Semesters or Quarters? The Effect of the Academic Calendar on Postsecondary Graduation Rates

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Abstract

We explore the relationship between academic calendars and graduation rates at postsecondary institutions in the U.S. for the 1991 through 2010 entering cohorts. To date, no work has examined this topic on a large scale. Using panel data from the Integrated Postsecondary Education Data System (IPEDS) – the universe of four-year nonprofit institutions in the U.S. – and leveraging quasi-experimental variation in academic calendars across institutions and years, we show switching from quarters to semesters negatively impacts on-time graduation rates. An event study reveals that the negative effect begins to emerge in the partially treated cohorts but grows larger as cohorts become more fully treated, and remains negative in the post-treatment period. The calendar switch does not affect six-year graduation rates, as the estimates are small in magnitude and indistinguishable from zero. Using administrative transcript data from the Ohio Longitudinal Data Archive, we replicate this analysis at the student-level and investigate several possible mechanisms for the delayed timing of graduation.[1] Our findings suggest that students still graduate as a result of the policy but are confronted with the costs – both a direct cost and an opportunity cost – of a delayed graduation. A back of the envelope calculation suggests that the total cost of the policy to students per year of delayed graduation at an average sized university is $1.6 million. Contrary to the goals of the policy, shifting the academic calendar from quarters to semesters is harmful to students.

JEL Codes: I2

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[1] Analysis using this dataset has yet to be approved for disclosure but will be included in future drafts.

1 Introduction

In 1995, the four-year postsecondary graduation rate in the United States was 33 percent, tied with New Zealand for the highest graduation rate in the world. By 2010, the U.S. graduation rate increased to 38 percent. Over the same 15 year time period, New Zealand's rate increased to nearly 50 percent and the average graduation rate in all OECD countries almost doubled from 20 percent to 39 percent. The U.S. graduation rate fell below the OECD average despite the fact that the U.S. spends more on tertiary education, 2.8 percent of GDP, than any other country in the world (OECD, 2012).

The costs of low graduation rates in U.S. colleges and universities extend beyond a poor showing in a cross-country ranking. Students who fail to graduate spend time and money taking classes, but are unable to fully capitalize on the wage premium associated with a postsecondary degree (Oreopoulos and Petronijevic, 2013). Moreover, because domestic university rankings are heavily weighted towards on-time graduation,[2] over 190 schools in the U.S. have responded to the relatively stagnant graduation rates by implementing a "15-to-finish" campaign. The campaign is a constant reminder to students that 15 hours per academic term are needed in order to graduate in four years. In conjunction with the campaign, some universities have adopted specific policies aimed at increasing on-time graduation. The University of Hawaii, for example, has stopped renewing scholarships for students who did not enroll in 30 credit hours in the previous year. Cleveland State University allows students to take 18 credit hours in a semester for the same price as 12 or 15 credit hours (Korn, 2016).

Institutional policies like "15-to-finish" rely on students altering their behavior in order to graduate on time. While policies of this nature may be helpful to some students, colleges and universities may not be providing students with the best academic structure to graduate in a timely manner. There is anecdotal evidence suggesting that marginal students perform worse if the academic calendar runs on 10-week quarters (Gordon, 2016). Consequently, over the past 20 years

[2] Approximately 16 percent of the total score in The U.S. News and World Report rankings are from a university's six-year graduation rate (Gnolek et al., 2014).

many academic institutions have adopted the 15-week semester system in place of a quarter system with the aims of bolstering student success in classes, increasing the rate of retention, and increasing on-time graduation rates, particularly for marginal students. Despite this, very little empirical evidence exists examining the causal link between academic calendars and student outcomes.

We explore whether institutions experience a change in graduation rates by switching from a quarter schedule to a semester schedule. Switching to semesters could affect graduation rates in several important ways which we discuss in the following section. To answer this question, we rely on panel data from the Integrated Postsecondary Education Data System (IPEDS) which provides information on four-year and six-year graduation rates and calendar systems for the universe of non-profit colleges and universities in the United States for the 1991 through 2010 entering cohorts. By leveraging quasi-experimental variation in academic calendars across institutions and years, panel regression results show that switching to semesters, on average, is harmful to all students as it substantially reduces four-year graduation rates. A heterogeneity analysis shows that the results persist across different subsets of the population. An event study reveals that the negative effect of a semester calendar on four-year graduation rates begins to emerge in the partially treated cohorts but grows larger as cohorts become more fully treated, and remains negative in the post-treatment period. On the other hand, it does not appear the switch affects six-year graduation rates, as the estimates are small in magnitude and indistinguishable from zero, suggesting that students still graduate as a result of the policy but are confronted with the costs of a delayed graduation. Contrary to the goals of the policy, shifting the academic calendar from quarters to semesters leads to worse student outcomes.

Using detailed transcript data from the Ohio Longitudinal Data Archive (OLDA), we replicate this analysis at the individual-level for all students in Ohio's public university system. There have been several calendar conversions from quarters to semesters within this system since 2000. Youngstown State University, Central State University, and Shawnee State University converted to semesters in 2000, 2005, and 2007, respectively. In 2012, another four Ohio colleges switched to semesters: University of Cincinnati, The Ohio State University, Ohio University, and Wright

State University. We leverage this variation in academic calendars across institutions over time to replicate the difference-in-differences and event study analysis at a micro level. This dataset also allows us to investigate several possible mechanisms for the delayed timing of graduation. These mechanisms include changes to grades, timing of course-taking, major choice, and timing of major switching. Analysis using the OLDA dataset has yet to be approved for disclosure but will be included in future drafts.

