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THE IMPACT ON U.S. MEN AND WOMEN
IN STEM FIELDS OF INCREASES IN
INTERNATIONAL STUDENTS

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EXECUTIVE SUMMARY

Enrolling more international undergraduate students does not crowd out U.S. students at the average American university and leads to an increase in the number of bachelor's degrees in STEM (science, engineering, computer science, and mathematics/statistics) majors awarded to U.S. students, according to new research. Each additional 10 bachelor's degrees—across all majors—awarded to international students by a college or university leads to an additional 15 bachelor's degrees in STEM majors awarded to U.S. students.

International students are considerably more likely to major in STEM fields than in most other areas of study, indicating U.S. students are taking more classes with international students rather than avoiding majors popular with international students. Colleges and universities that attract more international students likely are devoting more resources to STEM areas, such as increasing the number of courses and adding fields offered within STEM, hiring more faculty, and providing new lab spaces and buildings. To the extent such changes are occurring, they appear to be attractive to U.S. students as well. The positive relationship is after controlling for school fixed effects and linear trends, so regardless of its cause the finding an increase in international students at a school leads to an increase in the number of bachelor's degrees in STEM majors awarded to U.S. students is a robust relationship.

The number of international students pursuing a bachelor's degree in the U.S. doubled from 2006 to 2017. The rapid growth in the number of international students in the U.S. came to abrupt halt by 2017, and the number of international students fell over the next year. The COVID-19 outbreak and resultant global economic downturn almost surely will cause the number of international students to plummet in the near term. The financial implications of this reversal are grave for the large number of U.S. schools that depend on international students. This includes schools ranging from prestigious research universities to community colleges.

This study finds that a drop in international students will not mean more seats are available for U.S. students, since with limited exceptions, there is plenty of capacity at U.S. colleges and universities and international students are not taking away slots from American students.

This study uses data from the U.S. Department of Education's Integrated Postsecondary Education Data System (IPEDS), a comprehensive data source on U.S. colleges and universities, to examine the relationship between the numbers of international and U.S. undergraduate students at 1,234 non-profit higher-education institutions during the period 1990 to 2018. International students are students who are nonresident aliens (a group that does not include permanent residents or naturalized U.S. citizens) and usually have a temporary student visa.

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The results indicate that increases in enrollment of international students or bachelor's degrees awarded to international students generally do not lead to decreases in the number of U.S. students. Specifically, the analysis shows:

- Within 1,234 colleges and universities over 1990-2018, the number of international undergraduate students has no significant effect—either positive or negative—on the number of U.S. students enrolled, on average. This null result holds overall, for men and women, and for non-Hispanic white and black students.
- There is no effect of international students on the number of bachelor's degrees awarded to black U.S. students, either in total or by sex. The number of bachelor's degrees awarded to international students likewise has no significant effect on the total number of bachelor's degrees awarded to U.S. students within those 1,234 colleges and universities over 1990-2018, on average. This null result holds overall, for men and women, and for black students.
- The results indicate that the number of bachelor's degrees awarded to white U.S. women increases less if a school increases the number of bachelor's degrees awarded to international students. This does not mean that fewer white U.S. women earn bachelor's degrees in total because of international students, but rather that the increase in the number of them earning their degree from a particular school is smaller as the number of bachelor's degrees earned by international students increases at that school. In other words, the evidence is only that the increase in the number of white women graduating from a school is smaller when the increase in the number of international students graduate from that school is bigger, not that fewer white women in total are graduating from college. White women are the largest demographic group to attend and graduate from college in the U.S. Some colleges may be choosing to diversify away from this group as they enroll and graduate more international students.
- The research indicates U.S. students, both men and women, shift into STEM majors (science, engineering, computer science, and mathematics/statistics) from social sciences majors at schools that experience larger increases in the number of international students. This may be due to those schools devoting more resources to their STEM programs, making them more attractive to U.S. and international students alike.

The findings that international undergraduate students do not crowd out U.S. students and even prompt more of them to graduate with a STEM major have important economic implications. A college degree has become increasingly vital to financial security for many Americans, and—until very recently—international students were a growing source of revenue for many U.S. colleges and universities.

In much of the U.S., STEM graduates are in short supply. Students who graduate with a STEM major typically earn more than other graduates, especially early in their careers. The finding here that the presence of international

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students actually increases the number of U.S. students graduating with a STEM major is another reason to encourage international students to come to the U.S. once the COVID-19 crisis has passed.

Many international students are potential STEM professionals and their presence prompts more U.S. college graduates to become potential STEM workers as well, two important benefits of U.S. universities admitting international students. There is not a trade-off between U.S. students and international students. An increase in the number of international students should be viewed as good news for both U.S. students and U.S. schools.

*The Impact on U.S. Men and Women in STEM Fields of Increases in International Students***BACKGROUND**

The number of international students at U.S. colleges and universities has increased dramatically over the past two decades. Some critics have argued that foreign students take seats that otherwise would be filled by Americans, ultimately reducing the number of Americans who attend and graduate from college. Colleges and universities, in contrast, have pointed out that international students provide much-needed revenue in an era of declining state appropriations for higher education and help offset slower growth or even declines in the number of potential college-bound teenagers in some parts of the U.S.

Little is known about whether international students affect the number of U.S. students who attend and graduate from college.¹ Several studies of U.S. graduate programs—as opposed to undergraduates, the focus here—conclude that international graduate students do not crowd out U.S. graduate students and may even increase their numbers.² Such findings are notable given that growth in the number and share of international graduate students in the U.S. far outpaced growth in international undergraduate students.

At both the graduate and undergraduate levels, international students are more likely than U.S. students to pay full tuition and fees. Their presence therefore could reduce the costs of educating U.S. students, creating what economists call a “cross subsidy.” Further, the presence of international students may enable programs to hit a critical mass without reducing their admissions criteria or even allow programs to raise their criteria and increase their program offerings, making them more attractive to U.S. students.

This study provides a comprehensive analysis of the effect of international undergraduate students on U.S. students at a large number of colleges and universities. Using data for a long time period—1990 to 2018—on non-profit public and private institutions of higher education, the analysis examines how changes in the number of international students within an institution affect the number of U.S. students enrolled at or graduating from that institution.

