I Z A Institute
of Labor Economics
Initiated by Deutsche Post Foundation

DISCUSSION PAPER SERIES

IZA DP No. 18336

Growing from the STEM? OPT Classification and International Students in Economics

Shengrong Hu
John V. Winters

DECEMBER 2025

I Z A Institute
of Labor Economics

Initiated by Deutsche Post Foundation

DISCUSSION PAPER SERIES

IZA DP No. 18336

Growing from the STEM? OPT Classification and International Students in Economics

Shengrong Hu
Iowa State University

John V. Winters
Iowa State University and IZA

DECEMBER 2025

ISSN: 2365-9793

IZA – Institute of Labor Economics

Schaumburg-Lippe-Straße 5–9
53113 Bonn, Germany

Phone: +49-228-3894-0
Email: publications@iza.org

www.iza.org

ABSTRACT

Growing from the STEM? OPT Classification and International Students in Economics

The Optional Practical Training (OPT) program now provides up to 36 months of employment authorization for foreign students completing college degrees in the U.S. in science, technology, engineering, and math (STEM) fields. Econometrics and Quantitative Economics (EQE) was added as a STEM field in 2012, triggering an explosion of EQE programs and degrees conferred, but some of this growth involved displacement from other economics programs. We document the growth of EQE and examine effects of OPT and EQE program creation on overall economics bachelor's degrees conferred to international students. We find positive effects on international economics degrees with effects that appear larger at public colleges and universities than private ones. We also examine effects on domestic students and find more mixed results. Our results suggest that EQE program creation on average benefits foreign students and higher education institutions.

JEL Classification: A22, I23, J24, J61

Keywords: immigration policy, college education, economics, STEM

Corresponding author:
Shengrong Hu
Department of Economics
Iowa State University
1750 Beardshear Hall
Ames, IA 50011
USA

E-mail: alexhu@iastate.edu

1. Introduction

Foreign-born workers play an increasingly important role in the U.S. economy. In 2022, foreign-born workers accounted for 17.0 percent of college graduate workers in the U.S., up from only 12.3 percent in 2000. Foreign-born graduates also accounted for 24.9 percent of all economics bachelor's degree holders in 2022.[1] However, there are various restrictions, and the number of foreign-born persons wishing to work in the U.S. vastly exceeds the number able to do so. The Optional Practical Training (OPT) program provides temporary work access for foreign students completing college degrees in the U.S. with work authorization varying by field of study. Foreign students completing degrees in the U.S. in any field are eligible for 12 months of OPT employment authorization, but those earning degrees in specifically designated science, technology, engineering, and mathematics (STEM) fields are now eligible for up to 36 months of OPT employment authorization. This special status increases the attractiveness of U.S. STEM degrees to foreign-born persons interested in working in the U.S. (Bound et al. 2021). OPT policies have evolved over time, with one notable change being the inclusion of Econometrics and Quantitative Economics (EQE) as a STEM field beginning in 2012. EQE's inclusion as an OPT STEM field has contributed to more than 100 colleges and universities creating EQE bachelor's degree programs (Marshall and Underwood 2020; Mahon and Asarta 2024; Kim 2024). These programs receive both domestic and international students. However, it is unclear a priori if these programs attract new students to U.S. economics programs or just shift them from traditional economics degrees to EQE degrees, which leaves a gap in knowledge that this paper aims to fill.

[1] Statistics for 2000 are from author estimates using the decennial census 5% sample. Statistics for 2022 are from the American Community Survey. Statistics by college major are not available for 2000.

The current study examines the impact of OPT policy and EQE program creation on bachelor's degree conferrals in economics using data from the Integrated Postsecondary Education Data System (IPEDS). Given the increased benefits of EQE to foreign students, we expect treatment to increase foreign EQE and possibly total foreign economic degree conferrals. We first present national time trend data indicating strong increases in EQE degree conferrals, but the overall impact on economics degrees is less clear from aggregate data.[2] Thus, we develop a research design comparing treated higher education institutions to untreated institutions. Our setting involves differential treatment timing, i.e., staggered intervention, and possible concerns about parallel trends violations, so traditional two-way fixed effect methods are likely not appropriate. Instead, we apply the synthetic difference-in-differences (SDID) estimator developed by Arkhangelsky et al. (2021), which is well-suited to our setting. We find that OPT policy changes and EQE program creation combine to induce more foreign students to complete bachelor's degrees in economics. We also examine impacts on native bachelor's degree conferrals in economics, given potential spillover or crowding effects on domestic students, and find more mixed results.

The Optional Practical Training program was created in 1992 to allow for internships and other short-term work experiences of up to 12 months for foreign-born graduates completing degrees in the U.S. (Miano 2017). The number of OPT participants was relatively modest until a 2008 reform that for the first time provided additional work authorization for STEM graduates, increasing the initial duration from 12 to 29 months. The list of STEM fields was considerably expanded in June 2012 from about 90 to nearly 400, including EQE (Bound et al. 2021). In 2016, the maximum OPT work authorization for STEM graduates was extended to 36 months.

[2] According to Hanover Research (2023), EQE has the second highest annualized growth rate of 52.6% in degree completions in the United States from 2017 to 2021.

OPT has also become increasingly important over time due to shortages of other types of work visas (Demirci 2019). Caps on employment-based permanent visas have long been binding. The H-1B visa program was designed to provide temporary work visas, but the number of H-1B visa applicants has exceeded the cap in every year since 2013. Thus, foreign-born workers have increasingly relied on OPT work authorization as a short-term substitute and stepping stone to longer-term work visas (Bound et al. 2015, 2021).

Because STEM designation provides 24 additional months of OPT work authorization, it provides substantial benefits to international graduates of U.S. higher education institutions (HEIs). First, employment in the U.S. typically offers higher earnings than their home countries, so STEM designation provides two more years of relatively high earnings. OPT also involves training and work experience in the U.S. that increases their human capital and future earnings outside the U.S (Amanzadeh et al. 2024). Finally, many international graduates of U.S. HEIs work in the U.S. on OPT initially and apply for an H-1b visa for extended work authorization.[3] However, H-1b visas are oversubscribed and allocated via lottery. Additional years on OPT give more chances at the H-1b lottery and greater chances for longer-term work opportunities in the U.S.

The OPT STEM reclassification for EQE also applied to master's and doctorate degrees, but we focus on impacts on bachelor's degrees for multiple reasons. First, Ph.D. programs in economics typically include assistantships with tuition waivers and stipends, and programs are typically budget constrained in the number of students they can enroll with funding. Economics Ph.D. programs are also very competitive and typically enroll a high percentage of international

[3] H-1b visas are initially for three years but can be renewed for an additional three years. If an employer sponsors a worker for an employment-based green card and the application is approved, the worker can remain employed on an H-1b visa while on the waiting list for the green card.

students. The OPT STEM extension for EQE likely makes Ph.D. programs more attractive to international students, but there is likely limited scope for programs to enroll more international students. Master's programs in economics are very heterogeneous. Some are designed as preparation for Ph.D. programs, some are intended as terminal degrees, and some departments have no standalone master's program but award master's degrees to students along their way to completing a Ph.D. Some master's programs include funding while others don't. Bachelor's programs in economics are more consistent in that they do not directly fund students at the program level and they generally do not face hard constraints on the number of students they can enroll.

Our study contributes to a small but important literature at the intersection of immigration policy and higher education. To our knowledge, no previous study has examined impacts of immigration policy on economics degree completion. OPT policy impacts on STEM overall have been examined by a few studies. Amuedo-Dorantes et al. (2019) use the National Survey of College Graduates to examine the change in STEM prevalence among foreign-born graduates in the U.S. after the 2008 STEM OPT extension was created; they find that the STEM OPT extension increased the prevalence of STEM fields among foreign-born graduates in the U.S. by 18 percent. Amuedo-Dorantes et al. (2023) examine administrative data from the Student Exchange and Visitors Information Service (SEVIS) and find that the OPT reform also had a positive impact on international enrollments and the academic quality of international students. Khoo (2023) uses administrative student record data for Ohio and finds that the OPT extension increased international student enrollment in STEM fields in that state by 6 percent.[4] To our

[4] Additionally, Beine et al. (2023) find that increases in local STEM degree conferrals due to OPT leads to increased numbers of STEM graduates in the local workforce, consistent with OPT helping grow the local STEM workforce.

knowledge, no previous study of OPT reforms examines impacts on degree conferrals using the IPEDS.

A few notable studies have also examined higher education institutional decisions to create Econometrics and Quantitative Economics programs. EQE was historically a small portion of all economics degrees and only available at a few schools, but EQE has grown tremendously in recent years. This partially reflects the growing demand for quantitative and technical skills in economic curricula, but the OPT STEM extension is also an important driver (Marshall and Underwood 2020; Mahon and Asarta 2024; Kim 2024). Mahon and Asarta (2024) estimate a logistic regression explaining the determinants of whether an institution reclassifies its general economics program to EQE and find that the size of the economics program and the prior proportion of international students in the program are important factors with positive effects. Kim (2024) conducts a similar analysis and finds that the likelihood an institution offers EQE is positively influenced by the proportion of international students, being private, and being a doctoral/research university. We contribute to the literature by focusing on how OPT STEM classification affects international bachelor's degree completion in an important field, economics. EQE expansion provides a unique natural experiment with some higher education institutions adopting EQE at various times but many others not implementing EQE programs and serving as never treated control groups; this differs from the more general OPT expansions that affected previous STEM fields across all colleges and universities at the same time.

A related literature examines how international students affect native enrollment and degree outcomes in higher education. Prior studies document both crowding-out and crowding-in spillover effects, with mixed empirical evidence across fields and institutional settings (Winters 2012; Shih 2017; Ransom and Winters 2021; Anelli et al. 2023). Because OPT-related

incentives may increase international student participation in economics programs and induce curricular and capacity responses by institutions, the direction and magnitude of effects on domestic economics degree conferrals are theoretically ambiguous. We therefore examine domestic and international outcomes separately.

Beyond immigration policy and institutional responses, the OPT STEM classification of EQE also has implications for who participates in undergraduate economics education. Prior research documents persistent disparities in who studies economics and raises concerns about representation in the discipline, as well as how institutional incentives and peer composition can shape student enrollment patterns across fields of study (Bayer and Rouse 2016; Shih 2017; Anelli, Shih, and Williams 2023). International students now constitute a substantial share of economics undergraduates, and policy-driven changes such as OPT STEM designation may further alter the demographic and academic composition of economics programs.

Economics is also an interesting and important field to study. Economics is a popular college major in the U.S. with about 2 percent of all undergraduate degrees conferred in economics. Economics is generally a financially lucrative major with high average salaries (Black et al. 2003; Altonji et al. 2012; Winters and Xu 2014; Bleemer and Mehta 2022). Economics graduates also differ from other majors in financial behaviors related to savings, investment decisions, and retirement preparation (Allgood et al. 2011). Economics education is also touted for training in analytical thinking and high performance on standardized tests like the Law School Admission Test (LSAT) (Routon 2018; Nieswiadomy 2024). Thus, understanding the influence of OPT and EQE on economics degrees conferred is important to economists but also has broader implications given the particular importance of economic education.

