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The Role and Influence of Exclusively Online Degree Programs in Higher Education

Justin C. Ortagus
University of Florida

Rodney Hughes
West Virginia University

Hope Allchin
University of Florida

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Justin C. Ortagus
Director, Institute of Higher Education
University of Florida

Rodney Hughes
West Virginia University

Hope Allchin
University of Florida

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Abstract

This study leverages national data and a quasi-experimental design to examine the influence of enrolling in an exclusively online degree program on students' likelihood of completing their degree. We find that enrolling in an exclusively online degree program had a negative influence on students' likelihood of completing their bachelor's degree or any degree when compared to their otherwise-similar peers who enrolled in at least some face-to-face courses. The negative relationship between exclusively online enrollment and students' likelihood of bachelor's degree completion was relatively consistent among White, Black, Hispanic, Asian, low-income, and military students. Findings focused solely on those students enrolled in exclusively online degree programs revealed that the negative influence of exclusively online enrollment was exacerbated when the student attended a for-profit four-year institution.

Keywords: Online education, exclusively online degree programs, degree completion

Introduction

Colleges and universities have been criticized for low completion numbers, particularly among racially minoritized and historically underserved subgroups of students (e.g., Schneider & Yin, 2011). The completion gap between Black and White students has increased from 16 to 20 percentage points at public universities and 8 to 15 percentage points at public community colleges (National Center for Education Statistics, 2021). Completion rates among historically underserved students can vary considerably according to the type of institution attended. The six-year graduation rate for Black and Hispanic students who began college in Fall 2012 was substantially higher at public or private nonprofit four-year universities (between 42.9 and 57.1 percent) than for-profit four-year institutions (between 14.2 and 28.1 percent) (Ortagus & Hughes, 2021). These differential completion patterns reveal the need to further explore strategic approaches designed to increase access and improve educational attainment for historically underserved subgroups of students.

Online education, particularly exclusively online degree programs, has been identified as a viable strategy to increase the number of students who graduate from college (Sener, 2012). More specifically, online education can accommodate time- or location-constrained students by offering learning and student services in an online setting that accommodates learners in ways that do not align with the rigid class times and office hours associated with residential, face-to-face education (Bouchey et al., 2021; Goodman et al., 2019; LeBlanc, 2013). The proportion of college students enrolling in online courses has grown considerably over the past two decades, increasing from 5.9 percent in 2000 to 42.9 percent in 2016 (Ortagus, 2017). Among college students who enroll in online courses, 24.4 percent enroll in exclusively online degree programs

(authors' calculations using National Postsecondary Student Aid Study data).

For colleges and universities, exclusively online degree programs may represent a way to reduce costs and enhance revenue in ways that make financial sense. More specifically, Deming et al. (2015) reported that institutions with a higher percentage of exclusively online students are able to leverage advances in online learning technology to be able to charge lower tuition prices, suggesting that exclusively online degree programs can "bend the cost curve" in higher education. Additional work has indicated that exclusively online degree programs can generate substantial increases in the net revenue of colleges and universities when the online courses are offered at larger enrollment levels (Cheslock et al., 2016; Morris, 2008). Despite the growing prevalence and financial promise of online education in higher education, the quality of online degree programs has been called into question in recent years.

A fundamental question facing colleges and universities is whether online degree programs have a democratizing effect by opening new doors to higher education or a diversionary effect by attracting students who may have performed better in a face-to-face learning environment. Although online education has the potential to remove barriers and increase access to higher education, previous studies have revealed mixed results regarding the effects of online enrollment on college students' academic outcomes (Ortagus, 2020; Xu & Xu, 2020). However, prior research focuses primarily on comparing the short-term outcomes (e.g., exam scores and course grades) of online students to those of face-to-face students in the same type of class (Bowen et al., 2014; Figlio et al., 2013; Johnson & Mejia, 2014). This work is typically focused on a single class at a single institution and does not speak to the relationship between exclusively online degree programs and degree completion, which represents the most

important outcome for students, administrators, and policymakers.

Past research on the effectiveness of online education typically compares the academic outcomes of students enrolled in an online course relative to those in the face-to-face version of the same course. However, there may be important differences between students who enroll in an exclusively online degree program and students enrolling in a mixture of face-to-face and online coursework. Online courses often require stronger self-directed learning skills than in-person coursework, and students in entirely online degree programs may be more dependent on these skills than students also enrolled in face-to-face instruction (Allen & Seaman, 2014; Bambara et al., 2009; Guglielmino & Guglielmino, 2003; Xu & Xu, 2020). Additional work has shown that students underestimate the challenges of online learning when entering college (Bork & Rucks-Ahidiana, 2013). Performance reduction in online learning environments can impact certain populations of online learners, such as Black, Hispanic, and low-income students, at higher rates than their peers (Xu & Jaggars, 2014) due in part to the systemic disadvantages these populations encounter in schooling prior to postsecondary enrollment (Xu & Xu, 2020).

To examine the influence of enrolling in an exclusively online degree program on degree completion, we address the following research questions:

Research Question 1: To what extent does enrolling in an exclusively online degree program influence students' likelihood of degree completion?

Research Question 2: Do results vary according to students' demographic or background characteristics?

Research Question 3: Among exclusively online students, what is the relationship between enrollment at a specific institution type and students' likelihood of degree completion?

Literature Review

Prior research on postsecondary online education has typically reported negative or mixed effects of online courses on students' academic outcomes. Students in face-to-face instruction have earned higher course grades than their peers in online courses in several experimental studies (Alpert et al., 2016; Figlio et al., 2013; Joyce et al., 2015). While course grade is the most common measure of student performance, other research has highlighted subsequent outcomes of online learning, including course repetition, subject persistence, and college persistence. Many past studies on the effects of online course-taking focus on community college students (Hart et al., 2019; Huntington-Klein et al., 2017; Krieg & Henson, 2016; Shea & Bidjerano, 2018). Performance in online education varies by subpopulation, and previous work has shown that racially minoritized students and academically underprepared students may be at the greatest risk of performance decrement in online coursework (Xu & Xu, 2020).

The Impact of Online Education on Students' Academic Outcomes

Numerous studies related to the provision of online education in higher education focus on comparing the academic outcomes between face-to-face and online students (Xu & Jaggars, 2011, 2013, 2014; Shea & Bidjerano, 2014; Ortagus, 2018). A meta-analysis of the empirical literature on the effectiveness of online education found no significant difference between the academic outcomes of exclusively online students and face-to-face students (Means et al., 2013), but additional studies have provided differing takeaways regarding the effect of online enrollment on the academic outcomes of college students (Xu & Jaggars, 2011, 2013; Ortagus. 2018). In general, prior work focusing on online education in higher education has identified a negative relationship between online enrollment and short-term, course-level outcomes (Xu &

Jaggars, 2011, 2013) and a positive relationship between online enrollment and longer-term academic outcomes, such as completing an associate degree or transferring to a four-year institution (Shea & Bidjerano, 2014; Ortagus, 2018).

Shea and Bidjerano (2014) used online enrollment data in 2004 and propensity score methods to find that students who enrolled in at least one online course during their first year of college were more likely to earn their associate degree than their peers who did not enroll in any online courses in the first year. Importantly, the authors did not disaggregate between students who enroll in a single online course and those who enroll in exclusively online degree programs. Additional research has leveraged quasi-experimental approaches and shown that enrolling in some, but not all, online courses had a positive influence on the likelihood of both completing an associate degree and transferring vertically from a two- to four-year institution (Ortagus, 2018, 2022).

Fischer et al. (2021) also found that students from a large public university in California who enrolled in an online course that was required for their major had higher rates of bachelor's degree completion and a slightly shorter time to degree. Contrary to prior work indicating a positive relationship between online enrollment and degree completion, Huntington-Klein et al. (2017) used regional and longitudinal variation in the number of high-speed Internet providers as a source of identifying variation, reporting that students at Washington State community colleges who took the online version of a comparable face-to-face course were less likely to complete their associate or bachelor's degree.

However, numerous researchers have shown that college students perform worse in individual online courses at a variety of institution types (Alpert et al., 2016; Figlio et al., 2013;

Joyce et al., 2015), including for-profit institutions (Bettinger et al., 2017). Xu and Jaggars (2011, 2013) found that college students who enrolled in online courses were more likely to receive a lower grade and withdraw from their course when compared to their face-to-face peers. Additional researchers found that college students were less likely to earn an A or B or complete a given course when taking it online (Hart et al., 2018). Additional work examining students' performance on college exit exams in Colombia found that students in online programs performed worse on their exit exams when compared to students in face-to-face programs (Cellini & Grueso, 2021).

Even though 24.4 percent of online students enroll in exclusively online degree programs (authors' calculations using National Postsecondary Student Aid Study data), extant literature has yet to examine the influence of enrolling in exclusively online degree programs on students' academic outcomes. In a qualitative study, Su and Waugh (2018) reported that the work requirements for an exclusively online degree program exceeded students' expectations, providing further evidence that students may underestimate the academic challenges associated with online learning (Bork & Ruks-Ahidiana, 2013). Additional qualitative research revealed that student engagement and faculty-student interactions are strong predictors of academic success in exclusively online programs and should be a critical goal in developing any exclusively online degree program (Ortagus & Derreth, 2020).

Heterogeneous Impacts of Online Education

Prior literature has also examined the varying relationships between online education and academic outcomes based on students' demographic characteristics or the discipline of the online course. Xu and Jaggars (2014) focused specifically on short-term performance gaps between

face-to-face and online students, reporting that racially minoritized students, particularly Black students, were less likely to persist in online courses. While decreased course performance in online courses is present for all populations, Johnson and Meija (2014) found that racially minoritized students, male students, part-time students, and students with lower levels of academic achievement saw the largest decline in passing grades in online instruction compared to face-to-face instruction. These gaps are likely connected to the systemic disadvantages that low-income and racially minoritized students face prior to postsecondary enrollment, but more research is needed to understand the role of online education for these outcomes (Xu & Xu, 2020).

Past work has also demonstrated that the academic subject of the online class plays a role in outcomes for students (Hart et al., 2018; Xu & Jaggars, 2014). While the passing rates for online students was lower than the passing rate for face-to-face students in nearly every subject, Johnson and Meija (2014) noted that students' passing rates dropped between 18.5 and 19.4 percent for media and communications, engineering, and public and protective services courses that were offered online. Some of the performance decrement in online classes can be attributed to peer effects. Xu and Jaggars (2014) tracked how students' online performance weakened more in classes where there were more at-risk online learners, regardless of their own identities.

Although the body of literature examining the effectiveness of online education in higher education is continually growing, little is known regarding the influence of enrolling in an exclusively online degree program or the extent to which exclusively online enrollment affects different subgroups of students in varying ways. This lack of evidence pertaining to the long-term impacts of exclusively online enrollment precludes administrators and policymakers from

improving their understanding of the implications associated with increasing commitments to exclusively online degree programs.

Differential Completion Outcomes in Higher Education

Prior literature has shown that students' background characteristics and type of institution attended can play an important role in whether they complete their degree. Regardless of medium of instruction, specific subgroups of students have been identified as less likely to graduate than their peers. Completion rates among college students are stratified by race/ethnicity and socioeconomic status, with Black, Hispanic, and low-income students completing college at significantly lower rates than their White, Asian, and higher-income peers (Bailey et al., 2015; Causey et al., 2022). Flores et al. (2017) found that achievement gaps among Black and Hispanic students can be attributed to circumstances occurring prior to beginning college, including lack of access to challenging coursework, secondary school racial composition, and familial immigration status.

Previous literature has shown that students' likelihood of graduating increases alongside increases in socioeconomic status (Titus, 2006). In an analysis of bachelor's degree attainment, Nguyen et al. (2019) found that students from the bottom half of the income distribution had a six-year degree attainment rate of 12.0 percent. Meanwhile, students in the top half of the distribution had a bachelor's degree attainment rate of 58.8 percent (Nguyen et al., 2019). While there is limited research on the outcomes of nontraditional students, existing data suggest that students who do not enter as first-year, full-time students directly after high school have lower bachelor's degree attainment (National Center for Education Statistics, 2022; Taniguchi & Kaufman, 2005). Veterans, one subgroup of nontraditional learners, as a whole have similar

completion rates to other nontraditional groups, with 51.7 percent of enrolled veterans graduating with a certificate or degree (Ford & Vignare, 2015). However, the financial benefits earned from the federal GI Bill may support veteran persistence in unique ways (Barr, 2019).