The next section provides an overview of international undergraduate students in the U.S., followed by an explanation of the data and empirical methods used to analyze the relationship between international students and U.S. students. Overall, the results of that analysis indicate that international students do not take away slots from U.S. students.

¹ A few older studies have examined related but slightly different questions. Betts (1998) and Hoxby (1998) examine the effect of foreign-born students, which includes naturalized U.S. citizens, permanent residents, and nonresident aliens, on minority and low-income U.S.-born students.

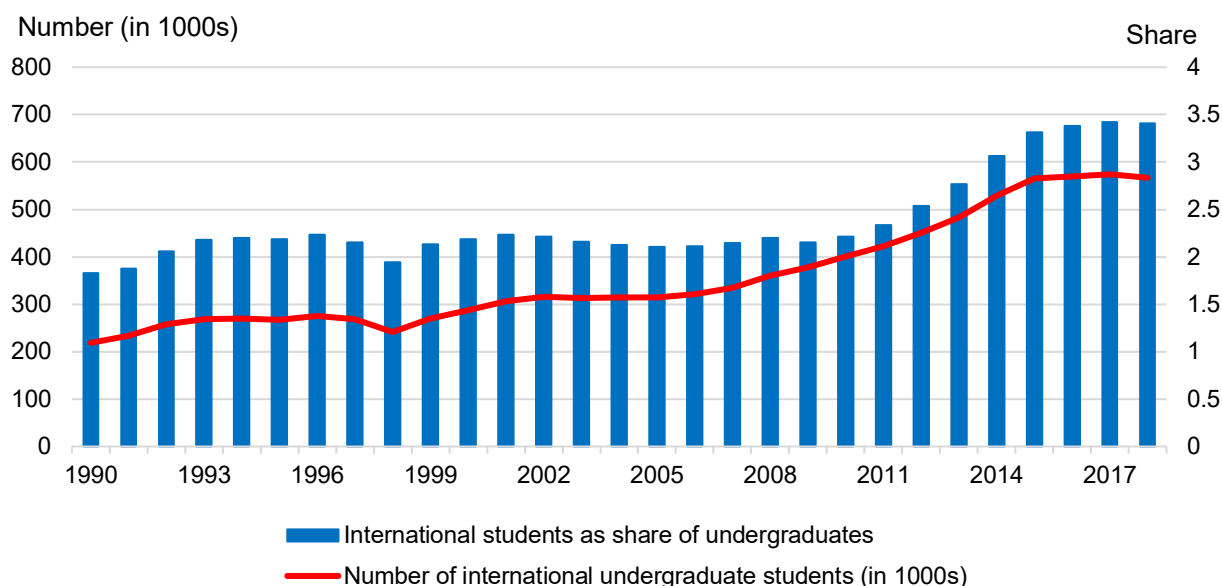
² See Regets (2007), Zhang (2008), and Shih (2017). Borjas (2007) finds a negative effect on white males within universities but null or positive effects on other groups; he does not examine the effect within programs.

*The Impact on U.S. Men and Women in STEM Fields of Increases in International Students***OVERVIEW OF INTERNATIONAL UNDERGRADUATE STUDENTS IN THE U.S.**

The number and share of international undergraduate students in the U.S. were trending upwards until recently. As Figure 1 shows, the number and share of international undergraduates rose from 1990 until the 1997-98 financial crisis, was fairly steady during the early to mid-2000s, and then rose at a brisk clip during the late 2000s. From 2006 to 2017, the number of international undergraduate students in the U.S. doubled. While that growth rate is dramatic, international students accounted for less than 3.5 percent of degree-seeking undergraduate students in 2017.

In 2017, growth in the number and share of international undergraduate students came to abrupt halt. The number and share of international undergraduates fell from 2017 to 2018, the first drop in over a dozen years.

Figure 1: Number and Share of International Undergraduate Students in the U.S, 1990-2018



Note: Based on fall enrollment data from the U.S. Department of Education, *Digest of Education Statistics*. International students are nonresident aliens.

The decline was more pronounced (and started a year earlier) when looking at new students, those enrolling for the first time at a U.S. college or university. Once they matriculate, students tend to stay at a school until they graduate, so changes in the number of new students are a bellwether of future changes in the total number of students. Even before the onset of COVID-19, the number of new international students was down 10 percent in Fall 2019 at U.S.

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colleges and universities compared with 2015 levels.³ In fact, the number of new international students enrolling at U.S. colleges and universities has been falling since 2016/17.⁴

There are several reasons why the number of international students rose, then plateaued, and ultimately began to fall. Rising family incomes in China combined with changes in the China-U.S. exchange rate and greater willingness to allow students from China to study in the U.S. drove much of the increase in international students. Widespread decreases in state appropriations for higher education and slower growth in state teenage populations, or even declines in parts of the Northeast and Midwest, prompted many U.S. colleges and universities to look abroad to fill seats and coffers.⁵ The plateau and subsequent decline (before the outbreak of COVID-19) was due to a combination of increased competition for international students from colleges and universities in other countries, particularly English-speaking ones; more limited pathways for staying in the U.S. after graduation compared with other countries; and concerns that the U.S. was becoming less welcoming to immigrants.

