College Course Shutouts

PRELIMINARY DRAFT, PLEASE DO NOT CITE

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Abstract

What happens when college students don't get the courses they want? We use a natural experiment at a large public university in which freshman students are conditionally randomly assigned enrollment in over-subscribed courses. We find that first-semester freshman students who are shutout from an over-subscribed course are approximately half as likely to ever take the oversubscribed course and approximately 30% less likely to ever take a course in the same subject. Shutouts decrease the number of credits students earn. Additionally, we find that students who are shutout of two or more courses as first-semester freshmen are 10% less likely to graduate within four years. We are also currently generating estimates of the effects of course shutouts on major choices.

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1 Introduction

Across the country, states are reducing spending on higher education. In real terms, state appropriations per student are 40% lower now than they were in 1990.[1] One of the results of this increasing budgetary pressure on colleges is that they may reduce course offerings and some students may be shutout of courses they want to take.[2] Public institutions have a significantly higher student-faculty ratio on average than private non-profit institutions (see Figure 1) and perhaps one of the most salient differences between public and private non-profit institutions is the extent to which a student is able to enroll in desired courses. While researchers have speculated that these "course shutouts" contribute to negative student outcomes including increased dropout rates and longer time-to-degree, there is limited and conflicting evidence of the effects of course shutouts.[3]

We contribute to the nascent literature on course shutouts by exploiting random variation in course shutouts at a large public university. In 2018, Purdue University introduced a "Batch Registration" algorithm to assign student course schedules. One result of this program is that it conditionally randomly assigned students to over-subscribed courses. Among first-semester freshmen, 49% of students were assigned their preferred course schedule, while the other 51% were excluded from at least one of their top six requested courses. We find that course rationing significantly changes both short- and long-term course-taking behavior. First-term freshmen who are initially shutout from a course are 71 percentage points less likely to complete that course in their first term, 47 percentage points less likely to complete the course within a year, and 38 percentage points less likely to ever complete the course. Furthermore, many students who are shutout from a course end up being shutout from a subject completely. Being shutout from a course reduces the probability of ever taking a course from the oversubscribed subject by 26 percentage points.

Not only does course rationing affect course-taking behavior, but also significantly affects

[1] See Chakrabarti et al. (2020).

[2] See Deming (2017); Mitchell et al. (2016); Bahr et al. (2015)

[3] Robles et al. (2021) find that course shutouts in community colleges significantly increase the probability that students take zero courses in a semester or transferred to a lower-quality two-year college. In contrast, Kurlaender et al. (2014) find that course shutouts only affect time-to-degree when students are shutouts occur in semesters when students could have otherwise graduated.

other short- and long-term educational outcomes. We find that each course shutout during the first semester of freshman year decreases credits earned by 0.3 credits in that semester. Furthermore, we do not find any evidence that students compensate by taking more credits in later semesters. Consistent with our findings on credit accumulation course-taking behavior, we find that students who are shutout from two or more courses in the first semester of their freshman year are 10% (5.9 percentage points) less likely to graduate within four years.

Our results contribute to the existing literature on course shutouts in several ways. First, this is the first paper we are aware of that examines the effects of course shutouts on course-taking patterns and major choice. Because college majors have large effects on long-term earnings, career trajectories, and lifestyles, (Altonji et al., 2012, 2014; Bleemer and Mehta, 2022; Chevalier, 2011; Hastings et al., 2013; Kirkeboen et al., 2016; Patnaik et al., 2020; Webber, 2014) significant policy attention has focused on steering students towards high-returns majors (Bleemer and Mehta, 2021; Denning and Turley, 2017; Sjoquist and Winters, 2015). Our results suggest that in addition to more intensive interventions such as changing the pecuniary costs of majors via fees (Andrews and Stange, 2019) and scholarships (Deming, 2017), policymakers can shift students toward certain subjects by increasing course availability in the subject area and decreasing course availability in other subjects. Our results are also consistent with recent findings that major choice is susceptible to influence from seemingly minor changes in student schedules such as time of day (Haggag et al., 2021; Yim, 2023) and semester taken (Patterson et al., 2021).

Our paper also helps to resolve conflicting evidence on course shutouts in the existing literature. Our paper finds negative results that are more consistent with Robles et al. (2021) than Kurlaender et al. (2014), despite greater institutional similarities between our context (Purdue) and Kurlaender et al. (2014)'s (University of California-Davis) versus Robles et al. (2021)'s (De Anza Community College-California Community College system). While our differences relative to Kurlaender et al. (2014) could be due to institutional differences, they could also be due to how Kurlaender et al. (2014) define course shutouts and limitations in their identification strategy.[4]

[4]Kurlaender et al. (2014) use randomization in how often students get early access to the course registration site

Our results also relate to research on on-time graduation. Fewer than half of graduating low-income students in the United States graduate within four years of college entry (Denning et al., 2022). Delays to graduation increase both the direct costs of college attendance (e.g. tuition, room, and board) and indirect costs (foregone wages). Researchers have investigated how financial incentives affect on-time graduation and have found mixed results. For example Scott-Clayton (2011) finds that a merit aid program in Georgia increased on-time graduation whereas Angrist et al. (2022) find that a merit aid program in Massachusetts decreased on-time graduation. Garibaldi et al. (2012) find that a 1000-Euro bump in continuation tuition increased on-time graduation by 5.2%. Our finding that two or more course shutouts during students' first semester decreases on-time graduation by 10% suggests that addressing course shutouts may be an important area of focus to address graduation rates among disadvantaged students.

The remainder of the paper is structured as follows. In Section 2 we describe our study environment and data. In Section 3 we describe our empirical strategy and report our primary results. In Section 4 we explore the potential mechanisms for our findings. In Section 5 we conclude.

