67)	(0.55)	(1.17)	(0.56)	(0.52)
C3 baccalaureate group × trend	0.70	−0.85	−2.17***	1.00*	1.01
	(0.68)	(0.72)	(0.75)	(0.58)	(0.64)
Joint p-value: all groups share the C1 doctoral trend	0.000	0.055	0.000	0.000	0.000
Observations	33,282	26,280	9,287	39,946	31,748
Universities	1,961	1,684	652	2,239	1,897

Each column: within-university regression of the log outcome on university fixed effects, year fixed effects, and Carnegie-group-specific linear trends; the C1 doctoral group's trend is the base, absorbed by the year effects, so coefficients are *differential* trends in approximate percent per year (trend variable = (year − 2002)/100). Sample: public and private nonprofit 4-year universities, 2002–2024; SEs clustered by university. The joint test is the homogeneous-trend restriction implicit in a plain-year-FE specification. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

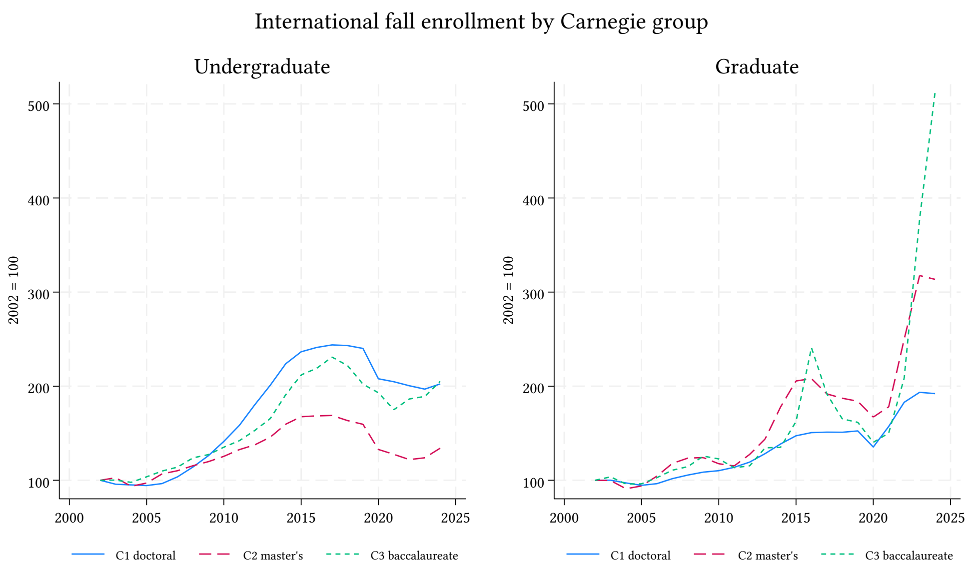
That classification follows from the definitions of "tax" used by the US federal government itself. The Internal Revenue Service defines taxes for the public as "required payments of money to governments that are used to provide public goods and services for the benefit of the community as a whole" (Internal Revenue Service 2026). That is, taxes are obligatory payments that go into the general treasury rather than offsetting the cost of services provided to a specific group of people. In its fullest official definition of "tax," the IRS ruled: "A tax is an enforced contribution, exacted pursuant to legislative authority in the exercise of the taxing power, and imposed and collected for the purpose of raising revenue to be used for public or governmental purposes. Taxes are not payments for some special privilege granted or service rendered and are, therefore, distinguishable from various other charges imposed for particular purposes under particular powers or functions of government. Ordinarily, when amounts are paid into a specific fund or earmarked for a specific purpose, they are treated as imposed as a regulatory measure or as a

Appendix Table A8: Annualized growth of the national total of international students, 2002–2024, by Carnegie group (% per year)

	Completions, by degree			Fall enrollment	
	BA	MA	PhD	UG	Grad
C1 doctoral institutions	3.60	4.69	3.02	3.20	2.97
C2 master's institutions	1.20	6.10	4.13	1.33	5.19
C3 baccalaureate institutions	3.31	8.29	1.36	3.27	7.43

Annualized log growth (×100) of the national total of international completions (by degree) and international fall enrollment (by level) between 2002 and 2024, summed over public and private nonprofit 4-year universities in each Carnegie group (the small unclassified group is omitted). A specification with plain year fixed effects assumes one shared national trend per outcome across these rows; Table A7 tests, and Figure 1–Figure A2 display, how far the groups' trends actually diverge.

