Annenberg Institute
BROWN UNIVERSITY

EdWorkingPaper No. 24-1040

Foreign Student Share and Supply of STEM-Designated Economics Programs

Sie Won Kim
Texas Tech University

Over the past decade, there has been a significant increase in the number of U.S. institutions offering STEM-eligible degree programs in economics. This paper documents the trends in STEM-degree offerings across degree levels and examines the share of foreign students and other characteristics of institutions that offer STEM-eligible programs. Using a difference-in-differences design, this paper finds that departments with a proportion of foreign students above the sample median are 6 and 9 percentage points more likely to offer a STEM-eligible degree program at the bachelor's and master's levels, respectively, after the STEM designation in 2013. Additionally, the tobit regression results suggest that early adopters of STEM-eligible programs are associated with a higher share of foreign students, private institutions and doctoral and research institutions.

VERSION: September 2024

Suggested citation: Kim, Sie Won. (2024). Foreign Student Share and Supply of STEM-Designated Economics Programs. (EdWorkingPaper: 24-1040). Retrieved from Annenberg Institute at Brown University: https://doi.org/10.26300/z76p-3f77

Foreign Student Share and Supply of STEM-Designated Economics Programs

Sie Won Kim*

September 3, 2024

Abstract

Over the past decade, there has been a significant increase in the number of U.S. institutions offering STEM-eligible degree programs in economics. This paper documents the trends in STEM-degree offerings across degree levels and examines the share of foreign students and other characteristics of institutions that offer STEM-eligible programs. Using a difference-in-differences design, this paper finds that departments with a proportion of foreign students above the sample median are 6 and 9 percentage points more likely to offer a STEM-eligible degree program at the bachelor's and master's levels, respectively, after the STEM designation in 2013. Additionally, the Tobit regression results suggest that early adopters of STEM-eligible programs are associated with a higher share of foreign students, private institutions and doctoral and research institutions.

JEL Classification: I21, I23, A22, A23

Keywords: STEM; economics major; international students; higher education

*Department of Economics, Texas Tech University, Lubbock, TX 79409, USA. E-mail address: siewon.kim@ttu.edu

1 Introduction

Science, technology, engineering, and mathematics (STEM) education has become increasingly important in recent decades due to its role in economic growth and innovation in the United States (Executive Office of the President, 2018). Economics, with its quantitative focus, is one of the few social sciences majors designated as STEM by the U.S. Department of Homeland Security (DHS). In May 2012, DHS added the Classification of Instructional Programs (CIP) code 45.0603 (Econometrics and Quantitative Economics) to the STEM list. It is important to note that not all economics programs are designated as STEM as the STEM-eligibility is determined only by the underlying CIP code and not by the title, curriculum, or degree requirements of the degree program.

The STEM designation of economics programs has a significant implication for international students and their post-study labor market prospects in the United States. International students seeking employment in the United States typically apply for an Optional Practical Training (OPT) visa, which allows them to stay in the country to work or seek employment for one year. Following this period, only STEM-designated degree holders are eligible to apply for an extension.[1] Since the OPT is a temporary student training program, international students seeking long-term employment need a work visa such as an H-1B visa. The STEM-OPT extension allows graduates with STEM degrees more time to find an employer sponsoring their H-1B petition and enter into the H-1B lottery in multiple cycles, which can increase their chances of obtaining the work visa.

This paper uses a sample of four-year institutions offering economics degree programs (all CIP codes starting with 45.06) between the academic years 2007−08 and 2021−22 from the Integrated Postsecondary Education Data System (IPEDS).[2] Figure 1 shows that prior to the inclusion of one economics CIP code in the STEM list in 2012, only four percent of

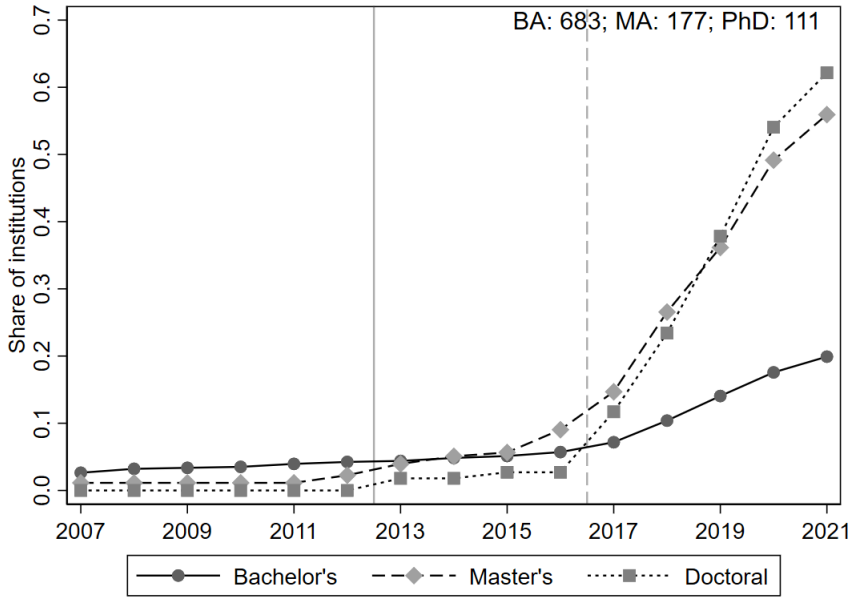
[1] When the STEM-OPT extension was first implemented in 2008, the extension period was 17 months, and it expanded to 24 months in 2016.