2 Study Environment and Data

Data for this study come from administrative and survey records at Purdue University, which include 25,872 student-course observations in 241 over-subscribed courses in the 2018 fall semester. The data follows 8,263 students in the fall 2018 enrolling cohort. Table 1 shows that 44% of students in our sample are female, 11% are Asian, 3% are Black, 6% are

as an instrument for course shutouts, but this instrument leads to an insignificant first stage. When they create a dichotomous variable for "extremely unlucky" or being at the 10th percentile of early registration, they get a statistically significant, but underpowered first stage (F-stat of 7.32). Furthermore, they do not show whether their instrument is balanced across treatment and control groups. Finally, their definition of a course shutout differs from how we define a course shutout. Specifically, Kurlaender et al. (2014) define a course shutout as any instance where a student attempts to register for a specific course section and finds that it is full. This appears to mean that many of the course shutouts in their data are instances where a student queries the registration site to find which sections of a course are not yet full. This is corroborated by the fact that students average four shutouts per term and that some students average over 40 shutouts per term.

Hispanic, and 66% are White.[5] The average Math SAT in our sample is 663 and average Verbal SAT is 650 (both out of 800). Additionally, 17% of our sample are first-generation college students.

As part of the enrollment process, students submit their course preferences to the university (see Figure A.1).[6] After students submit their preferences, they are assigned a course schedule through Purdue's batch algorithm system (Müller et al., 2010). The algorithm uses each student's preference ranking of courses and preferred class times as inputs in generating schedules for all students.[7] The algorithm uses these inputs, along with course availability and student schedule constraints, to assign each student a schedule. While 49% of students are assigned each of the courses they request, 51% are shutout from at least one of their preferred courses with 9% being shutout from two or more courses. In our sample of first-semester freshman, there are 241 courses where at least one student is shutout (See Appendix Table A.1). The two most common shutout courses are required English writing and communications courses.[8] The remaining 239 courses with shutouts come from nearly every subject area offered at the university.

In Columns 2 and 3 of Table 1 we explore the characteristics of students that have and have not been shutout of at least one course as a first-semester freshmen, respectively. In these raw data, we find that female and students from races/ethnicities other than Asian, Black, Hispanic, and White (predominantly international students) are less likely to be shutout of courses. Otherwise, we find that the characteristics of students who are and are not shutout of courses similar.

[5]The "Other" category predominantly consists of international students. Our data does not designate the race/ethnicity of international students and thus are included in the "Other" race/ethnicity category.

[6]Students can submit up to nine preferences, but in practice only 12% of students submit more than six preferences. Our analysis sample, therefore, includes the first 6 preferences requested by students.

[7]An academic advisor can also indicate whether a course is required for a student, which is typically the result of students being required to take a course with a specific group (e.g. band, sports team, or honors section). We exclude courses with a "required" designation from our analysis.

[8]Both English and communication requirements can be met with several alternative courses.

3 Empirical Approach

Our empirical approach takes advantage of the fact that Purdue's course assignment algorithm creates a natural experiment that assigns students to courses based on specific inputs, such as student preferences and schedule constraints. Once student preferences and schedule constraints are accounted for, assignment to sections is randomized and thus uncorrelated with student characteristics (See Appendix II). We confirm that this is the case in Table 2. This table investigates whether course shutouts are correlated with student observable characteristics. Specifically, our balance table reports estimates from the following equation:

$$shutout_{ic} = \boldsymbol{\theta X_i} + \delta LooShutoutProbability_{ic} + \gamma_{ic} + \epsilon_{ic} \tag{1}$$

Where $shutout_{ic}$ is an indicator for whether student i is not initially assigned (shutout from) potentially oversubscribed course c. $\boldsymbol{X_i}$ is a vector of individual characteristics including sex, race/ethnicity, first-generation student status, and SAT math/verbal test scores. $LooShutoutProbability_{ic}$ is the estimated probability that individual i will be shutout from her other preferred courses (leaving out course c).[9] Course-by-preference fixed effects are denoted by γ_{ic} and, by way of example, for Intro. English Composition we include fixed effects for (1) Intro. English Composition 1st preference, (2) Intro. English Composition 2nd preference, ..., (6) Intro. English Composition 6th preference. Finally, ϵ_{ic} is an individual-by-course idiosyncratic error term. In our estimates of equation 1, we cluster our standard errors at the course-by-preference level, which is the level of our treatment.

Column (1) of Table 2 estimates Equation 1 without course-by-preference fixed effects (γ_{ic}) or leave-one-out shutout probabilities ($LooShutoutProbability_{ic}$). Even with these omissions, only two coefficients vary significantly by course shutout probability (Female at the 1% level and Asian at the 10% level). Nevertheless, when all variables are considered jointly, we reject that the hypothesis that observable characteristics are the same among shutout and non-shutout students. However, when we include course-by-preference fixed effects (γ_{ic}) and leave-one-out shutout probabilities ($LooShutoutProbability_{ic}$) successively

[9] This amount averages the shutout rate across all of student i's preferred courses other than course c.

in columns (2) and (3) of Table 2, only one coefficient varies by course shutout probability (Asian at the 5% level) and we cannot reject the hypothesis that observable characteristics being equal among shutout and non-shutout students in either specification.

Our balance in column (3) of Table 2 motivates our individual-by-course level analysis of course shutouts. In this analysis, we examine how shutouts affect course related outcomes, including completing the requested course, taking courses in the subject of the shutout course, and choosing a major that corresponds to the shutout course. We do so by estimating the following equation:

$$Y_{ic} = \beta shutout_{ic} + \boldsymbol{\theta X_i} + \delta LooShutoutProbability_{ic} + \gamma_{ic} + \epsilon_{ic} \tag{2}$$

where Y_{ic} is a course-specific outcome for individual i that has expressed preference for taking course c and all other variables are as previously specified in Equation 1. The parameter of interest is β, which measures the effect of being shutout of a course in a student's first semester on her subsequent academic outcomes. We estimate this equation with ordinary least squares, clustering standard errors at the course-by-preference level.