Figure A1: International fall enrollment by Carnegie group, 2002 = 100

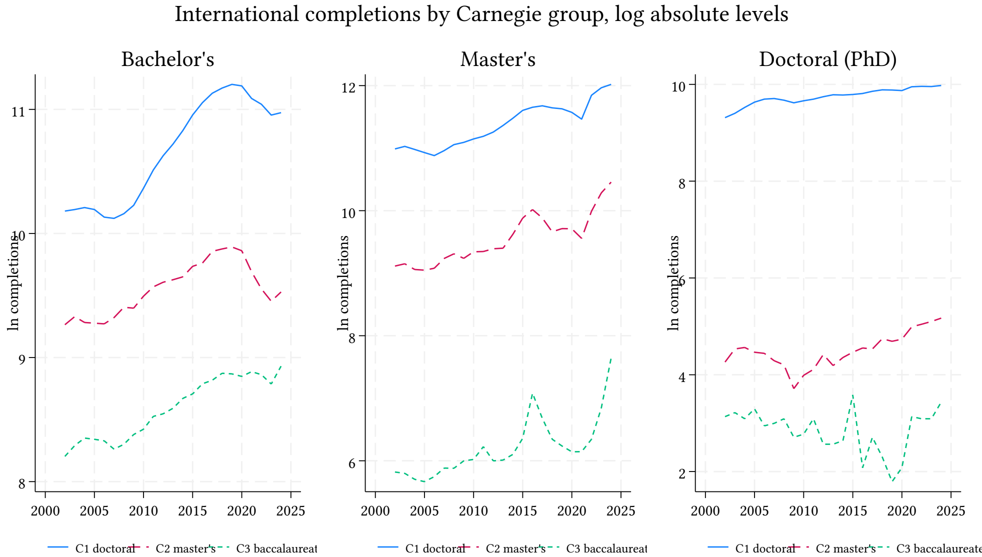


National totals of fall enrollment of US-nonresident students, by level and Carnegie group (C1 doctoral, C2 master's, C3 baccalaureate institutions), indexed to 2002 = 100.

charge for a privilege or service rendered" (Internal Revenue Service 1977). This definition is clear: a tax is an obligatory payment that does not offset the cost of a service provided but instead goes into the treasury. Required payments that serve as a charge for specific services rendered are fees or regulatory payments, not taxes.

A similar definition is universal in fiscal economics and fiscal regulation. The leading public finance textbook reads, "Taxes, the principal means of financing government expenditures, are compulsory payments that do not necessarily bear any direct relationship to the benefits from government goods and services received" (Hyman 2010, 21). The Congressional Budget Office writes: "The legal distinction between fees and taxes is based on whether charges are levied for purely private benefits, or whether they confer public

Figure A2: International completions by Carnegie group, log absolute levels



The completions series of Figure 1 in log levels rather than indexed: slopes are growth rates, and vertical gaps show the size differences between groups that indexing hides.

benefits that are independent of, rather than incidental to, private benefits. … The Congress may delegate to agencies the authority to levy charges that require private beneficiaries to pay for services that confer a public benefit, provided the Congressional intent to do so is clear and the guidelines for setting charges are adequately set forth in the legislation" (Congressional Budget Office 1993, p. 15). In other words, again, a forced payment to the government is a tax if it funds the general treasury, not the provision of a specific service to a private user, unless Congress gives "clear" instruction otherwise in law. *Black's Law Dictionary* defines a "tax" as "a charge, usu[ally] monetary, imposed by the government on persons, entities, transactions, or property to yield public revenue" (Garner, ed 2024), that is, not as a charge to offset the cost of a service. The OECD (OECD 2025, p. 9) agrees that a tax is "a compulsory unrequited payment to the general government," and the International Monetary Fund's definition is almost identical (International Monetary Fund 2014).