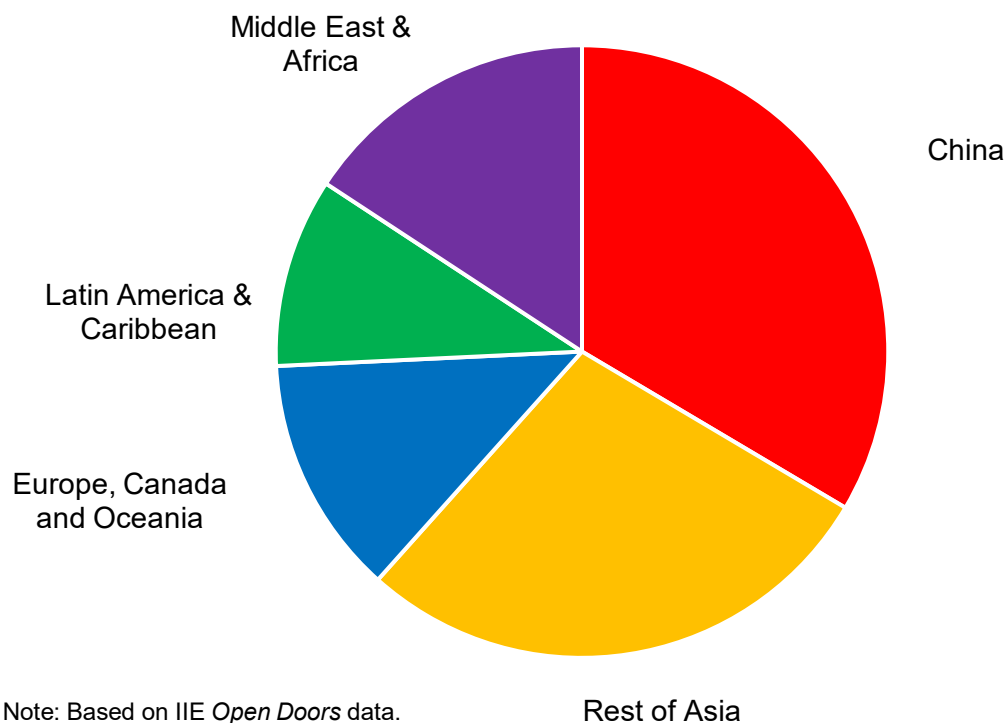
China has become by far the largest source country of international students in the U.S. and accounts for about one-third of international undergraduate students in recent years (Figure 2). China first began allowing students to study abroad in 1979, and the number of undergraduates from there studying in the U.S. rose briskly after 2007. The rest of Asia accounts for another roughly one-third of international undergraduates; South Korea and India are the other major Asian source countries. The Middle East and Africa together account for about one-sixth of international students. Many of those students are from Saudi Arabia, whose King Abdullah Scholarship program funds the cost of studying abroad for eligible students.

³ See https://www.chronicle.com/article/An-Admissions-Bet-Goes-Bust/248140?cid=wsinglestory_hp_1a.

⁴ See <https://www.forbes.com/sites/stuartanderson/2019/11/19/new-international-student-enrollment-in-us-has-fallen-10-since-2015/#3dbe42041ae9>.

⁵ See Bound et al. (2020).

Figure 2: Source Country of International Undergraduate Students in US, 2016/17 - 2018/19



Where international students are from matters for several reasons. Changes in the exchange rate between a country's currency and the U.S. dollar and source country economic conditions affect enrollment by students from that country.⁶ Geopolitical relations between a country and the U.S. also may influence the number of young adults studying in the U.S. Where students choose to study in the U.S. and what they study also can vary systematically by origin. For example, many Asian students traditionally prefer to go to the west coast while many Latin American and Caribbean students head to Florida, and Saudi Arabia only funds study at certain programs and institutions.

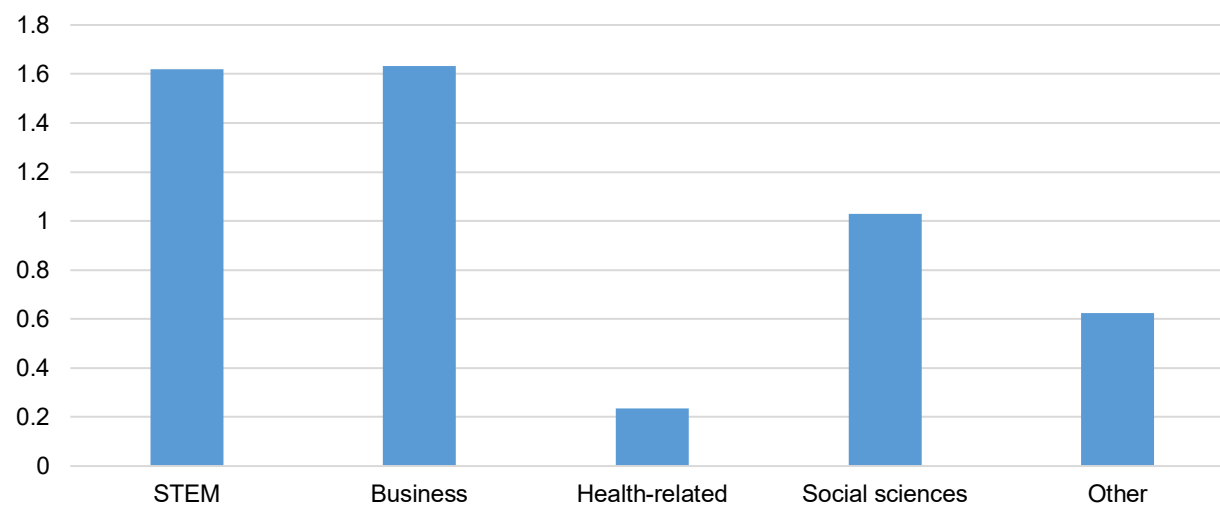
International and U.S. undergraduate students tend to choose different majors. International students are almost twice as likely as U.S. students to receive a bachelor's degree in a STEM field (defined here as biological sciences, physical sciences, computer science, engineering, and mathematics/statistics) or in business (Figure 3). International and U.S. undergraduates are about equally likely to receive degrees in a social science field, while U.S. students are over four times as likely to receive a degree in health professions and related programs. Looking at narrower fields, international students are most over-represented in mathematics/statistics, at four times more

⁶ See Bird and Turner (2014).

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likely than domestic students to receive a degree in that area. International students are heavily under-represented in law enforcement-related majors, education, and public administration as well as in health-related majors.

Figure 3: Relative Share of Bachelor's Degrees Awarded by Major Field to International Students, 2015/16 - 2017/18



Source: Calculations of share of degrees by field awarded to nonresident aliens divided by share of degrees by field awarded to U.S. students using data from the U.S. Department of Education, *Digest of Education Statistics*. Social sciences includes history and psychology.