Students attending different types of institutions also have varying outcomes. Some of the largest gaps in degree completion exist for students attending four-year for-profit institutions (Demings, 2013). Lynch et al. (2010) found that only 22 percent of first-time full-time students at for-profit colleges earned a bachelor's degree in six years compared to 55 percent of students at non-profit public schools and 65 percent of students at non-profit private schools. Graduation rates are also lower for students at two-year colleges. Moore and Shulock (2010) found that in the California community college system, only 31 percent of students had earned a certificate or degree or transferred to a four-year institution within six years of enrolling. Black and Hispanic students in the cohort studied completed fewer credits on average and were less likely to earn a degree (Moore & Shulock, 2010). Past work has also found that increases in institutional selectivity and indicators of college quality are positively related to completion rates (Long, 2008; Melguizo, 2010).

Conceptual Framework

Exclusively online degree programs have the potential to increase access by removing traditional time and location constraints associated with face-to-face education. However, the benefits of exclusively online enrollment may not be distributed equally. Students who do not take a single course on campus may not have the same level of built-in, personalized, and consistent interactions with their faculty, which forces exclusively online students to rely disproportionately on self-directed learning. Previous research has reported that White students

and individuals with higher levels of educational attainment fare better in learning environments that require self-directed learning when compared to Black students and individuals with lower levels of educational attainment, suggesting that the systemic disadvantages facing historically underserved students in face-to-face courses may be exacerbated in online environments (Xu & Xu, 2020).

Prior learning theories have outlined the importance of high-quality personal interactions in ways that center students' active interactions with faculty and peers as a critical predictor of students' sense of belonging and likelihood of academic success (e.g., Tinto 1998), particularly in the online learning environment (Anderson, 2008; Balaji & Chakrabarti, 2010). Anderson's (2008) "Theory of Online Learning" contends that any effective learning environment must prioritize multiple modalities of effective interactions among students, faculty, and the content in a given course. Online learning is thereby situated as a subset of learning in general, regardless of medium of instruction, in which faculty-student interactions and content-centered interactions outside of the traditional lecture structure are paramount in any high-quality course experience. Such interactions are made possible when the learning environment for a given course or degree program is learner-centered, knowledge-centered, assessment-centered, and community-centered.

Rovai's (2003) composite persistence model, which combines earlier persistence models of Tinto (1975) and Bean and Metzner (1985) in order to explain postsecondary student persistence in online education, can also guide the logical rationale of this study. Previous research focused on the impact of online education in higher education has extended Rovai's (2003) composite persistence model to examine long-term academic outcomes, such as degree

completion. (e.g., Fischer et al., 2022; Shea & Bidjerano, 2014). As one example, Fischer et al. (2022) used Rovai's model to classify students' academic and non-academic characteristics as a way to offer a logical rationale for the selection of covariates, subgroup analyses, and additional empirical decisions.

Rovai's (2003) composite model is divided into (1) students' background characteristics prior to enrollment and (2) factors affecting students after enrollment, such as work or family responsibilities. This conceptual model synthesizes prior persistence models and considers relevant research pertaining to online students' needs and learning styles to better explain persistence and degree completion among online students. By integrating key aspects of previous student persistence models and applying them to an online environment, Rovai informs the logical rationale of this study and provides a useful lens through which to interpret our findings. The academic and background characteristics explaining a student's likelihood of both exclusively online enrollment and subsequent degree completion are deemed as critical to better understanding whether exclusively online enrollment has democratizing or diversionary effects for student populations pursuing degree completion. The composite model described above, combined with previous literature, informs the logical rationale, selection of covariates (outlined in Table 1), and interpretation of the findings for the study.

Data and Methods

This study draws national data from the Beginning Postsecondary Students Longitudinal Study for 2012–2017 (BPS:12/17). BPS:12/17 provides the most recent longitudinal tracking of a nationally representative sample of college students. Students included in BPS:12/17 enrolled initially at a college or university in 2011-2012 and participated in three rounds of data collection

during their first, third, and sixth years after beginning college. The sample size of BPS:12/17 is 22,500 college students. By using BPS:12/17 data, we are able to examine student characteristics, course-taking patterns (such as exclusively online enrollment), and academic outcomes over a six-year period.

Key Variables

The primary outcome of this study is a given student's likelihood of degree completion for the pooled sample including all students and numerous subgroups of historically underserved students who have been found to be more likely to enroll in online degree programs or less likely to graduate from college than their peers. More specifically, we examine subgroups according to race/ethnicity (White, Black, Hispanic, Asian), low-income status, veteran status, and financial independence. In addition, we examine whether enrolling in exclusively online degree programs at specific types of institutions (e.g., public four-year, private nonprofit four-year, for-profit four-year, selective four-year, broad-access four-year, public two-year, and for-profit two-year) influences students' likelihood of degree completion, particularly among the historically underserved subgroups of students described previously. Selective four-year institutions are defined as those that are moderately or very selective in BPS:12/17, and broad-access four-year institutions are defined as those that are either open-access or minimally selective. We are unable to include subgroup analyses for Native American students or private nonprofit two-year institutions due to extremely low proportions of exclusively online students. As a robustness check, we ran alternative specifications for an exploratory outcome of "dropping out" of college (i.e., no longer enrolled and never graduated).

The treatment variable is enrollment in an exclusively online degree program at any

degree-granting college or university. In particular, we considered students to be treated if they were enrolled in an exclusively online degree program as of 2017. Approximately, 8.8 percent of students in the BPS:12/17 sample were classified as treated. The BPS:12/17 sample represents the most recent nationally generalizable data available to allow researchers to link exclusively online enrollment to students' completion outcomes. To be clear, our treatment variable is defined at the programmatic level, but a very small proportion (fewer than 1 percent in 2012) of students may seek to enroll solely in online courses throughout the entirety of their college experience despite not being enrolled in an exclusively online degree program. If students graduated or left college prior to 2017, we used their most recent degree program to determine treatment status. The comparison group included students who did not enroll in exclusively online degree programs at any point during college, as we excluded students who enrolled in an exclusively online degree program during an earlier year but switched to a face-to-face program. We excluded 4.2% of students in the BPS:12/17 sample for this reason, but we ran alternative specifications in which we included these students in the control group.

Background Information

This section provides additional background information pertaining to the treatment variable, outcome variables, and BPS:12/17 sample. As noted previously, the proportion of students in exclusively online degree programs has grown considerably over the past two decades, increasing from 2.5% in 2000 to 10.5% in 2016 (authors' calculations using National Postsecondary Student Aid Study data). Among students in BPS:12/17 who were enrolled in an exclusively online degree program, 46.8% were in an associate degree program, 41.7% were in a bachelor's degree program, and 9.0% were in a certificate program as of 2017. However, we

limit analyses, to be outlined below, to students who expected an associate or bachelor's degree.

In addition, 52.1% of students enrolled in exclusively online degree programs attended for-profit four-year institutions, 18.6% attended public two-year institutions, 12.4% attended private four-year institutions, 10.4% attended public four-year institutions, and 4.3% attended for-profit two-year institutions. Most students in exclusively online degree programs (64.5%) attended open-access or minimally selective four-year institutions, but 8.9% of exclusively online students attended moderately or very selective four-year institutions. Regarding the academic majors of exclusively online students at four-year institutions, 22.4% were in health-related majors, 21.1% of students were in business-related majors, and 16.3% of students were in STEM-related majors.

Analytic Strategy

When examining the influence of online enrollment in any non-experimental study, selection bias is a primary concern. If the college students who enroll in exclusively online degree programs differ from students who do not in ways that influence their likelihood of degree completion, we would face challenges determining whether differences in outcomes across groups are due to enrolling in the exclusively online degree program rather than pre-existing differences across student subgroups. In quasi-experimental studies, the counterfactual model can be used to allow treatment and control groups to be equivalent based on a host of pre-treatment characteristics. We account for individuals' conditional probability of receiving the treatment (enrolling in exclusively online degree programs) by using inverse probability of treatment weighting (IPTW). When random assignment is not possible, IPTW represents an effective approach to reduce selection bias and achieve better balance between non-equivalent

groups of data (Austin & Stuart, 2015).

After calculating the inverse probability treatment weights, we use a weighting scheme to calculate the average treatment effect on the treated (ATT) to identify the effects on those who experienced the treatment. We ran alternative specifications in which we removed units with extreme propensity scores (below 1 percent or above 99 percent and below 5 percent or above 95 percent). These alternative specifications revealed consistent results relative to the preferred specifications, which are reported below, in statistical significance, direction, and magnitude of coefficients.

In Figures 1 and 2, we demonstrate the overlap between treated and untreated units within the overall sample and the race/ethnicity sub-samples by including multiple graphs showing the probability densities for online and face-to-face students, displaying the estimated likelihood of choosing each modality, before and after inverse probability of treatment weighting. When investigating subgroups, including by students' race/ethnicity and institution sector, we recalculated IPTWs for each subgroup by using students from a given subgroup or students who enrolled at institutions at the same two- or four-year level. For analyses by student subgroup, we estimate propensity scores capturing the likelihood of students enrolling exclusively online. For analyses by institution type, we limit analyses to students who enrolled exclusively online and capture online students' propensity to enroll at different institution types (probability densities for all subgroups are available upon request). In addition, results from the model used to estimate propensity scores for exclusively online enrollment and enrollment among exclusively online students at public four-year institutions are available in Appendix Table 1.

[INSERT FIGURES 1 AND 2 HERE]

To estimate the influence of enrolling in exclusively online degree programs on students' likelihood of degree completion, we use various linear probability models in light of the ease of interpretability of linear regression coefficients relative to log-odds or odds ratios from logit models. Following Abadie et al. (2017), we cluster standard errors by sector of students' institutions attended upon entering college, which constituted the strata used for sampling institutions in the underlying National Postsecondary Student Aid Study from which the BPS:12/17 cohort was drawn. Additional analyses used logit models rather than linear probability models and found consistent results in statistical significance, direction, and magnitude of coefficients. The linear probability models for this study can be represented by the following equation:

$$y_i = \beta_0 + \beta_1 EO_i + \beta_2 \boldsymbol{X}_i + \varepsilon_i,$$

where y_i is an indicator equaling one or zero for whether individual *i* completes an associate or bachelor's degree. The variable EO is a treatment indicator that equals one if an individual enrolled in an exclusively online degree program. $\boldsymbol{X}_i$ represents a vector of demographic variables and information on the academic performance and circumstances of individual *i*. The error term is represented by ε_i.

In both the IPTW models and linear probability models, we included the following covariates: sex, race/ethnicity, age, low-income status, first-generation status, veteran status, marital status, dependency, employment status, attendance intensity, composite SAT scores, high school GPA, distance from the target institution, enrollment size of the institution, institutional selectivity, transfer status, and academic major. Table 1 displays means and standard deviations

for model covariates and outcomes for treated and control students. According to Table 1, students whose degree program was exclusively online as of 2017 were more likely to be older, financially independent, enrolled at for-profit institutions, and living farther from their institutions relative to their peers.

[INSERT TABLE 1 HERE]

To produce nationally generalizable findings, we combined IPTWs and nationally generalizable sample weights into one weight by multiplication. Both IPTWs and sample weights are probability-type quantities, and previous research has identified the combination of both weights into one regression equation through multiplication as a valid empirical approach (Guo & Fraser, 2015). In a relevant example, DuGoff et al. (2014) compared four different methods to estimate treatment effects, finding that combining a propensity score method and survey weighting was the most effective approach when seeking to achieve unbiased estimates deemed generalizable to the target population of interest.

In addition, we employed a covariate balancing approach using standardized mean differences and variance ratios in alignment with recommendations by Shadish et al. (2008) and Rubin (2001). We calculated the standardized mean differences (Cohen's d) before and after using IPTW using the following equation: $d = (\bar{x}_t - \bar{x}_c) / \sqrt{(s_t^2 + s_c^2)/2}$. After applying the IPTWs, Cohen's d was close to zero. We tested the variance ratio before and after the IPTW approach and specified an acceptable range near one ($4/5 < v < 5/4$) after using the IPTW approach. Taken together, this balance check affirms that covariates were well-balanced after employing the IPTW approach and ensuring that the standardized mean differences and variance ratios typically fell within their recommended ranges (results for all additional balance checks

for individual covariates can be found in Appendix Tables 2-5).