A tax on OPT work or H-1B work meets every element of these definitions. It is obligatory, and it goes into the treasury; the government has nowhere claimed that it is collected in return for $100,000 of services provided to the workers, schools or firms that might pay such taxes. It is not a regulatory payment because, as the IRS definition above clarifies, a regulatory payment would require the money to be "earmarked for a specific purpose," that is, to offset the cost of services rendered; the government's own court filings instead describe the revenue as "designed to mitigate the externalities of bringing such aliens into the country," not as compensation for the cost of any service.[24] The IRS definition also specifies that enforced payments into the general treasury – taxes – must be exacted "pursuant to legislative authority," and the CBO that they require Congress's "clear" guidelines "adequately set forth in the legislation." Whether that authority exists for duties of this kind is contested in litigation; the controversy concerns the authority to levy the tax, not its character as one. The hypothetical duties on students and universities simulated in this paper share the same structure: obligatory and unrequited payments to the general

[24]Defendants' motion at 8–9, *State of California v. Mullin*, No. 26-1699 (1st Cir.).

Appendix Table A9: Constructed cost per FTE vs. official IPEDS derived estimates, by overlap year (2024 USD)

	Means				Medians			
Year	Official	Constructed	Ratio	p	Official	Constructed	Ratio	p
Public universities: Instruction only (narrow)								
2020	15,361	15,269	0.994	0.618	10,691	10,980	1.027	0.292
2021	15,699	15,324	0.976	0.054	10,872	11,075	1.019	0.313
2022	15,464	14,996	0.970	0.058	10,551	10,847	1.028	0.489
2023	14,810	14,566	0.984	0.147	10,239	10,591	1.034	0.802
Public universities: Instruction + acad. support + student services + inst. support (broad)								
2020	27,991	28,029	1.001	0.898	20,270	20,815	1.027	0.264
2021	29,156	28,648	0.983	0.097	20,847	21,222	1.018	0.322
2022	28,686	28,166	0.982	0.163	20,861	21,048	1.009	0.528
2023	27,862	27,641	0.992	0.423	20,380	20,989	1.030	0.726
Private nonprofit universities: Instruction only (narrow)								
2020	16,153	16,687	1.033	0.059	11,831	12,760	1.079	0.004
2021	16,108	16,466	1.022	0.027	12,336	13,010	1.055	0.165
2022	16,137	16,236	1.006	0.649	11,922	12,360	1.037	0.678
2023	15,756	16,013	1.016	0.155	11,614	12,036	1.036	0.848
Private nonprofit universities: Instruction + acad. support + student services + inst. support (broad)								
2020	39,328	40,863	1.039	0.050	28,411	31,271	1.101	0.002
2021	39,501	41,298	1.045	0.002	29,965	32,562	1.087	0.064
2022	39,779	40,485	1.018	0.187	29,212	31,294	1.071	0.471
2023	38,870	39,897	1.026	0.085	28,665	30,420	1.061	0.720

Official: DRVF per-FTE expenses (instruction; broad adds academic support, student services, institutional support), mapped to fiscal-year start. Constructed: the expense grid of the present analysis over calibrated FTE. Ratio = constructed/official; p from a paired t-test (means) and Wilcoxon signed-rank (medians) of equality. Both sides in 2024 dollars.

treasury, with no earmark to offset the real cost of a specific service. They are taxes under every definition above.