This is the first paper to examine the consequences of changes in the academic calendar for the universe of non-profit colleges and universities in the United States. It is particularly timely and policy relevant as entire university systems are currently considering switching from quarters to semesters. The few studies on university calendar changes that do exist focus on a small subset of schools (Day, 1987; Matzelle et al., 1995). Coleman et al. (1984) find that switching to semesters is harmful for upper division students, but the analysis is limited to three years of data for only ten universities across two states. Gibbens et al. (2015) show that student performance fell after the University of Minnesota-Twin Cities changed from quarters to semesters in the fall of 1999.

Although little research exists examining the impact of university academic calendars, the potential effects of calendar changes have been explored in more depth at the elementary and secondary school levels.[3] These studies tend to find that longer school years (or weeks) are associated with worse student outcomes. Consistent with this literature, our results show that four-year graduation rates suffer when universities change from 10 to 15 week terms.

Moreover, research on university level policies that influence graduation is quite limited relative to high school graduation research, but growing.[4] There is evidence that financial aid is effective in increasing retention rates (Singell, 2004) and improving academic performance (Glocker, 2011). Using the same data source as our paper, Hinrichs (2014) shows that affirmative action bans reduce the number of underrepresented minorities at selective schools, but graduation rates

[3] Graves (2010) shows that when California schools adopt a year-round calendar to alleviate overcrowding, standardized test scores decrease. McMullen and Rouse (2012) show that the transition to year-round schooling in Wake County, North Carolina does not significantly change academic outcomes and is negatively related to home prices (Depro and Rouse, 2015). Anderson and Walker (2015) exploit changes in the weekly calendar system and find that school districts that move to a four-day school week increase academic outcomes for elementary students.

[4] See Murnane (2013) for an extensive review of research on high school graduation rates.

for those students increase. Arcidiacono et al. (2016) exploit an affirmative action ban in California and conclude that minority students would have higher graduation rates if they were matched to lower-ranked schools. Our paper adds to this stream of literature and shows that the calendar system imposes costs on students. We can only speculate on the policies that universities can implement to increase the graduation rate, but transitioning the academic calendar to semesters does not appear to be an effective one.

2 Background

In U.S. higher education, the two predominant academic calendars are the semester system and the quarter system. Typically, a semester academic year comprises two 15-week terms where the average full time student takes five courses per term. In contrast, a quarter academic year includes three 10-week terms where students take three to four courses per term. Quarters systems allow for a full 10-week summer term. While semesters have always been more common, quarters were first introduced to the U.S. in 1891 at the University of Chicago. When the school was founded, the organizers decided to keep it open year round and divide it into four terms instead of the then-traditional two terms (Malone, 1946). In 1930, about 75 percent of U.S. institutions reported being on a semester calendar and 22 percent on quarters. During the 1960s several large statewide educational systems switched from semesters to quarters to accommodate enrollment booms caused by the baby boomers (i.e. most notably the University of California system). In 1970, 70 percent of schools were on a semester and approximately 30 percent of schools were on quarters or trimesters (Day, 1987). By 1990, approximately 87 percent of the institutions operated on a semester calendar. Many of the recent calendar shifts occurred in the late 1990s, but the Ohio State University system converted from quarters to semesters in 2012 and many schools in the California State University system plan to change to semesters in the near future (Gordon, 2016). Today, about 95 percent of four-year institutions operate on a semester calendar.

The primary reasons institutions cite for switching from quarters to semesters is to synchro-

nize schedules with other schools in the state including other colleges and universities as well as community colleges. Because a majority of schools operate on a semester calendar, institutions on quarters often feel that their students are disadvantaged when it comes to securing summer internships and studying abroad. For instance, a semester school year typically begins in late August and concludes in early May, where a quarter academic year runs late September through the beginning of June. If firms center internship program dates around a semester schedule because they are more common (which is often the case), students who attend schools on quarters may be ineligible. Similarly, because most study abroad programs align with a semester schedule, quarter system students often have to forgo a term abroad. It is also the case that when community colleges and four-year schools operate on a common schedule, transferring course credits into the four-year institution is more straightforward, and transfer students lose fewer credits in the process. Finally, sometimes entire state-wide education systems such as the California State system and the Ohio university system will require all schools in the system to switch to a common schedule (in this case semesters) because it reduces administrative and governing costs. In Section 4, we provide an in-depth discussion of the ways in which policy adoption may affect our results, and show empirically that this is of little concern.

Along with the reasons administrators cite for switching from quarters to semesters, there are many other costs and benefits associated with a semester calendar, both to students and the faculty/administration, that could affect student's academic achievement. We begin with the costs to students. The obvious difference between a quarter term and a semester term is the length; quarter courses are more condensed (10 weeks versus 15 weeks) but students take fewer courses per term (three or four versus five). As a result, semester calendars offer less scheduling flexibility. In fact, by the end of one's undergraduate career, students on a semester calendar will take approximately six fewer courses than those on a quarter calendar making it more difficult to try out different majors or to take elective courses. Generally, there are fewer courses to choose from in a semester calendar and students are exposed to fewer professors.[5]

[5]Although descriptive in nature, a comparison of course offerings from UCLA, which is on quarter schedule, and UC Berkeley (semester schedule) in Psychology, English and Political Science shows that UCLA offers substantially

Due to the longer term associated with semesters, switching majors is also more costly. To highlight the added cost, consider a full-time student on a semester calendar who starts out as a pre-medicine major and who enrolls in the first prerequisite courses in the fall semester of her first year – i.e. General Chemistry, Biology, Calculus, and two other general education courses such as English 101 and History 101. At the start of the spring semester, she decides to switch to a business major where she must start over with the prerequisites for that major, but she has already spent 1/8 of her four years in college taking prerequisites that no longer count toward her new major. Had she been on a quarter schedule, she would have only given up 1/12 of her total time. Since approximately half of students cite switching majors at least once during their undergraduate education, this is one channel through which time to graduation may increase by switching to a semester system (Sklar, 2015).