Results

In this section, we present findings on the influence of exclusively online enrollment on bachelor's degree completion before considering the relationship between exclusively online enrollment and the completion of any degree (either an associate degree or a bachelor's degree). We focus initially on the pooled sample and subgroups by race/ethnicity (Table 2) prior to examining additional subgroups by low-income status, veteran status, and financial independence (Table 3). The comparison group for Tables 2 and 3 only includes students who did not enroll in an exclusively online degree program during college. For Tables 4 and 5, we shift our focus to consider only the subsample of students who enrolled in exclusively online degree programs, examining the influence of exclusively online enrollment among different types of institutions offering bachelor's degrees (Table 4) and institutions offering associate degrees (Table 5). The comparison group for Tables 4 and 5 includes students who enrolled in an exclusively online degree program at a different type of institution that offers the same level of degrees. For example, the first column of Table 4 focuses on exclusively online students at public four-year institutions, so the comparison group includes exclusively online four-year students who did not attend a public four-year college or university.

Table 2 shows that enrollment in exclusively online degree programs had a negative influence on bachelor's degree completion across student subgroups by race and ethnicity. When compared to students who did not enroll in online degree programs, enrolling exclusively online had a negative influence (8.3 percentage points) on bachelor's degree completion for students who expected to earn a bachelor's degree or higher (column 1 in Panel A of Table 2). The

relationship between exclusively online enrollment and bachelor's degree completion was negative and statistically significant for Black students in column 1 of Panel B (8.6 percentage points) and Asian students in column 7 of Panel B (21.7 percentage points). The negative relationship between exclusively online enrollment and bachelor's degree completion was marginally statistically significant for Hispanic students in column 4 of Panel B (5.6 percentage points) and significant for White students in column 10 of Panel B (8.1 percentage points). When focusing on the influence of exclusively online enrollment and completion of any degree (e.g., associate or bachelor's), findings were negative and statistically significant for all students and for each subgroup (20.9 percentage points for Asian students and between 8 and 9 percentage points for the pooled sample and all other subgroups).

[INSERT TABLE 2 HERE]

Table 3 reports the influence of enrolling in exclusively online degree programs for the additional subgroups of students from lower-income households, students who had military service, and students who were financially independent. Enrollment in exclusively online degree programs was associated with a decrease of 8.9 percentage points in low-income students' likelihood of bachelor's degree completion (column 1) and a decrease of 11.4 percentage points in the likelihood of bachelor's degree completion among students with military service (column 4). Exclusively online enrollment was unrelated to financially independent students' likelihood of earning a bachelor's degree (column 10) but had a positive and marginally statistically significant influence (1.9 percentage points) on financially independent students' likelihood of earning an associate degree. Exclusively online enrollment had a statistically significantly negative influence on completion of any degree for low-income students (9.3 percentage points)

and financially independent students (5.5 percentage points).

[INSERT TABLE 3 HERE]

In Table 4, only four-year students who were enrolled in exclusively online degree programs as of 2017 are included in the results, comparing exclusively online students in a bachelor's degree program at a specific four-year institution type to exclusively online students in a bachelor's degree program at all other four-year institution types. For these analyses, we accounted for exclusively online students' selection into different types of institutions and explored relationships between exclusively online enrollment at one institution type and exclusively online students' likelihood of degree completion. Results in column 3 of Table 4 show that exclusively online students who attended for-profit four-year institutions were 11.9 percentage points less likely to complete bachelor's degrees compared to students at other types of four-year institutions (column 3 of Table 4). However, exclusively online students who attended a selective four-year institution had a marginally significant increase (8.1 percentage points) in their likelihood to complete a bachelor's degree when compared to exclusively online students in bachelor's degree programs at other less-selective four-year institutions (column 4 of Table 4).

[INSERT TABLE 4 HERE]

Table 5 focuses solely on exclusively online students at institutions offering associate degrees. Each exclusively online student in Table 5 was enrolled in an associate degree program at their institution. Columns 1, 3, and 5 of Table 5 present results for students who expected to earn only an associate degree, and columns 2, 4, and 6 report results for students who expected to earn an associate degree or higher, which may also include a bachelor's degree or higher. Results

are negative but not statistically significant for students at public two-year, for-profit two-year, and for-profit four-year institutions who expected to earn associate degrees. The relationship with associate degree completion is negative and statistically significant (3.5 percentage points) for students enrolled in associate degree programs at for-profit four-year institutions and expected an associate degree or higher (column 6 of Table 5).

[INSERT TABLE 5 HERE]

To explore whether exclusively online students were leaving college without a degree or merely taking longer to graduate, we ran alternative specifications in which the outcome was "dropping out" of college (i.e., no longer enrolled and never graduated) and found that exclusively online students in associate degree programs at either public or for-profit two-year institutions were more likely to drop out of college than their peers (results for these exploratory analyses can be found in Appendix Tables 6 and 7). As mentioned previously, we ran an additional robustness check to include students who enrolled initially in an exclusively online degree program before switching to a face-to-face program. These students, who completed their coursework in a face-to-face program, were included in the control group for the purpose of this additional robustness check, and we found similar results whether we included or excluded them from analyses (see Appendix Table 8). Finally, we also explored whether the results pertaining to institutional types varied when comparing exclusively online students at a given institution type to students who did not enroll in online degree programs at the same institution type. Results for these exploratory analyses indicated that exclusively online students at all types of four-year institutions had a lower likelihood of completing a bachelor's degree relative to their peers at the same institution type. At the two-year level, the negative relationship between exclusively online

enrollment and associate degree completion was concentrated among for-profit institutions (see Appendix Table 9).

Sensitivity Analysis

Unobserved pre-treatment differences between exclusively online students and their peers represent a potential issue for our study. Our analyses would violate the strong ignorability assumption if unobserved pre-treatment differences of students in the BPS:12/17 sample were independent of the estimated propensity scores. To directly address this potential issue, we conducted Rosenbaum's (2002) sensitivity analysis to determine whether the presence of hidden bias due to unobserved covariates would affect our findings.

The extent to which an unobserved covariate influences the odds of a given student enrolling in an exclusively online degree program is captured by the value of Γ. Insignificant and low values of Γ are at a greater risk for contamination due to hidden bias, but significant and high values of Γ would be less likely to be impacted by hidden bias. For example, if two college students with the same observed covariates have a $\Gamma = 2$, one of the students would need to be twice as likely to receive treatment due to an unobserved covariate (i.e., hidden bias) than the observed covariate of interest to cast doubt on the observed treatment effect. Our sensitivity analysis checked all outcomes and model specifications, revealing that it would be unlikely that an observed treatment effect associated with enrolling in an exclusively online degree program was caused by an unmeasured or hidden confounder.

Discussion

Online education has the potential to mitigate time- or location-based constraints and increase access to higher education, particularly exclusively online degree programs. Prior

literature pertaining to the impact of online enrollment on college students' academic outcomes has reported mixed results and typically focused on comparing short-term outcomes, such as exam scores and course grades, of students in the online version of a course relative to those in the face-to-face version (Xu & Xu, 2020). Additional work focused specifically on the impact of online education on long-term outcomes typically reveals a positive relationship between enrolling in at least one online course, but not necessarily exclusively online enrollment, and degree completion (Shea & Bidjerano, 2014; Fischer et al., 2022; Ortagus, 2022). However, Huntington et al. (2017), which focused solely on Washington State community college students. reported that students who took the online version of a comparable face-to-face course were less likely to complete their associate or bachelor's degree. Despite the burgeoning body of literature on postsecondary online education and considerable growth of exclusively online degree programs across all types of American colleges and universities, little is known regarding the long-term implications of exclusively online enrollment for students' likelihood of degree completion.

Because online education can remove barriers to higher education for low-income students forced to work during college, adults, parents, veterans, and other independent students, many colleges and universities have increased their number of online offerings and exclusively online degree programs (Ortagus, 2017). Unfortunately, the potential benefits of online education are not distributed equally, as exclusively online students who do not take any coursework on campus may not have not have the same level of personalized and consistent interactions with their faculty and peers. This dynamic forces exclusively online students to rely disproportionately on self-directed learning, which may exacerbate the systemic inequities

benefitting white and higher-achieving students to a further degree than their peers (Xu & Xu, 2020). Anderson's "Theory of Online Learning" outlines the importance of high levels of engagement for online students by describing the effective online learning environment as one that prioritizes multiple modalities of effective interactions among students, faculty, and course content.

In this study, we use nationally generalizable data and a quasi-experimental approach to show that students who enrolled exclusively in online degree programs were less likely to complete bachelor's degrees than their otherwise-similar peers. Importantly, the negative influence of exclusively online enrollment was relatively consistent across race/ethnicity subgroups and concentrated primarily among low-income and veteran students. Findings also revealed that the negative influence of enrolling exclusively in online degree programs was exacerbated when the student attended a for-profit four-year institution. Exclusively online students at selective four-year institutions had a marginally significant increase in their likelihood of completing a bachelor's degree relative to exclusively online students at other four-year institutions, and financially independent students who enrolled in an exclusively online degree program had a marginally significant increase in their likelihood of completing an associate degree.

A disproportionate share of exclusively online students face time- or location-based constraints that can make them less likely to graduate from college—regardless of medium of instruction. This suggests that readers should exercise caution when interpreting our results, as some of the observed effects outlined in the present study may be due to selection. We sought to directly address this issue in our analyses by employing a quasi-experimental design to reduce

selection bias and conducting a series of sensitivity checks to measure the presence of hidden bias from unobserved covariates. However, we encourage readers to interpret our findings as another piece of evidence suggesting that online education can have a negative influence on students' academic outcomes, but that does not necessarily suggest that enrolling in an exclusively online degree program is the sole cause of a given student's decision to leave college without a degree.

Implications for Practice, Policy, and Future Research

In alignment with learning theories outlined by Xu and Xu (2020), we contend that systematic inequities associated with self-directed learning can explain why racially minoritized students and students attending institutions without adequate academic support and services struggle in exclusively online learning environments. From a policy perspective, our work has a clear link to critical issues surrounding both quality and accountability in higher education. Specifically, students enrolling in exclusively online degree programs are eligible for federal financial aid programs. Taxpayers are best served when financial aid funds support degree programs that enable students to complete their degrees, which has direct and positive implications for their likelihood to secure productive employment and make sustainable progress in repaying any loans.

Given that the likelihood of degree completion in exclusively online programs appears to differ across student and institution types, our findings can contribute to the design and targeting of accountability measures specific to online degree programs and inclusive of multiple institution types, including for-profit institutions, with the greatest need to ensure quality for these degree programs. Future research can explore whether exclusively online students in

specific academic disciplines fare better (or worse) in online settings when compared to their peers in other disciplines. In addition, future research should consider the effects of varying levels of online enrollment, including exclusively online degree programs, on student debt, students' labor market outcomes, and additional outcomes that may allow students to make evidence-based decisions when determining the benefits and burdens of online education.

Due to the institutional findings showing that exclusively online students at for-profit four-year institutions appear to be less likely to earn their degree than exclusively online students at other four-year institutions, several policy implications should be considered. First, policymakers should require transparent reporting of costs and revenues among exclusively online degree programs. Prior research has shown that for-profit degree programs invest considerably more toward advertising than institutional spending (Vazquez-Martinez & Hansen, 2020), which can have a negative impact on students' academic outcomes (Cellini, 2021; Ortagus & Hughes, 2021). Second, policymakers should regulate the use of for-profit online program managers (OPMs) by non-profit colleges and universities, as the economic model of for-profit online offerings appears to be misaligned with the critical need to increase degree attainment and narrow completion gaps facing historically underserved students. Finally, colleges and universities should increase their investment in wraparound services and targeted engagement for exclusively online students given the compelling body of literature showing the positive impact of these types of approaches in higher education, regardless of medium of instruction (e.g., Bouchey et al., 2021; Miller & Weiss, 2022).