[2] Throughout the paper, the terms "institutions" and "departments" are used interchangeably.

institutions offered STEM-eligible bachelor's degree in economics. The share of institutions offering STEM-eligible master's degrees in economics was even lower at two percent, and none of the institutions offered a STEM-eligible economics degree at the doctoral level.

Following the inclusion of one economics CIP code in the STEM-eligible list, there has been a significant increase in the supply of STEM-eligible degree programs in economics especially at the graduate level. Figure 1 shows that over 60 percent of institutions offered STEM-designated programs at the graduate level in 2021. This notable surge in the supply of STEM degree programs in economics provides a unique context for understanding how economics departments make their supply decisions of new degree programs.

Figure 1: Share of Institutions Offering STEM-Economics Programs



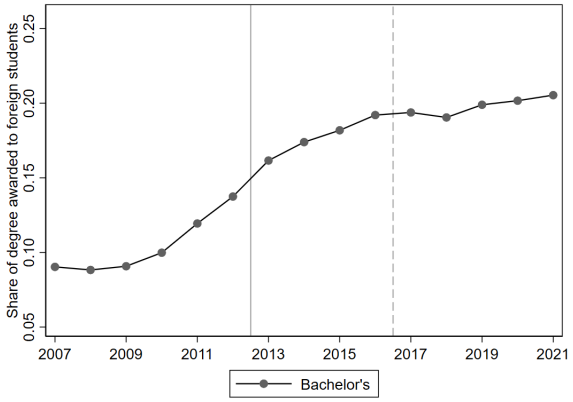
Notes: Each line illustrates the share of institutions offering STEM-eligible economics degree program under the CIP code 45.0603 (Econometrics and Quantitative Economics). The total number of institutions in each degree level offering any economics CIP codes is shown within the Figure. In May 2012 (a solid vertical line), CIP code 45.0603 was included as a STEM-eligible major. In May 2016 (a dashed vertical line), the OPT period was extended to 24 months (total 36 months).

Figure 2 illustrates that the proportion of economics degrees awarded to international

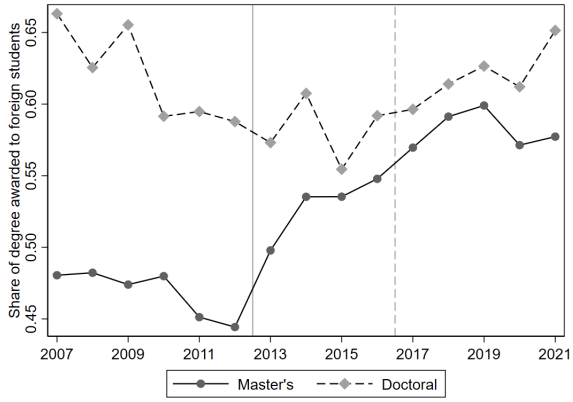
students increased over the last decade as well. The share of bachelor's degrees awarded to international students increased from 10 percent to 20 percent as shown in Figure 2(a) consistent with the findings in Marshall and Underwood (2020). Furthermore, Figure 2(b) shows that the percentage of master's degrees awarded to foreign students increased from 50 to 60 percent. Despite having the largest fraction of international students, the share of doctoral degrees awarded to international students remained constant during the same period.

Figure 2: Share of Economics Degrees Awarded to International Students

(a) Bachelor's degree



(b) Master's and doctoral degree



Notes: Each line illustrates the share of economics degrees awarded to international students under any economics CIP codes across degree levels. Panel (a) shows the share of bachelor's degrees awarded to foreign students, and Panel (b) displays the shares of master's and doctoral degrees awarded to foreign students. Note that the scales of y-axis vary. In May 2012 (a solid vertical line), CIP code 45.0603 was included as a STEM-eligible major. In May 2016 (a dashed vertical line), the OPT period was extended to 24 months (total 36 months).

This paper examines the share of foreign students and other characteristics of institutions that offer STEM-economics degree programs across bachelor's, master's, and doctoral levels when one economics CIP code became STEM-eligible. The research questions addressed include: What impact does the share of foreign students have on the supply of STEM degree programs? What institutional characteristics are associated with the timing of introducing STEM-designated programs? What are the distinctions between undergraduate and graduate

programs?

Using a difference-in-differences model, this paper finds that a department with a higher proportion of foreign students is 6 percentage points more likely to offer a STEM-eligible degree program at the bachelor's level and 9 percentage points more likely at the master's level compared to departments with a lower foreign student share. The results remain consistent using the number of years since an institution began offering a STEM-economics program as an outcome variable. Departments with a higher proportion of international students, that are at private institutions, and doctoral and research universities are strongly associated with earlier offerings of STEM-degree programs. In addition, across degree levels, economics departments at the graduate level are more likely to offer more STEM-designated programs in comparison to undergraduate programs. One potential explanation for this observation is that graduate programs inherently emphasize a quantitative focus within their program requirements, making the transition to the STEM designation easier for them.