There are a few other drawbacks to taking fewer total courses and having longer terms, as is the case with semesters, that could negatively impact student achievement. If a student performs poorly in a course, it is harder for her to improve her grade point average going forward because each term carries a larger weight compared with quarter terms. Also, students have to spend more weeks with a professor that they might not like or a class that is not desirable to them. Finally, semester calendars have longer breaks during the school year (i.e. winter and spring breaks), which may make it harder to stay focused or to recall prerequisite material.

On the other hand, a semester schedule has many potential benefits. A semester course spans more weeks (i.e. 15 versus 10) making it is easier to overcome a missed class due to illness; a single class in a semester term is a smaller fraction of the total course than in a quarter term. In a similar vein, because the term is longer, it is easier for a student to "turn-it around" if he finds himself performing poorly in the first half of the course. This may be particularly beneficial to first year students who are adjusting to college life. Because of the longer term and the fact that students have one less finals week per academic year, students also have more time with instructors and more time to master complex material. Given these benefits of a longer term, semesters have

more courses in each department; 61 percent, 37 percent and 43 percent more, respectively (Ramzanali, Accessed: 2016-11-9).

the potential to increase on-time graduation.

While the analysis in this paper exclusively addresses the impact of semesters on student outcomes, it is worth noting there are several costs and benefits associated with this calender to the faculty and administration. One major benefit of semesters is that they only involve two start-up periods per year (as opposed to three with quarters) which reduces resources allocated to course registration, and final exam writing and grading. A large downside of semesters for faculty, however, is they are less conducive to shorter term sabbaticals and maternity/paternity leave as taking off one semester term is one-half of the year versus a third of the year in a quarter system. Similarly, it is much harder for faculty to stack all of their teaching responsibilities into a single semester term; a common practice among faculty who teach on a quarter system to free up large blocks of research time. The lack of the option to stack courses may also harm new faculty recruitment.

Lastly, one must consider the direct cost of switching. Switching academic calendars is often a multi-year process and can take up to 4 years. It is administratively costly to convert course credits from quarters to semesters, three quarter hours are equivalent to two semester hours, and faculty have to redesign curriculum and courses to fit within the longer term. Guidance and scheduling counselors must also be re-trained to adequately advise students in the new system. Moreover, students caught in the transition period could be negatively impacted, as they may have trouble navigating a new system midway through their college career.

In summary, there are a multitude of costs and benefits associated with switching from a quarter to a semester academic calendar that could affect graduation rates, both on-time and delayed graduation. Ultimately it is unclear which effects dominate, and thus, this is an empirical question.

3 Data

All data in this study come from the Integrated Postsecondary Education Data System (IPEDS), a branch of the National Center for Education Statistics (NCES). Completion of the IPEDS surveys is mandatory for all postsecondary institutions that participate in Federal financial assistance

programs; consequently, there is nearly full compliance.[6] To construct the dataset, we combine several IPEDS files including general institutional characteristics and degrees conferred. Because we are interested in four and six-year graduation rates, we keep only non-profit colleges and universities that offer comparable, traditional, four-year bachelor's degrees which includes all schools in IPEDS defined as bachelors, masters or doctoral-granting institutions by the Carnegie Classification system. We then merge this sample of institutions with IPDES data on the calendar system, graduation rates, faculty, institution finances and tuition.

The final dataset includes 19 cohorts of students that entered a four-year college or university between 1991 and 2010.[7] We exclude 1994 from the analysis since IPEDS did not collect four-year graduation rates for this cohort. We also drop very small schools; those that have an average cohort size less than 250 students (about 20% of the total schools) as they are likely non-representative. Finally, to construct a balanced panel, we keep only institutions that report graduation rates in all 19 years (1991-2010, excluding the missing cohort of 1994).[8] The final dataset includes 635 institutions over 19 years for a total of 12,065 observations.

The two primary variables used in our analysis are the academic calendar system variable and graduation rates. The academic calendar variable includes seven different mutually exclusive categories: (1) two 15 to 16 week semesters, (2) three 10 to 12 week quarters plus a summer quarter, (3) three 12 to 13 week trimesters without a summer term, (4) a 4-1-4 system consisting of two four month (semester) blocks with a one month, one course block, (5) nontraditional calendar systems used often for online courses, (6) calendar systems that differ by program, commonly used by vocational and occupational programs, and (7) a continuous academic calendar system that allows students to enroll at any time during the year.

We restrict our sample to include schools that are on semesters, quarters, trimesters or 4-1-

[6] In subsequent analyses, we use the Ohio Longitudinal Data Archive (OLDA) – administrative transcript data for all students attending a public Ohio institution from 1999 to 2017 – which will be outlined in detail in future drafts.

[7] The most recent graduation file reported by IPEDS is for 2016, which corresponds to the 2010 entering cohort. The lag allows one to observe both four and six year graduation rates.