2. Conceptual Background

Economics degree conferrals to international students depend on both demand and supply (Bound et al. 2021). The demand depends on the costs and benefits to students. Costs include tuition, fees, materials, equipment, living expenses, and opportunity costs of time and effort. Benefits depend on the consumption value of learning and impacts on labor market opportunities. International students in the U.S. are often especially influenced by how their education will impact their ability to acquire a good job in the U.S. STEM eligible economics programs that provide extended OPT time will confer higher benefits to international students and are expected to have greater demand than otherwise similar economics programs.

The supply side includes stakeholders deciding what fields of study to offer at their college or university; they have various objectives including enhancing institutional resources, prestige, student well-being, societal well-being, and others consistent with their missions. Field offerings also depend on the costs of creating and maintaining programs. Startup costs and indivisibilities may be burdensome for small programs but easily overcome by large programs that can spread fixed costs over many students; i.e., EQE supply decisions depend on economies of scale. Thus, an institution considering offering Econometrics and Quantitative Economics will assess whether their marginal benefits exceed their marginal costs.[5]

In equilibrium, some colleges and universities will offer EQE, and some will not. A positive demand shock like the OPT redefinition of STEM fields to include EQE in 2012 will disrupt the equilibrium. Movement along the supply curve will occur as new EQE programs are offered. Aggregate effects depend on counterfactuals, i.e., what would have happened in the

[5] Institutional costs and benefits also vary at different levels within institutions. E.g., the economics department may bear most of the administrative and instructional costs of a new EQE program, but the extent to which the department benefits from having additional students and credit hours from EQE varies substantially.

absence of new EQE programs. In particular, as EQE programs gain students, they might a) draw students away from other economics program at the same college or university, b) draw students away from non-economics program at the same college or university, c) draw students away from other colleges or universities, or d) draw students into the higher education system that would not have otherwise attended.

Institutions have responded to the OPT STEM reclassification for EQE in a variety of ways at different paces, reflecting differences in existing program structures, resources, and strategic priorities. Prior work documents that EQE adoption often reflects both curricular differences, such as greater quantitative and mathematical requirements, and strategic institutional motivations related to enrollment, program size, and international student demand (Marshall and Underwood 2022; Marshall, Underwood, and Hyde 2024; Mahon and Asarta 2024). Many institutions largely converted their prior general economics (GE) programs to EQE, while a few chose to offer both GE and EQE programs concurrently.[6]

Among those institutions that fully converted to EQE, for example, at the University of California, Los Angeles (UCLA), the economics department introduced new course requirements, including Econ 104/104L (Data Science for Economists), reflecting a deliberate shift toward computational and data-driven competencies. Similarly, Georgetown University made few substantive changes to its program structure, likely because existing requirements—such as econometrics and advanced mathematics courses—already aligned with STEM expectations. The University of Chicago also reorganized its economics major into an EQE program, offering three specializations (standard economics, business economics, and data

[6] For all institutional changes examples in the next two paragraphs, we use the Internet Archive Wayback Machine for snapshots of the economics department's website prior to the reclassification and compare program requirements between then and now.

science) without maintaining a separate GE degree. Meanwhile, Denison University, a liberal arts institution, strengthened its quantitative foundation through the addition of more mathematics prerequisites as part of its transition to EQE.

In contrast, George Washington University maintains both a GE major and an EQE-designated track; while the EQE track incorporates a modest increase in quantitatively focused elective requirements, the core curriculum remains largely unchanged, suggesting a relatively limited curricular adjustment. Collectively, these cases demonstrate that the impact of STEM reclassification on undergraduate economics curricula has been highly institution specific. While some higher education institutions introduced new courses or tracks in response to the policy change, others already possessed the quantitative rigor for STEM designation and thus implemented minimal or no curricular modifications. These examples illustrate that EQE adoption varies widely in both timing and substance across institutions, ranging from full program reclassification to parallel degree offerings with minimal curricular change. This motivates the need for an empirical method that can address staggered adoption and dissimilar characteristics between treatment and control groups, leading to our use of SDID, the empirical strategy discussed in Section 4.

The effects of OPT reclassification may also vary across types of higher education institutions. Specifically, average treatment effects may differ between public and private HEIs for various reasons. Public colleges and universities are increasingly tuition dependent due to declining support from state budgets, which may especially incline them to pursue international students who pay much higher tuition rates than in-state students (Groen and White 2004; Bound et al. 2020). Private colleges and universities typically do not impose significantly different sticker prices for international students and may be on average less motivated to recruit and

enroll them. Similarly, many private colleges are relatively small, and smaller schools may not be especially attractive to foreign students.

There is also some concern that curricular changes and increased numbers of international students could adversely affect native students (Shih 2017). First, enrolling more international students could crowd natives out of economics programs if required resources are scarce, such as available enrollment in required courses (Winters 2012). Similarly, competition for course grades from international students or altered social interactions may make economics programs less attractive to some native students (Anelli et al. 2023). Native students may also anticipate increased labor market competition from international graduates and shift to other fields (Ransom and Winters 2021). Finally, curricular shifts from general economics to more technical areas for econometrics and quantitative economics may alter native interest in economics, even independent of the direct influence of foreign students. However, the effects on natives are not clearly negative. Some native students may value the increased diversity of economics classmates. Also, a larger program may facilitate better course offerings including more electives and multiple sections of the same course at different times that better fit student schedules. Some natives may also be directly drawn to the more technical aspects of econometrics and quantitative economics.

3. Time Trends in Economics Bachelor's Degrees

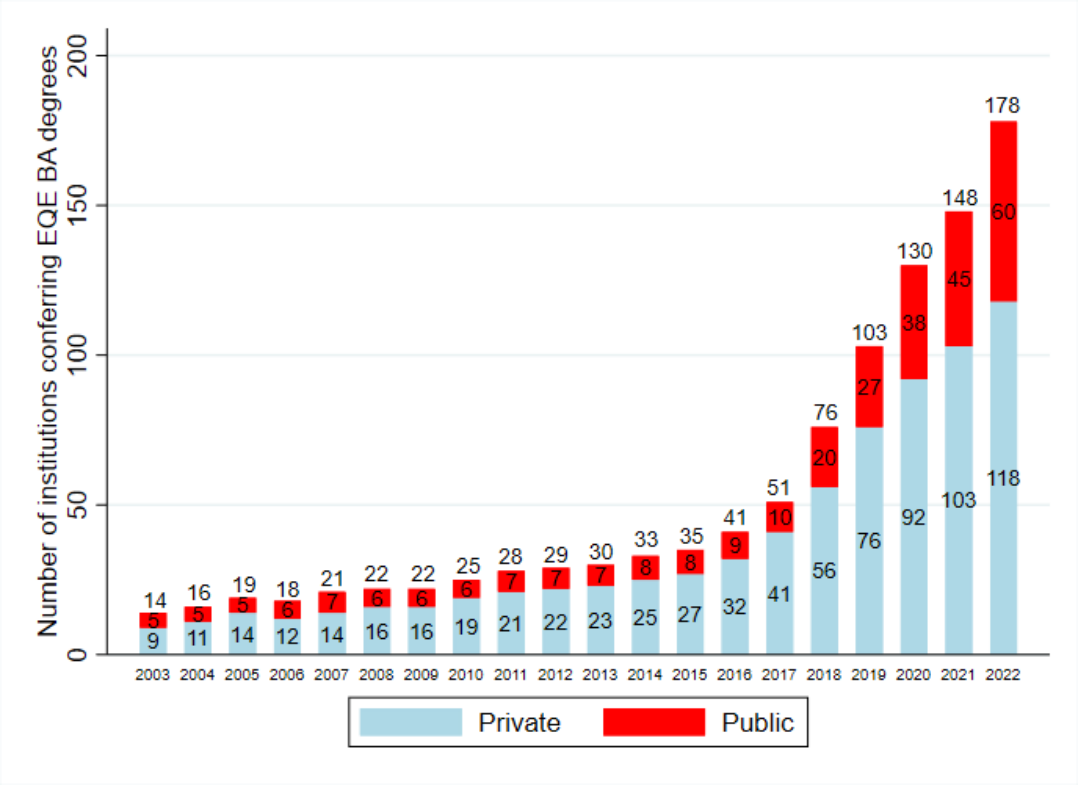

Figure 1. Numbers of institutions conferring EQE undergraduate degrees each year. Source: IPEDS

Figure 1 illustrates that the number of higher education institutions conferring undergraduate Econometrics and Quantitative Economics degrees has grown remarkably over time from only 14 in 2003 to 29 in 2012 and 178 by 2022. Thus, the number of EQE programs was already increasing slightly before the OPT policy change in 2012 and likely would have continued increasing somewhat over time in response to increased demand for quantitative instruction in economics (Marshall and Underwood 2020). However, the bulk of the increase in EQE programs occurred after EQE was included as an OPT STEM field in 2012, consistent with the policy change increasing demand and institutions creating new EQE programs in response. Among these institutions, the number of private institutions is consistently greater than the number of public institutions.

There was also a massive increase in the number of EQE bachelor's degrees conferred. Figure 2 illustrates trends in bachelor's degrees conferrals for all economics degrees, GE, EQE, business economics, and all other economics degrees. We include business economics in our definition of economics degrees because some institutions house their economics programs within business schools and classify the major administratively as business economics rather than general economics. Substantively, business economics programs cover core economic theory and applied economics content and represent close substitutes for general economics and EQE majors. Total economics degrees increased from 2003-2018 and then declined slightly during 2018-2022. More noticeably, there has been a remarkable increase in EQE, especially since 2016.[7] Around the same time, GE degrees began declining suggesting that much of the increase in EQE was from decreases in GE. In many cases, this change may have involved only moderate differences in coursework (Marshall and Underwood 2022).

Figure 3 presents similar trends in international economics bachelor's degree conferrals by program. The number of economics degrees to international students continued increasing through 2021 before decreasing in 2022. The 2022 decrease may partially reflect overall declines in international student enrollment following COVID-19 lockdowns and travel restrictions. While GE degrees account for much of the growth in international economics degrees prior to the mid-2010s, EQE expands rapidly after its STEM classification and becomes the dominant economics program for international students by 2022.

[7] Because EQE became STEM-eligible in 2012 and students typically take several years to complete a bachelor's degree, any response of international students to the STEM reclassification would only appear in degree data with a lag. In particular, students entering EQE programs in 2013 or later would tend to show up as graduates beginning around 2016. The sharp rise in EQE conferrals after 2016 is therefore consistent with a lagged response to the 2012 policy change and the staggered introduction of EQE programs across institutions.