2 Related literature

This paper focuses on the supply-side responses of institutions offering STEM-degree programs and contributes to the existing literature on the demand-side responses from the students to the changes in the immigration policy, in particular, the STEM-OPT extension rule. Previous research suggests that the STEM OPT extension leads to an increase in the number of international students majoring in STEM fields (Amuedo-Dorantes, Furtado, and Xu, 2019; Amuedo-Dorantes, Shih, and Xu, 2023; Khoo, 2023). Also, the extension of OPT periods increased the likelihood of STEM international students staying in the United States after graduation (Demirci, 2019). However, little is known about the supply-side responses of how institutions offer new STEM degree programs. Kim (2022) focuses on business majors and finds that departments offer more STEM-business degree programs to recruit and

benefit their international students in response to the STEM-eligibility of business majors. This paper focuses on economics majors as only one among the six economics CIP codes was STEM-designated. Economics is generally known for its quantitative training, and the National Science Foundation includes social sciences as one of the Science and Engineering (S&E) fields (National Science Foundation, 2022).

Additionally, this paper complements the existing literature on undergraduate economics programs by extending the analysis to the graduate level. Marshall and Underwood (2020) document an increase in bachelor's degrees awarded in STEM-designated economics and examine potential motivations for undergraduate departments. In addition, a survey of economics departments conducted by Marshall and Underwood (2022) reveals that the quantitative nature of economics is the main motivation for departments to offer STEM degree programs in bachelor's degree level. I investigate master's and doctoral programs in economics as well as undergraduate programs to examine differences across degree levels. This paper finds similar evidence that departments offering undergraduate programs only are less likely to offer STEM undergraduate degree programs compared to those with both undergraduate and graduate programs where graduate programs in economics tend to emphasize more on their quantitative training.

Using a logistic regression, Mahon and Asarta (2024) find that the share of international students, the relative size of the program, selectivity, and R1 classification are related to offering STEM-degree programs in economics. In this paper, I examine both undergraduate and graduate programs and find a positive differential effect of the inclusion of one economics CIP code in STEM-eligible list in May 2012 for institutions with above the sample median share of foreign students compared to those with below the sample median share of international students. In addition to estimating the differential effect on the probability of offering STEM-designated economics programs, this paper finds a positive correlation between the share of international students and the timing of STEM-degree program adoption

using a Tobit model. Additionally, the result shows that private institutions are positively associated with the earlier adoption of STEM-degree programs. This discrepancy can be partly explained by the findings of Marshall and Underwood (2022), where the authors find that public institutions require more college and university committee approval compared to private institutions.

3 Data and methodology

3.1 Data sample

I construct a sample of four-year colleges and universities using the Integrated Postsecondary Education Data System (IPEDS). The sample consists of four-year institutions offering economics degree programs (all CIP codes starting with 45.06) from the academic years 2007−08 to 2021−22. The sample consists of 683, 177, and 111 institutions at the bachelor's, master's and doctoral levels, respectively. I infer the timing of offering a STEM degree from the timing of STEM degrees awarded as the departments are expected to award STEM degrees shortly after they begin offering STEM degree programs. This is because current students can transition into new STEM degree programs when the current CIP code is updated to a STEM-eligible code. The variables include the number of degrees awarded in the six-digit CIP codes starting with 45.06, number of degrees awarded to international students, degree level, public/private control, Carnegie classification, and institution size category. For the Tobit analysis, to account for accurate timing and focus on the responses to the inclusion of economics in the STEM-eligible list in May 2012, institutions that offered STEM economics before 2013 are excluded as shown in the last row of Table 1.

Table 1 shows the differences in characteristics of economics departments across degree levels and the supply of STEM-programs. Across all degree levels, economics departments that offer a STEM-eligible degree program tend to have a higher share of international stu-

dents in the base year 2007, award more degrees implying larger departments, and be private institutions. Graduate programs tend to enroll a higher share of foreign students, which may affect departments' decisions to offer a STEM-degree program. At the bachelor's level, institutions that offer STEM-economics are twice as likely to be doctoral and research institutions. This implies that the presence of graduate programs may influence the decision to offer STEM-designated programs at the bachelor's level as well. Over 95 percent of economics departments offering STEM-designated master's and Ph.D. degrees fall into doctoral and research Carnegie classification compared to 50 percent of institutions offering STEM-designated bachelor's degrees in economics. This may reflect the quantitative nature of the economics degree programs at the undergraduate and graduate levels. Additionally, graduate programs are more likely to be found at larger institutions with enrollments of over 20,000 students than bachelor's programs.