Differences in majors between international and U.S. students may affect schools' capacity or desire to enroll additional students. Schools may have greater capacity to admit students who choose relatively low-enrollment majors, for example, or they may find it easier or less costly to add students in some majors than in others. Schools that want to attract more international students might devote more resources to fields that are popular with those students, such as building new facilities geared toward STEM and business majors and hiring faculty in those areas. Differences in majors have economic implications if international students stay in the U.S. instead of returning home or if going to school with more or fewer international students influences the majors chosen by U.S. students.

This study uses data from the U.S. Department of Education to examine whether the tremendous increase in the number of international undergraduate students affects the number of U.S. students and what they major in, as explained next.

DATA AND EMPIRICAL METHODS

The U.S. Department of Education requires colleges and universities to report voluminous amounts of data in its Integrated Postsecondary Education Data System (IPEDS). These data have several advantages: they include virtually every postsecondary educational institution in the U.S. since universities must participate in order for their students to receive federal financial aid; the measures schools must report are clearly defined; and the data undergo quality control checks.

This analysis includes only not-for-profit public and private institutions that grant undergraduate degrees and are in the Carnegie classifications of doctoral/research universities, masters colleges and universities, and baccalaureate colleges. Community colleges are not included since those institutions tend to enroll relatively few international students. The analysis does not include the military service academies since international students cannot attend those schools. The analysis focuses on a balanced panel of schools that were in the IPEDS data throughout the period 1989/90 to 2017/18 and that granted at least one bachelor's degree each year. This results in a sample of 1,234 schools and captures the overwhelming majority of bachelors' degree-granting schools and U.S. students and international students at such schools.

IPEDS includes counts of the number of students enrolled by degree level each fall and the number of degrees awarded by level and major each school year. Those counts are reported in total and by students' sex and race/ethnicity. The race/ethnicity categories used here are nonresident aliens; non-Hispanic whites; and non-Hispanic blacks.⁷ Nonresident aliens—called international students in this analysis—are non-U.S. citizens who are in the U.S. on a visa or other temporary legal basis and do not have the right to remain indefinitely. Most students in this group have an F-1 nonimmigrant student visa. U.S. students are defined in this analysis as the total number of students less the number of nonresident aliens, or international students. U.S. students therefore includes U.S. natives, naturalized citizens, and legal permanent residents as well as perhaps a small number of unauthorized immigrants at some institutions.⁸

⁷ Counts are available for several other race/ethnicity groups, such as Hispanics, Asians, and Native Americans, but are so small for most universities that the results are imprecisely estimated and not statistically significant. This analysis therefore examines only non-Hispanic whites and blacks as well as the total across all groups.

⁸ IPEDS data does not distinguish between these groups of students, such as between U.S. citizens and legal permanent residents. IPEDS instructs institutions to not include students who are unauthorized immigrants as nonresident aliens, with one exception: students who have temporary legal status under the Obama administration's 2012 Deferred Action for Childhood Arrivals (DACA) program. IPEDS instructs institutions to classify unauthorized immigrants without DACA as "race/ethnicity unknown." It is not clear whether institutions can accurately count their number of students who are unauthorized immigrants either before or after DACA. Institutions' counts of international students on educational visas should be very accurate, particularly after 2003, when educational institutions were required to use the SEVIS system to register and track international students.

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Degrees awarded by level and major are reported by 6-digit Classification of Instructional Programs (CIP) code. Those majors are aggregated in this analysis into five broad categories: STEM, business, health professions and related sciences, social sciences, and all other (which is largely majors in the humanities and fine arts).⁹

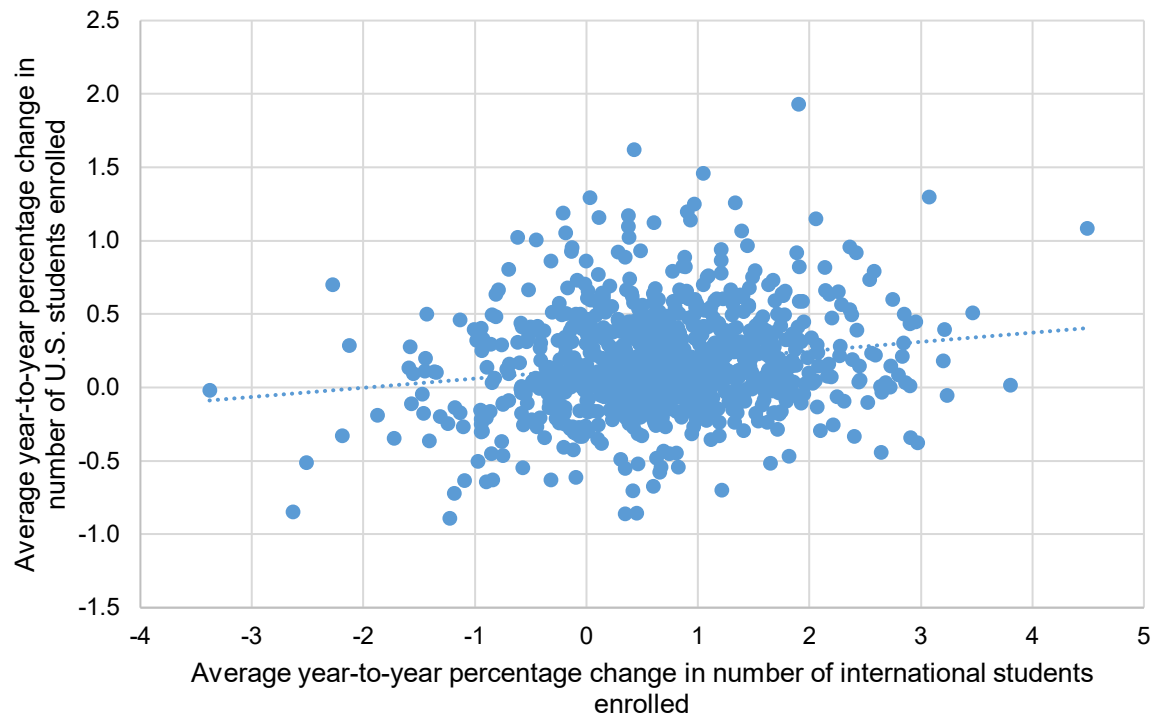
The analysis begins with a simple comparison of changes in the number of international and U.S. students across schools over time. Figure 4 shows the average year-to-year percentage change in the number of international students and U.S. students enrolled. These data include all enrolled undergraduates, from freshmen to seniors. Each data point is the average across the period 1990-2018 for a school.¹⁰ It is worth noting that average growth rates in the number of U.S. and international students are quite small. The change in the number of U.S. students ranges from -1 percent to +2 percent, while the change in the number of international students ranges from -4 percent to +5 percent.