Appendix Table A10: Summary statistics for the estimation samples (2024 USD)

(a) *Levels sample (cost-function table)*

	Mean	SD	Public mean	Private mean	Intl-wtd mean
Broad cost (USD millions)	142.94	325.21	249.34	95.97	911.90
Narrow cost (USD millions)	78.59	199.59	145.08	49.24	552.71
UG FTE (000)	3.97	7.59	9.04	1.73	17.43
Grad FTE (000)	1.21	2.91	2.10	0.82	7.84
PhD share of grad FTE	0.07	0.15	0.09	0.06	0.20
Research (USD millions)	31.53	143.32	65.27	16.64	321.83
Hospital (USD millions)	33.44	309.85	70.15	17.23	276.93
Avg faculty salary (USD 000)	92.43	30.34	100.35	88.93	128.95
UG out-of-state price (USD)	28,743.01	14,494.26	21,645.09	32,308.90	38,163.83
Grad out-of-state price (USD)	22,299.13	12,343.57	22,656.71	22,122.93	33,257.86
International students	315.07	887.48	610.97	184.46	2,691.44
F-1 graduates (SEVIS, 2005-2021)	100.42	288.57	169.95	69.51	773.50
OPT starts (SEVIS, 2005-2021)	57.80	176.81	101.94	38.17	468.83
University-years	45,902		14,057	31,845	

(b) *5-year-difference sample (long-difference table)*

	Mean	SD	Public mean	Private mean	Intl-wtd mean
Δ_5 broad cost (USD millions)	15.74	67.92	29.04	10.06	136.73
Δ_5 narrow cost (USD millions)	6.91	44.66	13.50	4.10	70.28
Δ_5 UG FTE	224.40	2,388.24	422.29	139.92	1,246.87
Δ_5 Grad FTE	111.10	959.66	129.24	103.36	877.99
Δ_5 PhD share $\times$ Grad FTE	16.02	259.59	31.38	9.47	105.57
University-years	34,579		10,345	24,234	

Levels sample: university-years passing the cost screen with salary data, 2002-2023, as in the cost- function table. Difference sample: university-years with a valid 5-year backward difference, as in the long-difference table. Intl-wtd: weighted by FY2023 (or latest) international enrollment, the weight used in the weighted estimates. F-1 graduates and OPT starts are school totals across degree levels from the SEVIS-IPEDS crosswalk, available for project years 2005-2021 only (stats over the covered years). All dollars are 2024 USD.

Appendix Table A11: International students as a percent of enrollment, by control, degree level, and Carnegie category, FY2023

(a) *All Carnegie categories*

	Undergraduate	Master's	Doctoral	All levels
Public	2.9%	17.5%	20.8%	5.6%
Private nonprofit	5.5%	17.8%	19.3%	9.6%
Overall	3.7%	17.7%	20.2%	6.9%

(b) *C3 baccalaureate institutions*

	Undergraduate	Master's	Doctoral	All levels
Public	1.9%	6.2%	17.4%	1.9%
Private nonprofit	5.8%	11.5%	16.0%	6.1%
Overall	3.9%	10.7%	16.0%	4.1%

(c) *C2 master's institutions*

	Undergraduate	Master's	Doctoral	All levels
Public	2.1%	9.3%	7.6%	3.2%
Private nonprofit	3.1%	11.6%	9.0%	5.2%
Overall	2.5%	10.5%	8.5%	4.1%

(d) *C1 doctoral institutions*

	Undergraduate	Master's	Doctoral	All levels
Public	3.5%	20.6%	22.1%	7.5%
Private nonprofit	7.3%	22.8%	21.2%	13.8%
Overall	4.4%	21.5%	21.8%	9.2%

Each cell: international enrollment as a percent of total fall enrollment in that cell, summed across the universities of the analysis sample, FY2023 (so shares are enrollment-weighted, not university averages). Master's and doctoral columns split graduate enrollment (total and international) by the duration-weighted completions stock (2 x MA, 5 x PhD degrees). The 'Overall' row combines controls; the 'All levels' column combines degree levels; the first subtable combines Carnegie categories, so its Overall x All-levels cell is the share of all students at US four-year universities who are international.

