Assessing Gender and Racial/Ethnic Parity in the Computing Fields: Evidence from the Integrated Postsecondary Education Data System

Abstract

Data show that science, technology, engineering and math (STEM) postsecondary training programs lack gender and racial/ethnic diversity. Recent policy efforts are aimed at creating more inclusive environments for underrepresented groups in STEM and several national reports highlight progress. We argue that prior analyses have not considered institutional contexts and changes in the demographics of students enrolled in higher education more broadly. We propose new measures of gender and racial/ethnic parity in the computing fields. Using these measures, we find that while computing fields have made progress in the number of female students and students of color receiving degrees, gender and racial/ethnic parity has changed little and, in some cases, declined. We conclude with recommendations for researchers, practitioners, and policymakers.

The increasingly globalized U.S. economy requires new leaders in science, technology, engineering and math (STEM) industries (Chubin & Ward, 2009). Yet data show that STEM training programs lack gender and racial/ethnic diversity. Increasing the number of female students and students of color in STEM undergraduate postsecondary programs thus serves as both an economic and educational equity imperative. Research shows that institutional culture and norms within postsecondary STEM training programs can serve as barriers to inclusive environments for women and people of color. Meanwhile, national policy efforts have attempted to create more inclusive environments for underrepresented groups in STEM (Núñez, 2014). Recent national reports have pointed to progress in the number of female students and students of color receiving degrees in computing fields (Garcia, 2019). We argue that prior analyses have not considered changes in the demographics of students enrolled in postsecondary education. We propose new measures of gender and racial/ethnic parity in the computing fields and then show how those measures can be used to track progress and measure success.

Perspective(s) or theoretical framework

We draw on theoretical frameworks from economics and sociology that focus on preparation pipelines and inclusive environments for historically underserviced populations. We argue that women and people of color should not be underrepresented in the computing fields, since research shows that such students are equally qualified to succeed in these fields (Garcia, 2019). We define underrepresentation as a lack of parity, where parity is defined as the extent to which the gender and racial/ethnic makeup of one field mirrors the gender and racial/ethnic makeup of other fields at the same institution. For racial/ethnic parity, we focus on parity for Latinx students because (a) this group represents an increasing share of the U.S. population; (b) Latinx students represent an increasing share of students in postsecondary education; and (c) the rate of enrollment of Latinx students in postsecondary education has not kept pace with growth in the Latinx population in the U.S. (Nicols, 2017; Nora & Crisp, 2009).

Methods, techniques, or modes of inquiry

We define two measures of gender and racial/ethnic parity. The first is the percent of degrees in computer science that are awarded to female students minus the percent of degrees awarded to female students in all other fields (AOF). Equation 1 describes the first measure of gender parity for institution *i*:

$$Gender\ parity_i = \frac{D_{female}{}^{CS}}{D_{all\ students}{}^{CS}} - \frac{D_{female}{}^{AOF}}{D_{all\ students}{}^{AOF}} = \%Female^{CS} - \%Female^{AOF} \quad (1)$$

This first measure shows the difference in gender parity in percentage points, where negative numbers imply larger gaps in gender parity. Institutions that enroll a higher percent of female students may have lower scores of gender parity based on this measure. Conversely, there may be a ceiling effect for institutions that serve a lower percent of female students, since the gender parity gap measure is capped by the percent of female students receiving degrees in AOF. To address this methodological concern, we use a second definition of gender parity that measures the *percent difference* between the percent of computer science degrees awarded to female students and the percent of degrees in AOF awarded to female students:

$$Gender\ parity\ percent_i = \frac{=\%Female^{CS} - \%Female^{AOF}}{\%Female^{AOF}} \quad (2)$$

We define racial/ethnic parity using a similar measure, comparing the percent of Latinx students in computer science to that of all other fields:

$$Racial/ethnic\ parity_i = \frac{D_{Latinx}{}^{CS}}{D_{all\ students}{}^{CS}} - \frac{D_{Latinx}{}^{AOF}}{D_{all\ students}{}^{AOF}} = \%Latinx^{CS} - \%Latinx^{AOF} \quad (3)$$