As noted previously, many colleges and universities may seek to expand their level of reliance on exclusively online degree programs due to financial motivations. For example,

previous researchers found that public universities responded to decreases in state appropriations by increasing their online enrollments (Ortagus & Yang, 2018). Because online offerings are not subject to the same physical space limitations as face-to-face education, exclusively online degree programs can generate substantial tuition revenue by leveraging extremely large enrollment levels (Cheslock et al., 2016). However, the financial advantage of exclusively online degree programs, which is associated with offering high-enrollment courses at scale, may come at the expense of high-quality and student-centered learning experiences (Ortagus, 2020).

For those time- or location-constrained students who have no choice but to enroll in exclusively online degree programs, colleges and universities would benefit from widespread distribution and communication of established best practices for the development and delivery of high-quality online degree programs. Future accreditation efforts should evaluate clear, shared, and elevated standards for exclusively online degree programs and online education at large.

This study advances knowledge pertaining to exclusively online degree programs, but our findings are subject to several limitations. First, national data capturing online enrollment patterns at the student level are rather limited, which forces researchers to capture whether a student was enrolled in an exclusively online degree program as of 2011-12, 2013-14, and 2016-17 and precludes more nuanced comparisons according to students' online enrollment patterns. Second, BPS:12/17 offers limited information pertaining to local characteristics, such as the local unemployment rate or county-level economic considerations, that may affect a given student's likelihood of selecting into and completing an online degree program. Third, BPS:12/17 provides a six-year window into students' enrollment patterns and educational attainment, but researchers are unable to continue to follow students in the BPS:12/17 cohort to examine whether they

completed a degree after the 2016-17 academic year, which is especially worrisome for students in bachelor's degree programs enrolling on a part-time basis.

Prior research has offered some actionable ways to enhance online course design in ways that can potentially improve students' academic outcomes (Xu & Xu, 2020). In particular, students have seen increased achievement in courses that allow for students to interact with their instructor and other students (Barnard et al., 2009; Young, 2006). These types of online course interactions can be facilitated through synchronous design components, ongoing feedback, and purposeful discussion among students (Means et al., 2009; Ortagus, 2020). Despite a growing body of evidence regarding best practices in online course design, the same types of synchronous interactions and student engagement activities that improve the quality of an online course may also make the course less convenient for non-traditional students who cannot participate in traditional face-to-face offerings (Jaggars & Xu, 2016).

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Figures and Tables

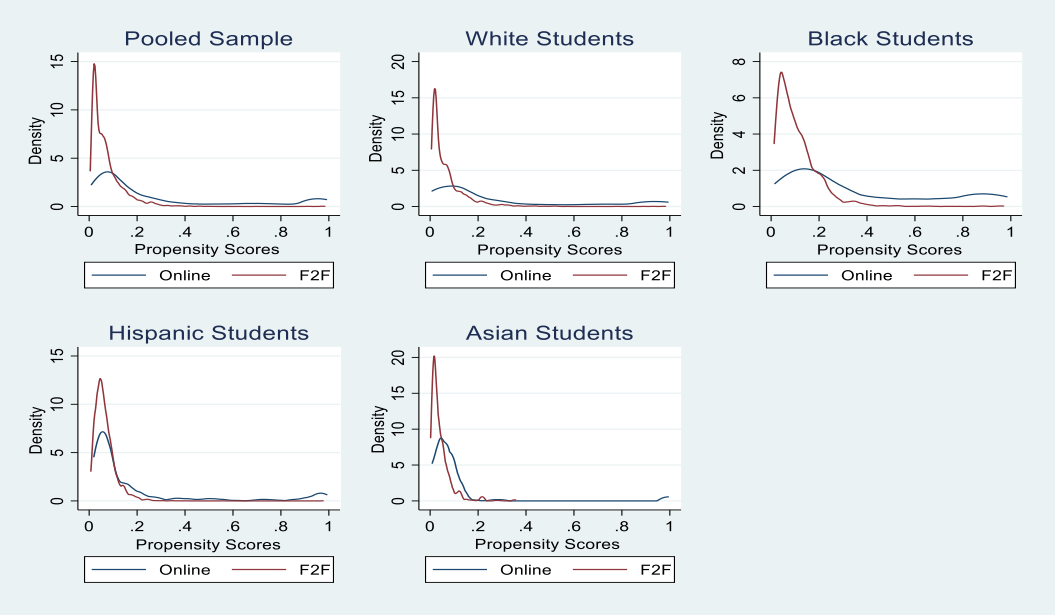

Figure 1. Probability densities for exclusively online and students enrolled in some or all face-to-face courses (before IPTW)

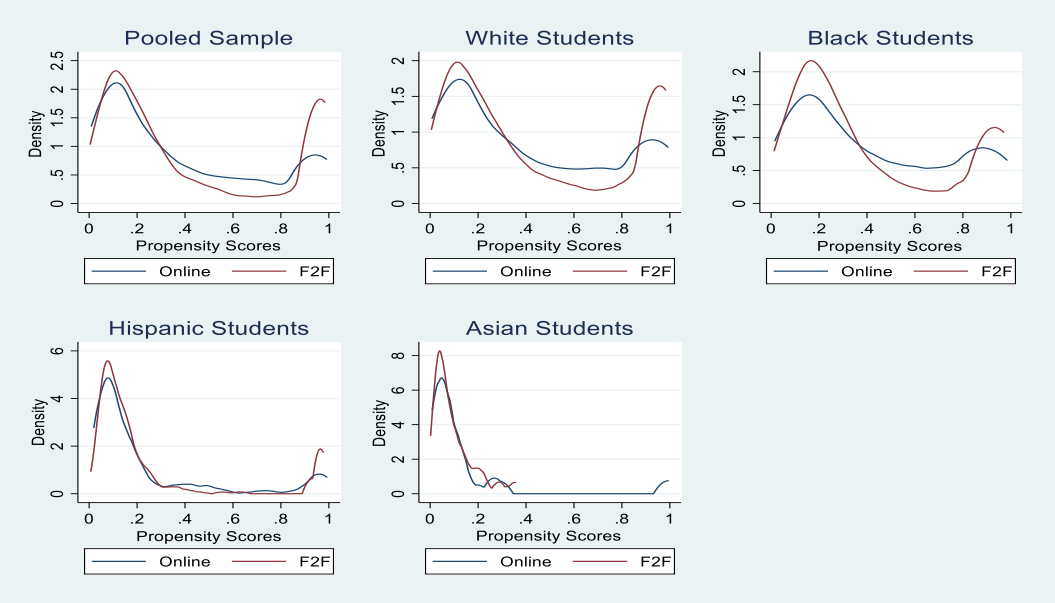

Figure 2. Probability densities for exclusively online and students enrolled in some or all face-to-face courses (after IPTW)

Table 1. Descriptive statistics by modality and degree type

	Modality		Bachelor's		Associate	
	Online	Not Online	Completed	Did Not Complete	Completed	Did Not Complete
Student is female	0.614	0.549	0.593	0.530	0.568	0.553
	(0.487)	(0.498)	(0.491)	(0.499)	(0.495)	(0.497)
Student is Black	0.213	0.132	0.086	0.177	0.115	0.145
	(0.409)	(0.339)	(0.280)	(0.382)	(0.319)	(0.352)
Student is Hispanic	0.134	0.185	0.123	0.220	0.205	0.176
	(0.341)	(0.389)	(0.328)	(0.414)	(0.404)	(0.380)
Student is Asian	0.022	0.061	0.079	0.043	0.041	0.061
	(0.147)	(0.239)	(0.270)	(0.202)	(0.199)	(0.239)
Student is American Indian	0.010	0.008	0.004	0.012	0.008	0.009
or Native American	(0.100)	(0.091)	(0.062)	(0.108)	(0.088)	(0.093)
Student is White	0.589	0.571	0.670	0.505	0.589	0.569
	(0.492)	(0.495)	(0.470)	(0.500)	(0.492)	(0.495)
Student's age at end of 2011	23.8	19.9	18.8	21.2	21.2	20.0
	(8.0)	(5.0)	(2.9)	(6.5)	(7.0)	(5.1)
Student was independent as of 2011-12	0.507	0.159	0.060	0.282	0.259	0.178
	(0.500)	(0.365)	(0.237)	(0.450)	(0.438)	(0.382)
Student was low-income as of 2011-12	0.525	0.318	0.175	0.450	0.364	0.332
	(0.500)	(0.466)	(0.380)	(0.497)	(0.481)	(0.471)
Student was first-generation as of 2011-12	0.765	0.571	0.382	0.731	0.683	0.569
	(0.424)	(0.495)	(0.486)	(0.444)	(0.466)	(0.495)
Student was ever married as of 2011-12	0.178	0.046	0.017	0.087	0.102	0.050
	(0.382)	(0.210)	(0.129)	(0.283)	(0.303)	(0.217)
Student had military service as of 2011-12	0.057	0.019	0.012	0.029	0.035	0.020

	(0.232)	(0.136)	(0.110)	(0.169)	(0.183)	(0.139)
Student's HS GPA 3.5 - 4.0	0.150	0.245	0.387	0.132	0.161	0.251
	(0.357)	(0.430)	(0.487)	(0.338)	(0.368)	(0.434)
Student's HS GPA < 3.0	0.360	0.340	0.185	0.450	0.361	0.338
	(0.480)	(0.474)	(0.388)	(0.497)	(0.480)	(0.473)
Student's concorded SAT/ACT (in 10s)	89.8	98.2	108.4	89.9	90.8	98.8
	(16.3)	(20.5)	(19.5)	(17.1)	(16.0)	(20.8)
Student attended FT in 2011-12	0.607	0.673	0.838	0.550	0.650	0.671
	(0.489)	(0.469)	(0.369)	(0.498)	(0.477)	(0.470)
Student attended PT in 2011-12	0.266	0.171	0.020	0.289	0.175	0.181
	(0.442)	(0.376)	(0.141)	(0.453)	(0.380)	(0.385)
Student worked FT in 2011-12	0.219	0.105	0.049	0.161	0.133	0.112
	(0.414)	(0.306)	(0.216)	(0.367)	(0.339)	(0.315)
Student worked PT in 2011-12	0.216	0.274	0.310	0.240	0.314	0.259
	(0.411)	(0.446)	(0.463)	(0.427)	(0.464)	(0.438)
Distance to institution in 2011-12	3.4	1.3	2.1	1.1	1.0	1.6
(in 100s of miles)	(5.9)	(3.5)	(4.3)	(3.4)	(3.4)	(4.0)
Student inst. selective in 2011-12	0.152	0.427	0.746	0.165	0.111	0.462
	(0.359)	(0.495)	(0.435)	(0.371)	(0.315)	(0.499)
Student inst. two-year in 2011-12	0.557	0.494	0.161	0.732	0.823	0.433
	(0.497)	(0.500)	(0.367)	(0.443)	(0.382)	(0.495)
Institution enrollment in 2011-12	52.1	16.1	18.5	20.1	21.1	19.1
(in 100s of students)	(97.8)	(16.8)	(22.1)	(42.5)	(46.1)	(33.0)
Student inst. public in 2011-12	0.560	0.763	0.646	0.811	0.822	0.727
	(0.497)	(0.425)	(0.478)	(0.392)	(0.382)	(0.445)
Student inst. private in 2011-12	0.112	0.192	0.340	0.078	0.069	0.209
	(0.316)	(0.394)	(0.474)	(0.268)	(0.253)	(0.406)

Student inst. for-profit in 2011-12	0.327	0.045	0.014	0.112	0.109	0.064
	(0.469)	(0.208)	(0.118)	(0.315)	(0.312)	(0.245)
Student's first program was 1 or 2 years	0.691	0.474	0.145	0.734	0.824	0.426
	(0.462)	(0.499)	(0.352)	(0.442)	(0.381)	(0.494)
Student transferred before deg. completion	0.323	0.243	0.157	0.314	0.179	0.265
	(0.468)	(0.429)	(0.364)	(0.464)	(0.384)	(0.441)
Student expected bachelor's or higher	0.805	0.898	0.992	0.819	0.843	0.899
	(0.396)	(0.302)	(0.089)	(0.385)	(0.364)	(0.301)
First degree was entirely online	0.217	0.000	0.005	0.031	0.024	0.020
	(0.412)	(0.000)	(0.073)	(0.173)	(0.153)	(0.139)
Student completed a bachelor's degree	0.182	0.431			0.254	0.376
	(0.386)	(0.495)			(0.436)	(0.484)
Student completed an associate degree	0.257	0.163	0.006	0.076		
	(0.437)	(0.369)	(0.080)	(0.265)		
Number of observations	1,990	13,700	6,070	9,610	3,030	12,650

Notes. Standard deviations in parentheses. The comparison group for students whose degree program was exclusively online as of 2017 is students who were not exclusively online in 2011, 2014, or 2017. Selective institutions are those that are moderately or very selective in BPS. Numbers of observations rounded to the nearest 10.