In addition to examining the effects of shutouts at the individual-course level, we also investigate the effects of shutouts at the individual level. We do so by estimating the following equation:

$$Y_i = \beta shutouts_i + \boldsymbol{\theta X_i} + \lambda 1_i + \lambda 2_i + \lambda 2_i + \lambda 3_i + \lambda 4_i + \lambda 5_i + \lambda 6_i + \epsilon_i \tag{3}$$

Where Y_i is an individual-level outcome, such as credits earned in each semester and on-time graduation. The variable of interest $shutouts_i$ is a measure of the number of courses an individual has been shutout from in their first semester of college. $\boldsymbol{X_i}$ is a vector of individual characteristics. Finally, $\lambda 1_i$ - $\lambda 6_i$ are fixed effects for their 1st through 6th preferred courses, respectively.

4 Results

4.1 Effects on Course Taking

We begin our analysis of the effects of course shutouts by examining the effects of a course shutout on course enrollment and course taking patterns. In Column (1) of Table 3 we use Equation 3 to estimate the effects of being shutout of a course in the first semester of freshman year on attending that course in the same semester.[10] We find that being shutout of a course reduces the probability of attending that course by 72 percentage points. The 28 percentage point slippage from assignment to enrollment is mostly driven by students who were assigned and then drop out of the course rather than by students who are shutout and then are able to enroll in the course. In column (2) we find nearly identical results: students who are shutout of a course in their first semester are 71 percentage points less likely to complete the course that semester. In columns (3) and (4) of Table 3 we show that shutouts do not just shift the timing of course taking, but whether students take a course at all. We find that being shutout of a course in the first semester of freshman year reduces the probability of taking the course as a freshman by 47 percentage points and reduces the probability of ever taking the course by 38 percentage points, as reported in columns (3) and (4), respectively.

Given that course shutouts affect what courses students are taking, a natural question is whether students are substituting shutout courses with other courses and, if so, what courses are they taking instead? In Figure 2, we show that a shutout during the first semester of freshman year reduces the credits earned in that semester by about 0.3 credits. In other terms, a shutout in the first semester of freshmen year leads students to take 0.1 fewer courses on average in that term. We also find that students do not compensate for this reduction in credits in future terms: a shutout during the first semester of freshman year does not significantly affect credit taking in any of the 10 subsequent terms. Rather than making up for the reduction by taking more credits in future semester, the point estimates are actually negative in 8 of the 10 subsequent terms.

[10] We define course attendance as being enrolled in a course immediately after the course add/drop deadline.

While a course shutout in a student's first semester in college does decrease the number of courses taken by 0.10, this indicates that most students are substituting their shutout course with another course. In Tables 4 and 5 we investigate whether or not students are substituting shutout courses with closely related courses. In Table 4, we estimate the effects of a first-term shutout on the number of courses students take in the same subject or broader college of the shutout course.[11] The result in column (1) of Panel (a) of Table 4 and in column (1) of Panel (a) of Table 5 show that most students do not substitute the shutout course with another course in the same subject in the term in which they are shutout. A course shutout decreases courses completed in the shutout subject by 0.64 courses (Table 4 and the probability that students complete any course in the shutout subject by 59 percentage points (Table 5). Both of these values are large relative to the baseline effect of a shutout decreasing the probability a student completing an oversubscribed course by 71 percentage points (Table 3).

While columns (2) and (3) of Tables 4 and 5 show that a significant fraction of students do eventually take courses in a subject they were shutout of as a first-semester freshman, being shutout still has a significant effect on student's exposure to shutout subjects. Panel (a) of Table 4 shows that a shutout in a student's first term decreases their exposure to the shutout course subject by 0.44 courses in their first year and 0.34 courses in their college career. Furthermore, Table 5 shows that being shutout of a course as a first-semester freshman decreases the probability that a student will be exposed to the shutout subject at all in their first year by 35 percentage points and decreases the probability they will ever be exposed to a course in the subject as an undergraduate student by 26 percentage points or approximately 30 percent.[12] In Panel (b) of 5 we show that shutouts lead to broad reductions in exposure to subject areas. Students who are shutout of a course are 21 percentage points less likely to be exposed to a course from the same college as the shutout in their first year and 10 percentage points less likely to ever be exposed to a course from that subject area.

[11] There are 10 colleges at Purdue including Agiculture, Education, Engineering, Health and Human Sciences, Liberal Arts, Management, Pharmacy, Polytechnic, Science, and Veterinary Medicine.

[12] Among students who are not shutout of a course, 92% ultimately take a course in the subject.

4.2 Effects on On-Time Graduation

When students are shutout of courses during the first semester of their freshman year, they both reduce the number of courses they are taking by approximately 0.1 courses and change the types of courses they are taking. Both of these outcomes could lead students to delay graduation. In our sample approximately 60% of students graduate within four years, which we define as an "on-time graduation". In Table 6, we estimate the effect of a course shutout on on-time graduation. In column (1) we find that a course shutout in the first semester of freshman year decreases the probability of on-time graduation by 3 percentage points or by about 5%. In columns (2) and (3) we examine if the effect varies by whether a student was shutout of a top priority course (one ranked in their top 3) or a lower priority course (one ranked in positions 4-6). There are reasons to think that the effects could be larger for either group—on one hand being shutout of a top priority course could be more disruptive for a student's plans but on the other hand, a student might be more responsive to a top priority shutout, either by finding a way to enroll in the same semester, finding better substitute courses, or more quickly by re-calibrating their schedule in subsequent semesters. However, in columns (2) and (3) of Table 6 we find that the effect is the same for both groups, perhaps due to these offsetting forces.