For racial ethnic parity, ceiling and floor effects are a greater concern. As noted, ceiling effects exist because the lowest possible level of racial/ethnic parity for given institution – where zero percent of computer science degrees are awarded to Latinx students – is equal to the percent of Latinx students receiving degrees in all other fields. For example, if an institution graduates only five percent Latinx students in fields outside computer science, and only one percent of computer science degrees are awarded to Latinx students, then the racial/ethnic parity measure is negative four percentage points. Conversely, an institution where 30 percent of non-computer science degrees are awarded to Latinx students and 25 percent of computer science degrees are awarded to Latinx students would have a lower measure of racial/ethnic parity (negative five percentage points), even though that institution's computer science department would have a much higher percent of Latinx students. The second measure of parity addresses this issue by comparing the percent difference in the percent of awards given to Latinx students:

$$Racial/ethnic\ parity\ percent_i = \frac{=\%Latinx^{CS} - \%Latinx^{AOF}}{\%Latinx^{AOF}} \quad (4)$$

Using the previous example, the first institution would have a racial/ethnic parity percent measure of negative 80 percent (instead of four percentage points) and the second institution would have a racial/ethnic parity percent measure of negative 20 percent (instead of five percentage points). In other words, the second measure of racial/ethnic parity is necessary to account for differences in the overall characteristics of students at a given institution.

Data sources, evidence, objects, or materials

We use the Integrated Postsecondary Education Data System (IPEDS) awards data for school years 1994-95 to 2014-15. These data include information about the number of degrees or certificates awarded in each major, disaggregated by degree type, race/ethnicity, gender, and visa status. We create an institution-by-year panel that tracks the number of Associates, Bachelors and Masters degrees awarded in Computer Science, based on the Classification of Instructional Program (CIP) short code 11. This 2-digit CIP code includes all majors that fall under the broad category of computer science (specific majors are classified using 6-digit CIP codes). Our dataset tracks the number of computer science degrees awarded at each level, for each institution, disaggregated by gender and Latinx students and the data also track the number of degrees in all other fields. The final dataset comprises all institutions that awarded at least one Associates, Bachelors, or Masters degree each year, from 1994-95 to 2014-15, which includes 147,119 institution-year observations, including 7,322 in 2014-15. As shown in Appendix Figure A1, parity measures are more varied in smaller institutions, especially those that award fewer than 1,000 non-computer degrees. Therefore, in our main analyses we limit the sample to institutions that award at least 1,000 degrees in computer science.

Results and/or substantiated conclusions or warrants for arguments/point of view

Results are shown in Figures 1 to 4. We first show in Figure 1 the number of Associates, Bachelors and Masters degrees awarded in Computer Science from 1994-95 to 2014-15 (Panel A) and the number of degrees awarded in all other fields (Panel B). While the number of degrees awarded across all majors and U.S. institutions has generally increased over the past two decades, the number degrees awarded in computer science reached a peak during the 2002-03 and 2003-04 school years, when a total of 47,353, 63,951, 21,180 Associates, Bachelors and Masters degrees in Computer Science were awarded, respectively (the number of Associates degrees peaked in 2002-03, while the number of Bachelors and Masters degrees both reached their maximum the following year in 2003-04). While the number of degrees in computer science declined over the next five years, the computing fields have experienced growth in degree awards in every year since 2008-09. One exception to this trend is that the number of

Associates degrees awarded in computer science has declined in recent years. Policymakers concerned with the number of degrees in computer science awarded by U.S. institutions may be encouraged by the general rise in degree awards over the past five years.

Figure 2 shows changes over time in the number of computer science degree awards, disaggregated by gender. Panel A shows the total number of degrees awarded to males and females, for the Associates, Bachelors and Masters level. These three graphs make clear that while the number of degrees awarded to men and women follow a similar path, increases in the overall number of computer science degrees awarded are concentrated among male students. This finding is confirmed in Panel B, which shows the percent of awards in computer science and all other fields given to female students. While the percent of postsecondary awards given to female students has been generally consistent at approximately 55 percent, the percent of computer science degrees awarded to females has declined over time for Associates and Bachelors degrees, while the percent of computer science Masters degree awards given to female student has remained generally constant. The difference between these two lines shown in each graph of Panel B is our first measure of gender parity while the percent different between these two lines is our second measure of parity.