Table 1: Descriptive Statistics: Economics Degree Programs

	Bachelor's		Master's		Doctoral	
	(1)	(2)	(3)	(4)	(5)	(6)
	Non-STEM	STEM	Non-STEM	STEM	Non-STEM	STEM
%Foreign$_{base}$	0.09	0.12	0.40	0.54	0.64	0.72
	[0.2]	[0.1]	[0.3]	[0.3]	[0.3]	[0.2]
High%foreign	0.44	0.74	0.33	0.56	0.38	0.48
	[0.5]	[0.4]	[0.5]	[0.5]	[0.5]	[0.5]
#Degrees awarded	34.8	135.6	11.7	33.5	5.9	13.2
	[71.7]	[158.3]	[18.1]	[45.4]	[5.1]	[10.2]
Private	0.49	0.72	0.18	0.31	0.26	0.39
	[0.50]	[0.45]	[0.39]	[0.47]	[0.45]	[0.49]
Doctoral/Research	0.24	0.51	0.74	0.96	1.00	1.00
	[0.43]	[0.50]	[0.44]	[0.20]	[0.00]	[0.00]
Institution size	0.18	0.25	0.47	0.66	0.62	0.72
($\geq$ 20,000)	[0.38]	[0.43]	[0.50]	[0.48]	[0.49]	[0.45]
Years STEM	-	3.25	-	3.46	-	3.19
		[1.74]		[1.90]		[1.68]
Observations	547	136	78	99	42	69
Obs. (Years STEM)		(107)		(95)		(69)

Notes: The table reports means and standard deviations of institutional characteristics by degree levels in 2021. Columns (1), (3), and (5) show institutions awarded degrees in economics (all CIP codes starting with 45.06 except 45.0603 (Econometrics and Quantitative Economics). Columns (2), (4), and (6) display institutions awarded degrees under the CIP code 45.0603 (Econometrics and Quantitative Economics). %Foreign$_{base}$ is the share of foreign students in the base year 2007. High%foreign is a binary variable that equals 1 if the share of foreign students is higher than the sample median share of foreign students in the base year 2007 and 0 otherwise. #Degree awarded is the average number of degrees awarded in each economics CIP code. Doctoral/Research category is the share of doctoral and research universities based on the Carnegie Classification. Institution size category is based on total students enrolled for credit. Years STEM is the average number of years since offering a STEM-degree program. For Years STEM variable, the average number of years is computed using the institutions offering STEM programs after 2013. The number of observations for Years STEM is shown in parentheses (last row). Standard deviations are shown in brackets.

3.2 Empirical strategy

Suppose two institutions offer a degree program in economics with similar curricula including quantitative courses (e.g., econometrics). One institution decides to update its CIP code, while the other does not. As a result, international students who have received similar quantitative training would face different labor market opportunities. One group would receive one year of OPT period to work in the United States after graduation, while the other group with STEM degrees could potentially obtain up to three years of OPT visa period due to the STEM-OPT extension rule.

Given this potential benefit to international students of inclusion of one economics CIP code in the STEM-eligible list, this paper hypothesizes that departments with a higher share of international students have a higher incentive to supply a new degree program in STEM-economics. The treatment status is assigned using the share of foreign students. I estimate the following difference-in-differences model:

$$Y_{jt} = \beta_0 + \beta_1 Post\text{-}2013_t \times High\%foreign_j^{base} + \delta_j + \delta_t + \epsilon_{jt} \tag{1}$$

where Y_{jt} is a binary variable equal to 1 if an institution j offers a STEM-degree in economics in the fall semester of year t. $Post\text{-}2013_t$ is a dummy variable equal to 1 if the year of observation is after 2013. $High\%foreign_j^{base}$ equals 1 if the share of foreign students is higher than the sample median share of foreign students in the base year 2007 and 0 otherwise. This binary variable is used as a treatment variable instead of the continuous measure of the proportion of international students. Examining the share of foreign students in the base year and STEM offering status suggests that the relationship between the share of international students and the supply of STEM-degree program is likely to be non-linear.[3] δ_j and δ_t denote institution and year fixed effects, respectively. ϵ_{jt} is an idiosyncratic error term.

[3]Specifically, I estimate a local polynomial (smoothing) regression of the STEM-degree program status as of 2021 ($Y_{j,2021}$) on the share of foreign students at the base year ($\%foreign_j^{base}$).

In this model, $\left\{High\%foreign_j^{base} = 1\right\}$ represents the high treatment intensity group and $\left\{High\%foreign_j^{base} = 0\right\}$ represents the low treatment intensity group. The parameter of interest β_1 represents the average treatment effect of the inclusion of economics in the STEM-eligible list on the high treatment intensity group compared to the low intensity group assuming that both groups are treated at the same time in the year 2013. Alternatively, one could consider the awareness of the STEM-designation of 45.0603 and assign different $Post_t$ across institutions. An illustrative example of this staggered timing is presented with the event-study model estimates in Section 4.1. Due to the unobserved awareness level of institutions on the STEM-designation, this paper assumes that all institutions were aware of the STEM designation at the time of the policy implementation. To evaluate the parallel trends assumption, the event-study model estimates are presented in the results section.[4] However, the parallel trends assumption is less of a concern as only a limited number of institutions offered STEM-economics before 2013.