Appendix Table A12: The distribution of international students across control, degree level, and Carnegie category, FY2023 (percent of all international students)

(a) *All Carnegie categories*

	Undergraduate	Master's	Doctoral	All levels
Public	24.2%	24.0%	7.2%	55.4%
Private nonprofit	17.2%	22.8%	4.6%	44.6%
Overall	41.4%	46.8%	11.8%	100.0%

(b) *C3 baccalaureate institutions*

	Undergraduate	Master's	Doctoral	All levels
Public	1.0%	0.0%	0.0%	1.1%
Private nonprofit	3.3%	0.3%	0.0%	3.7%
Overall	4.3%	0.4%	0.0%	4.7%

(c) *C2 master's institutions*

	Undergraduate	Master's	Doctoral	All levels
Public	3.7%	3.0%	0.1%	6.7%
Private nonprofit	3.6%	4.0%	0.1%	7.8%
Overall	7.3%	7.0%	0.2%	14.5%

(d) *C1 doctoral institutions*

	Undergraduate	Master's	Doctoral	All levels
Public	16.0%	20.8%	7.0%	43.8%
Private nonprofit	9.2%	17.0%	4.2%	30.3%
Overall	25.1%	37.8%	11.2%	74.1%

Each cell: international students in that cell as a percent of ALL international students in the analysis sample, FY2023 – the same grand denominator in every subtable, so cells are comparable and additive across subtables and the Overall x All-levels cell of the first subtable is 100 percent. (The companion prevalence table reports instead the percent of each cell's enrollment that is international.) Master's and doctoral columns split international graduate enrollment by the duration-weighted completions stock (2 x MA, 5 x PhD degrees). Institutions outside the three named Carnegie categories (special-focus and unclassified) host the remaining 6.6% of international students, which is why the three Carnegie subtables sum to slightly less than 100 percent.

Appendix Table A13: OPT starts as a percent of all graduates, by control, degree level, and Carnegie category, project year 2021 (SEVIS FY2022 cohort)

(a) *All Carnegie categories*

	Bachelor's	Master's	Doctoral	All levels
Public	1.3%	6.1%	26.8%	3.1%
Private nonprofit	2.7%	8.3%	18.2%	5.4%
Overall	1.8%	7.2%	23.3%	3.9%

(b) *C3 baccalaureate institutions*

	Bachelor's	Master's	Doctoral	All levels
Public	0.6%	1.6%	0.0%	0.6%
Private nonprofit	3.3%	4.1%	11.4%	3.4%
Overall	2.5%	3.7%	11.4%	2.5%

(c) *C2 master's institutions*

	Bachelor's	Master's	Doctoral	All levels
Public	1.0%	3.2%	7.8%	1.5%
Private nonprofit	1.5%	2.8%	4.0%	2.0%
Overall	1.2%	3.0%	5.2%	1.7%

(d) *C1 doctoral institutions*

	Bachelor's	Master's	Doctoral	All levels
Public	1.5%	7.2%	27.6%	3.7%
Private nonprofit	3.3%	11.2%	18.8%	7.8%
Overall	1.9%	9.0%	24.2%	4.9%

Each cell: OPT starts among the cell's graduating cohort as a percent of ALL degrees awarded in that cell (completions, all students, from IPEDS), summed across the universities of the analysis sample – the flow analogue of the enrollment-prevalence table. OPT starts and their degree levels come from the SEVIS-IPEDS crosswalk; the cohort shown is project year 2021 (SEVIS fiscal year 2022, the latest covered). Shares are graduate-weighted, not university averages.