Figure 3 shows similar results for Latinx students. We show in the left side of Panel A what are otherwise promising outcomes related to the percent of computer science degree awarded to Latinx students. However, the right side of Figure 3 shows that Latinx students have also experienced significant gains in degree attainment in other fields. As a result, Latinx parity has remained flat over the past two decades and, for Associates degrees, has actually declined.

While we have focused on national averages of diversity and gender and racial/ethnic parity within computer science training programs across U.S. institutions, these averages mask a great deal of variation across institutions. Figure 4 shows the level of gender and racial/ethnic parity for each individual institution in our sample. This figure makes clear that while most institutions have negative parity measures, the student population in many computer science departments mirrors the rest of the university. In the top panel, which shows gender parity, we highlight a few institutions that appear as outliers, including the University of Maine, the Art institute of Atlanta, the Catholic University of America, and Touro College. These institutions have computer science departments with a greater percent of female Bachelors students than the percent of Bachelors students in all other departments at the same institution. Only one institution in our sample, Wellesley College, has a computer science department with 100 percent of female Bachelors students (this institution is a women's college).

Scientific or scholarly significance of the study or work

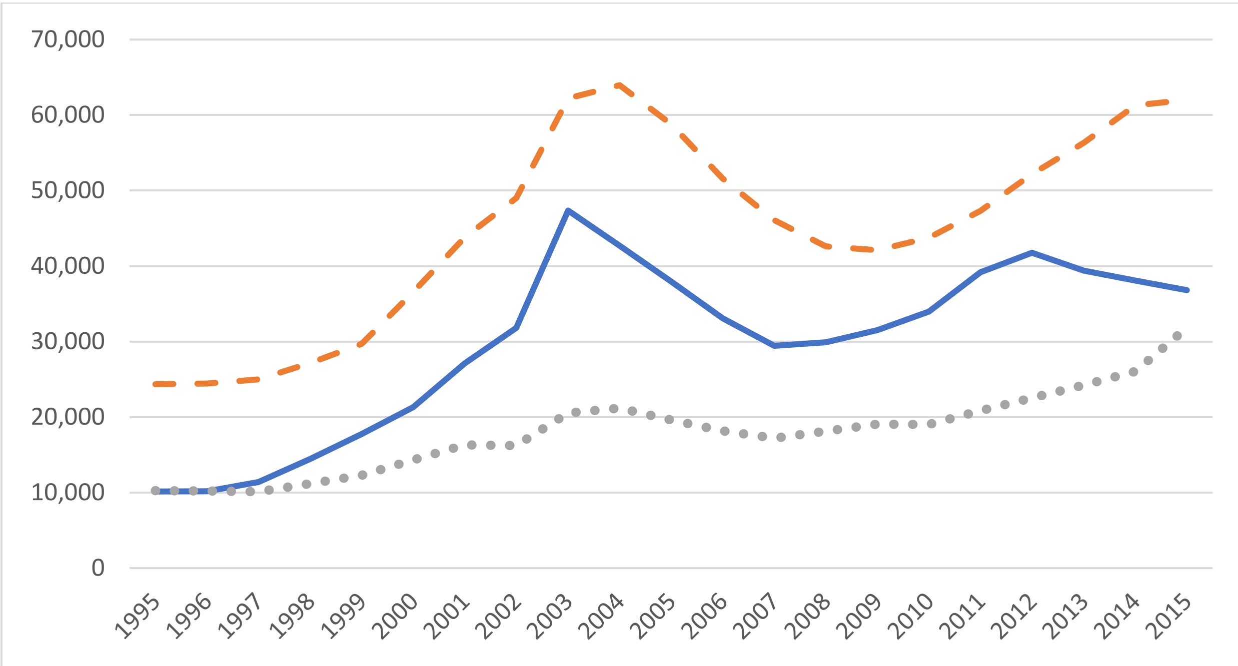
This study shows that despite substantial increases in the number of awards given to female and Latinx students in the computing fields, the level of diversity has not kept pace with higher education more broadly. These findings highlight the need to improve the extent to which female students and students of color perceive computer science training programs as inclusive and inviting spaces (Murakami & Nuñez, 2014). Future research may explore how these results differ across different institutions, particularly Hispanic Serving Institutions. Ultimately, our hope in this work is to highlight the fact that while some progress has been made, more work is needed to increase the educational opportunity of underrepresented students in STEM fields.