Next, this paper examines the timing of the supply of new STEM degree programs by using the number of years since an institution began offering a STEM-economics program. Following the inclusion of one CIP code in the STEM-eligible list, economics departments begin offering STEM-eligible economics programs in various years. To account for a left-censoring in the dependent variable (i.e., institutions that have not offered STEM-degree program as of 2021), this paper estimates the following Tobit regression model:

[4] I estimate an event-study model separately for departments with high- and low-share of foreign students $\left(High\%foreign_j^{base} = \{1, 0\}\right)$.

$$Y_{jt} = \beta_0 + \sum_{\substack{y=-5 \\ y\neq -1}}^{9} \alpha_y \mathbf{1}\left(t - t^* = y\right) + \delta_j + \epsilon_{jt} \tag{2}$$

for $t \in \{2007, \ldots, 2021\}$ and $t^* = 2013$.

$$YearsSTEM_j = \gamma_0 + \gamma_1 High\%foreign_j^{base} + X_j\delta + \epsilon_j \tag{3}$$

$$YearsSTEM_j = \begin{cases} YearsSTEM_j^* & if \quad YearsSTEM_j^* > 0 \\ 0 & if \quad YearsSTEM_j^* \leq 0 \end{cases}$$

where $YearsSTEM_j^*$ is a latent variable, and $YearsSTEM_j$ is the number of years from 2012 if an institution j offers a STEM-designated economics degree at each degree level in 2021, and the institutions not offering STEM economics degree programs by 2021 are assigned 0. Note that this Tobit model uses cross-sectional data as of 2021. $High\%foreign_j^{base}$ equals 1 if the share of foreign students is higher than the sample median share of foreign students in the base year 2007. Due to unobserved characteristics of institutions, the results should not be interpreted as causal effects. For example, unobserved characteristics such as supportive environment for international students can lead to an overestimation of the correlation between the share of foreign students and the years since the start of STEM-degree program. To alleviate the potential endogeneity of international students' enrollment affecting a STEM CIP code change, year 2007 is selected as the base year and control for institutional characteristics, X_j, including public/private status, the Carnegie classification, and institution size category. γ_1 measures the correlation between a high share of foreign students and the number of years since the institution offers a new STEM-degree program.

4 Results

4.1 Foreign student share and supply of STEM programs

Table 2 shows the difference-in-differences model estimates. The differential effect of the inclusion of economics in the STEM-eligible list in 2013 between economics departments with a high-share and a low-share of foreign students is 6.3 percentage points at the bachelor's

level. Considering the pre-2013 mean of 4 percent, it is a large effect. Column (2) shows that the differential effect of the share of international students after the STEM designation in 2013 is larger at the master's degree level. After the inclusion of economics in the STEM-eligible list in 2013, a department with a higher than the sample median share of international students is 8.9 percentage points more likely to offer a STEM master's degree than below the sample median departments. The magnitude of this effect is large compared to only 2 percent of departments offered a STEM degree before the STEM-designation.

Table 2: Effects of Foreign Student Share on the Supply of STEM Degree Programs

	Bachelor's	Master's	Doctoral
	(1)	(2)	(3)
High%foreign×Post-2013	0.063***	0.089***	0.020
	(0.006)	(0.020)	(0.025)
Observations	10,245	2,655	1,665
R-squared	0.652	0.540	0.527
Mean pre-2013 STEM offering	0.04	0.02	0.00

Notes: The table reports difference-in-differences model (1) estimates across degree levels. High%foreign is a binary variable that equals 1 if the share of foreign students is higher than the sample median share of foreign students in the base year 2007 and 0 otherwise. The model includes institution and year fixed effects. $^{*}p < 0.1; ^{**}p < 0.05; ^{***}p < 0.01$

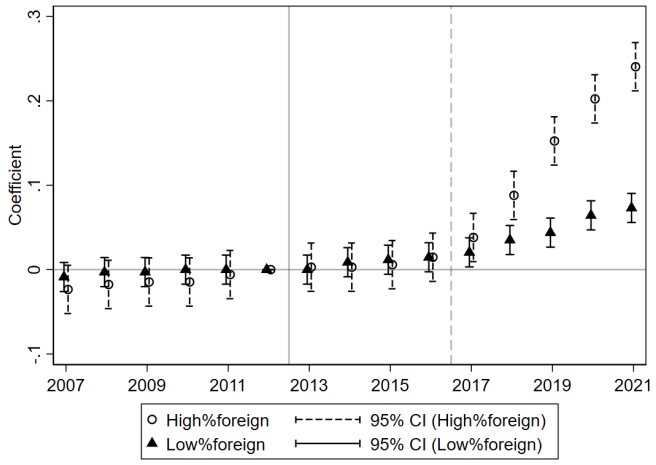
On the other hand, at the doctoral level, the results do not show a statistically significant difference between departments with high and low percentages of foreign students after the STEM-designation of economics. The first row of Table 1 shows that the share of foreign students in doctoral programs is relatively high with 64 percent in departments offering non-STEM degrees and 72 percent in departments offering STEM degree programs. Also, the average number of students in doctoral programs is relatively small (a mean of 10.4). As a result, having an above or below the sample median share of foreign students does not differentiate departments in a significant manner.

Figure 3 displays the event-study model estimates and 95% confidence intervals for the coefficients on the years relative to 2012 separately for high- and low-share of foreign students across degree levels. Panels (a) and (b) illustrate that starting 2017, the high- and low-share departments start to diverge and the difference in the coefficient estimate increases. Bachelor's and master's programs show a statistically significant difference; however, doctoral programs do not show a statistically significant difference between high and low foreign student share departments.