The dotted line in Figure 4 shows the best-fit linear relationship between the data points. That relationship is positive, although small in magnitude—on average, if a school increases its enrollment of international students by 1 percentage point, it increases its enrollment of U.S. students by 0.06 percentage points. These data thus suggest that increases in international students do not crowd out U.S. students, on average, and may even slightly increase their number.

⁹ STEM includes all majors within computer and information sciences; engineering; biological sciences/life sciences; mathematics; and physical sciences. Business includes marketing majors. Social sciences includes all majors within the social sciences plus history and psychology. Data for health-related and business majors are first available in 1991/92.

¹⁰ If a school has no international students in a given year, that year is not included when creating its average because the school then has two near-infinite year-to-year changes in its number of international students.

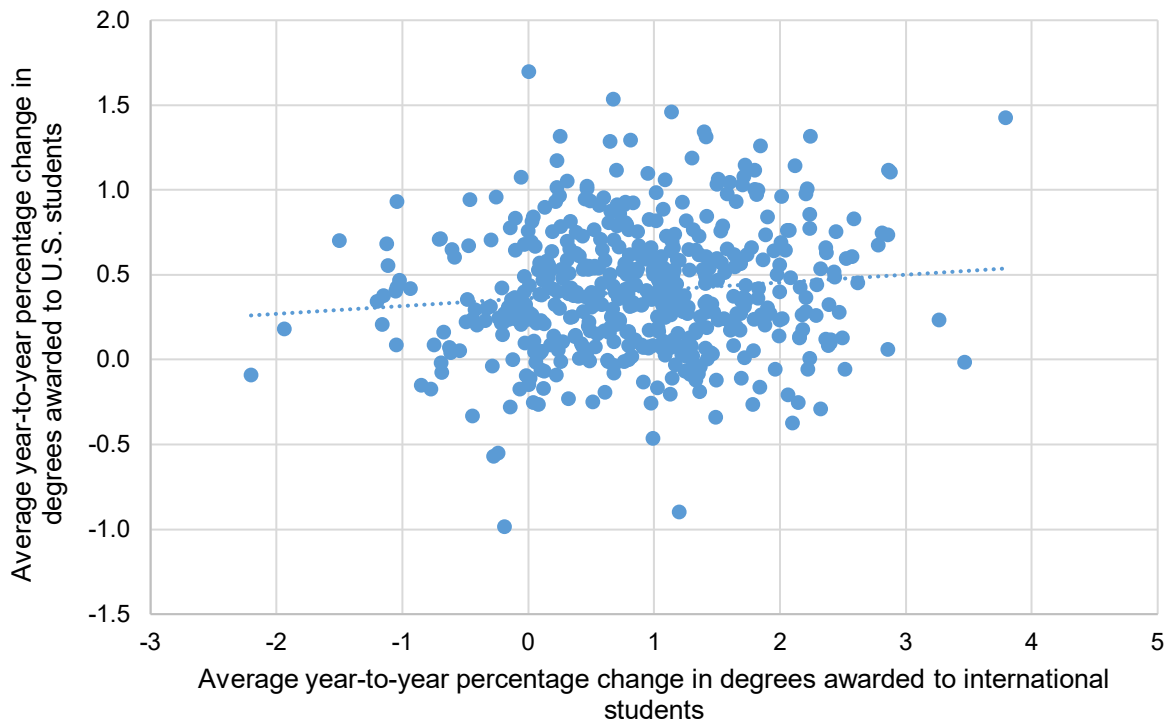
Figure 4. Relationship between undergraduate enrollment of international students and U.S. students



Note: Calculations are based on 1990-2018 IPEDS data. Each dot represents the average year-to-year percentage change for a school. Schools with no international students are not included.

Figure 5 gives a similar first glance at the total number of bachelor's degrees awarded across all majors. Each data point is again the average year-to-year change for a school over 1990-2018. As with enrollment, average changes in the number of bachelors' degrees awarded are quite small. The best-fit linear relationship between the average change in the number of degrees awarded to international students and to U.S. students is positive. If a school increases the number of bachelor's degrees awarded to international students by 1 percentage point, it increases the number of degrees awarded to U.S. students by 0.05 percentage points, on average. Like the enrollment numbers, the degrees data suggest that international students do not crowd out U.S. students and perhaps even increase their numbers.

Figure 5. Relationship between bachelor's degrees awarded to international students and U.S. students



Note: Calculations are based on 1990-2018 IPEDS data. Each dot represents the average year-to-year percentage change for a school. Schools with no degrees awarded to international students are not included.