Figures and Tables

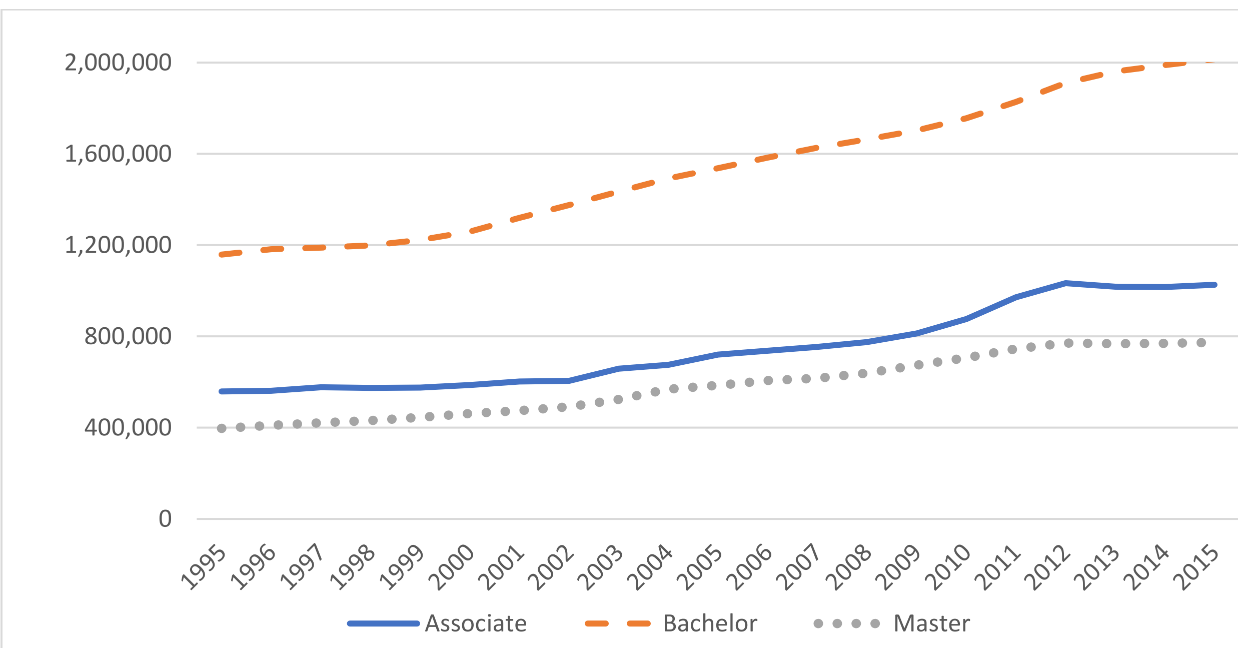
FIGURE 1

Number of degrees awarded overall and in computer science fields, 1994-95 to 2014-15