Appendix Table A14: The distribution of OPT starts across control, degree level, and Carnegie category, project year 2021 (percent of all OPT starts)

(a) *All Carnegie categories*

	Bachelor's	Master's	Doctoral	All levels
Public	16.0%	22.9%	10.6%	49.5%
Private nonprofit	14.7%	30.8%	4.9%	50.5%
Overall	30.7%	53.7%	15.5%	100.0%

(b) *C3 baccalaureate institutions*

	Bachelor's	Master's	Doctoral	All levels
Public	0.3%	0.0%	0.0%	0.3%
Private nonprofit	3.1%	0.3%	0.0%	3.5%
Overall	3.4%	0.3%	0.0%	3.7%

(c) *C2 master's institutions*

	Bachelor's	Master's	Doctoral	All levels
Public	3.0%	2.9%	0.1%	5.9%
Private nonprofit	2.9%	3.0%	0.1%	6.0%
Overall	5.9%	5.9%	0.1%	11.9%

(d) *C1 doctoral institutions*

	Bachelor's	Master's	Doctoral	All levels
Public	12.6%	20.0%	10.4%	43.0%
Private nonprofit	7.7%	25.9%	4.5%	38.1%
Overall	20.4%	45.9%	14.9%	81.1%

Each cell: OPT starts from that cell as a percent of ALL OPT starts in the analysis sample, project year 2021 (SEVIS fiscal year 2022, the latest covered). All subtables share one grand denominator, so any two cells can be compared directly, cells sum across subtables, and the Overall x All-levels cell of the first subtable is 100 percent. (The companion table instead reports OPT starts as a percent of each cell's graduates.) Degree levels come directly from SEVIS. Institutions outside the three named Carnegie categories account for the remaining 3.2% of OPT starts.

Appendix Table A15: Within-university cost responses: 5- and 10-year long differences, all universities (2024 USD)

	5-yr narrow	5-yr broad	10-yr narrow	10-yr broad
Δ UG FTE	1,580*	5,295***	959	4,792***
	(954)	(1,179)	(1,339)	(1,772)
Δ Grad FTE	4,962*	10,363**	7,199	13,126*
	(2,863)	(4,182)	(4,740)	(6,776)
Δ PhD sh. $\times$ Grad FTE	3,766	2,622	-854	1,964
	(4,821)	(7,142)	(9,232)	(13,596)
University-years	34,579	34,579	23,139	23,139
Universities	2,419	2,419	2,165	2,165

h-year long differences of cost on enrollment (university effects differenced out; research and hospital changes as controls; year dummies; SEs clustered by university; stars from the normal approximation at 10/5/1 percent). Coefficients are 2024 dollars per student-year. As the horizon lengthens, capacity adjusts and the coefficients should climb toward the long-run cost function (Getz et al. 1991; Sav 2011).

A3 Robustness checks

A3.1 Long-difference cost responses

Table A15 re-estimates the cost response of equation (9) in 5- and 10-year long differences rather than levels. Within-university responses climb with the horizon toward the levels estimates, the adjustment pattern documented by Getz et al. (1991) and Sav (2011). That is the pattern expected if the levels coefficients of Table 3 measure long-run costs, which is how the margin calculations use them.

A3.2 The cost function on the most recent five years

Table A16 repeats Table 4 with the cost function estimated on the most recent five years of data only, so marginal costs describe today's universities at today's prices rather than the 2002–2024 average. The margins that drive the supply analysis are broadly similar: bachelor's margins barely move, and the international-student- and OPT-weighted master's and doctoral margins mostly widen. The whole-period estimates are therefore robust to the restriction, and where the two windows differ, the whole-period estimates are the cautious choice.