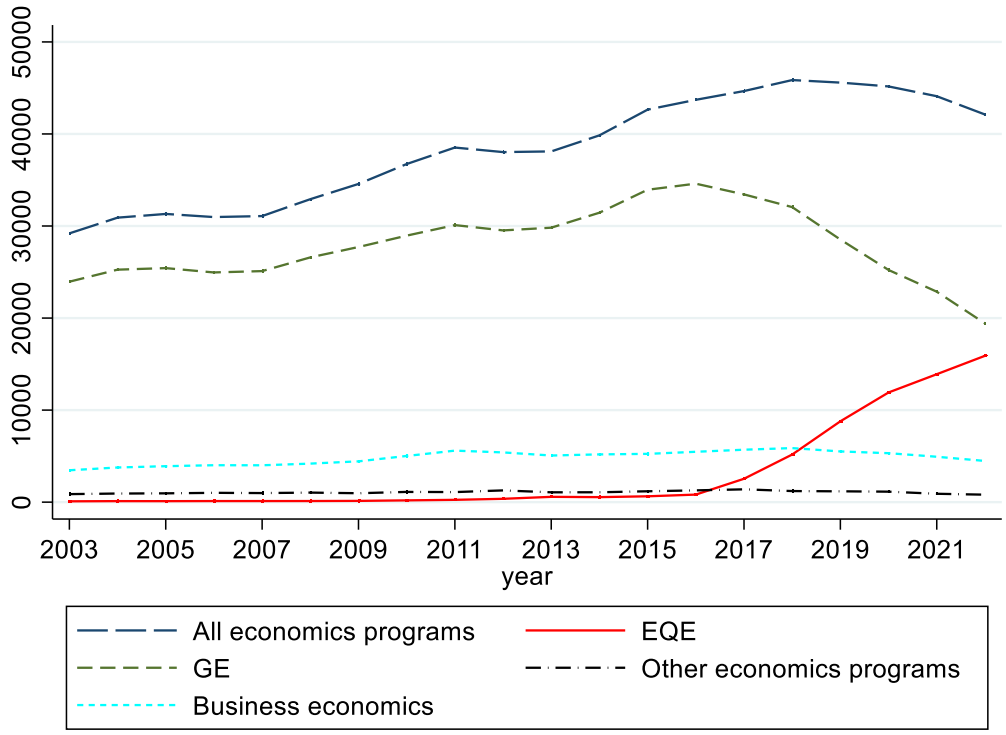

Figure 2. Total number of bachelor's degree conferrals in economics programs from 2003 to 2022. Source: IPEDS

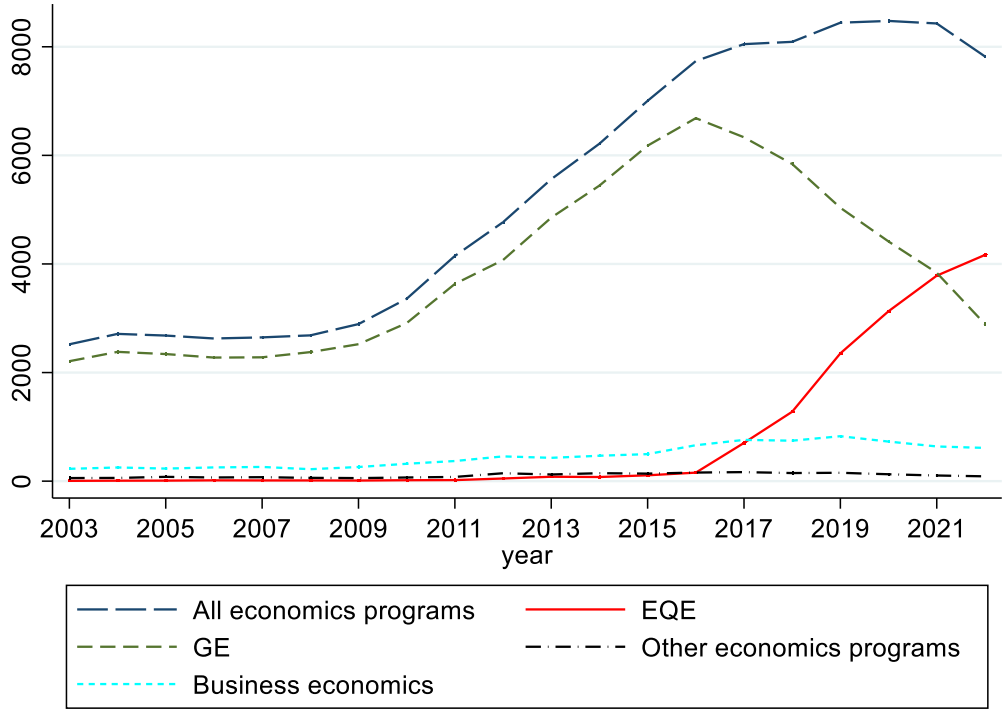

Figure 3. Total number of bachelor's degree conferrals to international students in economics programs from 2003 to 2022. Source: IPEDS

4. Research Design

We examine effects of OPT on bachelor's degree conferrals in economics at U.S. colleges and universities using 2003-2022 IPEDS data. 2022 was the most recent year of IPEDS data available at the time of our analysis. 2003 is chosen as the initial period to give exactly 20 year of data.[8] Our main research question is whether having a STEM eligible economics program at a higher education institution (HEI) increases economics bachelor's degrees conferred to international students. Figure 3 illustrates that increases in EQE conferrals coincided with decreases in general economics conferrals, so our primary interest is the impact on overall economics degrees conferred. We henceforth limit the sample to the 693 colleges and universities who continuously offer at least one bachelor's program in economics and have a balanced panel of non-missing data on bachelor's degrees conferred in economics during each year of our sample period because the SDID method we use requires a balanced panel. We also exclude U.S. service academies because of their very limited enrollment of international students. We consider all higher education institutions (HEIs) jointly and also examine public and private HEIs separately.

The SDID models we estimate are generalizations of the following two-way fixed effects model.

$$Y_{it} = \mu + \alpha_i + \gamma_t + \beta Treatment_{it} + \beta X_{it} + \varepsilon_{it},$$

The main dependent variable, Y_{it}, is the inverse hyperbolic sine (IHS) transformation of the total number of economics bachelor's degrees awarded to international students at higher education institution i in year t. This definition includes all persons earning bachelor's degrees in general economics, EQE, all others with a four-digit economics Classification of Instructional Programs

[8] This results in 10 pre-treatment and 10 post-treatment years for the earliest EQE institutions, but institutions implementing EQE later have more pre-treatment and fewer post-treatment years.

(CIP) code, and business economics.[9] We will also consider a related outcome for economics degrees conferred to domestic students. The IHS transformation is similar to a natural log transformation yet retains zero values and is increasingly used in a wide range of applications (Bellemare and Wichman 2020). Specifically, for any variable x, IHS(x) is computed as $arcsinh(x) = ln(x + \sqrt{x^2 + 1})$. Semi-elasticities in arcsinh–linear equations with dummy explanatory variables can be interpreted as percentage changes similarly to semi-elasticities with a log transformed dependent variable. E.g., a β coefficient of 0.10 would correspond to a roughly 10 percent increase in degrees conferred due to the treatment. The IHS transformation is used primarily because degree counts include a substantial mass at zero and are right-skewed.[10]

The main explanatory variable of interest is an OPT-EQE treatment variable defined at the institution-year level. It equals one if the HEI has an EQE bachelor's program eligible for the OPT STEM extension in the given year and zero otherwise. Thus, the treatment variable is always zero for HEIs that never offer EQE. The treatment variable also equals zero for all institutions in 2012 and prior years because EQE was first added to the OPT STEM list in June 2012. For HEIs with EQE prior to 2012, we define 2013 as the first treatment year because that was the first year that the OPT STEM extension could have affected degree choices. For HEIs that created EQE programs after 2012, we define the first treatment year as the first year that they confer at least one EQE bachelor's degree.[11] Some institutions continue to confer GE

[9] For students earning degrees with two or more major fields, they are counted if any of those fields has an economics CIP code. The primary four-digit economics CIP code is 4506, which falls under the two-digit CIP code for social sciences (45). This includes general economics, EQE, and four other less prevalent economics categories However, the four-digit CIP code for business economics is 5206 because it falls under the two-digit CIP code for business (52).

[10] We don't use levels for outcomes because estimates in levels are sensitive to a small number of very large institutions and yield less stable inference.

[11] Notably, the treatment effects may intensify over time because the full impact may take several years. For example, a new EQE program may be able to draw students away from similar programs at the same college or university relatively quickly by enticing existing students at the HEI to change their major or add a second major. However, it may take four years or so to entice many students to enroll in a particular college or university to

degrees after introducing EQE programs. In our baseline definition, an institution is considered treated beginning in the first year it confers any EQE bachelor's degree in 2013 or later, regardless of whether GE degrees continue to be offered. However, the treatment effects may be different for those institutions. Therefore, we conduct additional sensitivity analysis in Section 5.

The model also includes institution fixed effects, α_i, year fixed effects, γ_t, and an intercept term for the omitted period and unit, μ. X_{it} includes one or more time-varying control variables. Our main specification controls for the IHS transformation of bachelor's degrees conferred to international students in "all other" fields excluding economics, business, social science, and STEM. Thus, the all other category includes humanities, education, and various other college majors. We view the all other category as unlikely to be substitutes with economics. We include the degrees conferred to international students in all other fields to account for overall changing marketability and recruitment of international students at the institution level, which could be correlated with the EQE treatment adoption. We also estimate sensitivity analysis for specifications that 1) exclude the all other degrees control variable, 2) include the all other degrees control variable and an additional control variable for other STEM bachelor's degrees conferred to international students, both IHS transformed, and 3) include additional controls for admission rate, economics program size, and R1 research status. ε_{it} is a mean zero error term uncorrelated with the treatment variable.

While one can estimate a two-way fixed effects model via ordinary least squares, such an approach is not ideal in our setting. EQE adoption is staggered over time and occurs at institutions that differ systematically from non-adopters in observable characteristics and pre-

complete an EQE there. We will also conduct event study analyses below to consider heterogeneous treatment effects over time.

treatment outcome trajectories, including selectiveness, research intensity, and program size. As a result, no single untreated group provides a clearly credible counterfactual, and unweighted DID estimates rely on a strong parallel trends assumption that may be violated in this context. Recent DID estimators designed for staggered adoption, such as Sun and Abraham (2021) and Callaway and Sant'Anna (2021), address biases arising from heterogeneous treatment timing but continue to rely on comparisons with untreated or not-yet-treated units. When treated and untreated institutions exhibit systematically different pre-treatment trends, these approaches may still be sensitive to violations of parallel trends.