Panel A. Computer science fields



Panel B. All fields

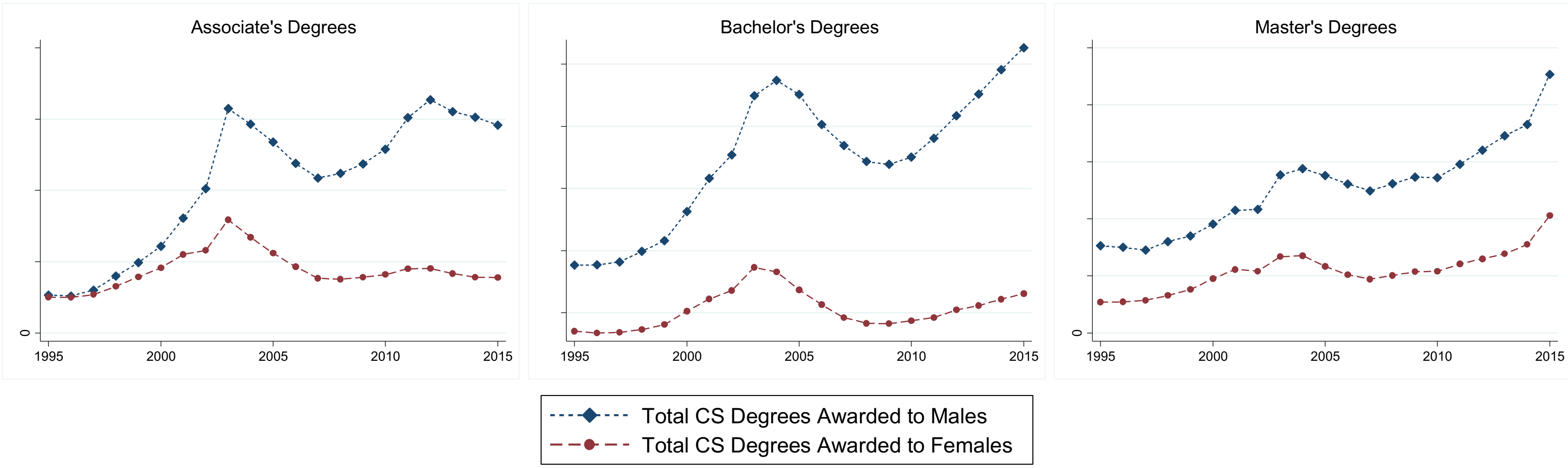


Source: Authors' calculation based on IPEDS data.

FIGURE 2

Number and percent of degrees awarded to males and females in the computer science fields, 1994-95 to 2014-15

Panel A. Number of degrees awarded



Panel B. Percent of degrees awarded

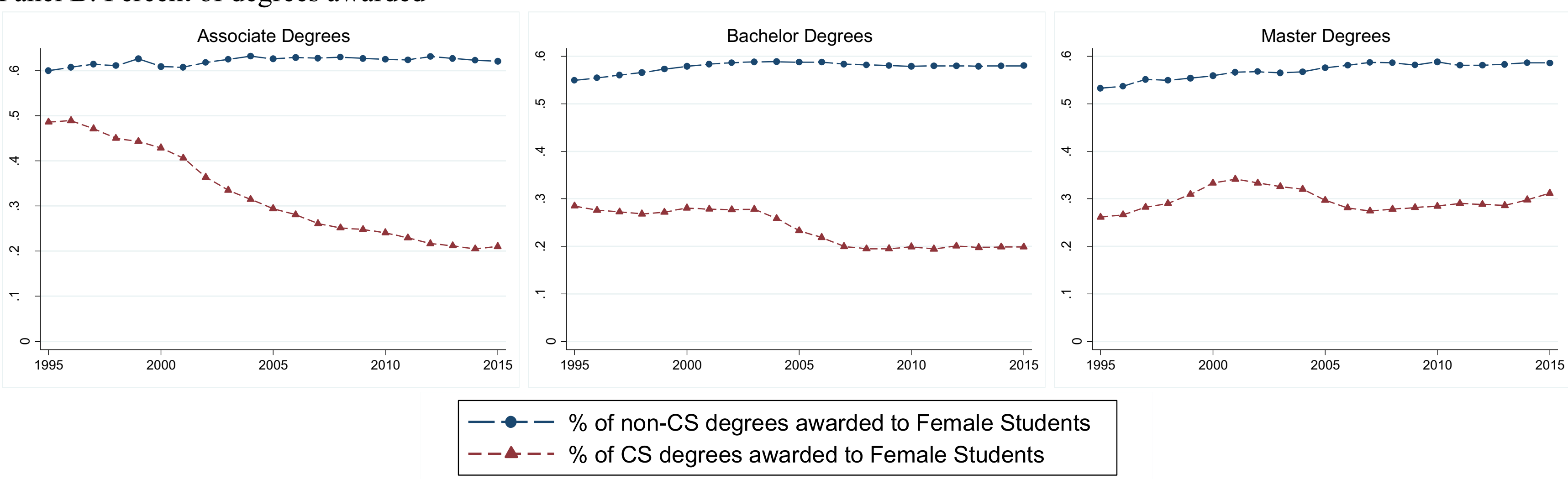
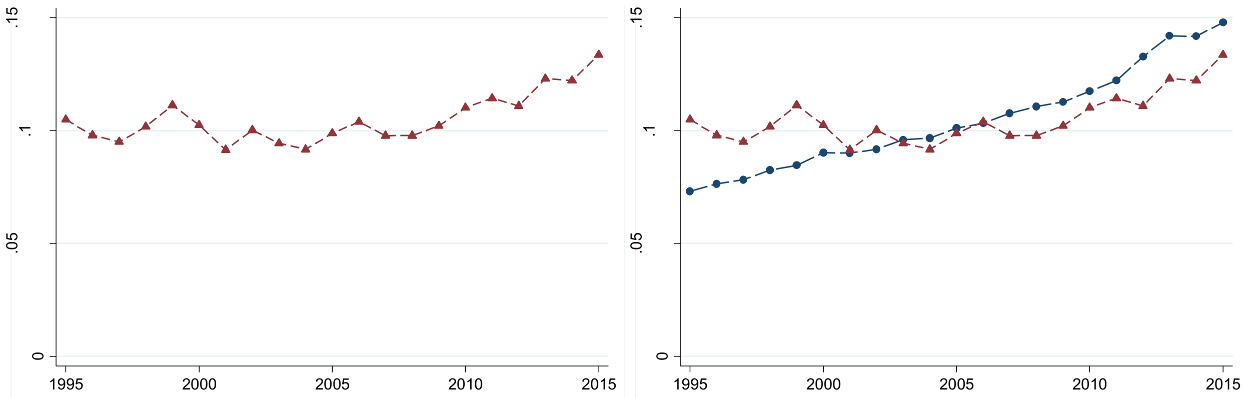