To further investigate the effects of course shutouts, in Figure 3 we compare the effects of having a single course shutout to having two or more course shutouts (the case for approximately 20% of the students with any course shoutouts).[13] We find evidence consistent with a compounding effect of course shutouts: one course shutout leads to a statistically insignificant drop in the probability of on-time graduation of 1.2 percentage points whereas having two or more course shutout decreases the probability of graduation by a statistically and economically significant 5.9 percentage points.

[13] We pool three, and four course shutouts with two shutouts because instances of three and fours shutouts are rare. Only 85 students (1.03%) having 3 shutouts and 5 students (.06%) have 4 shutouts.

5 Conclusion

In this paper, we examine what happens when college students cannot get into the courses they request. Using data from a large public university where students were conditionally randomly assigned to over-subscribed courses, we find that being shutout from a course changes the types of courses students take, the number of credits that they earn, and the probability that students graduate on time. A course shutout has particularly large effect on what subjects students are exposed to. Students who are shutout of a course as a first-semester freshman are 30% less likely to ever take a course in the shutout subject. Additionally, even shutouts at the very beginning of students academic careers can have large effects on whether they graduate on time. We find that students who are shutout of two or more courses as first-semester freshmen are 10% less likely to graduate in four years. In an environment where educators are interested in exposing disadvantaged students to high-paying fields and helping them avoid graduation delays, our estimates suggest that addressing course shutouts can be an effective way to improve student outcomes.

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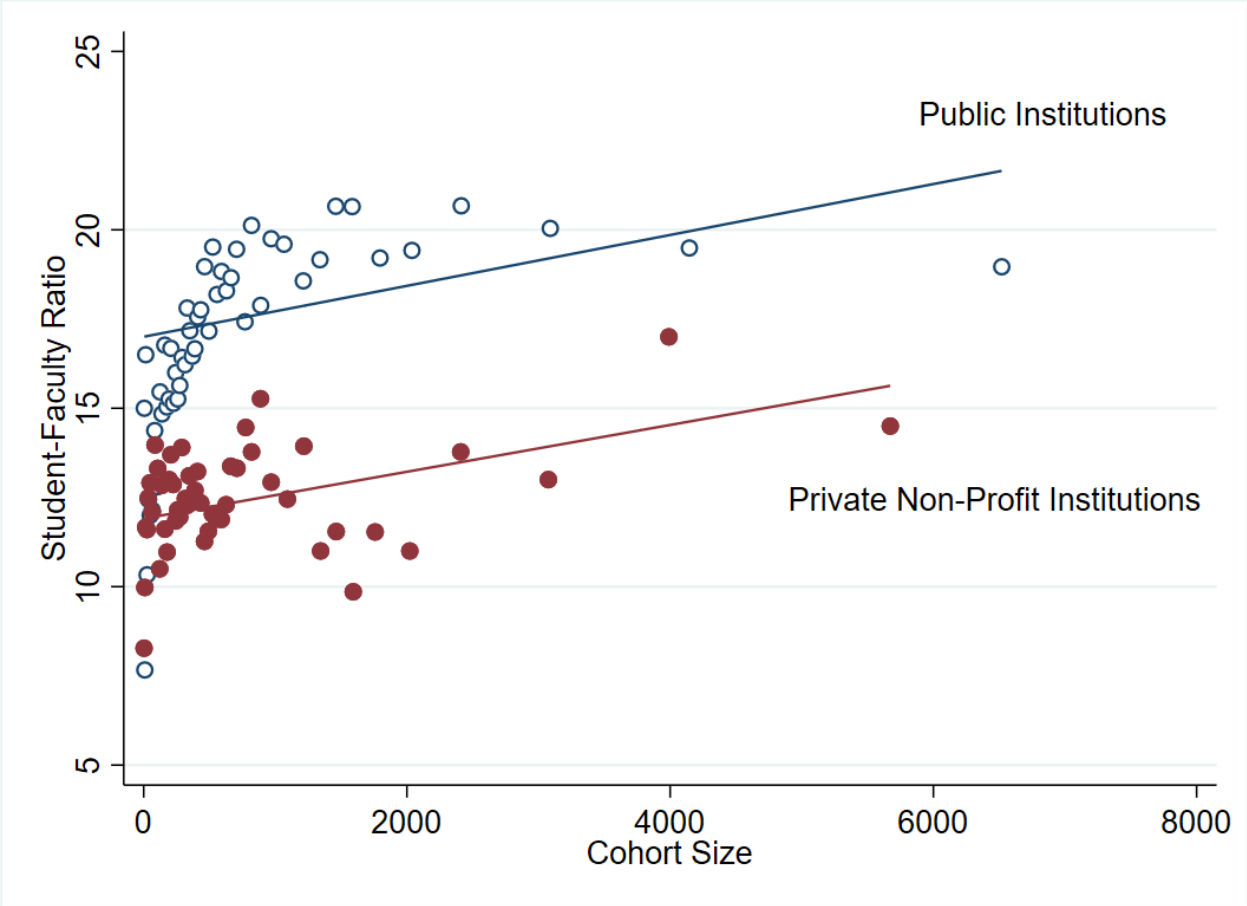
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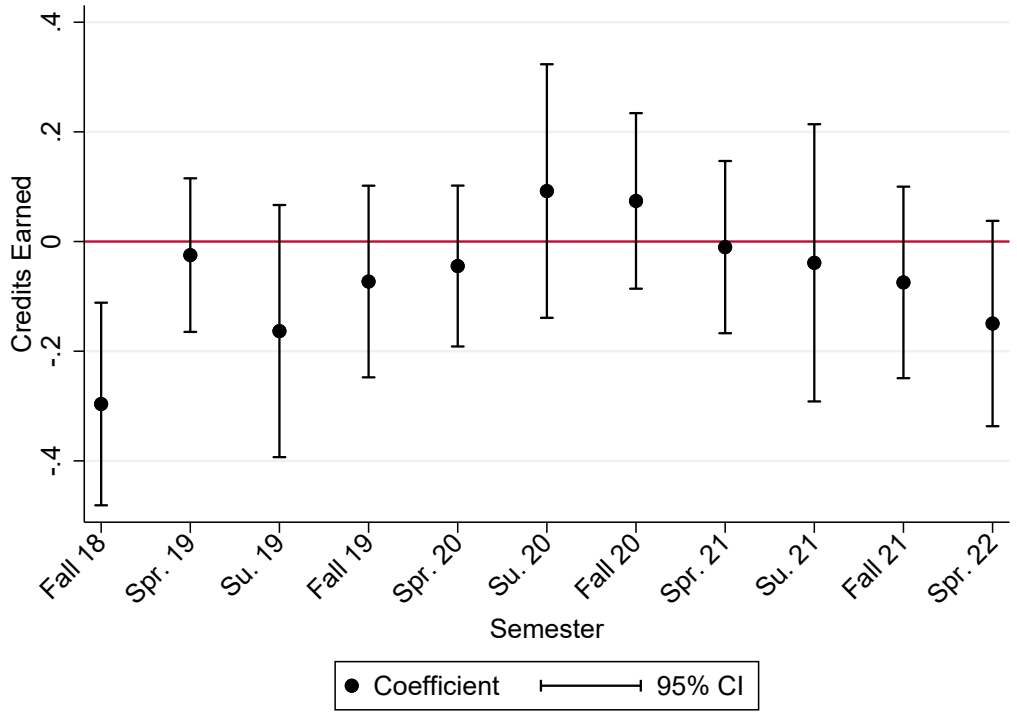
Tables and Figures