Therefore, we use synthetic difference-in-differences (SDID), which accounts for staggered intervention and ensures pre-intervention parallel trends between treatment and control groups. SDID was developed by Arkhangelsky et al. (2021) and combines elements of traditional difference-in-differences methods with synthetic control methods (SCM) developed by Abadie and Gardeazabal (2003) and Abadie et al. (2010) and reviewed by Abadie (2021). Specifically, SDID compares treated units to a synthetic control group much like SCM, but SDID constructs the synthetic control group to have pre-treatment parallel trends to the treatment group without the much stronger restriction of SCM that the treatment and synthetic control have similar levels for pre-treatment outcomes. SDID is also better suited than SCM for dealing with multiple treatment groups with staggered treatment adoption.

More formally, synthetic difference-in-differences (SDID) estimates the average treatment effect on the treated (ATT) as follows:

$$\left(\hat{\tau}^{\text{sdid}}, \hat{\mu}, \hat{\alpha}, \hat{\gamma}\right) = arg \min_{\tau,\mu,\alpha,\gamma} \{ \sum_{i=1}^{N} \sum_{t=1}^{T} (Y_{it} - \mu - \alpha_i - \gamma_t - D_{it}\tau)^2 \widehat{w_i}^{\text{sdid}} \widehat{v_t}^{\text{sdid}} \}.$$

Here τ is the ATT of interest and $\hat{\tau}^{\text{sdid}}$ is its SDID estimate, D_{it} is the treatment variable, $\widehat{w_i}^{\text{sdid}}$ is the optimal weight for individual units, $\widehat{v_t}^{\text{sdid}}$ is the optimal weight for time periods. The rest of

the notation follows from above. Thus, SDID constructs a synthetic control group based on optimal weights for both individual units and time periods. Furthermore, SDID incorporates unit fixed effects, so that the treatment group and synthetic control group are matched on pre-intervention parallel trends but not levels.

SDID is particularly well-suited to settings in which treatment adoption is not random but is related to persistent institutional characteristics or smoothly evolving latent factors. Unlike conventional DID, SDID allows for selection on pre-treatment outcome levels and trends by constructing a weighted donor pool that closely matches the entire pre-treatment outcome trajectories of treated units. Under the assumption that unobserved factors driving both treatment adoption and outcomes have stable effects over time, a close pre-treatment fit implies that these factors are accounted for by the synthetic weights. As a result, SDID reduces sensitivity to violations of unweighted parallel trends that may arise when institutions adopting EQE differ systematically from non-adopters prior to treatment.[12]

Arkhangelsky et al. (2021) also indicate how synthetic DID can be applied to a staggered treatment setting by applying the SDID estimator repeatedly, once for every initial treatment year and then aggregating. We implement SDID using the sdid Stata program described in Clarke et al. (2024).[13] We construct standard errors using the bootstrap option.

To assist in later interpretation of ATT magnitudes, Table 1 includes treatment group summary statistics for economics bachelor's degree conferrals over the full period. Across all

[12] While SDID allows for selection on pre-treatment outcome levels and trends reflected in the data, it does not rule out all forms of endogenous adoption, particularly if treatment coincides with unanticipated shocks that differentially affect treated institutions. We therefore assess the plausibility of the identifying assumptions using event-study evidence and robustness checks that incorporate institutional controls and alternative estimators.
[13] SDID allows inclusion of time-varying control variables by first applying linear regression of the dependent variable on the control variable(s), constructing residuals, and using the residuals as dependent variable in the SDID estimator. We use the "projected" option, which estimates control variable coefficients only on the untreated units in order to construct residuals.

HEIs, the mean for international economics degree conferrals is 20.2. However, it is 34.2 for public HEIs and 14.0 for private HEIs. For economics bachelor's degree conferrals to domestic students, the full period means are 99.5 for all HEIs, 166.3 for public HEIs, and 69.6 for private HEIs. Thus, among our treatment group, public HEIs have larger numbers for both international and domestic economics bachelor's degrees.

Table 1: Treatment Group Summary Statistics for Economics Bachelor's Degree Conferrals

	(1) All HEIs	(2) Public HEIs	(3) Private HEIs
A. International Students			
Mean	20.203	34.153	13.962
Standard Deviation	41.236	65.021	21.096
% Zero	12.73%	11.37%	13.33%
B. Domestic Students			
Mean	99.521	166.328	69.633
Standard Deviation	126.120	184.027	70.653
% Zero	0.36%	0.10%	0.53%
Total Observations	3,300	1,020	2,280

Notes: The sample includes U.S. higher education institutions with a balanced panel of economics bachelor's degrees conferred during 2003-2022. U.S. service academies are excluded. HEI stands for higher education institutions.

5. SDID Results

5.1 Main Results

Table 2 presents SDID results for average treatment effects on the treated (ATT) for IHS of economics bachelor's degrees conferred. Column (1) reports ATT estimates for all higher education institutions (HEIs), and Columns (2) and (3) report separate ATTs for public and private HEIs, respectively. Panel A reports impacts for degrees conferred to international students. The ATT estimate of 0.195 is statistically significantly different from zero at the one percent level in Panel A Column (1). In Panel A Column (2), public HEIs have a statistically

significant ATT estimate of 0.273. In Panel A Column (3), private HEIs have a significant ATT estimate of 0.187. Thus, the ATT estimate is slightly larger for public HEIs than private HEIS, but both are positive and significant. Again, IHS coefficients can be roughly interpreted similarly to logs; these coefficients correspond to roughly 20-30 percent increases in economics degrees conferred to international students for having an EQE program after the OPT policy change. Furthermore, we can use treatment group sample means to get a sense of average effects by exponentiating the coefficients, subtracting one, and then multiplying by the sample means. This implies that the treatment on average increases international economics bachelor's degrees by 4.3 across all HEIs and by 10.7 at public HEIs and 2.9 at private HEIs.

Table 2: SDID ATT Estimates for IHS Economics Bachelor's Degree Conferrals

	(1) All HEIs	(2) Public HEIs	(3) Private HEIs
A. International Students	0.195***	0.273***	0.187***
	(0.042)	(0.095)	(0.052)
B. Domestic Students	0.058**	-0.020	0.103***
	(0.027)	(0.069)	(0.035)
Treatment Group Institutions	165	51	114
Control Group Donor Institutions	528	273	255

Notes: The sample includes U.S. higher education institutions with a balanced panel of economics bachelor's degrees conferred during 2003-2022. U.S. service academies are excluded. Average Treatment Effects on the Treated (ATT) estimated are computed via synthetic difference-in-differences (SDID). HEI stands for higher education institutions. Dependent variables use the inverse hyperbolic sine (IHS) transformation. Results include a control variable for IHS transformation of all other degrees conferred to international graduates; all other excludes economics, business, social sciences, and STEM. Standard errors are bootstrapped. *Significantly different from zero at the ten percent level. **Significant at five percent level. ***Significant at one percent level.

Table 2 Panel B conducts a similar analysis, but the dependent variable is economics bachelor's degrees conferred to domestic students. Domestic students do not gain OPT benefits from EQE, but program changes and spillover effects could possibly increase or decrease native degrees in economics. Column (1) of Table 2 Panel B reports an ATT estimate of 0.058 that is

statistically significant. However, the ATT estimate in Column (2) for public HEIs is small and not statistically significant. For private HEIs in Column (3), the ATT of 0.103 is significant. Thus, EQE programs appear to attract domestic students to economics at private HEIs but not at public HEIs. Furthermore, the ATT estimates for domestic students are always smaller than the estimates for international students, which is largely to be expected because of the OPT benefits that international students receive from EQE being a STEM field.[14]

5.2 Sensitivity Analysis

We next explore the sensitivity of our main results to alternative specifications. Table 3 first reports the main results for foreign students in Panel A. Panel B excludes the all other degrees control variable, and ATT estimates generally increase relative to Panel A. Panel C includes the all other degrees control variable and a second control variable for other STEM degrees (excluding EQE) conferred to international students. Some other STEM fields may be partially substitutable with economics and controlling for this could bias the estimates because it shuts down a potential mechanism by which economics degrees might increase, so these are not our preferred estimates. However, it is reassuring to observe that adding this additional control does not substantially alter the qualitative conclusions. The ATT estimates in Panel C are moderately smaller than in Panel A, but they are all positive and significant.

In addition, Mahon and Asarta (2024) identify several institutional characteristics that influence the likelihood of EQE program adoption, including admission rate, economics program size, and R1 research status. To further assess the robustness of our findings, we augment the Panel C specification by sequentially adding these covariates with a four-year lag. Results from

[14] It is also potentially consistent with domestic students being less interested in or less prepared for EQE compared to their international counterparts.

Panel C1-C4 for international students remain positive and statistically significant across all specifications, although effect magnitudes are somewhat attenuated. Even with a four-year lag, these controls are potentially altered by OPT policy and EQE program changes, preventing them from being clearly exogenous controls, so we exclude them from the baseline model, but it is notable that the main results for international students are qualitatively robust to their inclusion.

Our main analysis uses the IHS transformation instead of a log transformation because there are a large number of zero values in the untransformed dependent variable. However, another alternative approach that could be used for the dependent variable is to add one to each count of degree conferrals and then conduct a logarithmic transformation. We do this for Panel D of Table 3. ATT estimates are modestly smaller than the IHS estimates in Panel A, but they are always positive and significant. This log(Degrees + 1) dependent variable specification is somewhat ad hoc and not our preferred approach, but it can facilitate an intuitive comparison for readers unfamiliar with IHS. The results are qualitatively similar.

We noted previously that some institutions had EQE programs prior to the OPT policy change, but most adopted EQE programs after the OPT change and likely largely in response to the policy change. The EQE decision for the latter may depend on their expected benefits via bringing in more international students. More generally, the pre-OPT change adopters may have experienced differing effects from the later adopters. Panels E and F of Table 3 examine effects separately for the pre-adopter and later adopter treatments groups, respectively. Results for the all HEIs sample are very similar and results are largely similar for the private HEIs sample. For the public HEIs sample, the ATT estimate is larger for the pre-adopters (0.412) than the later adopters (0.214), but the number of pre-adopters is relatively small, so the standard errors are relatively large and we cannot be confident that the effects differ between these groups because

the implied confidence intervals overlap considerably. Still, it is notable that our main result for economics degrees conferred to international students is not driven exclusively by either group.