[8] In Appendix Table 1 we report results using the unbalanced panel and obtain similar results. In this sample, there are 993 institutions for a total of 17,821 observations. Appendix Table 2 reports results from a more restricted sample where the number of observations are held constant across the various subgroups.

4 academic calendar systems, and drop the small share that move from semesters to quarters. Furthermore, 4-1-4 systems are recoded as semesters in our analysis as they are equivalent to two traditional semesters surrounding a single, one month course. Trimesters and quarters are closely related in many cases and trimesters are recoded as quarters. Less than one percent of the institutions in our sample are on trimesters and eight percent of the institutions are on a 4-1-4 schedule. Our results below are not sensitive to the recoding of semesters and quarters.

The main dependent variables in our analysis are four and six-year graduation rates. The IPEDS provides information on the incoming cohort size at each school and the number of students in the cohort that graduate within four and six years, allowing us to construct four-year and six-year graduation rates for every incoming cohort since 1991. Graduation rates only include full-time students who enrolled at the institution as a freshman, and thus exclude transfer students.

The dashed black line in Figure 1 shows the average four-year graduation rate for all schools in our dataset. Consistent with data from the OECD, the four-year graduation rate in the U.S. has grown slowly over the past 15 years, rising from 30 percent in 1995 to 39 percent in 2011. Figure 1 also provides initial evidence that there may be a relationship between academic calendars and graduation rates. The average graduation rate is particularly stagnant in the early 2000s, just after a relatively large fraction of schools moved to a semester system. Although, the aggregate relationship between graduation rates and academic calendars documented in Figure 1 does not control for school specific characteristics that may be associated with both calendar shifts and graduation rates, it is suggestive of a negative relationship. The panel data framework in which we employ below controls for a number of institutional characteristics and allows us to estimate the relationship between graduation rates and academic calendars net of selection.

Table 1 reports summary statistics for the main sample. The first column of Table 1 shows that 93 percent of the observations in the dataset are on semester systems. The four-year graduation rate for all students is 36 percent, with women having a significantly higher rate, 41 percent, than men, 30 percent. Underrepresented minority graduation rates are just below male rates at 29 percent. As expected, the average six-year graduation rates is much higher, 59 percent. The analysis in

this paper also controls for tuition, the number of faculty at an institution, and annual costs and revenue. The average number of full-time faculty at a university is 382, in-state tuition (without room and board) averages $10,819 and the average cohort size is 1,237 students.

The second and third columns report summary statistics disaggregated by school calendar, those that do not change their calendar system between 1991 and 2010 and those that change to semesters during the time period. The most striking difference between the two groups is the share of public institutions; 77 percent of switchers are public compared to 48 percent of never-switchers. This difference also drives differences in the average cohort size (1,199 vs. 1,548) and the average in-state tuition ($11,302 vs. $6,853) between never-switchers and switchers as public institutions typically have larger average cohorts and lower in-state tuition. Importantly, these differences do not threaten the internal validity of the regressions results presented in Section 5. As outlined in Section 4, the identifying assumption is the parallel trends assumption (see event study presented in Figure 2). Rather, we report the disaggregated summary statistics to highlight the fact that the effect of switching is, for the most part, identified off of large public universities.[9]

4 Empirical Framework

We leverage quasi-experimental variation in academic calendars across institutions and years to identify the causal relationship between semester systems and graduation rates. Estimates come from a difference-in-difference framework:

$$Y_{it} = \beta_0 + \beta_1 S_{it} + X'_{it}\alpha + \gamma_i + \phi_t + \rho_i * t + \varepsilon_{it} \tag{1}$$

where Y_{it} is either the four-year or six-year graduation rate for university i in year t. S_{it} is the treatment which is equal to one if a university is on a semester schedule in year t, and zero if it is on a quarter schedule in that year. The coefficient of interest is β_1, which measures the effect of a semester calendar on graduation rates.

[9] In a heterogeneity analysis, we show that the results persist across the subset of private schools too (see Table 3, Column 9).

The vector X_{it} includes time-varying university level controls such as in-state tuition, number of full time equivalent faculty, and annual operation costs and revenue. γ_i and ϕ_t are university and year fixed effects, respectively. $\rho_i * t$ is a university-specific time trend. ε_{it} is the usual error term and is clustered by institution. All regressions are weighted by average cohort size.

Additionally, to construct an event study, we estimate the below equation.

$$Y_{it} = \beta_0 + \sum_{k=-17}^{-1} \theta_k S_{itk} + \sum_{k=1}^{20} \theta_k S_{itk} + X'_{it}\alpha + \gamma_i + \phi_t + \rho_i * t + \varepsilon_{it} \tag{2}$$

S_{itk} is an indicator for k years from the adoption of a semester system for institution i and the year t. The omitted category is t-5. T-4 through t-1 are partially treated cohorts. The year t corresponds to the first fully treated cohort; those who were freshmen when the policy was adopted. There are a total of 25 pre-policy years and 22 post years.

The identifying assumption for estimating the effect of a semester calendar is that the adoption of the semester calendar is uncorrelated with other unobserved time-varying determinants of four-year and six-year graduation rates. The inclusion of institution and year fixed effects controls for time-invariant institution-level variables and overall time trends that might affect graduation rates. Moreover, by including institution-specific linear time trends, we control for differential trends in graduation rates across institutions over time. Finally, we include several institution time-varying controls to reduce concerns that unobserved characteristics, that also explain graduation rates, are correlated with the adoption of a semester calendar.