Figure 1: Student-Faculty Ratio at Public and Private Institutions



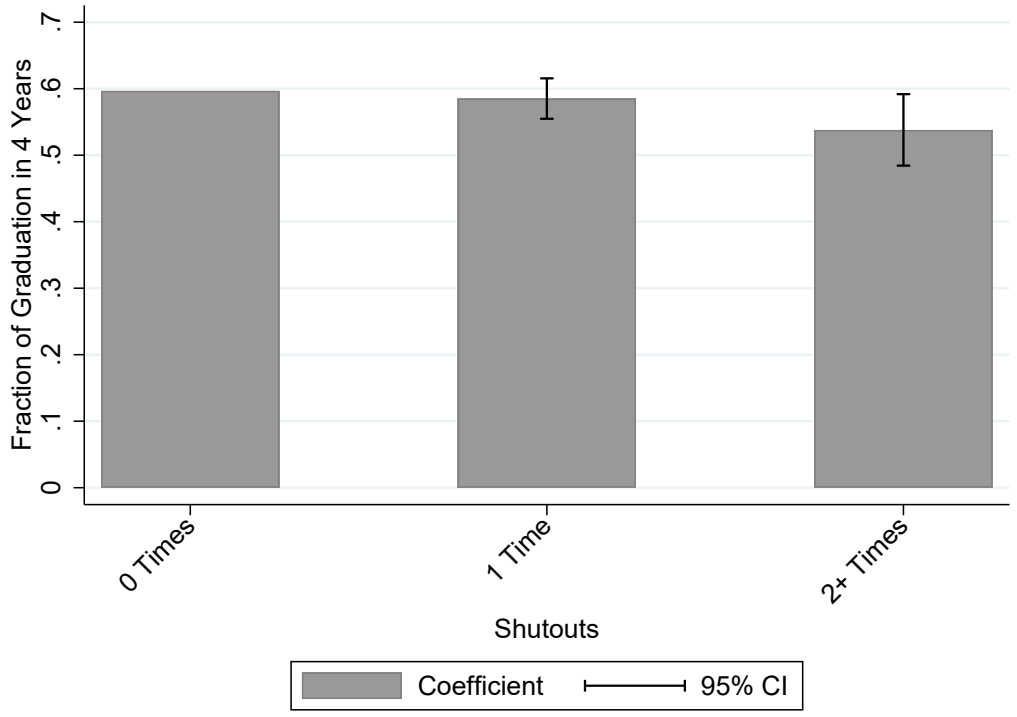
This figure shows the student-faculty ratio by the size of the incoming class as reported in IPEDS for the 2019 academic year separately for public institutions and private non-profit institutions.

Figure 2: Effects of a First-Term Shutout on Subsequent Credit Accumulation



This figure shows estimates of the effects of a course shutout during the first term of student's freshman year (Fall 2018) on credits earned in that and 10 subsequent terms. Each point and accompanying confidence interval come from a separate regression where credits earned in that semester is the dependent variable and course shutout is the independent variable of interest. Regressions include controls for demographic characteristics (sex, race/ethnicity, first generation status, and SAT scores), course-by-preference fixed effects, and controls for shutout probability in other requested courses. 95% confidence intervals come from standard errors clustered at the course-by-preference level.

Figure 3: Effects of Course Shutouts on On-Time Graduation



This figure shows estimates of the effects of course shutouts during the first term of student's freshman year (Fall 2018) on graduation in 4 years. Regressions include controls for demographic characteristics (sex, race/ethnicity, first generation status, and SAT scores) and course fixed-effects for each six preference slots. 95% confidence intervals come from robust standard errors. We pool three, and four course shutouts with two shutouts because instances of three and fours shutouts are rare. Only 85 students (1.03%) having 3 shutouts and 5 students (.06%) have 4 shutouts.