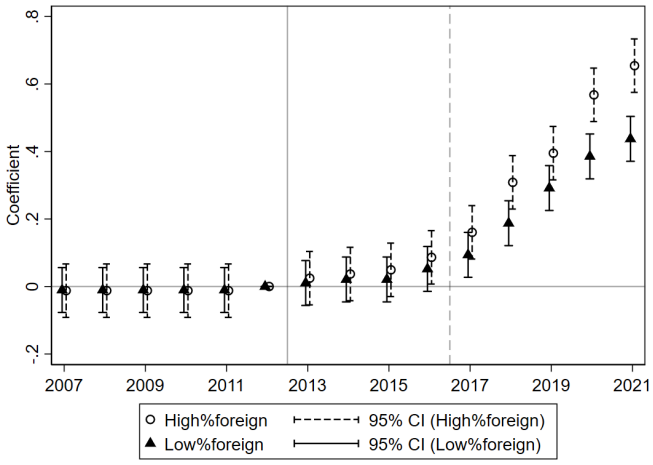
Although this paper does not model the staggered implementation of STEM economics across institutions, for illustration purposes, suppose the high foreign share (circles) institutions were immediately aware of the STEM-designation in 2013, while the low foreign share (triangles) institutions became aware of the STEM-designation four years later. In Figure 3, the coefficients for the low foreign share (triangles) institutions would shift downward, representing estimates relative to 2017 (four years after the STEM-designation). In this case, the magnitude of the difference between the high foreign share (circles) and the low foreign share (triangles) institutions would be larger.

Figure 3: Effects of Foreign Student Share on the Supply of STEM Degree Programs

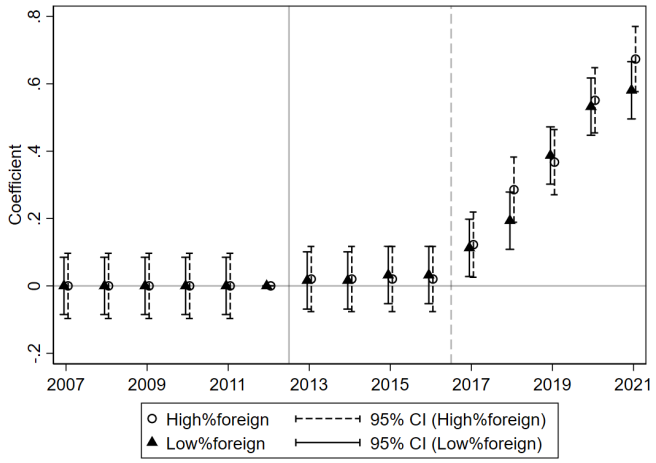
(a) Bachelor's degree



(b) Master's degree



(c) Doctoral Degree



Notes: Figures report the event-study model (2) estimates and 95% confidence intervals for the coefficients on the years relative to 2012. I separately estimate high- and low-share departments which correspond to above and below the sample median share of foreign students in the base year 2007 and 0 otherwise. The dependent variable, a STEM-economics program offering is a binary variable that equals 1 if a department awards a degree in 45.0603 and 0 otherwise. Year -1 (2012) is a reference category and is omitted. In May 2012 (a solid vertical line), CIP code 45.0603 was included as a STEM-eligible major. In May 2016 (a dashed vertical line), the OPT period was extended to 24 months (total 36 months). Note that the scales of y-axis vary.

4.2 Timing of new STEM program offerings

This section examines institutional characteristics associated with the earlier adoption of STEM programs using a Tobit model. Table 3 reports the Tobit regression estimates of the number of years since offering a STEM-degree program. First, results in columns (1)−(4) show that the departments with a higher share of foreign students in the base year are more likely to offer STEM-eligible economics programs earlier at the bachelor's and master's levels. Departments that already have a higher share of international students may be more inclined to offer STEM-designated programs to retain and potentially recruit more international students, as STEM degree holders are eligible for 24-month extension to work in the United States compared to non-STEM degree holders. While the estimates are not directly comparable, Mahon and Asarta (2024) also find that the share of international students is positively correlated with the probability of offering STEM-degree programs in economics. Column (4) shows that at the master's level, a department with a proportion of foreign students above the sample median offers a STEM-eligible degree program 1.2 years earlier. At the doctoral level (columns (5) and (6)), a high share of foreign students is not correlated with the earlier adoption of STEM-degree programs. The international student share is relatively high in doctoral programs (mean of 60 percent), while the total number of students in these programs is comparatively small (a mean of 10.4). As a result, being above the sample median percentage of foreign students does not distinguish one doctoral program from another.

Table 3: Timing of New STEM-Economics Program Offerings

	Bachelor's		Master's		Doctoral	
	(1)	(2)	(3)	(4)	(5)	(6)
High%foreign	3.785***	2.594***	1.617***	1.249**	0.407	0.134
	(0.704)	(0.629)	(0.590)	(0.531)	(0.608)	(0.581)
Private		5.228***		2.499***		2.344***
		(0.882)		(0.649)		(0.748)
Doctoral/Research		2.669***		3.241***		
Universities		(0.966)		(1.022)		
Observations	654	654	173	173	111	111
(institutions)						

Notes: The table reports the Tobit regression (3) estimates. The dependent variable is the number of years since awarding a STEM-degree after STEM-designation in May 2012. Institutions that awarded degrees in STEM-economics before 2013 are excluded. High%foreign is a binary variable that equals 1 if the share of foreign students is higher than the sample median share of foreign students in the base year 2007 and 0 otherwise. Columns (2), (4), and (6) include institutional characteristics. All doctoral programs are offered at doctoral/research universities. The institution size category estimates are not statistically significant and are not shown in the table. $^{*}p < 0.1; ^{**}p < 0.05; ^{***}p < 0.01$