Table 2. The influence of exclusively online enrollment on degree completion by race/ethnicity

Panel A. *All students*.

	All Students		
	BA	AA	Any
Exclusively online degree program	-0.083**	0.003	-0.084**
	(0.022)	(0.007)	(0.018)
Number of observations	13,610	2,070	15,680
R^2	0.198	0.046	0.119

Panel B. *Subgroups by race/ethnicity*.

	Black Students			Hispanic Students			Asian Students			White Students		
	BA	AA	Any	BA	AA	Any	BA	AA	Any	BA	AA	Any
Exclusively online degree program	-0.086***	0.057**	-0.088**	-0.056~	-0.031	-0.087***	-0.217***	0.125*	-0.209***	-0.081*	-0.008	-0.082**
	(0.016)	(0.014)	(0.023)	(0.027)	(0.036)	(0.014)	(0.017)	(0.038)	(0.018)	(0.033)	(0.013)	(0.020)
Number of observations	2,060	360	2,420	2,590	410	3,000	720	30	750	7,520	1,170	8,690
R^2	0.260	0.082	0.143	0.237	0.218	0.183	0.428	0.919	0.326	0.199	0.071	0.122

Notes. ~ $p < 0.1$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

All models include inverse-probability-of-treatment weights estimated for each subsample and previously described covariates. The "BA" column is limited to students who expected a bachelor's degree or higher, the "AA" column is limited to students who expected specifically an associate degree, and the "Any" column is limited to students who expected an associate degree or higher. Standard errors clustered on the sector of the first institution attended. Numbers of observations rounded to the nearest 10.

Table 3. The influence of exclusively online enrollment on degree completion by low-income status, veteran status, and financial independence

	Lower-Income Students			Military Students			Independent Students		
	BA	AA	Any	BA	AA	Any	BA	AA	Any
Exclusively online degree program	-0.089** (0.019)	0.014~ (0.006)	-0.093** (0.020)	-0.114* (0.039)	0.044 (0.206)	-0.069 (0.048)	-0.037 (0.024)	0.019~ (0.010)	-0.055** (0.017)
Number of observations	4,860	1,190	6,040	250	70	320	2,680	990	3,660
R^2	0.219	0.047	0.124	0.308	0.543	0.228	0.141	0.057	0.082

Notes. ~ $p < 0.1$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

All models include inverse-probability-of-treatment weights estimated for each subsample and previously described covariates. The "BA" column is limited to students who expected a bachelor's degree or higher, the "AA" column is limited to students who expected specifically an associate degree, and the "Any" column is limited to students who expected an associate degree or higher. Standard errors clustered on the sector of the first institution attended. Regression models for Military Students exclude the covariate for Asian race. Numbers of observations rounded to the nearest 10.

Table 4. The influence of institution type on bachelor's degree completion among exclusively online students

	Public Four-Year	Private Four-Year	For-Profit Four-Year	Selective Four-Year	Broad-Access Four-Year
Exclusively online student attended institution type	0.012 (0.071)	0.076 (0.059)	-0.119* (0.043)	0.081~ (0.039)	-0.054 (0.077)
Number of observations	770	770	770	770	770
R^2	0.239	0.176	0.145	0.218	0.167

Notes. ~ $p < 0.1$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

All models include inverse-probability-of-treatment weights estimated for each subsample and previously described covariates. Samples are limited to students who were in exclusively online degree programs as of 2017, who pursued a bachelor's degree, and who expected a bachelor's degree or higher. The regression sample includes 440 exclusively online students at for-profit four-year institutions, 170 students at public four-year institutions, 160 students at private four-year institutions, and fewer than 5 each at public two-year and for-profit two-year institutions. Standard errors clustered on the sector of the first institution attended. Numbers of observations rounded to the nearest 10.

Table 5. The influence of institution type on associate degree completion among exclusively online students

	Public Two-Year		For-Profit Two-Year		For-Profit Four-Year	
	Expected Only AA	Expected AA or Higher	Expected Only AA	Expected AA or Higher	Expected Only AA	Expected AA or Higher
Exclusively online student attended institution type	-0.033 (0.026)	-0.021 (0.023)	-0.005 (0.069)	0.022 (0.033)	-0.034 (0.058)	-0.035* (0.011)
Number of observations	260	900	260	900	260	900
R^2	0.249	0.059	0.303	0.229	0.134	0.048

Notes. ~ $p < 0.1$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

All models include inverse-probability-of-treatment weights estimated for each subsample and previously described covariates. Samples are limited to students who were in exclusively online degree programs as of 2017, who pursued an associate degree, and who expected specifically an associate degree ("Expected Only AA") or an associate degree or higher ("Expected AA or Higher"). Standard errors clustered on the sector of the first institution attended. Regression models for For-Profit Two-Year exclude the covariates for Asian and American Indian or Alaska Native race and institutional selectivity. Numbers of observations rounded to the nearest 10.

Appendix Table 1. Probability of exclusively online enrollment and enrollment at public four-year institution among exclusively online students

	Exclusively Online as of 2017	Public Four-Year Institution
Student is female	0.018***	0.001
	(0.005)	(0.025)
Student's age as of 2011-12	0.000	-0.002
	(0.001)	(0.004)
Student was financially independent in 2011-12	0.045***	-0.069~
	(0.006)	(0.041)
Student was first-generation as of 2011-12	0.014*	-0.035
	(0.005)	(0.025)
Student was ever married as of 2011-12	0.017*	-0.055
	(0.007)	(0.047)
Student ever had military service as of 2011-12	0.006	0.017
	(0.011)	(0.064)
Student HS GPA 3.5 - 4.0	-0.005	-0.025
	(0.007)	(0.033)
Student HS GPA under 3.0	0.004	-0.046~
	(0.005)	(0.027)
Student missing HS GPA over age 30	0.003	-0.006
	(0.012)	(0.076)
Student's concorded SAT/ACT score	-0.001***	0.001
	(0.000)	(0.001)
Student is missing concorded SAT/ACT score	-0.001	-0.001
	(0.006)	(0.034)
Student in STEM major	0.004	-0.024
	(0.006)	(0.033)
Student in health major	-0.013*	-0.021
	(0.006)	(0.031)
Student in business major	0.020**	-0.012
	(0.006)	(0.032)
Student attended full-time in 2011-12	-0.011~	-0.048
	(0.006)	(0.031)
Student attended part-time in 2011-12	0.008	-0.037
	(0.007)	(0.042)
Student worked full-time in 2011-12	0.031***	0.033

	(0.006)	(0.032)
Student worked part-time in 2011-12	0.001	0.055*
	(0.006)	(0.027)
Student's distance to institution in 2011-12	0.007***	-0.016***
	(0.001)	(0.004)
Student attended selective institution in 2011-12	-0.122***	0.183***
	(0.009)	(0.037)
Student attended two-year institution in 2011-12	-0.071***	0.129***
	(0.008)	(0.032)
Institution enrollment in 2011-12	0.001***	0.000
	(0.000)	(0.000)
Student is Black	0.006	-0.012
	(0.006)	(0.032)
Student is Hispanic	-0.043***	-0.005
	(0.006)	(0.034)
Student is Asian	-0.038**	0.000
	(0.014)	(0.060)
Student is American Indian or Alaska Native	-0.012	0.151~
	(0.020)	(0.087)
Student was low-income as of 2011-12	0.023***	-0.096***
	(0.005)	(0.025)
Student attended public institution in 2011-12	-0.007	
	0.008	
Student attended for-profit institution in 2011-12	0.059***	
	0.008	
Student in one- or two-year program in 2011-12	0.027***	
	(0.008)	
Student expected bachelor's degree or higher	0.012*	0.040
	(0.005)	(0.038)
Number of Observations	18,780	970
Pseudo R2	0.266	0.269

Notes. ~ $p < 0.1$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$
Numbers of observations rounded to the nearest 10.

Appendix Table 2. Balance tests for the influence of exclusively online enrollment on bachelor's degree completion by race/ethnicity

	All		Black		Hispanic		Asian		White	
	No Cov.	Cov.	No Cov.	Cov.	No Cov.	Cov.	No Cov.	Cov.	No Cov.	Cov.
Student is female	-0.034~	-0.013	-0.026	0.006	0.007	0.015	0.043	0.050	-0.028	-0.027~
	(0.017)	(0.011)	(0.047)	(0.020)	(0.028)	(0.022)	(0.068)	(0.057)	(0.019)	(0.012)
Student's age at end of 2011	0.173	-0.099	1.241~	0.580*	0.712	0.339	-0.071	0.372	-0.099	-0.451
	(0.624)	(0.150)	(0.639)	(0.219)	(0.922)	(0.424)	(0.445)	(0.433)	(0.863)	(0.258)
Student was independent	0.046	0.053	0.049	0.027	0.030	-0.028	0.001	-0.039~	0.079	0.088
as of 2011-12	(0.050)	(0.034)	(0.064)	(0.039)	(0.050)	(0.020)	(0.053)	(0.017)	(0.044)	(0.049)
Student was first-generation	-0.005	-0.013	0.035~	0.031*	-0.016	-0.014	-0.037	-0.042	-0.025	-0.019
as of 2011-12	(0.044)	(0.017)	(0.019)	(0.012)	(0.025)	(0.021)	(0.063)	(0.064)	(0.034)	(0.023)
Student was ever married	-0.048	-0.060	-0.095	-0.083*	0.040	0.022	0.022	-0.021	-0.066	-0.091
as of 2011-12	(0.044)	(0.036)	(0.058)	(0.035)	(0.045)	(0.025)	(0.075)	(0.020)	(0.071)	(0.068)
Student had military service	0.016~	0.009~	0.011	0.001	0.006	0.000	0.000	0.000	0.017~	0.010
as of 2011-12	(0.009)	(0.005)	(0.014)	(0.008)	(0.011)	(0.016)	(0.000)	(0.000)	(0.008)	(0.008)
Student HS GPA 3.5 - 4.0	-0.019	-0.011	-0.002	0.003	-0.002	-0.003	-0.014	-0.041	-0.005	0.004
	(0.014)	(0.008)	(0.017)	(0.016)	(0.025)	(0.027)	(0.054)	(0.046)	(0.014)	(0.005)
Student HS GPA under 3.0	0.028	0.008	0.038	0.011	-0.009	-0.019	0.060	0.069	-0.012	-0.003
	(0.020)	(0.008)	(0.041)	(0.017)	(0.029)	(0.018)	(0.109)	(0.068)	(0.011)	(0.007)
Student missing HS GPA	0.011	0.007*	0.029	-0.019	0.009	-0.017	-0.032	-0.011	0.028	0.017*
over age 30	(0.025)	(0.003)	(0.029)	(0.015)	(0.016)	(0.021)	(0.017)	(0.011)	(0.024)	(0.004)
Student's concorded	-0.797	-0.261	-3.470~	-1.268	-0.792	-0.884	0.382	1.263	-0.842	-0.313
SAT/ACT score (in 10s)	(1.123)	(0.536)	(1.622)	(0.745)	(1.944)	(2.399)	(4.713)	(1.690)	(1.095)	(0.471)
Student is missing concorded	0.033	0.009	0.088~	0.023	0.008	-0.017	-0.074	-0.011	0.037	0.003
SAT/ACT score	(0.033)	(0.006)	(0.040)	(0.025)	(0.034)	(0.042)	(0.070)	(0.074)	(0.033)	(0.012)
Student in STEM major	0.002	-0.014	0.007	0.019	0.011	0.017	-0.044	0.026	-0.029	-0.054
	(0.011)	(0.022)	(0.014)	(0.017)	(0.013)	(0.011)	(0.051)	(0.057)	(0.029)	(0.036)
Student in health major	0.010	-0.007	-0.009	0.000	-0.030	0.001	0.087	0.051	0.035	-0.004