Table 1: Summary Stats

	All	1+ Shutouts	No Shutouts
	(1)	(2)	(3)
Any shutouts	0.51	1.00	0.00
	(0.50)	(0.00)	(0.00)
Total shutouts	0.62	1.20	0.00
	(0.68)	(0.46)	(0.00)
Female	0.44	0.42	0.47
	(0.50)	(0.49)	(0.50)
First generation	0.17	0.17	0.17
	(0.38)	(0.37)	(0.38)
Asian	0.11	0.12	0.10
	(0.32)	(0.33)	(0.30)
Black	0.03	0.02	0.03
	(0.16)	(0.16)	(0.16)
Hispanic	0.06	0.06	0.05
	(0.23)	(0.24)	(0.23)
White	0.66	0.67	0.65
	(0.47)	(0.47)	(0.48)
Other race/ethnicity	0.16	0.13	0.18
	(0.36)	(0.34)	(0.39)
Math SAT	663	664	662
	(88)	(87)	(89)
Verbal SAT	650	652	649
	(83)	(82)	(84)
Observations	8,263	4,247	4,016

Summary Statistics are for the 8,263 Freshman from the Fall 2018 entering cohort who are in our analysis sample. This sample excludes those students who are over age 23, all Division I athletes (who receive special treatment during scheduling due to unique practice and game restrictions), and 14 individual students who did not request any over-subscribed courses. Standard deviations are given in parentheses below the reported mean.

Table 2: Balance Test

	(1)	(2)	(3)
Female	-0.030**	-0.006	-0.006
	(0.012)	(0.004)	(0.004)
Black	0.002	-0.004	-0.004
	(0.017)	(0.012)	(0.012)
Hispanic	0.009	-0.001	-0.001
	(0.012)	(0.008)	(0.008)
Asian	0.021*	0.011**	0.011**
	(0.012)	(0.005)	(0.005)
Other Race/Ethnicity	-0.012	0.006	0.005
	(0.013)	(0.005)	(0.005)
First Generation	-0.002	0.006	0.006
	(0.006)	(0.005)	(0.005)
SAT Math	-0.003	0.001	0.001
	(0.013)	(0.004)	(0.004)
SAT Verbal	0.003	-0.002	-0.002
	(0.006)	(0.003)	(0.003)
F-stat P-Value	0.003	0.228	0.229
Observations	25,872	25,872	25,872
R^2	0.002	0.459	0.459
Course by Preference FEs		X	X
Leave-One-Out Shutout Probability			X

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The outcome in this regression is an indicator for being shutout of a potentially oversubscribed course. This sample includes all course-by-individual observations in potentially oversubscribed courses. F-stat p-value comes from a joint test of significance for sex, race/ethnicity, first-generation status, and SAT score variables. Standard errors clustered at the course-by-preference level are reported in parentheses.

Table 3: Effects of Shutouts on Attendance and Completion in Oversubscribed Courses

	Attend First Semester (1)	Complete First Semester (2)	Complete First Year (3)	Ever Complete (4)
Shutout	-0.723***	-0.710***	-0.472***	-0.379***
	(0.032)	(0.032)	(0.029)	(0.030)
Observations	25,872	25,872	25,872	25,872
R^2	0.695	0.640	0.520	0.495

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Each outcome in this table relates to attendance or completion of the exact course a student was potentially shutout from. "Shutout" is an indicator for being shutout of a requested course. Each regression includes controls for demographic characteristics (sex, race/ethnicity, first generation status, and SAT scores), course-by-preference fixed effects, and controls for shutout probability in other requested courses. Standard errors clustered at the course-by-preference level are reported in parentheses.

Table 4: Effects of Shutouts on Number of Courses Taken in the Same Subject or College

Panel A: Courses Taken in Same Subject			
	First Semester	First Year	Ever
	(1)	(2)	(3)
Shutout	-0.636***	-0.441***	-0.340***
	(0.033)	(0.025)	(0.027)
Observations	25,872	25,872	25,872
R^2	0.638	0.587	0.564
Panel B: Courses Taken from Same College			
	First Semester	First Year	Ever
	(1)	(2)	(3)
Shutout	-0.631***	-0.453***	-0.356***
	(0.036)	(0.030)	(0.043)
Observations	25,872	25,872	25,872
R^2	0.468	0.418	0.420

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Each outcome in this table relates to completion of courses in the same subject area as a course a student was potentially shutout from. "Shutout" is an indicator for being shutout of a requested course. Each regression includes controls for demographic characteristics (sex, race/ethnicity, first generation status, and SAT scores), course-by-preference fixed effects, and controls for shutout probability in other requested courses. There are 10 colleges at Purdue including Agiculture, Education, Engineering, Health and Human Sciences, Liberal Arts, Management, Pharmacy, Polytechnic, Science, and Veterinary Medicine. Standard errors clustered at the course-by-preference level are reported in parentheses.

Table 5: Effects of Shutouts on Taking Any Courses in the Same Subject or College

Panel A: Any Courses Taken in Same Subject			
	First Semester	First Year	Ever
	(1)	(2)	(3)
Shutout	-0.590***	-0.351***	-0.260***
	(0.037)	(0.029)	(0.026)
Observations	25,872	25,872	25,872
R^2	0.574	0.449	0.419
Panel B: Any Courses Taken From Same College			
	First Semester	First Year	Ever
	(1)	(2)	(3)
Shutout	-0.443***	-0.207***	-0.096***
	(0.036)	(0.026)	(0.016)
Observations	25,872	25,872	25,872
R^2	0.471	0.399	0.415

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Each outcome in this table relates to completion of courses in the same subject area as a course a student was potentially shutout from. "Shutout" is an indicator for being shutout of a requested course. Each regression includes controls for demographic characteristics (sex, race/ethnicity, first generation status, and SAT scores), course-by-preference fixed effects, and controls for shutout probability in other requested courses. There are 10 colleges at Purdue including Agiculture, Education, Engineering, Health and Human Sciences, Liberal Arts, Management, Pharmacy, Polytechnic, Science, and Veterinary Medicine. Standard errors clustered at the course-by-preference level are reported in parentheses.