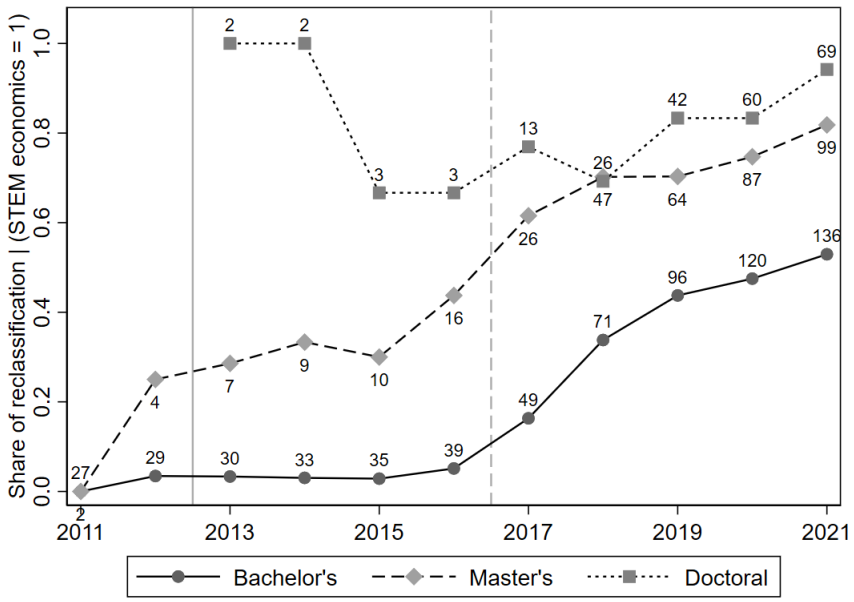
Second, private institutions are more likely to start offering STEM-economics programs early at all degree levels. This difference between public and private institutions may be partly due to variations in the CIP code changing process. For example, Marshall and Underwood (2022) find that more public institutions require college and university committee approval compared to private institutions. Although Marshall and Underwood (2022) focus on undergraduate programs, this process is likely to be similar at the graduate level. Private institutions offer STEM degree programs 5.2, 2.5, and 2.3 years earlier than public institutions at the bachelor's, master's, and doctoral programs, respectively.

Lastly, institutions classified as doctoral and research universities are more likely to offer STEM-economics programs earlier. Departments at doctoral and research universities offer

STEM degrees 2.6 and 3.2 years earlier at the bachelor's and master's programs, respectively. Graduate programs typically require mathematics and econometrics courses as part of their admission criteria and degree requirements. For instance, a doctoral program in economics requires at least one econometrics course, regardless of the STEM designation. Also, master's programs at doctoral and research universities often share the first-year core curriculum with doctoral programs. In Figure 4, the reclassification is defined as a change when an institution stops offering a degree in general economics (45.0601) and begins offering only a degree in STEM economics (45.0603).[5] This differentiation helps highlight the varying responses of graduate and undergraduate programs to the inclusion of economics in the STEM-eligible list. Conditional on an institution offering STEM-economics program, the proportions of institutions exclusively offering degrees in STEM-eligible CIP code (45.0603) are 80 percent and 90 percent for master's and doctoral programs, respectively. Approximately half of undergraduate programs offering degrees in STEM-economics also offer degrees in general economics (non-STEM) at the same time.

[5]This definition of reclassification is the same as the (re)classification in Marshall and Underwood (2022), but it is different from the definition in Mahon and Asarta (2024). Mahon and Asarta (2024) define reclassification as awarding a STEM economics degree for the first time in 2016 or later.