	(0.012)	(0.016)	(0.026)	(0.026)	(0.029)	(0.025)	(0.074)	(0.059)	(0.032)	(0.011)
Student in business major	-0.011	-0.016	0.109*	0.086*	0.043	0.027~	0.009	0.030	-0.088	-0.080
	(0.028)	(0.026)	(0.035)	(0.020)	(0.033)	(0.013)	(0.080)	(0.074)	(0.064)	(0.051)
Student attended full-time	-0.004	0.003	-0.037	-0.019	0.031	0.036	0.056	0.014	0.023	0.011
in 2011-12	(0.026)	(0.018)	(0.063)	(0.036)	(0.041)	(0.021)	(0.070)	(0.055)	(0.030)	(0.013)
Student attended part-time	-0.006	-0.005	0.012	-0.009	0.009	0.030	-0.059	-0.020	-0.015	-0.004
in 2011-12	(0.015)	(0.008)	(0.032)	(0.007)	(0.022)	(0.022)	(0.032)	(0.014)	(0.021)	(0.011)
Student worked full-time	0.003	-0.018	0.011	-0.010	0.020	0.008	0.041	0.003	0.017	0.007
in 2011-12	(0.017)	(0.022)	(0.014)	(0.014)	(0.038)	(0.030)	(0.034)	(0.045)	(0.024)	(0.010)
Student worked part-time	0.003	-0.003	0.006	0.007	-0.011	0.008	-0.021	-0.006	0.002	-0.002
in 2011-12	(0.022)	(0.020)	(0.023)	(0.029)	(0.016)	(0.018)	(0.086)	(0.080)	(0.030)	(0.027)
Student's distance to institution	-2.617	-1.840	-0.830	-0.273	1.162	0.711	0.324	-0.059	-1.004	-0.770
in 2011-12 (in 100s of miles)	(1.999)	(1.741)	(0.842)	(0.387)	(1.208)	(0.852)	(0.579)	(0.305)	(0.917)	(0.884)
Student is Black	-0.051	-0.055								
	(0.048)	(0.033)								
Student is Hispanic	0.020*	-0.003								
	(0.007)	(0.012)								
Student is Asian	-0.001	-0.002								
	(0.003)	(0.004)								
Student is American Indian	-0.002	-0.004~								
or Alaska Native	(0.001)	(0.002)								
Student was low-income	0.001	-0.017	-0.014	-0.042	-0.017	-0.001	-0.001	-0.049	0.006	-0.040
as of 2011-12	(0.043)	(0.014)	(0.035)	(0.024)	(0.056)	(0.049)	(0.088)	(0.082)	(0.031)	(0.025)
Student transferred before	-0.062	-0.021	-0.055	-0.020	0.026	0.000	0.020	-0.009	-0.027	-0.028
bachelor's completion	(0.119)	(0.040)	(0.108)	(0.029)	(0.084)	(0.008)	(0.094)	(0.010)	(0.120)	(0.059)
Student inst. selective in 2011-12	-0.019	-0.007	-0.016	0.006	-0.014	-0.006	0.043	0.003	0.000	-0.004
	(0.036)	(0.022)	(0.029)	(0.018)	(0.036)	(0.031)	(0.077)	(0.032)	(0.023)	(0.024)
Student inst. two-year in 2011-12	0.034	0.009	0.023	0.020	-0.052~	0.016	-0.122~	-0.060	0.013	0.016

	(0.030)	(0.019)	(0.039)	(0.030)	(0.026)	(0.034)	(0.062)	(0.037)	(0.038)	(0.021)
Institution enrollment in 2011-12	-17.356	-0.189	-11.698	4.930	16.267	8.202	20.295	4.077	-9.576	9.525
(in 100s of students)	(13.758)	(2.317)	(9.755)	(8.155)	(10.634)	(4.699)	(21.036)	(3.549)	(11.593)	(6.719)
Student inst. public in 2011-12	-0.008	-0.009	-0.033	-0.017	-0.053	0.014	-0.063	-0.017	-0.032	-0.014
	(0.020)	(0.020)	(0.031)	(0.029)	(0.046)	(0.014)	(0.100)	(0.039)	(0.029)	(0.020)
Student inst. for-profit in 2011-12	0.014	0.000	0.020	0.001	0.059	0.018	0.046	-0.001	0.023	-0.005
	(0.024)	(0.024)	(0.048)	(0.033)	(0.050)	(0.015)	(0.114)	(0.033)	(0.039)	(0.026)

Notes. ~ $p < 0.1$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

All models include inverse-probability-of-treatment weights estimated for each subsample. The "No Cov." columns only include a treatment indicator and the "Cov." columns include previously described covariates. Samples correspond with the "BA" columns for each subgroup in Table 2. Each regression coefficient and standard error combination comes from a separate regression of the dependent variable in the row label on the treatment indicator or treatment indicator plus covariates for the sample in the column label.

Appendix Table 3. Balance tests for the influence of exclusively online enrollment on bachelor's degree completion by low-income status, veteran status, and financial independence

	All		Low-Income		Military		Independent	
	No Cov.	Cov.	No Cov.	Cov.	No Cov.	Cov.	No Cov.	Cov.
Student is female	-0.034~	-0.013	-0.016	-0.005	-0.003	0.047	-0.096**	-0.041***
	(0.017)	(0.011)	(0.015)	(0.009)	(0.044)	(0.044)	(0.022)	(0.008)
Student's age at end of 2011	0.173	-0.099	-0.453	-0.255	3.281*	1.302*	-0.130	-0.386~
	(0.624)	(0.150)	(0.828)	(0.314)	(0.993)	(0.415)	(0.512)	(0.189)
Student was independent	0.046	0.053	0.041	0.072	0.027	-0.005		
as of 2011-12	(0.050)	(0.034)	(0.044)	(0.048)	(0.029)	(0.027)		
Student was first-generation	-0.005	-0.013	-0.020	-0.009	-0.002	0.039	-0.054~	-0.035
as of 2011-12	(0.044)	(0.017)	(0.029)	(0.013)	(0.121)	(0.060)	(0.027)	(0.023)
Student was ever married	-0.048	-0.060	-0.111	-0.089~	0.027	-0.004	-0.150*	-0.130*
as of 2011-12	(0.044)	(0.036)	(0.069)	(0.045)	(0.041)	(0.052)	(0.056)	(0.049)
Student had military service	0.016~	0.009~	0.018~	0.012~			0.032*	0.019~
as of 2011-12	(0.009)	(0.005)	(0.009)	(0.006)			(0.013)	(0.010)
Student HS GPA 3.5 - 4.0	-0.019	-0.011	0.001	0.004	-0.019	0.026	-0.047~	-0.034*
	(0.014)	(0.008)	(0.023)	(0.018)	(0.053)	(0.019)	(0.022)	(0.013)
Student HS GPA under 3.0	0.028	0.008	0.024	0.003	-0.052	-0.002	0.033	-0.012
	(0.020)	(0.008)	(0.014)	(0.007)	(0.120)	(0.060)	(0.021)	(0.008)
Student missing HS GPA	0.011	0.007*	-0.020	0.001	0.130*	-0.023	0.007	0.002
over age 30	(0.025)	(0.003)	(0.036)	(0.003)	(0.041)	(0.034)	(0.028)	(0.006)
Student's concorded	-0.797	-0.261	-1.723	-0.852	-4.146***	-1.970**	-1.629**	0.088
SAT/ACT score (in 10s)	(1.123)	(0.536)	(1.070)	(0.741)	(0.566)	(0.389)	(0.496)	(0.197)
Student is missing concorded	0.033	0.009	0.033	0.022*	0.124~	0.020	0.039~	0.014
SAT/ACT score	(0.033)	(0.006)	(0.030)	(0.008)	(0.056)	(0.032)	(0.020)	(0.011)
Student in STEM major	0.002	-0.014	-0.021	-0.032	0.104~	0.094	-0.014	-0.020
	(0.011)	(0.022)	(0.017)	(0.032)	(0.046)	(0.058)	(0.017)	(0.023)

Student in health major	0.010	-0.007	0.013	-0.013	0.003	0.024	0.010	-0.003
	(0.012)	(0.016)	(0.015)	(0.030)	(0.034)	(0.022)	(0.015)	(0.018)
Student in business major	-0.011	-0.016	-0.003	-0.010	-0.014	-0.012	0.047	0.019
	(0.028)	(0.026)	(0.037)	(0.038)	(0.029)	(0.039)	(0.028)	(0.030)
Student attended full-time	-0.004	0.003	0.008	0.009	-0.033	-0.043	-0.044	-0.001
in 2011-12	(0.026)	(0.018)	(0.019)	(0.015)	(0.075)	(0.028)	(0.026)	(0.007)
Student attended part-time	-0.006	-0.005	-0.015	-0.004	0.017	-0.029	0.037~	0.009
in 2011-12	(0.015)	(0.008)	(0.018)	(0.011)	(0.071)	(0.030)	(0.019)	(0.009)
Student worked full-time	0.003	-0.018	0.001	-0.029~	0.087	0.144*	0.017~	-0.034
in 2011-12	(0.017)	(0.022)	(0.014)	(0.014)	(0.061)	(0.052)	(0.009)	(0.019)
Student worked part-time	0.003	-0.003	-0.014	-0.019	0.067	0.118*	-0.013	-0.019
in 2011-12	(0.022)	(0.020)	(0.025)	(0.025)	(0.036)	(0.034)	(0.032)	(0.021)
Student's distance to institution	-2.617	-1.840	-1.459~	-0.415	3.065*	2.970~	-2.410**	-0.564**
in 2011-12 (in 100s of miles)	(1.999)	(1.741)	(0.669)	(0.235)	(1.116)	(1.311)	(0.617)	(0.167)
Student is Black	-0.051	-0.055	-0.088	-0.086	-0.007	-0.041	-0.086	-0.069
	(0.048)	(0.033)	(0.055)	(0.053)	(0.032)	(0.027)	(0.059)	(0.045)
Student is Hispanic	0.020*	-0.003	0.018~	-0.014	0.005	-0.022	0.026~	-0.003
	(0.007)	(0.012)	(0.008)	(0.022)	(0.051)	(0.054)	(0.014)	(0.007)
Student is Asian	-0.001	-0.002	-0.001	-0.003			0.000	-0.001
	(0.003)	(0.004)	(0.004)	(0.003)			(0.002)	(0.002)
Student is American Indian	-0.002	-0.004~	-0.002	-0.004	0.012	0.002	-0.002	-0.005~
or Alaska Native	(0.001)	(0.002)	(0.004)	(0.003)	(0.007)	(0.004)	(0.002)	(0.002)
Student was low-income	0.001	-0.017			0.108	0.146~	-0.020	-0.026***
as of 2011-12	(0.043)	(0.014)			(0.072)	(0.065)	(0.012)	(0.005)
Student transferred before	-0.062	-0.021	-0.109	-0.028	0.079	0.046	-0.212	-0.079
bachelor's completion	(0.119)	(0.040)	(0.109)	(0.029)	(0.094)	(0.074)	(0.110)	(0.056)
Student inst. selective in 2011-12	-0.019	-0.007	-0.007	-0.009	-0.007	-0.013	0.002	-0.001

	(0.036)	(0.022)	(0.022)	(0.020)	(0.031)	(0.023)	(0.003)	(0.006)
Student inst. two-year in 2011-12	0.034	0.009	0.043	0.005	-0.044	0.070	0.076	0.025
	(0.030)	(0.019)	(0.030)	(0.022)	(0.044)	(0.059)	(0.043)	(0.034)
Institution enrollment in 2011-12	-17.356	-0.189	-27.292	0.599	0.210	2.364	-38.177**	6.840
(in 100s of students)	(13.758)	(2.317)	(15.156)	(4.266)	(1.787)	(1.686)	(11.273)	(8.701)
Student inst. public in 2011-12	-0.008	-0.009	-0.005	-0.014	-0.052	0.021	-0.001	-0.039
	(0.020)	(0.020)	(0.016)	(0.022)	(0.041)	(0.036)	(0.017)	(0.024)
Student inst. for-profit in 2011-12	0.014	0.000	-0.015	-0.010	0.057	0.035	-0.044	-0.033
	(0.024)	(0.024)	(0.028)	(0.030)	(0.051)	(0.037)	(0.041)	(0.038)

Notes. ~ $p < 0.1$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

All models include inverse-probability-of-treatment weights estimated for each subsample. The "No Cov." columns only include a treatment indicator and the "Cov." columns include previously described covariates. Samples correspond with the "BA" columns for each subgroup in Table 3. Regression models for Military exclude the covariate for Asian race. Each regression coefficient and standard error combination comes from a separate regression of the dependent variable in the row label on the treatment indicator or treatment indicator plus covariates for the sample in the column label.