Table 3: Sensitivity Analysis for International Economics Bachelor's Degree Conferrals

	(1) All HEIs	(2) Public HEIs	(3) Private HEIs
A. Main Results from Table 2			
	0.195***	0.273***	0.187***
	(0.042)	(0.095)	(0.052)
B. Excluding Control for All Other International Degrees Conferred			
	0.279***	0.381***	0.266***
	(0.055)	(0.124)	(0.072)
C. Adding Additional Control for Other STEM International Degrees Conferred			
	0.171***	0.251***	0.159***
	(0.042)	(0.093)	(0.049)
C1. Adding Additional Control for Admission Rate			
	0.158***	0.239***	0.146***
	(0.036)	(0.085)	(0.050)
C2. Adding Additional Control for Economics Program Size			
	0.162***	0.227***	0.154***
	(0.043)	(0.086)	(0.049)
C3. Adding Additional Control for Admission Rate and Economics Program Size			
	0.147***	0.215***	0.139***
	(0.040)	(0.081)	(0.048)
C4. Adding Additional Control for Admission Rate, Economics Program Size, and R1			
	0.147***	0.214***	0.146***
	(0.040)	(0.080)	(0.048)
D. Dependent Variable as log(Degrees + 1)			
	0.163***	0.242***	0.153***
	(0.037)	(0.088)	(0.041)
E. Pre-Adopters Treatment Group			
	0.198**	0.412**	0.177**
	(0.081)	(0.197)	(0.082)
F. Later Adopters Treatment Group			
	0.194***	0.214**	0.193***
	(0.045)	(0.084)	(0.057)

Notes: The specification in Panel A is the same as the main results from Table 2 Panel A; see Table 2 notes. Additional panels differ as indicated; see text for additional details.
*Significantly different from zero at the ten percent level. **Significant at five percent level. ***Significant at one percent level.

Table 4: Sensitivity Analysis for Domestic Economics Bachelor's Degree Conferrals

	(1) All HEIs	(2) Public HEIs	(3) Private HEIs
A. Main Results from Table 2			
	0.058**	-0.020	0.103***
	(0.027)	(0.069)	(0.035)
B. Excluding Control for All Other International Degrees Conferred			
	0.059**	-0.023	0.104***
	(0.027)	(0.068)	(0.035)
C. Adding Additional Control for Other STEM International Degrees Conferred			
	0.059*	-0.020	0.105***
	(0.028)	(0.069)	(0.035)
C1. Adding Additional Control for Admission Rate			
	0.048*	-0.033	0.098***
	(0.028)	(0.054)	(0.031)
C2. Adding Additional Control for Economics Program Size			
	0.034	-0.055	0.086***
	(0.030)	(0.074)	(0.032)
C3. Adding Additional Control for Admission Rate and Economics Program Size			
	0.023	-0.068	0.074**
	(0.032)	(0.057)	(0.035)
C4. Adding Additional Control for Admission Rate, Economics Program Size, and R1			
	0.023	-0.067	0.075**
	(0.032)	(0.058)	(0.036)
D. Dependent Variable as log(Degrees + 1)			
	0.044*	-0.031	0.085***
	(0.025)	(0.066)	(0.031)
E. Pre-Adopters Treatment Group			
	-0.006	-0.256*	0.070
	(0.062)	(0.138)	(0.063)
F. Later Adopters Treatment Group			
	0.091***	0.081	0.121***
	(0.028)	(0.052)	(0.037)

Notes: The specification in Panel A is the same as the Table 2 Panel B; see Table 2 notes. Additional panels differ as indicated; see text for additional details. *Significantly different from zero at the ten percent level. **Significant at five percent level. ***Significant at one percent level.

Table 4 presents similar sensitivity checks for bachelor's degrees conferred to domestic students. Results in Panels B and C are qualitatively similar to the main specification in Panel A,

but other panels have some differences. Panels C1–C4 suggests that after incorporating admission rate, economics program size, and R1 status into the Panel C specification, the estimated effects become smaller and lose statistical significance for the all HEIs sample. These findings are consistent with the OPT STEM extension and EQE program creation primarily affecting international student enrollment and degree conferrals, rather than substantially altering outcomes for domestic students. Additionally, effects are more positive for the later adopters sample than for the pre-adopters sample. In fact, the ATT estimate is negative and significant at the ten percent level for domestic economics bachelor's degree conferrals at pre-adopting public HEIs. This is not a strong or robust result but may offer weak suggestion of crowd out effects at this subset of institutions.

While our preferred specification uses synthetic difference-in-differences (SDID), we also estimate a conventional two-way fixed effects (TWFE) difference-in-differences model for comparison. The TWFE results are reported in Table A1. Consistent with the SDID estimates, the TWFE results indicate a positive and statistically significant effect of EQE adoption on international economics bachelor's degree conferrals, with larger effects at public institutions than at private institutions. Estimated magnitudes are generally similar or modestly larger under TWFE, a pattern consistent with concerns that unweighted DID may place greater weight on institutions with dissimilar pre-treatment trends. The estimates regarding domestic student outcomes are also similar. These results reinforce the motivation for SDID and suggest that our findings are qualitatively robust.

To assess whether treatment effects differ by GE program availability, we conduct sensitivity analyses that distinguish institutions that continue to confer both GE and EQE degrees from those that fully transition away from GE. Table A2 reports SDID estimates excluding

institutions that offer both GE and EQE and estimates restricted to this subgroup alone. Column 1 reports the baseline estimates. Column 2 reports the estimates excluding those institutions offering both GE and EQE. The estimated effects on international economics degree conferrals remain positive and statistically significant and are slightly smaller than the baseline estimates, indicating that our main findings are robust to excluding these institutions. Column 3 reports the estimates only for institutions offering both GE and EQE. These estimates are larger in magnitude but should be interpreted with caution. Institutions in this group are heterogeneous because some offer both degrees only briefly during a transition period, while others maintain both programs for longer periods.

5.3 SDID Event Analysis

We next present SDID event study results using the sdid_event Stata package described in Ciccia (2024). This computes separate effects for each treatment cohort and year relative to treatment and then computes a weighted average across treatment cohorts to give treatment effect estimates by event year. Specifications are otherwise the same as Table 2. Results for international degrees are in Figure 4-6 with treatment effect estimates indicated by diamonds and 95 percent confidence intervals indicated via the shaded area. Results for degrees conferred to domestic students are in Figures 7-9. Estimates are noisy for some years but overall consistent with the main finding of significant positive effects on economics bachelor's degrees to international students and inconsistent impacts on native economics bachelor's degrees between public and private HEIs.

In addition to the baseline specification, we also present SDID event-study results using two alternative specifications that are particularly informative: Figure A1-A3 use the

specification including all additional institutional controls (Table 3, Panel C4), and Figure A4-A6 use a specification using log(degrees + 1) as the outcome (Table 3, Panel D). The event study estimates are qualitatively similar to the baseline results. This indicates that the dynamic treatment effects are qualitatively robust to alternative control sets and outcome transformations.

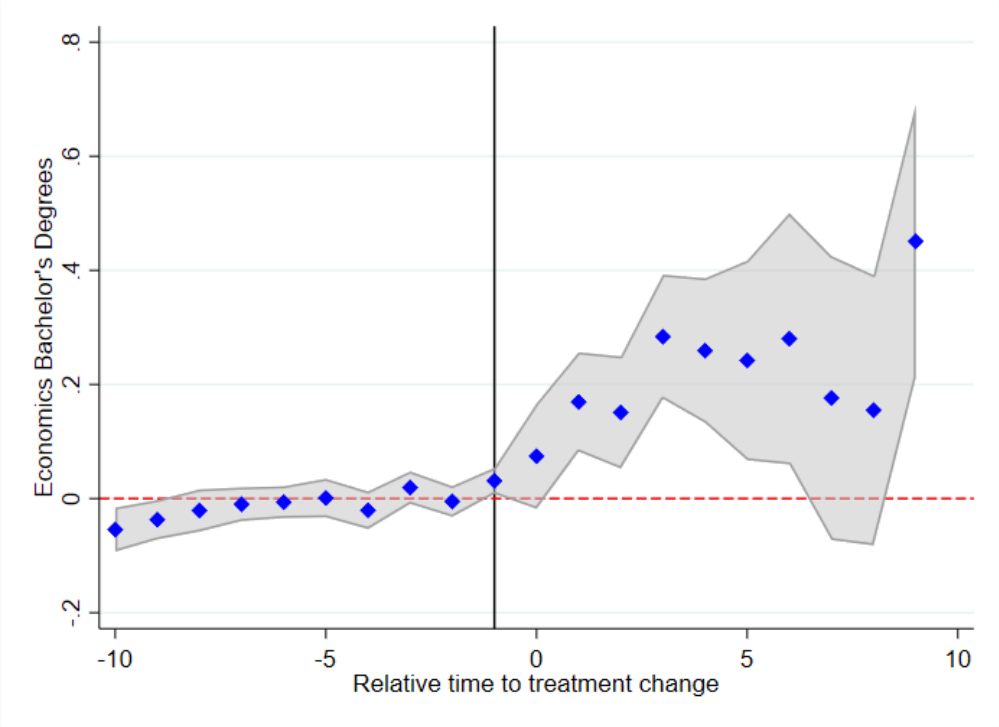

Figure 4. SDID Event Analysis Estimates for International Economics Bachelor's Degree at all HEIs

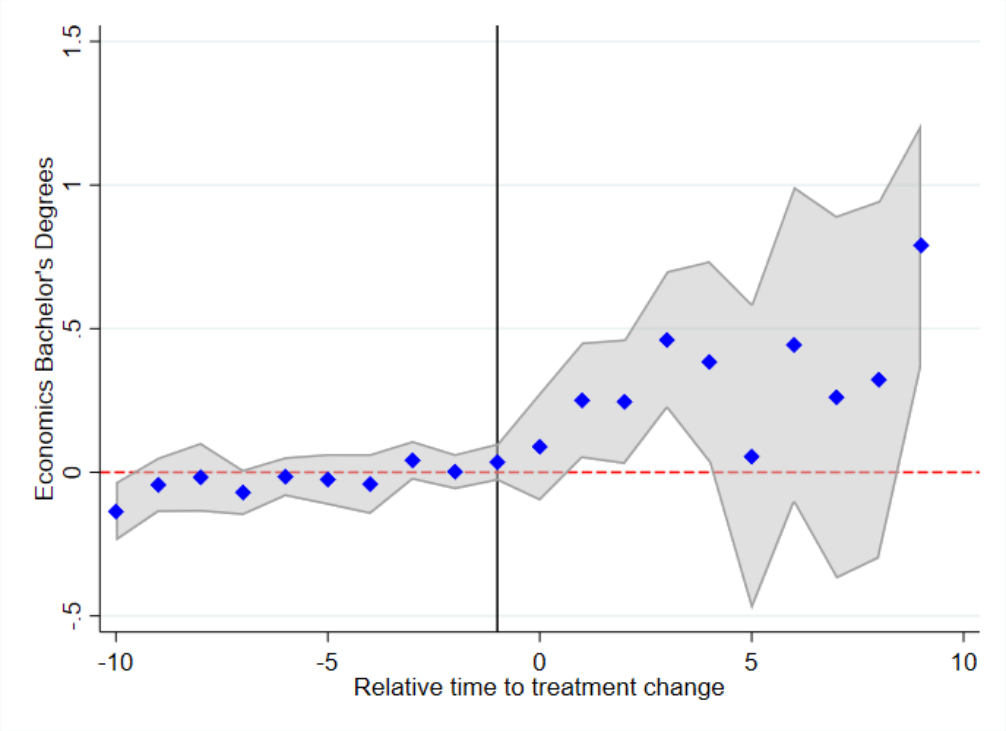

Figure 5. SDID Event Analysis Estimates for International Economics Bachelor's Degree at Public HEIs