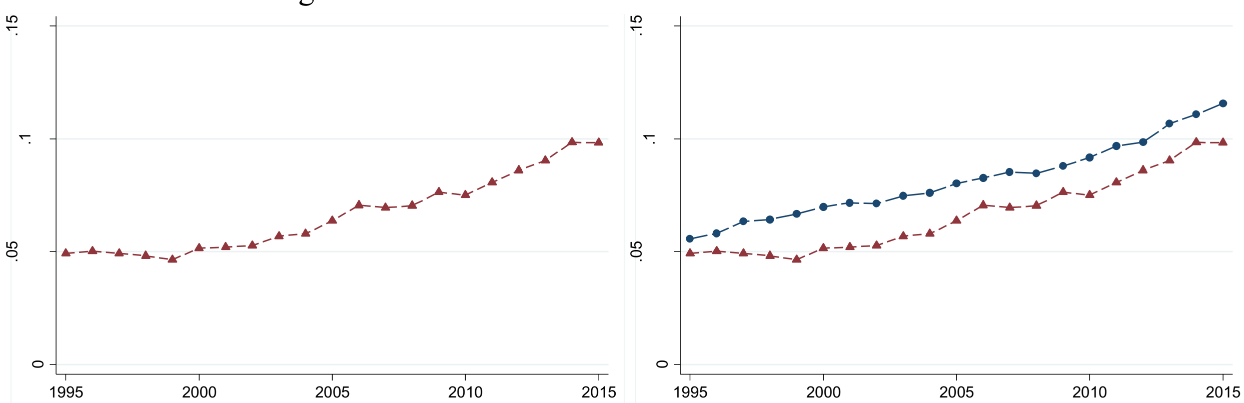
FIGURE 3

Percent of degrees awarded to Hispanic students in the computer science fields and all other fields, 1994-95 to 2014-15