Appendix Table 4. Balance tests for the influence of exclusively online enrollment across institution types for bachelor's degree completion

	Public 4-Yr		Private 4-Yr		For-Profit 4-Yr		Selective 4-Yr		Broad-Access 4-Yr	
	No Cov.	Cov.	No Cov.	Cov.	No Cov.	Cov.	No Cov.	Cov.	No Cov.	Cov.
Student is female	0.022	0.006	-0.011	-0.013	0.048	0.045	-0.029	-0.039	0.016	0.038
	(0.055)	(0.045)	(0.054)	(0.058)	(0.054)	(0.063)	(0.072)	(0.045)	(0.059)	(0.031)
Student's age at end of 2011	0.083	0.197	-0.559	-0.274	0.603	-0.351**	0.024	-0.030	1.202	0.540
	(0.496)	(0.201)	(2.067)	(0.256)	(1.200)	(0.097)	(0.699)	(0.227)	(1.665)	(0.706)
Student was independent	0.016	-0.008	0.003	0.025	0.004	-0.016	0.011	0.006	0.055	-0.029
as of 2011-12	(0.055)	(0.018)	(0.113)	(0.020)	(0.037)	(0.019)	(0.060)	(0.014)	(0.091)	(0.037)
Student was first-generation	0.048	0.041	-0.022	-0.009	-0.047	-0.062*	-0.010	-0.003	0.035	-0.003
as of 2011-12	(0.084)	(0.060)	(0.036)	(0.043)	(0.036)	(0.026)	(0.066)	(0.043)	(0.041)	(0.029)
Student was ever married	0.005	0.011	-0.007	-0.005	-0.022	-0.026	0.001	-0.003	-0.036	-0.026
as of 2011-12	(0.034)	(0.015)	(0.038)	(0.009)	(0.026)	(0.020)	(0.034)	(0.015)	(0.054)	(0.031)
Student had military service	-0.009	-0.011	-0.006	-0.008	0.002	0.026	0.004	0.002	-0.015	-0.008
as of 2011-12	(0.006)	(0.006)	(0.019)	(0.016)	(0.016)	(0.018)	(0.004)	(0.005)	(0.049)	(0.046)
Student HS GPA 3.5 - 4.0	0.027	0.022	0.021	0.012	0.012	0.011	0.007	0.017	-0.065*	-0.035
	(0.056)	(0.035)	(0.056)	(0.034)	(0.017)	(0.016)	(0.042)	(0.025)	(0.023)	(0.026)
Student HS GPA under 3.0	-0.010	0.006	-0.001	0.003	-0.063	-0.001	0.010	0.010	0.008	0.022
	(0.063)	(0.041)	(0.029)	(0.038)	(0.040)	(0.033)	(0.057)	(0.037)	(0.043)	(0.025)
Student missing HS GPA	-0.011	-0.012	-0.019	0.003	0.074	0.019	-0.005	-0.002	0.054	-0.011
over age 30	(0.023)	(0.007)	(0.085)	(0.008)	(0.072)	(0.014)	(0.026)	(0.012)	(0.057)	(0.035)
Student's concorded	1.050	1.414	0.762	0.182	1.601	1.304	-0.318	0.231	-0.600	0.090
SAT/ACT score (in 10s)	(2.492)	(0.781)	(1.870)	(0.303)	(2.118)	(1.735)	(2.577)	(2.255)	(1.396)	(1.239)
Student is missing concorded	0.002	0.001	-0.011	0.005	0.052	0.040	0.013	0.011	0.026	0.001
SAT/ACT score	(0.063)	(0.028)	(0.056)	(0.023)	(0.034)	(0.027)	(0.043)	(0.017)	(0.089)	(0.048)
Student in STEM major	-0.014	-0.009	0.011	-0.004	-0.056	-0.009	-0.020	-0.022	-0.014	0.024
	(0.054)	(0.053)	(0.042)	(0.035)	(0.038)	(0.044)	(0.073)	(0.060)	(0.090)	(0.053)

Student in health major	0.048~	0.043	-0.021	-0.019	0.031	0.037*	0.007	0.008	-0.045	-0.005
	(0.023)	(0.023)	(0.047)	(0.023)	(0.042)	(0.016)	(0.064)	(0.040)	(0.056)	(0.026)
Student in business major	0.009	0.008	-0.008	-0.007	0.043	0.022	0.006	0.000	0.097**	0.056
	(0.026)	(0.025)	(0.054)	(0.024)	(0.034)	(0.029)	(0.057)	(0.066)	(0.027)	(0.036)
Student attended full-time	-0.015	0.011	0.015	0.017	-0.011	-0.012	0.009	-0.002	0.021	-0.019
in 2011-12	(0.036)	(0.035)	(0.050)	(0.033)	(0.070)	(0.009)	(0.046)	(0.026)	(0.035)	(0.024)
Student attended part-time	0.033	0.027	0.004	0.011	0.009	-0.011	-0.013	-0.010	-0.029	-0.021
in 2011-12	(0.042)	(0.024)	(0.053)	(0.031)	(0.065)	(0.025)	(0.039)	(0.020)	(0.031)	(0.015)
Student worked full-time	0.025	0.007	-0.010	-0.005	0.058	0.044*	0.023	0.018	-0.014	-0.029
in 2011-12	(0.058)	(0.048)	(0.042)	(0.027)	(0.033)	(0.016)	(0.032)	(0.017)	(0.048)	(0.034)
Student worked part-time	-0.022	-0.023	0.005	-0.002	0.003	0.006	-0.032	-0.016	-0.018	0.008
in 2011-12	(0.045)	(0.034)	(0.058)	(0.027)	(0.015)	(0.017)	(0.021)	(0.017)	(0.033)	(0.024)
Student's distance to institution	-0.072	-0.093	0.286	0.278	-0.199	0.172	0.091	0.022	2.115*	0.964
in 2011-12 (in 100s of miles)	(0.239)	(0.243)	(0.800)	(0.420)	(0.879)	(0.628)	(0.374)	(0.298)	(0.827)	(0.527)
Student is Black	-0.013	-0.014	-0.008	-0.006	-0.013	0.015	0.019	0.009	-0.033	-0.068~
	(0.023)	(0.021)	(0.052)	(0.046)	(0.048)	(0.042)	(0.025)	(0.019)	(0.040)	(0.031)
Student is Hispanic	0.016	0.012	-0.001	0.002	-0.005	0.007	-0.006	-0.003	-0.036	-0.039
	(0.049)	(0.044)	(0.018)	(0.014)	(0.018)	(0.017)	(0.043)	(0.037)	(0.047)	(0.033)
Student is Asian	-0.008	-0.010	0.015	0.012	0.000	0.002	-0.012	0.000	-0.018	-0.024
	(0.017)	(0.015)	(0.021)	(0.018)	(0.002)	(0.003)	(0.036)	(0.022)	(0.017)	(0.017)
Student is American Indian	0.007	0.008	-0.005~	-0.004~	0.006	0.006	0.008	0.010	0.006	0.005
or Alaska Native	(0.017)	(0.011)	(0.002)	(0.002)	(0.006)	(0.004)	(0.014)	(0.016)	(0.005)	(0.007)
Student was low-income	0.057	0.049	0.006	0.006	-0.062	-0.023	0.020	0.008	0.129~	0.102
as of 2011-12	(0.036)	(0.029)	(0.058)	(0.017)	(0.055)	(0.037)	(0.063)	(0.050)	(0.067)	(0.069)
Student transferred before	0.043	0.055	0.044	0.050	-0.251	-0.230	0.082	0.096	-0.311~	-0.247~
bachelor's completion	(0.220)	(0.176)	(0.228)	(0.166)	(0.238)	(0.187)	(0.137)	(0.101)	(0.136)	(0.127)
Student inst. selective in 2011-12	-0.023	-0.001	0.006	0.003	-0.003	-0.002	0.267	0.259*	-0.198	-0.206*
	(0.139)	(0.053)	(0.095)	(0.067)	(0.010)	(0.012)	(0.142)	(0.090)	(0.117)	(0.064)

Student inst. two-year in 2011-12	0.007	-0.011	0.000	-0.008	-0.005	0.026	-0.028	-0.058	-0.107	0.066
	(0.112)	(0.043)	(0.100)	(0.068)	(0.051)	(0.045)	(0.103)	(0.054)	(0.133)	(0.054)
Institution enrollment in 2011-12	2.747	2.283	-1.395	-2.464	-2.516	4.972	0.875	0.288	26.024**	13.947*
(in 100s of students)	(3.360)	(3.756)	(9.370)	(11.250)	(41.386)	(27.642)	(1.188)	(0.771)	(7.228)	(5.448)
Student inst. public in 2011-12	0.446*	0.455*	-0.167	-0.180	-0.122	-0.103	0.255	0.261~	-0.395**	-0.296**
	(0.140)	(0.141)	(0.199)	(0.097)	(0.079)	(0.063)	(0.139)	(0.118)	(0.083)	(0.062)
Student inst. for-profit in 2011-12	-0.231	-0.247~	-0.276~	-0.268~	0.439*	0.459**	-0.299	-0.300~	0.365***	0.263*
	(0.168)	(0.124)	(0.145)	(0.116)	(0.171)	(0.098)	(0.184)	(0.143)	(0.057)	(0.083)

Notes. ~ $p < 0.1$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

All models include inverse-probability-of-treatment weights estimated for each subsample. The "No Cov." columns only include a treatment indicator and the "Cov." columns include previously described covariates. Samples correspond with subgroups in Table 4. Each regression coefficient and standard error combination comes from a separate regression of the dependent variable in the row label on the treatment indicator or treatment indicator plus covariates for the sample in the column label.

Appendix Table 5. Balance tests for the influence of exclusively online enrollment across institution types for associate degree completion

	Public 2-Yr		For-Profit 2-Yr		For-Profit 4-Yr	
	No Cov.	Cov.	No Cov.	Cov.	No Cov.	Cov.
Student is female	-0.034	-0.011	-0.092	-0.046	0.075	-0.031
	(0.043)	(0.010)	(0.101)	(0.042)	(0.068)	(0.018)
Student's age at end of 2011	0.056	-0.050	0.394	0.377	0.825~	-0.412
	(0.458)	(0.166)	(0.691)	(0.326)	(0.346)	(0.357)
Student was independent	0.068	0.010	-0.148**	-0.019	-0.068*	0.004
as of 2011-12	(0.042)	(0.033)	(0.032)	(0.021)	(0.018)	(0.013)
Student was first-generation	0.044	0.001	-0.080~	0.063***	0.001	-0.017
as of 2011-12	(0.059)	(0.036)	(0.040)	(0.006)	(0.018)	(0.010)
Student was ever married	-0.007	-0.009	-0.035*	-0.016	-0.123	-0.021
as of 2011-12	(0.019)	(0.015)	(0.011)	(0.011)	(0.075)	(0.021)
Student had military service	0.015	-0.008	-0.010	0.009	0.005	0.003
as of 2011-12	(0.017)	(0.014)	(0.009)	(0.007)	(0.022)	(0.017)
Student HS GPA 3.5 - 4.0	-0.001	-0.006	0.072	0.006	-0.026	-0.017~
	(0.037)	(0.021)	(0.090)	(0.048)	(0.020)	(0.009)
Student HS GPA under 3.0	0.051	-0.008	-0.100*	-0.036	-0.051	0.010
	(0.066)	(0.047)	(0.036)	(0.042)	(0.030)	(0.016)
Student missing HS GPA	0.018	-0.005	0.022	-0.021~	-0.031	0.013
over age 30	(0.013)	(0.009)	(0.031)	(0.010)	(0.021)	(0.009)
Student's concorded	-2.184	0.715	4.279	-1.592	2.154	0.020
SAT/ACT score (in 10s)	(1.303)	(1.080)	(3.761)	(2.284)	(1.528)	(0.719)
Student is missing concorded	-0.128*	0.019	-0.081	-0.024	-0.042	-0.029
SAT/ACT score	(0.041)	(0.019)	(0.066)	(0.038)	(0.025)	(0.018)
Student in STEM major	0.026	-0.007	-0.066***	-0.027~	0.003	-0.019