While the identifying assumption is not directly testable, several indirect tests support its plausibility. We begin with an event study. Suppose institutions enact policies such as a calendar change, aimed at improving student outcomes, in response to falling graduation rates. A pre-existing trend of this nature would undermine the causal interpretation of the treatment, as it will be impossible to distinguish the effect of a semester calendar from the pre-trend. Empirically, this does not appear to be the case. An event study presented in Figure 2 shows that graduation rates in the five years leading up to the calendar switch are not statistically different from those in the year

right before the policy adoption.[10] We discuss the event study in more detail in Section 5.

A second concern that would confound the interpretation of the results is if other aspects of the institution or student body change as a result of the calendar adoption that also affect graduation rates. For instance, it is possible that different types of students attend the university because of the calendar change or the resources available to students is different because of the switch and this also affects graduation rates. To help rule out this concern, we regress institution and student characteristics (fulltime equivalent faculty, operation costs, cohort size, percent of student body white, percent URM, percent male, and percent female) on a semester calendar indicator and year and institution fixed effects. Table 2 shows no sign of a relationship between observable institution or student characteristics and the adoption of a semester calendar, alleviating concerns of confounding factors of this nature.

A final concern is that institutions that change to a semester system may be inherently different from those who do not. If this is the case, it would not jeopardize the internal validity of our analysis – we include institution fixed effects to estimate a local average treatment effect – rather it would call into question the external validity of our results. That is, do our results extend to those institutions who we do not observe switching if they were to switch? First, we show in Table 1 that switchers are predominantly public institutions. Since a majority of students attend public institutions – the average cohort size at a public institution is 1,727 compared to 662 at private schools and just over 50 percent of institutions in the dataset are public – our results are relevant to a majority of students in the U.S. Second, in a heterogeneity analysis, we find similar results among the subset of private schools, again suggesting that our results extend widely.

5 Results

The main results are represented in the event study in Figure 2a and come from estimating Eq. (2). Figure 2a reports the effect of policy adoption on four-year graduation rates (on-time graduation),

[10] The estimates plotted in Figure 2 come from Eq. (2).

and Figure 2b for six-year graduation rates. The "Pre-Treatment" region (t-10 through t-5) includes untreated cohorts. All estimates are relative to the left out group, t-5, which is the last untreated cohort before policy adoption. The "Partially-Treated" region includes t-4 through t-1. These cohorts were fifth, fourth, third, and second year students when semesters were implemented and, as such, were treated for one, two, three, and four years, respectively. Year 0 represents the first fully treated cohort because this is the group of students who were incoming freshmen in the fall that the institution adopted a semester calendar. The "Post-Treatment" region, t=0 through t+5, includes cohorts who are fully treated (i.e., cohort t+1 is the group who entered the university the year after a calendar switch).

Figure 2a shows that on-time graduation falls as a result of semester calendar implementation. The "Pre-Treatment" region reveals that prior to adoption, graduation rates are trending similarly across institutions that switch and those that do not. The negative effect of a semester calendar on four-year graduation rates begins to emerge in the"Partially-Treated" cohorts. The decrease in four-year graduation rates grows larger as cohorts become more fully treated (i.e., as they are exposed to more years of a semester calendar). This impact levels out as all entering cohorts become fully treated (i.e., the "Post-Treatment" cohorts).

Figure 2b repeats this exercise for six-year graduation rates. Similar to four-year graduation rates, we find no evidence of differential trends in six-year graduation rates prior to the adoption of a semester calendar. After adoption, there is no statistically significant impact on six-year rates. In summary, the event study suggests that the policy does not affect completion, but it decreases on-time graduation.[11]

Table 3 Panel A presents estimates of the mean effect of switching to semesters on four and six-year graduation rates. Each estimate comes from a separate regression and is obtained by estimating Eq. (1). The results from the main specification (Row 1, Column 3) indicate that switching from a quarter system to a semester system reduces four-year graduation rates by 1.6 percentage-

[11] Ideally we would like information on retention, however, because this is not available for the universe of schools and because the majority of students who enter college and who graduate do so within six years, we use six-year graduation rates as a proxy for whether students ever graduate.

points. For context, the average four-year graduation rate is 36 percent, thus a 1.6 percentage-point reduction is 4.4 percent. This finding is robust to a variety of subgroups as reported in Columns 4-9. Consistent with the event study results, Row 2 shows no statistically significant effect of semesters on six-year graduation rates.

One downside of reporting the mean effect is that it is likely understated. In Eq. (1), the treatment variable S_{it} is equal to one if a school is on a semester calendar in a given year and zero otherwise. As such, the treatment group includes those cohorts who are treated all years (i.e., they are on a semester calendar starting as a freshman) and the control group includes many partially-treated cohorts (i.e., those cohorts that are already at the institution in their second, third, fourth, or fifth year when the calendar is adopted), in addition to those that never switch. To overcome this issue, we explore an alternative estimation strategy that is in a similar vein to the event study (Eq. (2)). It is outlined below.

$$Y_{it} = \beta_0 + \beta_1 G1_{it} + \beta_2 G2_{it} + \beta_3 G3_{it} + X'_{it}\alpha + \gamma_i + \phi_t + \rho_i * t + \varepsilon_{it} \tag{3}$$

We define the three partially treated cohorts $G1$ and all other fully treated cohorts $G2$. The left out group is all pre-treatment cohorts, where $t \leq -4$. As such, $G1$ is equal to one if $t \in (-4, 0)$ and zero otherwise and $G2$ is equal to one if $t \in [0, 22)$ and zero otherwise. All other variables are the same as in Eq. (1).