Table 6: Effects of Shutouts on On-Time Graduation

	All	Top 3 Preference	Bottom 3 Preference
(1)	(2)	(3)	
shutout	-0.029***	-0.028*	-0.028**
	(0.010)	(0.017)	(0.013)
Observations	25,872	13,190	12,682
R^2	0.086	0.080	0.094

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The outcome in this table is an indicator for graduation within 4 years among students who began courses in the Fall of 2018. "Shutout" is an indicator for being shutout of a requested course. Each regression includes controls for demographic characteristics (sex, race/ethnicity, first generation status, and SAT scores), course-by-preference fixed effects, and controls for shutout probability in other requested courses. Standard errors clustered at the course-by-preference level are reported in parentheses.

Appendix I Appendix- Supplementary Tables and Figures

Table A.1: Oversubscribed Courses

Course Title	Course Requests	Shutouts	Course Title	Course Requests	Shutouts	Course Title	Course Requests	Shutouts
Intro African American Studies	8	3	Civil Engineering Projects	10	2	Introduction To Earth Sciences	24	1
Basic Drawing	111	7	Technical Graphic Comm	50	31	Environmental Scienc & Conserv	13	1
Black And White Photography	20	10	Graphics For CE &Const	56	2	Freshman Seminar In EAS	47	1
Intro To Int Design	44	2	General Chemistry	748	3	Prin Of Economics	75	4
Ceramics I	16	15	General Chemistry	2498	149	Microeconomics	441	6
Art Appreciation-Honors	13	1	General Chemistry	65	9	Microeconomics	28	8
New Media Culture	10	3	Chm Freshman Honor Res	12	1	Macroeconomics-Honors	115	1
Spreadsht Use Agr Bus	8	3	Chinese Level I	15	1	Exploring Teaching	87	26
Microecon Food & Agbus	125	2	Chinese Level III	3	1	Intro Ed Tech-Honors	68	10
Economics	103	2	Chinese Calligraphy	2	1	Media For Children	22	5
Intro To ANSC Programs	180	18	Classical Wrld Civiliz	10	1	Academic And Career Planning	746	11
Intro To YDAE Programs	27	1	Intr To Classical Myth	22	2	Study Skills Seminar	77	6
Intro To PRMD Programs	22	1	Intro To C Program	76	6	Learning & Motivation	31	2
Crop Production	37	4	Visual Programming	9	5	Inclusive Classroom	23	5
America And The World	9	4	Info Tech Architecture	10	2	Collab Leader: Interpersonal	208	97
Interpreting America	14	2	Intro To Com Theory-Honors	22	12	First-Year Composition	2250	1516
Intro To Animal Agr	106	9	Fundament Of Speech-Honors	1287	646	First-Year Composition	4	0
Physiolo/Domestic Anim	1	0	Fundamentals Of Speech Communication	47	8	First-Year Composition	101	4
Intro Anthropology	37	1	Fundamentals Of Speech Communication	79	18	First-Year Composition	6	3
Technology And Culture	23	2	Crit Perspectives Com	7	1	Accel First-Yr Compos	181	59
Native American Cultures	3	1	Science Writing & Presentation	5	4	Engaging English	34	18
Std Arabic Level I	11	1	Prin Of Persuasion	10	1	Intro Creative Writing	8	2
Intro Asian Amer Studie-Honors	3	1	Intro To Computers	73	34	Magic And Marvels	9	2
Dscr Astr-Solar System	57	18	Prog Appl For Enginrs-Honors	251	5	Elements Linguistics	6	2
Intro Aviation Tech	126	9	Progrmng With MM Objs	49	1	Sports & Literature	6	5
Aviation Business	149	86	Problem Solving And Object-Oriented Programming	177	2	Great American Books	13	11
Private Pilot Lectures	51	1	Problem Solving And Object-Oriented Programming	134	1	Literature Of Black America	3	1
Human Factors Flight Crew	6	3	Tools	314	8	Bible As Literature	7	3
Symphonic Band	18	5	Intro To Personal Finance	53	17	Shakespeare On Film	2	2
Wind Ensemble I	12	1	Intro To Retail Mgmt	20	1	Intro Engineering In Practice	3	3
Fundamentals Biol I	999	105	Customer Relation Mgmt	23	4	Intro To Engineering In Practice	63	16
Fundamentals Biol II-Honors	51	1	Leadership Strategies	1	1	Intro To Engineering In Practice	11	1
Biology Resource Sem	137	1	Modern Dance Technique I	8	4	Intro To Engineering In Practice	119	17
Biol I Divrs Ecol Behv	273	2	Dance Appreciation	15	5	Trans Ideas To Innovation II	42	1
First Year Biology Lab	191	79	Planet Earth	81	32	Forensic Investigation	84	50
Year 1 Biology Lab	43	23	Planet Earth	1	0	Intro Entr & Innov	27	25
Biol Freshman Honr Sem	58	3	The Planets	63	39	Environmental Scienc & Conserv	34	3
Human Antmy & Physiol	8	3	Geosciences Cinema	16	15	World's Forest&Society-Honors	10	3
Biol Elem Sch Teach	81	2	Physical Geology	15	3	Wildlife In America	12	1
Lab Bio III Cell Strct	15	2	Earth Through Time	8	1	French Level II	73	32
Intro To Plant Science	105	10	Earthquakes Volcanoes	28	10	French Level V	9	1