Appendix Table A16: Price, marginal cost, and net margin: cost function estimated on the most recent five years (2024 USD)

(a) *Unweighted*

	Public			Private nonprofit			Combined
	Price	MC	P−MC	Price	MC	P−MC	P−MC
Bachelor's (whole sample)	19,616	9,485	10,131	33,227	10,110	23,117	15,537
	(368)	(1,485)	(1,530)	(490)	(2,862)	(2,904)	(1,503)
Bachelor's (C3 baccalaureate insts)	17,077	10,518	6,559	36,710	18,925	17,785	15,126
	(844)	(1,508)	(1,728)	(907)	(1,801)	(2,016)	(1,592)
Master's (whole sample)	21,302	21,645	-343	21,478	9,713	11,765	5,554
	(367)	(6,441)	(6,452)	(414)	(6,853)	(6,865)	(4,705)
Master's (C2 master's insts)	18,074	3,469	14,605	17,696	927	16,769	15,856
	(385)	(3,969)	(3,988)	(511)	(3,435)	(3,473)	(2,620)
Doctoral (whole sample)	21,302	60,832	-39,530	21,478	59,557	-38,080	-38,968
	(367)	(26,212)	(26,214)	(414)	(29,319)	(29,322)	(19,670)
Doctoral (C1 doctoral insts)	25,379	22,772	2,607	28,470	36,439	-7,969	-1,327
	(556)	(28,858)	(28,863)	(1,131)	(30,507)	(30,528)	(21,390)

(b) *Weighted by each university's share of international students*

	Public			Private nonprofit			Combined
	Price	MC	P−MC	Price	MC	P−MC	P−MC
Bachelor's (whole sample)	28,899	8,415	20,484	53,740	1,827	51,912	33,567
	(450)	(3,391)	(3,421)	(507)	(7,387)	(7,404)	(3,673)
Bachelor's (C3 baccalaureate insts)	13,671	11,628	2,043	45,233	12,215	33,019	25,681
	(642)	(1,814)	(1,924)	(1,112)	(2,900)	(3,106)	(2,414)
Master's (whole sample)	27,767	99	27,667	39,790	4,227	35,563	31,513
	(401)	(14,712)	(14,717)	(610)	(14,828)	(14,841)	(10,452)
Master's (C2 master's insts)	18,040	919	17,120	21,495	-7,037	28,533	23,716
	(359)	(6,983)	(6,993)	(736)	(4,470)	(4,530)	(3,945)
Doctoral (whole sample)	27,767	-18,428	46,195	39,790	43,054	-3,263	27,027
	(401)	(46,845)	(46,846)	(610)	(52,473)	(52,476)	(35,168)
Doctoral (C1 doctoral insts)	29,322	-19,134	48,456	45,995	41,763	4,231	32,004
	(588)	(49,444)	(49,448)	(1,170)	(59,676)	(59,688)	(38,175)

(c) *Weighted by each university's opt graduates*

	Public			Private nonprofit			Combined
	Price	MC	P−MC	Price	MC	P−MC	P−MC
Bachelor's (whole sample)	30,585	4,557	26,028	57,821	1,933	55,888	40,129
	(468)	(3,855)	(3,883)	(471)	(7,984)	(7,998)	(4,297)
Bachelor's (C3 baccalaureate insts)	17,172	8,619	8,553	47,979	12,099	35,880	33,653
	(839)	(1,546)	(1,759)	(1,159)	(3,133)	(3,341)	(3,072)
Master's (whole sample)	27,792	3,598	24,194	44,262	-3,767	48,029	37,796
	(425)	(15,479)	(15,485)	(597)	(17,418)	(17,428)	(11,963)
Master's (C2 master's insts)	17,575	2,056	15,518	25,770	-894	26,664	21,239
	(396)	(5,828)	(5,842)	(861)	(7,951)	(7,997)	(4,994)
Doctoral (whole sample)	27,792	-18,407	46,199	44,262	44,546	-284	31,565
	(425)	(49,521)	(49,522)	(597)	(56,464)	(56,467)	(38,306)
Doctoral (C1 doctoral insts)	29,209	-10,754	39,962	47,996	39,162	8,834	30,697
	(594)	(51,328)	(51,331)	(1,135)	(58,453)	(58,464)	(40,033)

As Table 4, with every marginal cost re-estimated on the most recent five years of data only; rows, prices, weights, and the combined column are constructed identically. Broad cost concept; 2024 dollars. Purpose and findings: see Appendix A3.2.