Table 3 Panel B reports results from Eq. (3) for the entire sample (Columns 1-3) and for several subgroups including males, females, underrepresented minorities, non-underrepresented minorities, and public universities. Private universities follow a similar pattern, but the results are relatively noisy. All reported estimates are relative to the group of years before the policy adoption. The results show, across the board, declining four-year graduation rates as a result of the adoption of a semester calendar. As expected, the impact is strongest among those cohorts who are fully treated ($G2$). Switching to semesters leads to a 2.9 percentage-point decline in on-time graduation. This effect persists across a variety of subgroups. To add context to our estimates, Hinrichs (2014) finds that among top fifty universities, affirmative action bans increase six-year

graduation rates for Hispanics by about 6 percent, but do not affect four-year rates.

Similar to the findings reported in Table 3 and the event study, there is no strong evidence that the calendar switch affects six-year graduation rates, as the estimates are small in magnitude and indistinguishable from zero. Again, these results imply that while a semester calendar is not affecting completion, it is causing students to incur a cost – both a direct cost and an opportunity cost – from delayed graduation.

6 Discussion and Conclusion

The documented negative relationship is unexpected. Colleges and universities that have switched to semesters often cite higher graduation rates as a reason for making the calendar shift (Burns, 2013), but we show that the switch is costly to students. To put the policy into context, based on an National Center for Education Statistics report, the cost of one year of tuition at a four-year public institution in 2014 was \$18,110[12] and the average starting salary for 2014 graduates was \$26,217.[13] Thus, the total cost of an additional year of school for a student is \$44,327.43.[14] Further, the average cohort size in our sample is 1,237 students. Given that we find switching to semesters reduces on-time graduation by 2.9 percentage-points, 36 students in the average sized cohort will experience delayed graduation as a result of the policy adoption. Therefore, a back of the envelope calculation suggests that the total cost of the policy to students per year of delayed graduation at an average sized university is \$1.6 million.

One likely channel, as outlined in Section 2, is that quarter calendars afford more flexibility in course scheduling, and in particular, they make it relatively less costly to change majors midway through college. According to the National Center for Education Statistics, on average, about half of students switch majors during college. In a quarter system, students take, on average, six more

[12] NCESstats

[13] This salary was calculated using the 2014 March Current Population Survey. It includes all individuals who are age 22-24, with a four-year degree, who are not in school, and includes those with a zero wage too.

[14] This is a back of the envelope calculation. We acknowledge that there other costs associated with delayed graduation including the year of forgone experience in the labor market. As such, our estimated cost is a lower bound.

courses by the end of college which allows them to more easily try out a major. An added bonus of the short terms associated with quarters is that it is also easier to recover from a poor academic performance in a given quarter or course.[15]

In summary, this paper examines the impact of colleges and universities in the U.S. moving from quarters to semesters. No previous study to our knowledge has examined the effect of post-secondary calendar shifts on such a large scale. Using a panel of the near universe of four-year non-profit institutions for the 1991 to 2010 entering cohorts, we find that on-time graduation rates decrease after a school moves from quarters to semesters. This result is consistent across several subsets of the data including women, men, whites, underrepresented minorities, public institutions and private institutions. While the majority of colleges and universities in the U.S. are on semesters, the results of this study are timely as large state systems, such as the California State University system, continue to make the transition.

[15]Table 1 of Gibbens et al. (2015) presents a comprehensive list of the benefits of quarter and semesters.

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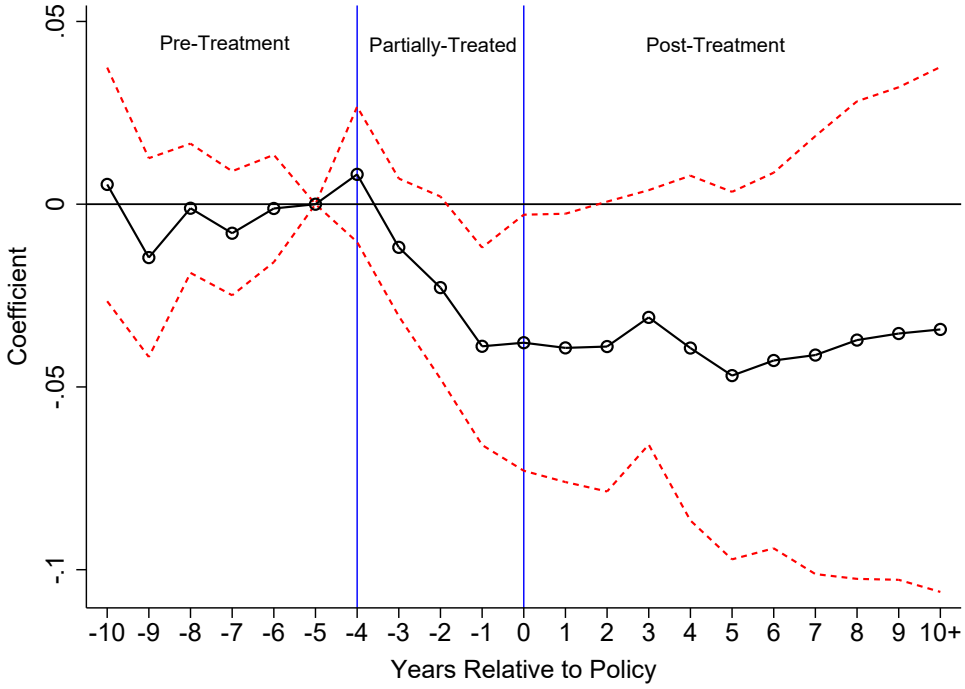
Figure 1: Fraction of Schools on Semester Calendar and Four-year Graduation Rates