	(0.026)	(0.020)	(0.007)	(0.014)	(0.041)	(0.039)
Student in health major	-0.032	-0.025	0.022	0.026	-0.122**	-0.024*
	(0.051)	(0.014)	(0.025)	(0.042)	(0.025)	(0.010)
Student in business major	-0.004	0.010	0.032	0.025	-0.079*	0.000
	(0.026)	(0.015)	(0.023)	(0.019)	(0.030)	(0.013)
Student attended full-time	-0.126*	0.002	-0.044	-0.023	0.085~	0.026
in 2011-12	(0.032)	(0.018)	(0.061)	(0.044)	(0.034)	(0.026)
Student attended part-time	-0.103*	0.023	-0.031	-0.030	0.026~	0.018
in 2011-12	(0.037)	(0.016)	(0.020)	(0.032)	(0.010)	(0.017)
Student worked full-time	-0.017	0.006	-0.084~	-0.003	0.102*	0.020
in 2011-12	(0.043)	(0.021)	(0.041)	(0.013)	(0.031)	(0.030)
Student worked part-time	0.053~	0.012	0.008	0.016	0.038	0.044
in 2011-12	(0.025)	(0.025)	(0.016)	(0.014)	(0.022)	(0.033)
Student's distance to institution	-0.140	0.003	1.461*	-0.090	0.133	0.016
in 2011-12 (in 100s of miles)	(0.385)	(0.159)	(0.479)	(1.241)	(0.191)	(0.427)
Student is Black	-0.053~	0.002	-0.262**	-0.096***	-0.023	0.016
	(0.026)	(0.024)	(0.053)	(0.012)	(0.060)	(0.018)
Student is Hispanic	-0.013	-0.002	0.051	-0.021	-0.060*	0.039~
	(0.047)	(0.066)	(0.100)	(0.046)	(0.022)	(0.017)
Student is Asian	0.016*	0.008			-0.001	0.002
	(0.005)	(0.019)			(0.001)	(0.002)
Student is American Indian	0.018**	-0.009	-0.029	-0.013	0.011	0.009
or Alaska Native	(0.004)	(0.013)	(0.016)	(0.005)	(0.020)	(0.011)
Student was low-income	-0.056	0.011	0.199***	0.016	-0.036	0.002
as of 2011-12	(0.083)	(0.041)	(0.024)	(0.054)	(0.049)	(0.019)
Student transferred before	-0.097	-0.100	-0.014*	-0.033~	-0.257	-0.270
associate completion	(0.205)	(0.227)	(0.004)	(0.018)	(0.189)	(0.203)
Student inst. selective in 2011-12		0.018				0.000

		(0.014)				(0.002)
Student inst. two-year in 2011-12	0.049~	0.008	0.000	-0.035	-0.060	-0.023
	(0.020)	(0.013)	(0.036)	(0.044)	(0.088)	(0.080)
Institution enrollment in 2011-12	8.247*	-1.755	-18.587***	-15.688*	-1.264	8.282
(in 100s of students)	(2.720)	(1.975)	(2.312)	(5.215)	(11.208)	(19.660)
Student inst. public in 2011-12	0.621**	0.376**	-0.353	-0.358	-0.264~	-0.190*
	(0.111)	(0.079)	(0.209)	(0.211)	(0.113)	(0.082)
Student inst. for-profit in 2011-12	-0.545*	-0.348**	0.444	0.451~	0.395**	0.382***
	(0.148)	(0.099)	(0.222)	(0.235)	(0.076)	(0.058)

Notes. ~ $p < 0.1$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

All models include inverse-probability-of-treatment weights estimated for each subsample. The "No Cov." columns only include a treatment indicator and the "Cov." columns include previously described covariates. Samples correspond with the "Expected AA or Higher" columns for each subgroup in Table 5. Regression models for For-Profit Two-Year exclude the covariates for Asian and American Indian or Alaska Native race and institutional selectivity. Each regression coefficient and standard error combination comes from a separate regression of the dependent variable in the row label on the treatment indicator or treatment indicator plus covariates for the sample in the column label.

Appendix Table 6. The influence of exclusively online enrollment on dropout by race/ethnicity, low-income status, veteran status, and financial independence

Panel A. *All students.*

	All Students		
	BA	AA	Any
Exclusively online degree program	0.000	0.031*	0.047**
	(0.019)	(0.011)	(0.011)
Number of observations	13,610	2,070	15,680
R^2	0.079	0.110	0.058

Panel B. *Subgroups by race/ethnicity*.

	Black Students			Hispanic Students			Asian Students			White Students		
	BA	AA	Any	BA	AA	Any	BA	AA	Any	BA	AA	Any
Exclusively online degree program	0.005	0.132*	0.083***	-0.001	-0.131~	-0.055*	0.042	-0.139	0.038	0.015	0.051	0.061*
	(0.015)	(0.038)	(0.014)	(0.017)	(0.064)	(0.021)	(0.043)	(0.267)	(0.075)	(0.012)	(0.029)	(0.022)
Number of observations	2,060	360	2,420	2,590	410	3,000	720	30	750	7,520	1,170	8,690
R^2	0.139	0.175	0.075	0.135	0.766	0.238	0.292	0.530	0.163	0.086	0.089	0.068

Panel C. *Subgroups by low-income status, veteran status, and financial independence*.

	Lower-Income Students			Military Students			Independent Students		
	BA	AA	Any	BA	AA	Any	BA	AA	Any
Exclusively online degree program	0.010	0.075**	0.068***	0.042	0.019	0.130*	-0.043	0.027	0.043*
	(0.017)	(0.014)	(0.012)	(0.036)	(0.142)	(0.041)	(0.026)	(0.029)	(0.018)
Number of observations	4,860	1,190	6,040	250	70	320	2,680	990	3,660
R^2	0.098	0.118	0.077	0.186	0.779	0.220	0.219	0.175	0.117

Notes. *Notes*. ~ $p < 0.1$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

All models include inverse-probability-of-treatment weights estimated for each subsample and previously described covariates. The "BA" column is limited to students who expected a bachelor's degree or higher, the "AA" column is limited to students who expected specifically an associate degree, and the "Any" column is limited to students who expected an associate degree or higher. Regression models for Military Students exclude the covariate for Asian race. Standard errors clustered on the sector of the first institution attended. Numbers of observations rounded to the nearest 10.

Appendix Table 7. The influence of institution type on dropout among exclusively online students

Panel A. *Bachelor's-granting institutions*.

	Public Four-Year	Private Four-Year	For-Profit Four-Year	Selective Four-Year	Broad-Access Four-Year
Exclusively online student attended institution type	-0.043 (0.029)	0.005 (0.022)	0.032 (0.044)	-0.074 (0.047)	0.052 (0.033)
Number of observations	770	770	770	770	770
R^2	0.061	0.08	0.164	0.086	0.162

Panel B. *Associate-granting institutions*.

	Public Two-Year		For-Profit Two-Year		For-Profit Four-Year	
	Expected Only AA	Expected AA or Higher	Expected Only AA	Expected AA or Higher	Expected Only AA	Expected AA or Higher
Exclusively online student attended institution type	-0.129** (0.031)	-0.077** (0.021)	-0.085* (0.029)	-0.051~ (0.025)	0.031 (0.046)	0.015 (0.043)
Number of observations	260	900	260	900	260	900
R^2	0.220	0.122	0.330	0.208	0.255	0.115

Notes. ~ $p < 0.1$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

All models include inverse-probability-of-treatment weights estimated for each subsample and previously described covariates. Samples in Panel A are limited to students who were in exclusively online degree programs as of 2017, who pursued a bachelor's degree, and who expected a bachelor's degree or higher. Samples in Panel B are limited to students who were in exclusively online degree programs as of 2017, who pursued an associate degree, and who expected specifically an associate degree ("Expected Only AA") or an associate degree or higher ("Expected AA or Higher"). Regression models for For-Profit Two-Year exclude the covariates for Asian and American Indian or Alaska Native race and institutional selectivity. Standard errors clustered on the sector of the first institution attended. Numbers of observations rounded to the nearest 10.

Appendix Table 8. The influence of exclusively online enrollment on degree completion by race/ethnicity, low-income status, veteran status, and financial independence with students who were exclusively online in 2011-12 or 2013-14 included as controls

Panel A. *All students.*

	All Students		
	BA	AA	Any
Exclusively online degree program	-0.069**	0.002	-0.066**
	(0.019)	(0.006)	(0.017)
Number of observations	14,190	2,160	16,350
R^2	0.192	0.042	0.123

Panel B. *Subgroups by race/ethnicity*.

	Black Students			Hispanic Students			Asian Students			White Students		
	BA	AA	Any	BA	AA	Any	BA	AA	Any	BA	AA	Any
Exclusively online degree program	-0.083***	0.052**	-0.073**	-0.041	-0.034	-0.084***	-0.231***	0.060**	-0.223***	-0.066*	-0.003	-0.057*
	(0.013)	(0.014)	(0.018)	(0.025)	(0.029)	(0.014)	(0.021)	(0.007)	(0.029)	(0.028)	(0.006)	(0.022)
Number of observations	2,160	370	2,530	2,720	420	3,140	740	40	770	7,840	1,220	9,060
R^2	0.248	0.098	0.119	0.235	0.203	0.180	0.420	0.860	0.314	0.172	0.065	0.121

Panel C. *Subgroups by low-income status, veteran status, and financial independence*.

	Lower-Income Students			Military Students			Independent Students		
	BA	AA	Any	BA	AA	Any	BA	AA	Any
Exclusively online degree program	-0.062***	0.013*	-0.062***	-0.156**	-0.048	-0.140**	-0.018	0.019*	-0.020**
	(0.012)	(0.005)	(0.011)	(0.040)	(0.149)	(0.031)	(0.013)	(0.008)	(0.006)
Number of observations	5,120	1,240	6,360	260	80	340	2,860	1,050	3,910
R^2	0.145	0.042	0.081	0.399	0.535	0.359	0.078	0.050	0.047

Notes. Notes. ~ $p < 0.1$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

All models include inverse-probability-of-treatment weights estimated for each subsample and previously described covariates. The "BA" column is limited to students who expected a bachelor's degree or higher, the "AA" column is limited to students who expected specifically an associate degree, and the "Any" column is limited to students who expected an associate degree or higher. Regression models for Military Students exclude the covariate for Asian race. Standard errors clustered on the sector of the first institution attended. Numbers of observations rounded to the nearest 10.

Appendix Table 9. The influence of exclusively online enrollment on degree completion by institution sector for bachelor's and associate degree students

Panel A. *Bachelor's-granting institutions.*

	Public Four-Year	Private Four-Year	For-Profit Four-Year	Selective Four-Year	Broad-Access Four-Year
Exclusively online degree program	-0.221*	-0.160**	-0.084***	-0.190**	-0.122*
	(0.068)	(0.045)	(0.012)	(0.047)	(0.038)
Number of observations	3,940	2,880	1,020	5,240	2,600
R^2	0.288	0.394	0.287	0.298	0.297

Panel B. *Associate-granting institutions.*

	Public Two-Year		For-Profit Two-Year		For-Profit Four-Year	
	Expected Only AA	Expected AA or Higher	Expected Only AA	Expected AA or Higher	Expected Only AA	Expected AA or Higher
Exclusively online degree program	0.020	-0.023	-0.073	-0.077**	-0.027**	-0.091***
	(0.025)	(0.014)	(0.080)	(0.020)	(0.006)	(0.010)
Number of observations	780	3,430	120	330	240	860
R^2	0.167	0.060	0.500	0.269	0.245	0.272

Notes. ~ $p < 0.1$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

All models include inverse-probability-of-treatment weights estimated for each subsample and previously described covariates. The outcome for Panel A is bachelor's degree completion, and the outcome for Panel B is associate degree completion. For each result, non-treated students are students at the same institution type who are not exclusively online. Standard errors clustered on the sector of the first institution attended. Numbers of observations rounded to the nearest 10.