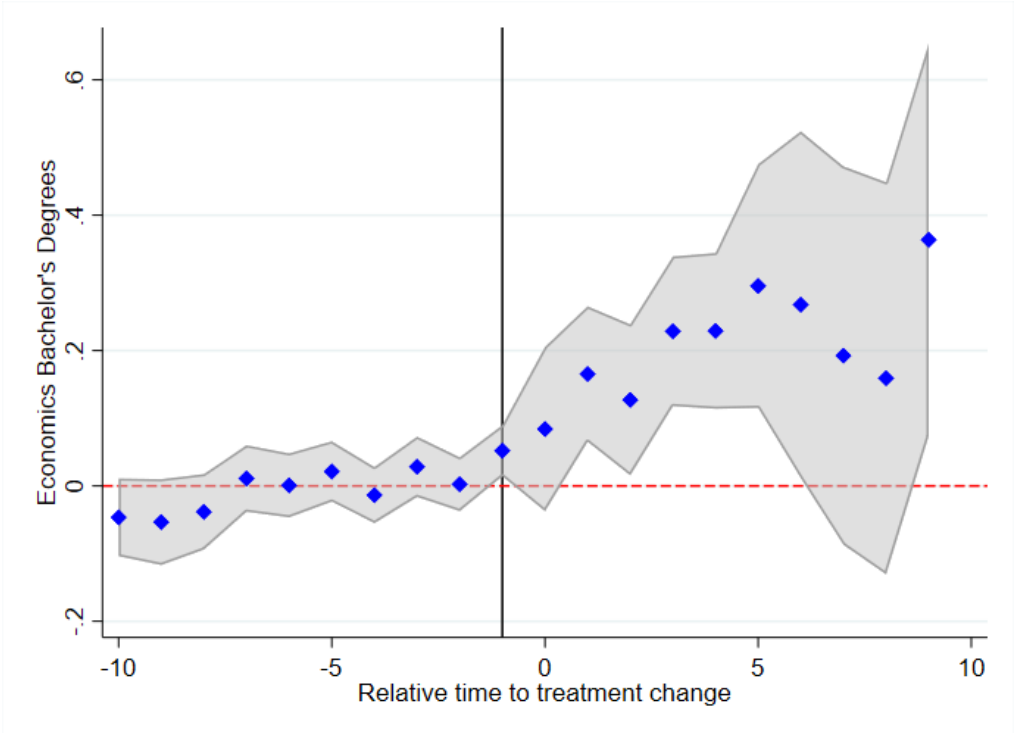

Figure 6. SDID Event Analysis Estimates for International Economics Bachelor's Degree at Private HEIs

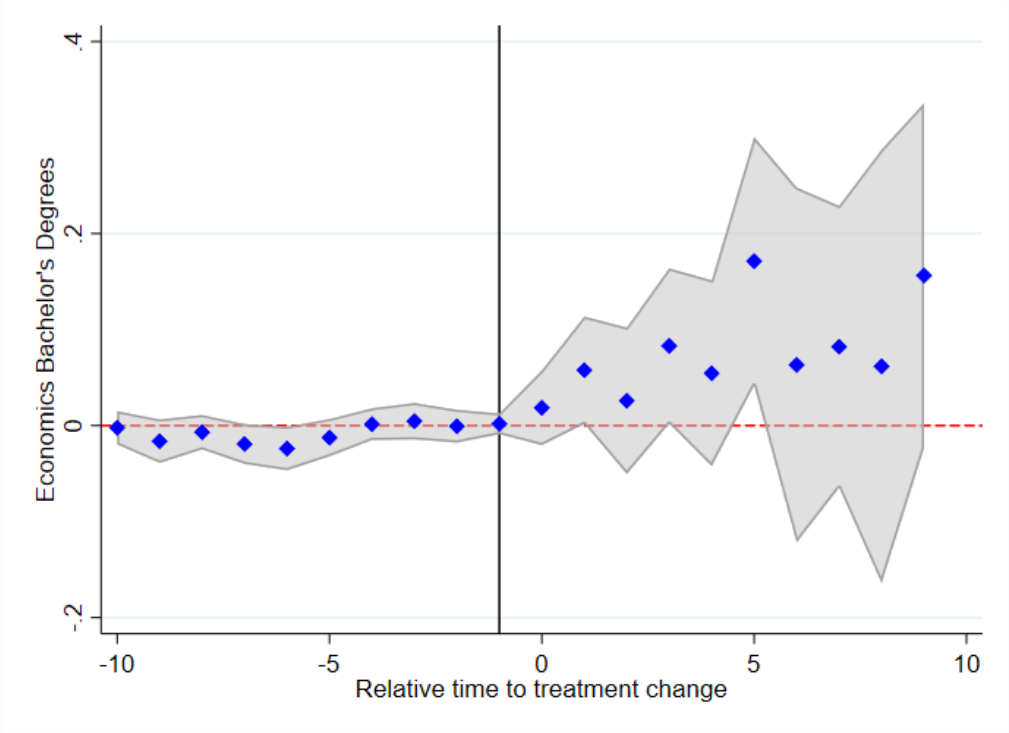

Figure 7. SDID Event Analysis Estimates for Domestic Economics Bachelor's Degree at all HEIs

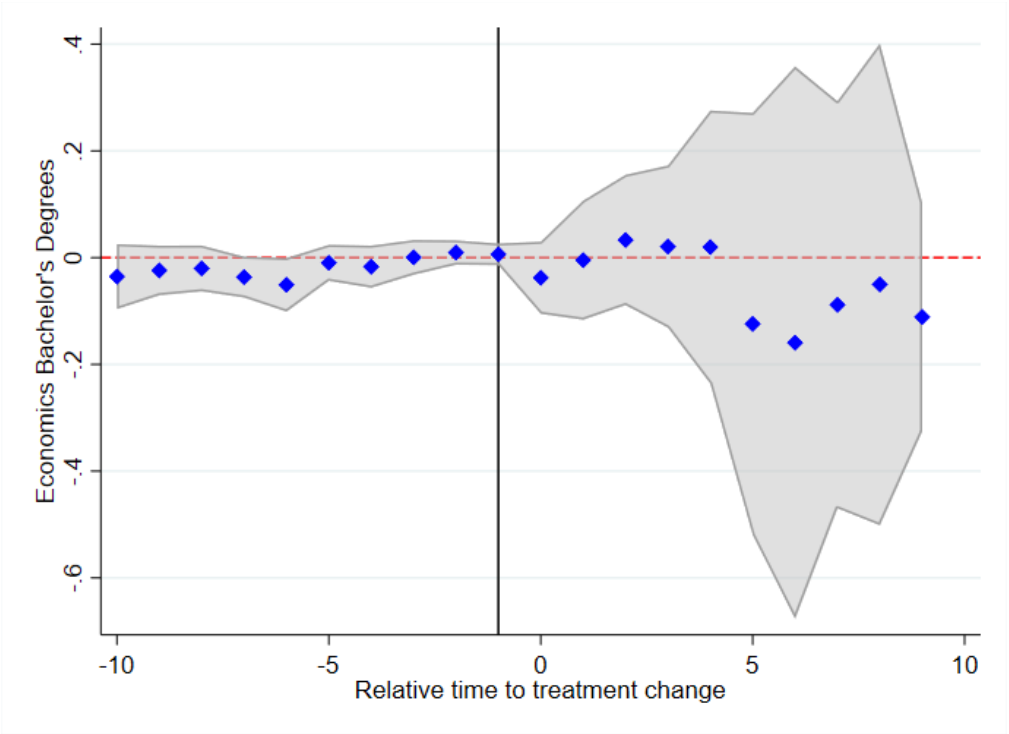

Figure 8. SDID Event Analysis Estimates for Domestic Economics Bachelor's Degree at Public HEIs

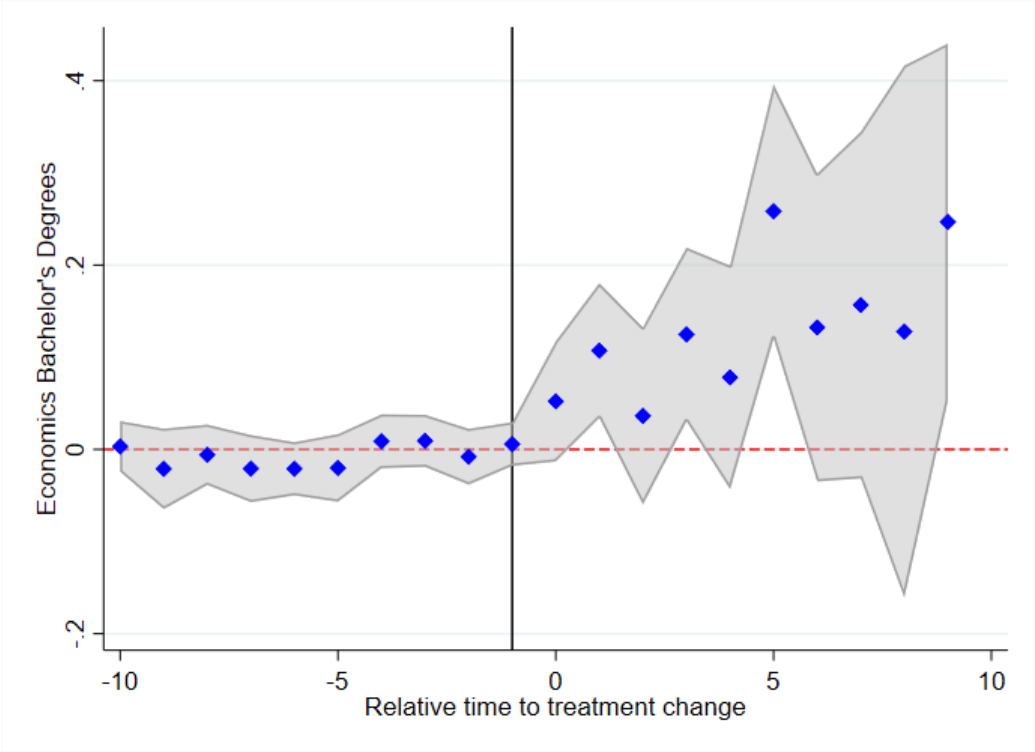

Figure 9. SDID Event Analysis Estimates for Domestic Economics Bachelor's Degree at Private HEIs

6. Conclusion

The Optional Practical Training (OPT) program underwent an important change in 2012 with the inclusion of Econometrics and Quantitative Economics (EQE) as a STEM field. This contributed to more than 100 colleges and universities creating new EQE undergraduate programs to benefit and attract international students. National time trend data show strong increases in EQE degree conferrals, but this partially involves displacement of other economics degrees by EQE. We use synthetic difference in differences (SDID) methods to examine the combined effects of OPT policy changes and EQE program creation on bachelor's degree conferrals in economics at U.S. colleges and universities. We find that OPT policy changes and EQE program creation combine to induce more foreign students to complete bachelor's degrees

in economics. The average effect magnitudes correspond to roughly 10.7 additional foreign economics graduates at public HEIs and 2.9 at private HEIs.