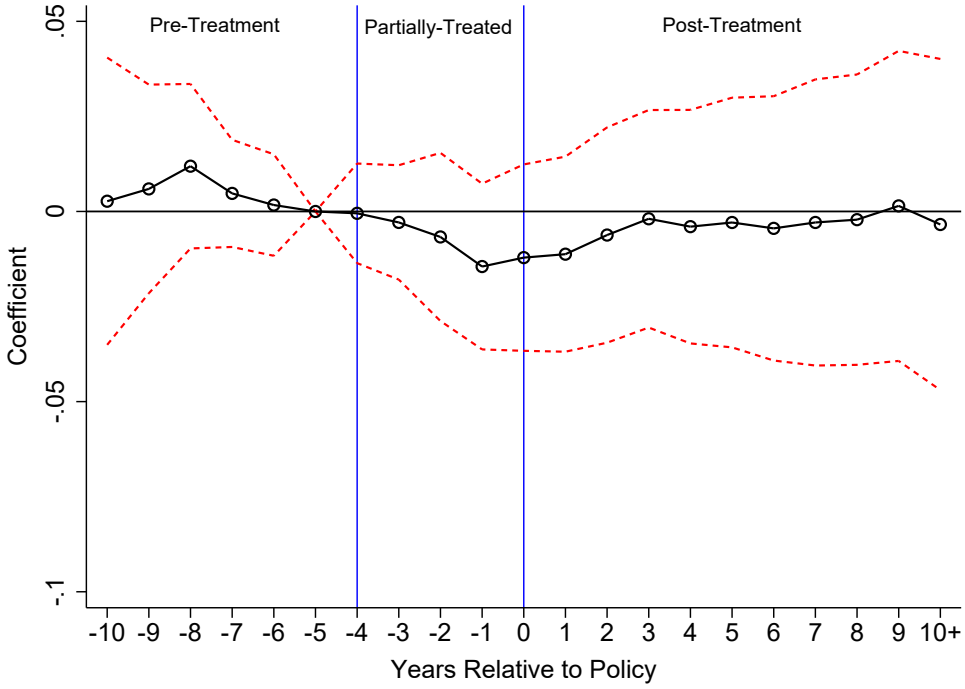
Notes: Data on graduation rates are for the 1991-2010 cohorts.

Figure 2: Event Study

(a) Four-Year Graduation Rates



(b) Six-Year Graduation Rates



Notes: This figure plots θ_k, and 95% confidence intervals in dashed pink lines, from estimating Eq. (2). S_{itk} is an indicator for k years from the adoption of a semester system for institution i and the year t. The omitted category is t-5. T-4 through t-1 are partially treated cohorts. The year t corresponds to the first fully treated cohort; those who were freshmen when the policy was adopted. There are a total of 25 pre-policy years for the most recent changers and 22 post years for the earliest changers. Year and institution fixed effects, institution linear time trends, and time varying controls are included.

Table 1: Summary Statistics

	All	Never Switchers	Switchers
	(1)	(2)	(3)
Semester calendar	0.93	0.95	0.69
	(0.26)	(0.21)	(0.46)
Four-yr grad rate	0.36	0.37	0.28
	(0.22)	(0.22)	(0.16)
Four-yr women grad rate	0.41	0.42	0.34
	(0.22)	(0.23)	(0.18)
Four-yr men grad rate	0.30	0.32	0.23
	(0.22)	(0.22)	(0.15)
Four-yr URM grad rate	0.29	0.30	0.21
	(0.20)	(0.21)	(0.14)
Four-yr non URM grad rate	0.37	0.39	0.30
	(0.22)	(0.23)	(0.17)
Six-yr grad rate	0.59	0.59	0.54
	(0.18)	(0.18)	(0.17)
Six-yr women grad rate	0.62	0.62	0.57
	(0.17)	(0.17)	(0.17)
Six-yr men grad rate	0.55	0.56	0.51
	(0.19)	(0.19)	(0.18)
Six-yr URM grad rate	0.51	0.52	0.46
	(0.19)	(0.19)	(0.16)
Six-yr non URM grad rate	0.60	0.61	0.56
	(0.18)	(0.18)	(0.17)
Public	0.51	0.48	0.77
	(0.50)	(0.50)	(0.42)
FTE faculty	381.78	370.63	473.24
	(393.71)	(383.53)	(459.01)
Cohort size	1,236.64	1,198.89	1,548.01
	(1,211.28)	(1,177.05)	(1,424.94)
In-state tuition	10,818.93	11,302.44	6,852.70
	(9,549.79)	(9,699.73)	(7,065.06)
Costs ($ per 1M)	215.42	207.15	283.30
	(418.82)	(407.89)	(494.52)
Observations	12,065	10,754	1,311

Note: The balanced panel dataset includes the 1991-2010 entering cohorts. There are 635 institutions and 19 years. An observation is an institution-year. Standard deviations are reported in parentheses.