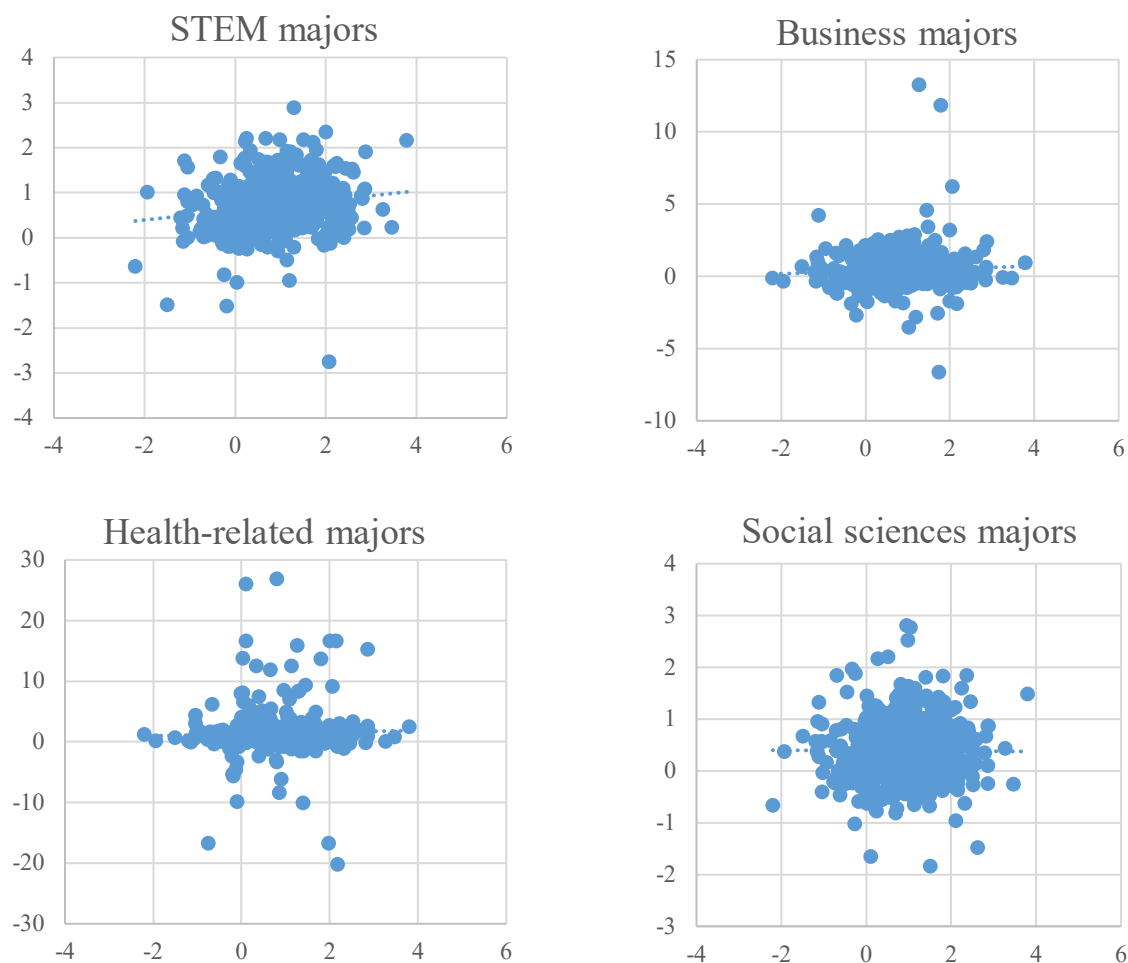
Figure 6 shows the relationship between the average change in the number of bachelor's degrees awarded to international students and the number awarded to U.S. students by major. The data here are degrees awarded to all international students, regardless of major, and degrees awarded to U.S. students by major. This allows for examining whether going to a school with more international students affects what major U.S. students graduate in, regardless of what major the international students graduate in. In other words, if going to school with many international students—who tend to major in STEM and business—causes fewer U.S. students to major in STEM and business and more to major in the social sciences, health-related majors, or other majors, the data should show a negative relationship for the former and a positive relationship for the latter.

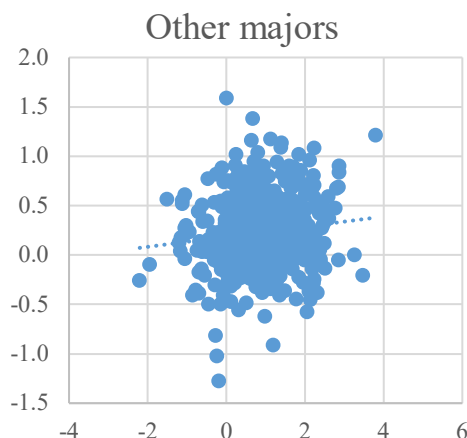
The data show that the relationship between the average change in the total number of international students awarded bachelor's degrees and in the number of U.S. students by broad major area is positive or flat for the five areas examined here. The magnitude of the positive relationships varies, however. If a school awards 1 percentage point more bachelor's degrees to international students, it awards 0.11 percentage point more bachelor's degrees

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in STEM majors to U.S. students, on average. The data thus suggest that U.S. students are more likely to major in STEM fields if they go to a school with more international students. For business, health-related, or social sciences majors, the average change in the total number of bachelor's degrees awarded to international students is neither positively nor negatively associated with a change in the number of bachelor's degrees in those majors awarded to U.S. students. A 1 percentage point increase in the total number of bachelor's degrees awarded to international students is associated with 0.05 percentage point increase in the number of bachelor's degrees in other majors awarded to U.S. students. Again, there is no evidence that increases in international students crowd out U.S. students, although it may change what they major in.

Figure 6. Relationship between bachelor's degrees awarded to international students and U.S. students, by major field



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Note: The horizontal axis in each diagram is the average year-to-year percentage change in bachelor's degrees awarded to international students across all majors at a school. The vertical axis is the average year-to-year percentage change in bachelor's degrees awarded to U.S. students in the major field indicated. Calculations are based on 1990-2018 IPEDS data. Schools with no international students are not included.

The relationships between average year-to-year changes in the number of international students and U.S. students shown in the above figures are not necessarily causal relationships. After all, those data are averages over almost 30 years. Some schools may have experienced growth in their number of U.S. students in different years than they experienced growth in their number of international students. The analysis therefore turns to a regression model in which the number of U.S. students enrolled at or graduating from each school each year is regressed on the number of international students enrolled at or graduating from that school that year, or

$$\text{U.S. students}_{st} = \alpha + \beta \text{International students}_{st} + \text{School}_s + \text{Year}_t + \text{Trend}_{st} + \varepsilon_{st}.$$

The dependent variable is the number of U.S. students enrolled at or awarded a bachelor's degree overall or by major field at school s in year t . The key independent variable is the number of international students enrolled at or awarded a bachelor's degree, also at school s in year t . The estimated coefficient on that variable, β , gives the average relationship between the number of international students and U.S. students within schools over time.