Figure 4: Reclassification Conditional on Offering STEM Economics

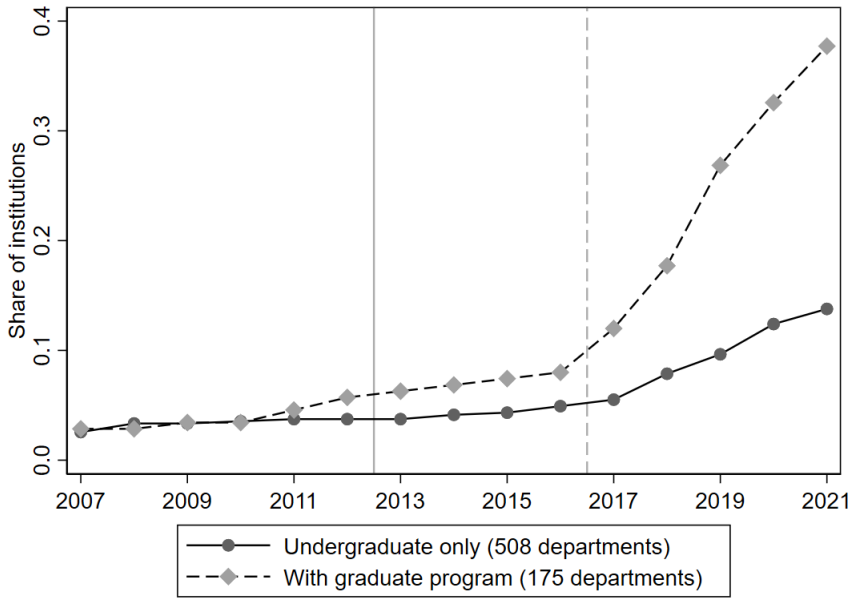


Notes: The share of STEM reclassification by degree level conditional on an institution offering a STEM degree program. Reclassification equals 1 if an institution stops offering a degree in general economics (45.0601) and begins offering only a degree in STEM economics (45.0603). The number of institutions offering a STEM degree program in economics are shown in each degree level. In May 2012 (a solid vertical line), CIP code 45.0603 was included as a STEM-eligible major. In May 2016 (a dashed vertical line), the OPT period was extended to 24 months (total 36 months).

Compared to the quantitative focus in graduate programs, there exist disparities in mathematics and econometrics requirements between STEM-eligible and general economics programs at the undergraduate level (Marshall and Underwood, 2022). These differences can be partly attributed to the potential interaction between undergraduate and graduate programs at doctoral and research universities. Figure 5 shows that undergraduate only programs are less likely to offer STEM-degree programs compared to departments offering both undergraduate and graduate programs. The quantitative focus of a graduate program could influence the curriculum of bachelor's programs. Among departments offering a STEM degree at the bachelor's level after 2013, 26.8 percent of undergraduate economics programs began offering

a STEM-designated degree one or more year after the graduate program, and 55.3 percent of CIP code changes at the bachelor's level occurred simultaneously with the graduate level.

Figure 5: Supply of Bachelor's STEM-Economics Programs



Notes: The share of institutions awarding STEM-degrees by undergraduate programs with and without graduate programs. In May 2012 (a solid vertical line), CIP code 45.0603 was included as a STEM-eligible major. In May 2016 (a dashed vertical line), the OPT period was extended to 24 months (total 36 months).

5 Discussion and conclusion

Over the past decade, institutions have been increasingly offering STEM-eligible degree programs. This paper examines the impact of the share of foreign students on the supply of STEM degree programs and the characteristics of institutions that offer STEM-economics degree programs. First, the findings suggest that departments with a share of foreign students above the sample median are more likely to offer a STEM-eligible degree program at the bachelor's and master's levels after the STEM designation of economics. In terms of the timing, a higher percentage of foreign students in a department is associated with a greater

likelihood of offering STEM-eligible economics programs early, particularly at the bachelor's and master's levels. This suggests that departments with a substantial international student presence may be more inclined to introduce STEM-designated programs to attract and retain international students. Second, the results suggest that private institutions are more proactive in offering STEM-economics programs across all degree levels. This disparity might be due to differences in the CIP code change process between public and private institutions, with more administrative hurdles in some public institutions. Lastly, doctoral and research universities tend to be early adopters of STEM-eligible programs. This is partly because graduate programs often have mathematical prerequisites, and economics graduate programs are known for their quantitative training.

Future research could explore staggered offering of STEM programs across different institutions as a treatment instead of the outcome as used in this paper. Different timings of offering STEM programs could explain various academic outcomes such as enrollment of domestic and international students and enrollment in related non-STEM fields such as business majors.

The findings have implications for decision makers in higher education. To facilitate the CIP code changes, institution-level approval process could be streamlined for changes that do not involve extensive modifications in the program (e.g., reclassification from 45.0601 to 45.0603 without curriculum or degree requirement changes). Based on the findings of this paper that public institutions tend to offer STEM-eligible economics programs later than private institutions, state-level approval process could also be streamlined for a simple reclassification, reducing the marginal cost of CIP code changes. At the same time, institutions could carefully evaluate the marginal benefit associated with CIP code changes. This paper finds that institutions with a higher share of international students and those classified as doctoral and research institutions tend to offer STEM-economics programs earlier. These factors could affect how institutions perceive benefits of the CIP code changes.

To raise awareness of these potential benefits, organizations like the American Economic Association could create an informational resource highlighting the STEM designation in economics and its advantages, similar to how institutions promote their STEM-designation and its labor market benefits.[6] These changes in the cost and benefit evaluations related to offering STEM-designated economics programs would facilitate the STEM reclassification in economics, especially considering the quantitative focus of graduate programs in economics.

[6]School of Economic, Political and Policy Sciences. The University of Texas at Dallas. Retrieved April 18, 2024, from https://epps.utdallas.edu/about/programs/stem-degrees.

References

Amuedo-Dorantes, C., Furtado, D., and Xu, H. (2019). OPT policy changes and foreign born STEM talent in the U.S. *Labour Economics*, 61:101752.

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.

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

Executive Office of the President (2018). Charting a course for success: America's strategy for STEM education. Technical report, National Science and Technology Council.

Khoo, P. (2023). If you extend it, they will come: The effects of the STEM OPT extension. *The Center for Growth and Opportunity, Working Paper*.

Kim, S. W. (2022). The effects of the OPT visa extension rule on STEM business programs in the U.S. *Applied Economics*, 54(14):1654–1671.

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. *The 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. *The Journal of Economic Education*, 53(3):250–258.

National Science Foundation (2022). *The State of U.S. Science and Engineering*. National Center for Science and Engineering Statistics.