Panel A. Associate degrees



Panel B. Bachelor's degrees



Panel C. Master's degrees

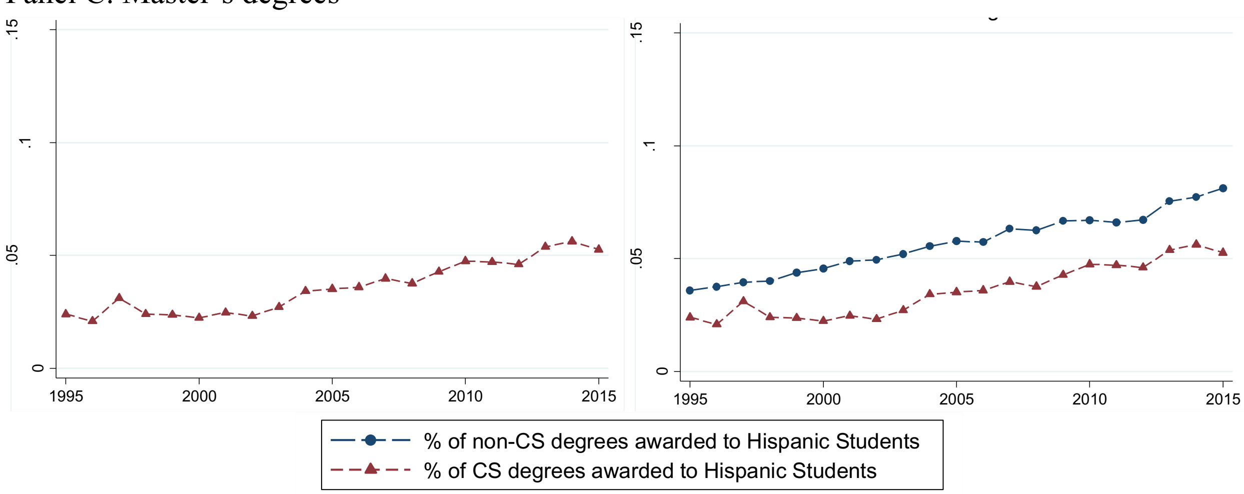
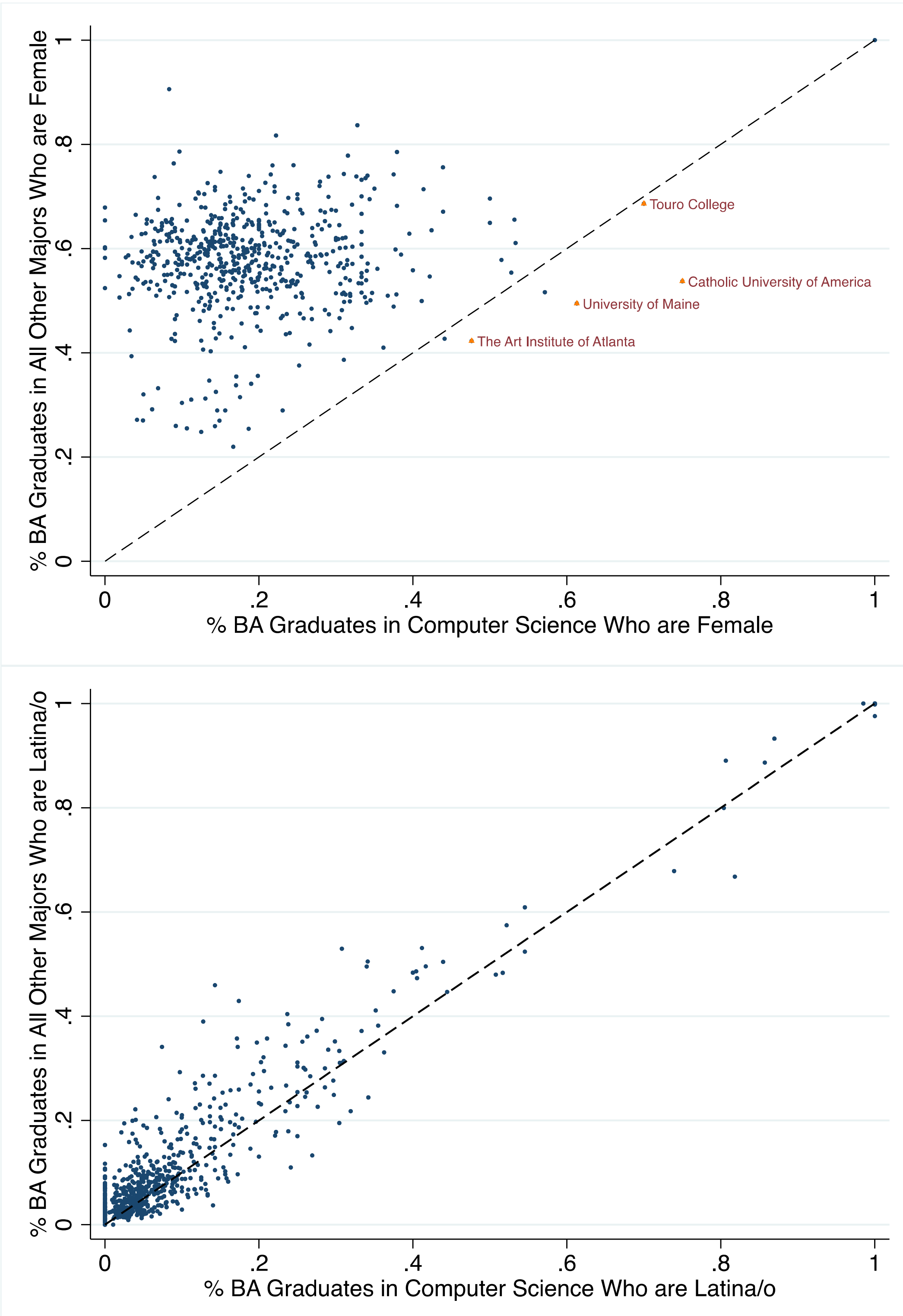