The regressions include school and year fixed effects and school-specific linear time trends. The school fixed effects capture time-invariant differences across schools, such as their location. The year fixed effects capture changes over time shared by all schools, such as changes in U.S. immigration policy. The school-specific linear time trends capture any smooth school-specific changes, such as changes in the demographics of its nearby population. Because the regressions include these variables, the estimate of β should be interpreted as the average change in the number of U.S. students enrolled at or earning their degree from a given school if that school increases the

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number of international students by one, controlling for the long-run trend in U.S. students at that school. The estimates are “within school” estimates, not total changes across the U.S. The last term in the equation, ϵ , is the error term.¹¹

The analysis here uses a technique called instrumental variables in order to capture the causal relationship between the number of international and U.S. students. There are several reasons to use instrumental variables here. One is the possibility of reverse causation. Schools facing a decline in their number of U.S. students may recruit, admit, and retain more international students. Another reason is the possibility of unobservable factors that attract both domestic and international students, such as quality of the school. In addition, schools that are trying to grow may enroll and graduate more of both groups of students. The instrumental variable used here is a standard shift-share instrument based on enrollment patterns of international students in 1980.¹²

The regression models are estimated for all students as well as by sex (men and women) and race (non-Hispanic whites and non-Hispanic blacks; all students also includes Hispanics, Asians, and other race/ethnicity groups).

RESULTS

The number of international undergraduates had no effect—either positive or negative—on the number of U.S. undergraduate students within the 1,234 colleges and universities examined here for the period 1990-2018, on average. As Table 1 shows, the estimated coefficient on the variable measuring the number of international students in the instrumental variables regressions is not statistically significant in any of the specifications estimated here. This null relationship holds for all students, men, women, whites, and blacks. The null result may be a bit of a surprise since Figure 4 suggested a positive relationship between changes in the number of international students and U.S. students. However, that figure did not control for year fixed effects, school-specific linear trends, or the causality concerns that motivate the use of instrumental variables. When controlling for all of those factors, the analysis shows that enrolling more international undergraduate students neither crowds out nor boosts the number of U.S. students at the average school.

Why don't international students crowd out U.S. students? Simply put, most colleges and universities have more than enough capacity to enroll the students they want to enroll. Only the most highly selective colleges and

¹¹ Standard errors are clustered on the school. Observations are weighted using the number of students enrolled or bachelor's degrees awarded for a given school and year.

¹² The instrument involves redistributing the total number of international students across institutions in a given year based on their distribution across those institutions in 1980. See Card (2001) for details. The total does not include the number of students at a specific institution; i.e., Ohio State's enrollment of international students in 2012 is not counted in the total number of international students in 2012 when creating the instrument for Ohio State in 2012. This purges the instrument of any school-specific supply or demand shifts. See Wozniak and Murray (2012). The first-stage F-statistic is above 10 for all of the regressions shown here.

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universities receive considerably more applications from students who meet their admissions criteria than they can enroll. For those schools, enrolling an international student does mean not enrolling a U.S. student, at least in the short run when additional faculty cannot be hired, more dorms be built, or more classrooms be added. But that is not the case for the vast majority of schools in the U.S. Most bachelor's degree-granting schools could enroll more students if they reduce their admissions criteria, but they choose not to in order to maintain their rankings and their perceived ability to attract other students.

Table 1: Estimated relationship between number of international students and number of U.S. students enrolled, by racial/ethnic group and sex, 1990–2018

Group	Combined	Men	Women
All	0.316 (1.297)	0.678 (0.668)	-0.321 (0.670)
Whites	-0.238 (0.879)	0.150 (0.421)	-0.367 (0.474)
Blacks	0.137 (0.692)	-0.109 (0.376)	0.305 (0.344)

Note: Each estimate is from a separate instrumental variables regression, where the number of international students is instrumented based on historical enrollment patterns from 1980. Regressions include institution and year fixed effects and institution-specific linear time trends. Standard errors (in parentheses) are clustered on the institution.

The number of bachelor's degrees awarded to international students similarly has no effect on the total number of bachelor's degrees awarded to U.S. undergraduate students, on average. As the top row in Table 2 shows, the number of degrees awarded to international students is neither positively nor negatively significantly related to the number of degrees awarded to U.S. students as a whole, nor to the number awarded to U.S. men or U.S. women. The results in row 2 indicate a negative effect on the number of bachelor's degrees awarded to white women, with an additional 10 degrees awarded to international students reducing the number of degrees awarded by the average school to white U.S. women by about 9.5. However, it is important to note that, because of the school fixed effects included in the regression, this does not mean that fewer white U.S. women were graduating from college—it simply means that their numbers increased less at schools that increased their number of international students more. White women are the biggest demographic group attending and graduating from college in the U.S., and the number of bachelor's degrees awarded to white women rose by over one-quarter between 2000 and 2015.¹³ The growth in the number of international students may have changed what schools white women graduated from, but the number of bachelor's degrees awarded to white U.S. women did not actually drop even as the number of international students in the U.S. doubled. Given the disproportionate number of white women on most college campuses, some

¹³ See Appendix Table 2-20 in <https://nsf.gov/statistics/2018/nsb20181/report/sections/higher-education-in-science-and-engineering/undergraduate-education-enrollment-and-degrees-in-the-united-states>.

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colleges may be choosing to diversify their student bodies by increasing the number of international students. Meanwhile, there is no effect of international students on the number of bachelor's degrees awarded to black U.S. students, either in total or by sex.

Table 2: Estimated relationship between number of bachelor's degrees awarded to international students and U.S. students, by racial/ethnic group and sex, 1990–2018

Group	Combined	Men	Women
All	-0.630 (1.196)	0.132 (0.492)	-0.700 (0.753)
Whites	-1.326* (0.792)	-0.326 (0.310)	-0.951* (0.512)
Blacks	-0.030 (0.158)	-0.021 (0.052)	0.017 (0.135)

Note: Each estimate is from a separate instrumental variables regression, where the number of international students is instrumented based on historical enrollment patterns from 1980. Regressions include institution and year fixed effects and institution-specific linear time trends. Standard errors (in parentheses) are clustered on the institution.