Longer OPT work authorization provides significant benefits to international students in U.S. degree programs including more time for training, increased earnings in the U.S., and more opportunities to apply for an H-1b visa. These benefits for international students alone make EQE program creation desirable for many higher education institutions. We show that OPT classification and EQE program creation combine to increase bachelor's degree completion in economics, indicating that higher education institutions directly benefit as well.

References

Abadie, A., 2021. Using synthetic controls: Feasibility, data requirements, and methodological aspects. Journal of Economic Literature, 59(2), 391-425.

Abadie, A. and Gardeazabal, J., 2003. The economic costs of conflict: A case study of the Basque Country. American Economic Review, 93(1), 113-132.

Abadie, A., Diamond, A. and Hainmueller, J., 2010. Synthetic control methods for comparative case studies: Estimating the effect of California's tobacco control program. Journal of the American Statistical Association, 105(490), 493-505.

Allgood, S., Bosshardt, W., Van Der Klaauw, W. and Watts, M., 2011. Economics Coursework and Long-Term Behavior and Experiences of College Graduates in Labor Markets and Personal Finance. Economic Inquiry, 49(3), 771-794.

Altonji, J.G., Blom, E. and Meghir, C., 2012. Heterogeneity in human capital investments: High school curriculum, college major, and careers. Annual Review of Economics, 4(1), 185-223.

Amanzadeh, N., Kermani, A. and McQuade, T., 2024. Return migration and human capital flows. NBER Working Paper No. 32352.

Amuedo-Dorantes, C., Furtado, D. and Xu, H., 2019. OPT policy changes and foreign born STEM talent in the US. Labour Economics, 61, Article 101752.

Amuedo-Dorantes, C., Shih, K. and Xu, H., 2023. The implications of optional practical training reforms on international student enrollments and quality. Economic Inquiry, 61(2), 253-281.

Anelli, M., Shih, K. and Williams, K., 2023. Foreign students in college and the supply of STEM graduates. Journal of Labor Economics, 41(2), 511-563.

Arkhangelsky, D., Athey, S., Hirshberg, D.A., Imbens, G.W. and Wager, S., 2021. Synthetic difference-in-differences. American Economic Review, 111(12), 4088-4118.

Bayer, A., and Rouse, C.E., 2016. Diversity in the Economics Profession: A New Attack on an Old Problem. Journal of Economic Perspectives 30 (4): 221–42**.**

Beine, M., Peri, G. and Raux, M., 2023. International college students' impact on the US skilled labor supply. Journal of Public Economics, 223, 104917.

Bellemare, M.F. and Wichman, C.J., 2020. Elasticities and the inverse hyperbolic sine transformation. Oxford Bulletin of Economics and Statistics, 82(1), 50-61.

Black, D.A., Sanders, S. and Taylor, L., 2003. The economic reward for studying economics. Economic Inquiry, 41(3), 365-377.

Bleemer, Z. and Mehta, A., 2022. Will studying economics make you rich? A regression discontinuity analysis of the returns to college major. American Economic Journal: Applied Economics, 14(2), 1-22.

Bound, J., Braga, B., Khanna, G. and Turner, S., 2020. A passage to America: University funding and international students. American Economic Journal: Economic Policy, 12(1), 97-126.

Bound, J., Braga, B., Khanna, G. and Turner, S., 2021. The globalization of postsecondary education: The role of international students in the US higher education system. Journal of Economic Perspectives, 35(1), 163-184.

Bound, J., Demirci, M., Khanna, G. and Turner, S., 2015. Finishing degrees and finding jobs: US higher education and the flow of foreign IT workers. Innovation Policy and the Economy, 15(1), 27-72.

Callaway, B., and Sant'Anna, P.H.C., 2021. Difference-in-differences with multiple time periods. Journal of Econometrics, 225(2) 200-230.

Ciccia, D. (2024) A short note on event-study synthetic difference-in-differences estimators. arXiv preprint arXiv:2407.09565. https://doi.org/10.48550/arXiv.2407.09565.

Clarke, D., Pailañir, D., Athey, S. and Imbens, G.W., 2024. Synthetic difference-in-differences estimation. Stata Journal, Forthcoming.

Demirci, M., 2019. Transition of international science, technology, engineering, and mathematics students to the US labor market: The role of visa policy. Economic Inquiry, 57(3), 1367-1391.

Groen, J.A. and White, M.J., 2004. In-state versus out-of-state students: The divergence of interest between public universities and state governments. Journal of Public Economics, 88(9-10), 1793-1814.

Khoo, P., 2023. If You Extend It, They Will Come: The Effects of the STEM OPT Extension. Utah State University Center for Growth and Opportunity Working Paper. https://www.thecgo.org/research/if-you-extend-it-they-will-come-the-effects-of-the-stem-opt-extension/

Kim, S.W., 2024. Foreign student share and supply of STEM-designated economics programs. SSRN Working Paper. http://dx.doi.org/10.2139/ssrn.4591239

Mahon, D.M. and Asarta, C.J., 2024. Why are Schools Reclassifying Their Economics Major?. Eastern Economic Journal, 50(1), 103-116.

Marshall, E.C. and Underwood, A., 2020. Is economics STEM? Trends in the discipline from 1997 to 2018. Journal of Economic Education, 51(2), 167-174.

Marshall, E.C. and Underwood, A., 2022. Is economics STEM? Process of (re) classification, requirements, and quantitative rigor. Journal of Economic Education, 53(3), 250-258.

Miano, J., 2017. A history of the 'optional practical training'guestworker program. Center for Immigration Studies Report. https://cis.org/sites/default/files/2017-10/miano-OPT.pdf

Nieswiadomy, M.L., 2024. LSAT® scores of economics majors: The 2022–23 class update and 7-year history. Journal of Economic Education, 1-6.

Ransom, T. and Winters, J.V., 2021. Do foreigners crowd natives out of STEM Degrees and occupations? Evidence from the US Immigration Act of 1990. ILR Review, 74(2), 321-351.

Routon, P.W., 2018. Is an economics degree good preparation for the LSAT? Journal of Economic Education, 49(3), 271-277.

Shih, K., 2017. Do international students crowd-out or cross-subsidize Americans in higher education? Journal of Public Economics, 156, 170-184.

Sun, L., and Abraham, S., 2021. Estimating dynamic treatment effects in event studies with heterogeneous treatment effects. Journal of Econometrics, 225(2), 175-199.

Winters, J.V., 2012. Cohort crowding and nonresident college enrollment. Economics of Education Review, 31(3), 30-40.

Winters, J.V. and Xu, W., 2014. Geographic differences in the earnings of economics majors. Journal of Economic Education, 45(3), 262-276.

Appendix

Table A1: TWFE DID Estimates for IHS Economics Bachelor's Degree Conferrals

	(1) All HEIs	(2) Public HEIs	(3) Private HEIs
A. International Students	0.238***	0.390***	0.189***
	(0.043)	(0.088)	(0.048)
B. Domestic Students	0.091**	0.045	0.133***
	(0.035)	(0.059)	(0.045)
Treatment Group Institutions	165	51	114
Control Group Donor Institutions	528	273	255

Notes: The sample includes U.S. higher education institutions with a balanced panel of economics bachelor's degrees conferred during 2003-2022. U.S. service academies are excluded. TWFE DID stands for two-way fixed effects difference in differences. HEI stands for higher education institutions. Dependent variables use the inverse hyperbolic sine (IHS) transformation. Results include a control variable for IHS transformation of all other degrees conferred to international graduates; all other excludes economics, business, social sciences, and STEM. Standard errors are bootstrapped. *Significantly different from zero at the ten percent level. **Significant at five percent level. ***Significant at one percent level.

Table A2: SDID ATT Estimates for IHS Economics Bachelor's Degree Conferrals

	(1) Baseline	(2) Excluding GE+EQE inst.	(3) Only GE+EQE inst.
A. International Students	0.195***	0.142***	0.274***
	(0.042)	(0.052)	(0.063)
B. Domestic Students	0.058**	0.074***	0.036
	(0.027)	(0.027)	(0.043)
Treatment Group Institutions	165	112	53
Control Group Donor Institutions	528	528	528

Notes: The sample includes U.S. higher education institutions with a balanced panel of economics bachelor's degrees conferred during 2003-2022. U.S. service academies are excluded. Average Treatment Effects on the Treated (ATT) estimated are computed via synthetic difference-in-differences (SDID). HEI stands for higher education institutions. Dependent variables use the inverse hyperbolic sine (IHS) transformation. Results include a control variable for IHS transformation of all other degrees conferred to international graduates; all other excludes economics, business, social sciences, and STEM. Standard errors are bootstrapped. *Significantly different from zero at the ten percent level. **Significant at five percent level. ***Significant at one percent level.

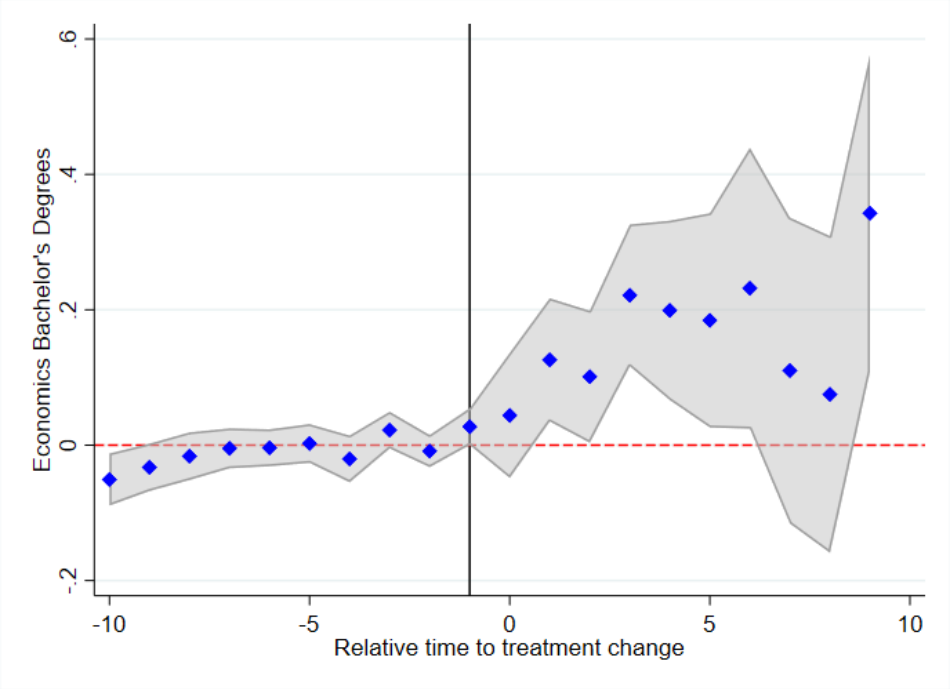

Figure A1. SDID Event Analysis Estimates for International Economics Bachelor's Degree at all HEIs, with all controls