FIGURE 4

Percent of degrees awarded to female students in the computer science fields and all other fields, 2014-15



Source: Authors' calculation based on IPEDS data

References

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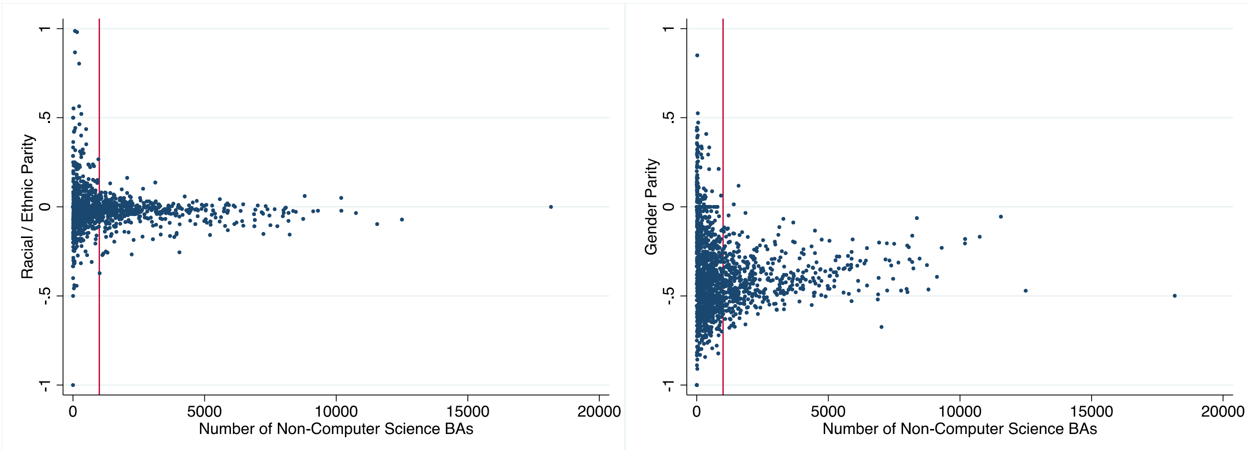
APPENDIX FIGURE A1

The relationship between parity measures and the number of non-computer science degrees awarded, 2014-15



Note. Red vertical line is for institutions with fewer than 1,000 non-computer science Bachelors degrees awarded in 2014-15.