U.S. students choose different majors in response to going to college with more international students. As Table 3 shows, the number of bachelor's degrees in STEM majors awarded to U.S. students increases when a school also awards more bachelor's degrees in total to international students. Each additional 10 bachelor's degrees—across all majors—awarded to international students by a college or university leads to an additional 15 bachelor's degrees in STEM majors awarded to U.S. students, as reported in row 1. The increase is larger among U.S. men than among U.S. women but occurs for both sexes. The increases come at the expense of social sciences majors, as row 4 shows. There is no significant impact on the number of bachelor's degrees awarded in business, health-related majors, or other fields to U.S. students.

Table 3: Estimated relationship between number of bachelor's degrees awarded to international students and U.S. students, by major field and sex, 1990–2018

Group	Combined	Men	Women
STEM	1.489*** (0.359)	1.111*** (0.298)	0.388*** (0.089)
Business	0.124 (0.136)	-0.027 (0.101)	0.035 (0.061)
Health-related	0.645 (0.476)	0.100 (0.071)	0.582 (0.426)
Social sciences	-1.124*** (0.279)	-0.530*** (0.175)	-0.603*** (0.127)

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Other fields	-1.807 (1.923)	-0.121 (0.815)	-1.593 (1.158)
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Note: Each estimate is from a separate instrumental variables regression, where the number of international students is instrumented based on historical enrollment patterns from 1980. Regressions include institution and year fixed effects and institution-specific linear time trends. Standard errors (in parentheses) are clustered on the institution.

Why would U.S. students shift their major to STEM from social sciences in response to international students? International students are considerably more likely to major in STEM areas than in most other areas, so this suggests U.S. students are taking more classes with international students rather than avoiding majors popular with international students. Colleges and universities that attract more international students probably are devoting more resources to STEM areas, such as increasing the number of courses and even fields offered within STEM, hiring more faculty, and adding new lab spaces and buildings. To the extent such changes are occurring, they appear to be attractive to U.S. students as well. It also may be the case that schools that are attractive to international students are more attractive for unrelated reasons to U.S. students who want to major in STEM fields. The positive relationship is after controlling for school fixed effects and linear trends, so regardless of its cause it is a robust relationship.

DISCUSSION AND CONCLUSION

The U.S. risks falling behind in the international competition for talent. The strong reputations of many U.S. universities traditionally have attracted students from around the world, and the possibility of being able to work in the U.S. after graduation via the Optional Practical Training (OPT) program or the H-1B temporary worker visa for specialty occupations has contributed to this attraction.¹⁴ But other countries have recognized that promoting their educational institutions and post-graduate immigration programs can help them attract and retain bright young adults. For example, Boris Johnson's government created a new policy that allows international students to stay and work in the UK for two years after graduation. In 2019, Canada streamlined and expanded its policy that allows international students to work there after graduating from a Canadian university. Meanwhile, the U.S. was slowing its processing of visa requests, increasing denial rates, and raising visa fees even before the COVID-19 outbreak. The Trump administration also proposed new rules that would make it more difficult for international students to remain in or re-enter the U.S.¹⁵

¹⁴ See Kato and Sparber (2013), Bound et al. (2015), and Shih (2016) on the importance of OPT and the H-1B visa program for attracting international students.

¹⁵ The Trump administration proposed a rule that would establish a maximum period of stay for international students. This rule would eliminate "duration of status," which currently allows a student, once admitted to America, to continue his or her studies until completion, without requiring additional approvals. In addition, since 2018, the State Department has been limiting Chinese graduate students in sensitive fields to one-year visas. The administration also tried to implement an "unlawful presence" policy. The Trump Administration's policy on unlawful presence meant that tens of thousands of international students and scholars on F, J, and M visas could technically accrue enough time out of lawful status to earn a three- or ten-

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International students are important to the U.S. economy. Most of them pay full freight at private schools or out-of-state tuition at public schools. This potentially reduces the cost of attendance for U.S. students. On a less tangible level, international students bring different perspectives that benefit U.S. students. International students also spend money in local communities on food, rent, and other necessities or luxuries—up to \$45 billion annually, which helps support over 450,000 jobs.¹⁶ This spending occurs not only in major cities like New York and Los Angeles but in small college towns around the country. Students who remain in the U.S. after graduation are skilled workers desired by many employers. And since they disproportionately major in STEM fields, international students contribute to innovation and the knowledge economy that is vital to U.S. economic growth.

Enrolling fewer international students does not mean more seats available for American students at the vast majority of U.S. colleges and universities. As the analysis here shows, the number of international undergraduate students has no impact on the number of U.S. students enrolled at or receiving bachelor's degrees from U.S. schools, on average. The only evidence of a negative impact is on bachelor's degrees awarded to white women, the largest demographic group to attend and graduate from college in the U.S. Some colleges may be choosing to diversify away from this group as they enroll and graduate more international students. The evidence here is only that the increase in the number of white women graduating from a school is smaller when the increase in the number of international students graduate from that school is bigger, not that fewer white women in total are graduating from college. The evidence here also indicates that more U.S. students graduate with a STEM major—and fewer with a major in the social sciences—when their school graduates more international students. This points to a surprising benefit from international students given the strong demand for workers in STEM fields in the U.S.: not only are many international students themselves potential STEM workers, but their presence prompts more U.S. college graduates to become potential STEM workers as well.

year reentry bar, without even being aware of the alleged violation and with no time to remedy the situation. The net effect would be to eventually render hundreds of thousands of individuals subject to three or ten-year re-entry bars. That policy was enjoined in early 2020. See <https://www.forbes.com/sites/stuartanderson/2020/02/07/court-hands-international-students-big-immigration-victory/#154e6145147f>.

¹⁶ See <https://www.iie.org/Research-and-Insights/Open-Doors/Data/Economic-Impact-of-International-Students> and <https://www.nafsa.org/policy-and-advocacy/policy-resources/nafsa-international-student-economic-value-tool-v2>.

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