Table 2: The Effect of Semesters on Institution and Student Characteristics

	Institution Characteristics			Student Characteristics		
	FTE Faculty	Costs	Cohort Size	% URM	% White	% Female
	(1)	(2)	(3)	(4)	(5)	(6)
Semester	2.299	18.757	9.203	-0.002	-0.004	-0.004
	(10.450)	(33.304)	(59.688)	(0.009)	(0.008)	(0.004)
Observations	12,065	12,065	12,065	12,065	12,065	12,065

Note: Each column represents a separate regression, where different pre-treatment characteristics are the outcomes. All regressions include a dummy for being on a semester calendar, year fixed effects, and institution fixed effects. Standard errors are reported in parentheses and are clustered at the institution level. *** p<0.01, ** p<0.05, * p<0.1.

Table 3: Effect of Switching to Semesters on Graduation Rates

	All (1)	All (2)	All (3)	Women (4)	Men (5)	URM (6)	Non-URM (7)	Public (8)	Private (9)
Panel A: Average Effect of Switch									
Four-Yr Grad Rate	-0.008	-0.009	-0.017**	-0.017*	-0.018**	-0.010	-0.020**	-0.015*	-0.021*
	(0.017)	(0.016)	(0.008)	(0.009)	(0.007)	(0.011)	(0.008)	(0.008)	(0.012)
Six-Yr Grad Rate	0.017	0.015	-0.001	-0.003	0.003	-0.007	-0.004	-0.000	-0.006
	(0.014)	(0.013)	(0.007)	(0.007)	(0.007)	(0.012)	(0.009)	(0.007)	(0.006)
Panel B: Effect in Transition and Post-Period									
Four-Yr Grad Rate									
G1 (t-3 to t-1)	0.006	0.005	-0.013	-0.015	-0.013	-0.016	-0.012	-0.010	-0.012
	(0.021)	(0.021)	(0.010)	(0.011)	(0.009)	(0.011)	(0.011)	(0.011)	(0.024)
G2 (t to t+22)	-0.004	-0.007	-0.029**	-0.030**	-0.030**	-0.025	-0.031**	-0.024*	-0.033
	(0.021)	(0.021)	(0.013)	(0.014)	(0.013)	(0.016)	(0.014)	(0.014)	(0.027)
Six-Yr Grad Rate									
G1 (t-3 to t-1)	0.005	-0.001	-0.012	-0.014	-0.009	-0.019	-0.009	-0.010	-0.013
	(0.015)	(0.011)	(0.009)	(0.010)	(0.009)	(0.012)	(0.009)	(0.010)	(0.012)
G2 (t to t+22)	0.020	0.014	-0.012	-0.016	-0.005	-0.024	-0.012	-0.010	-0.019
	(0.016)	(0.014)	(0.010)	(0.012)	(0.011)	(0.018)	(0.011)	(0.012)	(0.016)
Observations	12,065	12,065	12,065	12,041	12,052	12,064	11,989	6,194	5,871
School, Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Trends	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: The sample includes 635 institutions for 19 years. All regressions are weighted by average cohort size. In Panel A, each point estimate comes from a separate regression. In Panel B within each column, point estimates in rows 3 and 4 come from the same regression. Similarly, point estimates in rows 5 and 6 within a column come from the same regression. The left out category in Panel B is G0 (t-4 through t-25), which are the pre-treatment years. Standard errors are reported in parentheses and are clustered at the institution level. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Appendix

Table A1: Effect of Switching to Semesters on Graduation Rates (Unbalanced Panel)

	All	All	All	Women	Men	URM	Non-URM	Public	Private
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Four-Year Grad Rates	-0.016	-0.015	-0.016**	-0.016*	-0.016*	-0.010	-0.019**	-0.015	-0.011
	(0.014)	(0.013)	(0.008)	(0.008)	(0.008)	(0.010)	(0.009)	(0.009)	(0.008)
Six-Year Grad Rates	0.015	0.015	0.006	0.005	0.007	0.001	0.005	0.008	-0.002
	(0.011)	(0.010)	(0.006)	(0.006)	(0.006)	(0.010)	(0.007)	(0.007)	(0.006)
Observations	17,821	17,821	17,821	17,760	17,624	17,817	17,384	8,553	9,268
School, Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Trends	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: The sample includes 993 institutions over 19 years. Not all institutions are observed in each year. All regressions are weighted by average cohort size. Standard errors are reported in parentheses and are clustered at the institution level. *** p<0.01, ** p<0.05, * p<0.1.

Table A2: Effect of Switching to Semesters on Graduation Rates (Obs. held constant across outcomes)

	All	All	All	Women	Men	URM	Non-URM	Public	Private
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Four-Year Grad Rates	-0.008	-0.009	-0.017**	-0.017*	-0.018**	-0.010	-0.022***	-0.015*	-0.021*
	(0.017)	(0.016)	(0.008)	(0.009)	(0.007)	(0.011)	(0.008)	(0.009)	(0.012)
Six-Year Grad Rates	0.017	0.015	-0.002	-0.004	0.002	-0.008	-0.009	-0.001	-0.006
	(0.014)	(0.013)	(0.007)	(0.007)	(0.007)	(0.012)	(0.007)	(0.007)	(0.006)
Observations	11,723	11,723	11,723	11,723	11,723	11,723	11,723	6,099	5,624
School, Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Trends	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: The sample includes 617 institutions in 19 years. All regressions are weighted by average cohort size. Standard errors are reported in parentheses and are clustered at the institution level. *** p<0.01, ** p<0.05, * p<0.1.