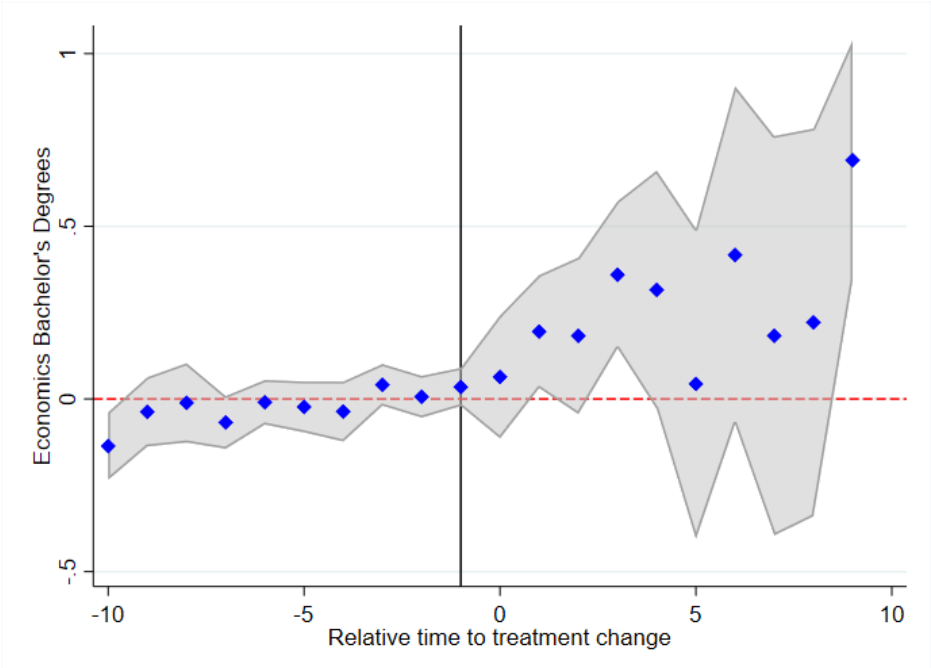

Figure A2. SDID Event Analysis Estimates for International Economics Bachelor's Degree at public HEIs, with all controls

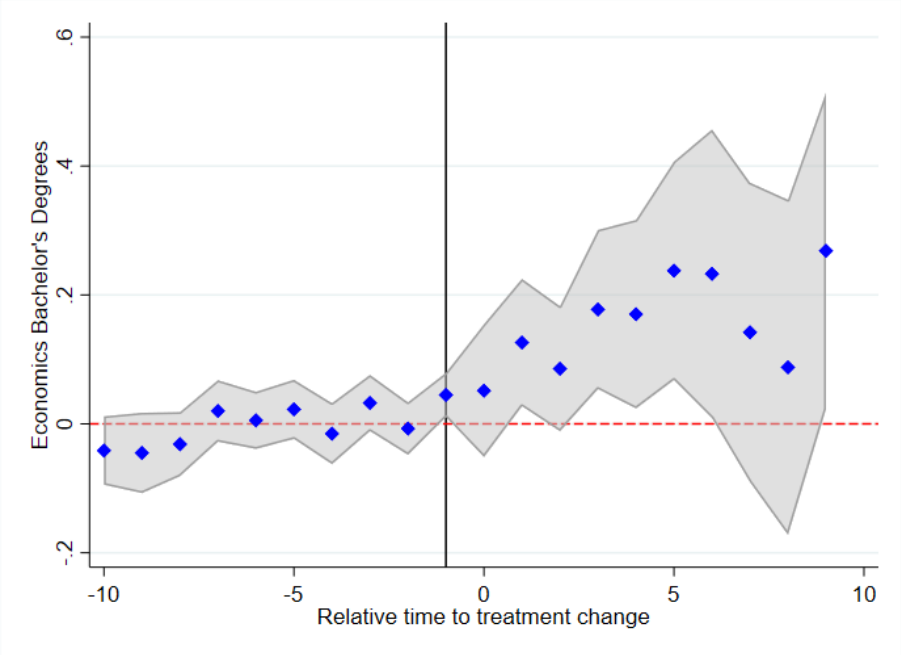

Figure A3. SDID Event Analysis Estimates for International Economics Bachelor's Degree at private HEIs, with all controls

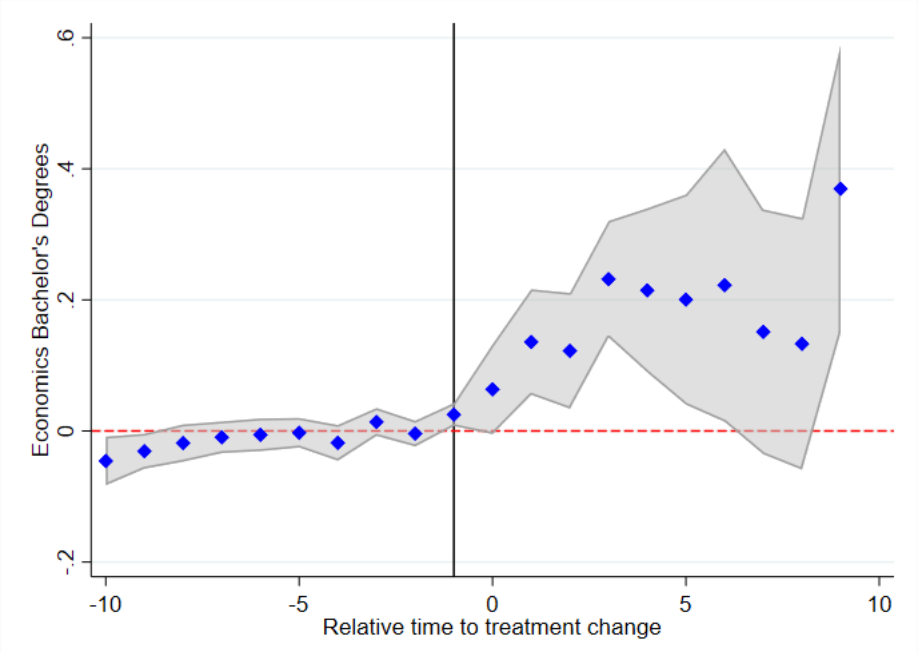

Figure A4. SDID Event Analysis Estimates for International Economics Bachelor's Degree at all HEIs, using log(Degree + 1) as outcome

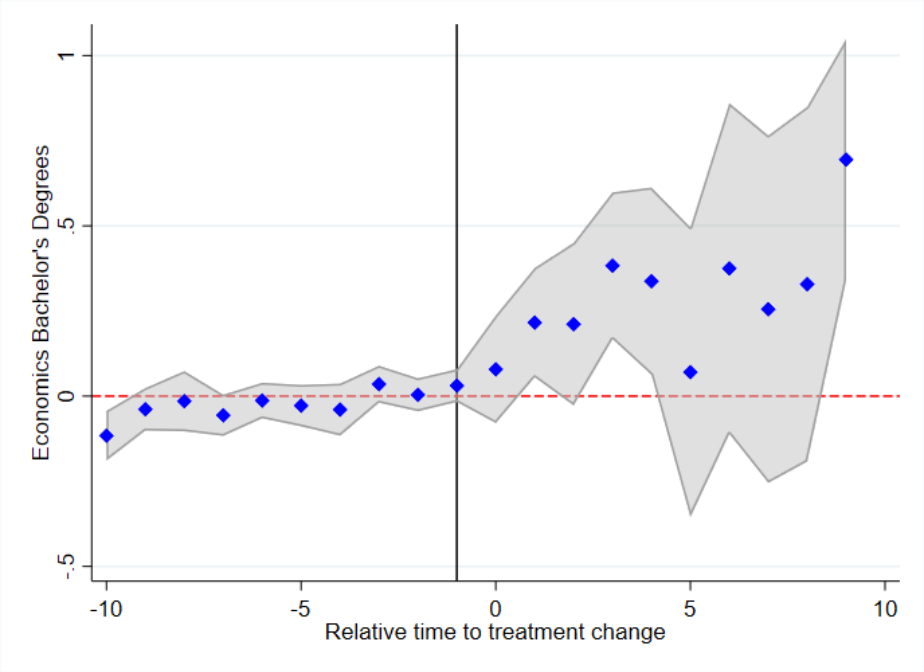

Figure A5. SDID Event Analysis Estimates for International Economics Bachelor's Degree at public HEIs, using log(Degree + 1) as outcome

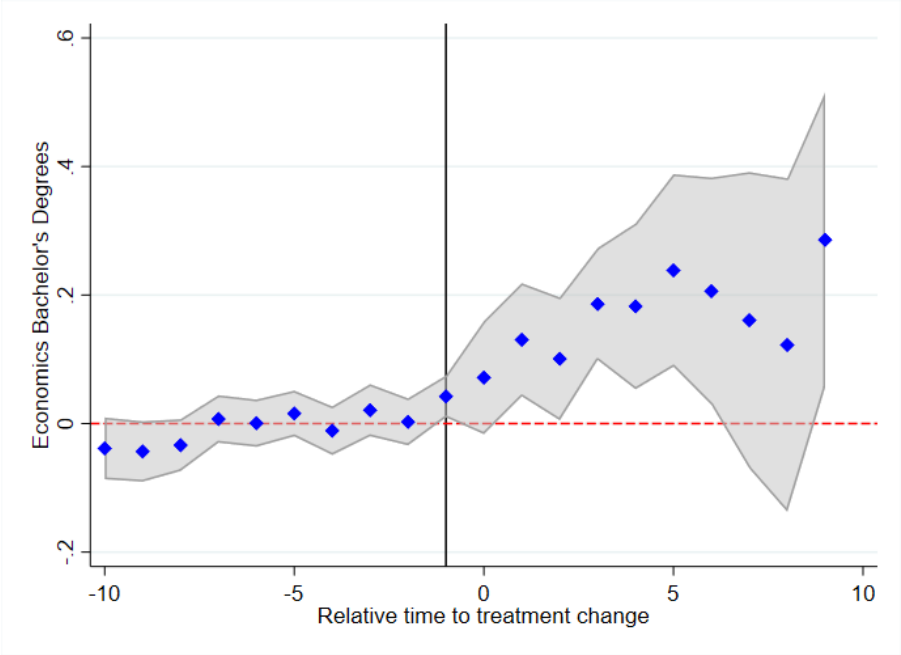

Figure A6. SDID Event Analysis Estimates for International Economics Bachelor's Degree at private HEIs, using log(Degree + 1) as outcome