Course Title	Course Requests	Shutouts	Course Title	Course Requests	Shutouts	Course Title	Course Requests	Shutouts
Science Of Food	32	5	Math For Elm Tchrs I	104	2	Intro Polit Analysis	3	2
Screenwriting	19	4	Quantitative Reasoning	172	31	Global Green Politics	5	1
Special Topics In Film/Video Studies	2	1	Applied Calculus I	1657	12	Intro Sci Fields Psy	106	2
German Level I	35	9	Pl Anly Geo Calc I	918	1	Elementary Psychology-Honors	862	40
German Level II	26	10	Pl Anly Geo Calc II	380	4	Intro Res Meth In Psy	3	1
German Level V	12	2	Anlytc Geomtry&Calc I	1093	3	Intro Behvr Neurosci	12	1
Intro Acad Prog-Purdue	80	2	Analytc Geom & Calc II	345	52	Child Psychology	37	1
Information Strategies	1	1	Intr Actuarial Science	59	2	Intro Social Psych	37	4
Strat Success First Yr	24	1	Multivariate Calculus	725	19	Intro To Ind-Org Psych	3	0
Global Awareness	17	3	Honors Multivariate Calculus	51	2	Glee Club	14	1
Intro Family Processes	47	1	Introduction to Data Science for Mechanical Engineers	194	121	Purduettes	14	1
Intro To Medieval Wrld	36	4	Materials &Processes I	83	2	Cheerleading	5	1
Global History	22	1	Materials And Processes II	102	9	Golf Men	2	1
U S Since 1877-Honors	100	13	Introduction To Management	308	1	Soccer	5	1
East Asia & Hist Trad	8	1	Th Minorities In Mgmt	25	1	Softball	5	1
Money, Trade & Power	3	1	Junior Level Problems In Management	22	4	Track & Field 1	5	1
America In The 1960s	3	2	Navigating Gender	28	3	Multicult Leadrshp Sem	12	1
The Nuclear Age	7	2	Intr To Materials Engr	29	1	Global Science Leadership Seminar	1	1
Sci & Society In Western Civ I	4	1	Foundation Officership	32	3	Crit Think & Com I	474	118
Second World War	7	5	Fundamentals Of Music	6	3	Crit Think & Com II	180	18
Society & Rock & Roll	4	2	Music Theory I	9	8	Elements Linguistics	13	1
Special Topics Seminar	55	32	Environmental Scienc & Conserv	35	3	Social Problems	98	3
Interdisc Approach To Writing	68	46	Intro To Energy Engr	56	6	Rac & Ethn Diversity	13	1
Special Topics Seminar	3	1	Essentials Of Nutr-Honors	36	22	Gen Social Psychology	6	3
Special Topics Seminar	6	3	Bowling	8	7	Spanish Level I	45	12
Special Topics Seminar	6	1	Intro To Philosophy-Honors	74	13	Spanish Level III	265	1
Special Topics Seminar	4	2	Global Moral Issues	31	24	Spanish Level V	77	22
Fundamentals Of Horticulture	3	1	Philos Of Religion	5	2	Statistics & Society	180	9
Intro Health Sciences	223	6	Phil & The Meaning Of Life	4	1	Intr Actuarial Science	41	4
Intro Hosp & Tourism Industry	25	1	Fate And Free Will	3	1	First Year Statistics Seminar	67	1
Intro To Tourism Mgmt	41	7	Religions Of The West-Honors	4	2	Intro Probability Mdls	11	9
Lodging Management	10	7	Philosophy And Law-Honors	11	7	Elem Stat Meth	59	15
Sanitation And Health	7	0	Ethics And Animals	13	4	Intro To Statistics	13	12
Org &Mgt Hosp&Tour Ind	3	2	Ancient Philosophy	2	1	Women Tech:Expl Possib	15	1
Biotechnology Lab I	4	2	Pre-Doctor Of Pharm Orient I	227	2	Design Thinking In Technology	25	3
Italian Level I	29	1	General Physics	47	10	Design Thinking In Technology	51	14
Italian Renaissance Impact	6	2	Gen Physics	63	38	Design Thinking In Technology	553	153
The Italian Cinema	9	2	E&M Interactions	13	1	Survey Of Acting	38	14
Japanese Level V	5	1	Intr Pub Pol-Pub Admin	16	5	Intro Costume Des/Tech	2	1
Graphic Communication	19	2	Wom Pol And Publ Pol-Honors	12	7	Theatre Appreciation	19	1
Intro Ling St For Lang	5	1	Intr Environmental Pol-Honors	26	2	Foundations Of Org Leadership	276	238
Intro To Linguistics-Honors	5	3	Mod Weapons & Intl Rel-Honors	21	21	Veterinary Tech Career Explor	9	2

Appendix II Appendix- Batch Registration Process

Purdue's Batch Registration process is the algorithm used to assign student course schedules. This algorithm is meant to best satisfy students' course preferences subject to the course offerings, classroom capacity, and physical distance between classes. The batch registration process has six steps:

1. The algorithm starts by ordering priority students in order of constraints (those with fewest choices first) and uses a branch and bound technique to evaluate best possible assignments
2. Students who are not enrolled in their desired number of courses from step 1 are ordered randomly. In this order, the algorithm looks for assignments that do not conflict with existing assignments or schedule constraints.
3. The algorithm randomly selects and assigns an unassigned section to students.
4. The algorithm improves the overall schedules by using backtracking technique.
5. Students are selected randomly and try to fill in any available sections at that point if all their requests are unassigned.
6. The algorithm goes back to step 2 and starts over again.

Interested readers can refer to (Müller et al., 2010) for more information about the batch registration at Purdue University. The figure below also illustrates what information students need to fill out for their course submission.

Figure A.1: Course Request Form

