Course Availability and College Enrollment: Evidence from administrative data and enrollment discontinuities

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Abstract

Community colleges serve close to half of the undergraduate students in the United States and tuition at two-year public colleges is mostly a public expenditure. We measure the effect of decreased course availability on grades, degree attainment, and transfer to four-year colleges using a regression discontinuity from course enrollment queues due to oversubscribed courses. Using a panel from a large California community college and the National Student Clearinghouse we find that in the short run students substitute unavailable courses with other courses in the same subject area. We find no significant effects on later outcomes, given the precision of our tests, however we cannot rule out economically significant effects.

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1 Introduction

About half of undergraduate education in the United States takes place at two year colleges[1]. These schools have to meet increased demand for courses and for more varied courses under strict fiscal constraints. This paper is one of the first to study the impact of limited course offerings on student outcomes in community colleges[2]. Recent evidence suggests that two year schools have increasingly moved from vocational education to preparing students for four-year degrees[3][4]. This new mission involves providing lower division courses in a given major and offering foundational liberal arts courses. There has also been a long term rise in the length of time students spend at two year schools[5]. Two year schools, as their main source of funds comes from states, are particularly affected by budget pressures[6]. The primary impact of funding changes is on the amount of course offerings. Two-year schools are also becoming increasingly popular, further decreasing the per capita supply of courses.

Are these factors causing an increase in the length of time it takes the typical student to complete the first two years of a four year degree or in the chances of completing these goals at all? We will shed light on this question by examining what happens when students at two year schools are denied course admission. We find that, in general, students successfully find substitute courses.

We form estimates of the effect of course offerings by comparing students who were barely admitted onto courses from wait lists to students who were almost admitted. Enrollment queues are processed by having the first entrant in be the first entrant out. The last person enrolled from the wait list is thus governed by the number of individuals that are either enrolled or ahead on the wait list who withdraw from the course. Detailed adminis-

[1]See Boswell (2000) for recent statistics. Bound, Lovenheim, and Turner (2010), Table 1, documents an increase in the proportion of first time students who attend community colleges; from 31% for 1972 high school graduates to 43% for 1988 high school graduates.

[2]Thoughout the paper we will use the terms *two-year colleges*, *public two-year colleges* and *community colleges* interchangebly. When referring to *private two-year* colleges we will note the distinction.

[3]In the college we examine the fraction of first-time non-foreign students entering in the fall term who declared an intent to transfer to a four-year college increased from 46% to 71% from 2003 to 2007. The proportion who declared an intent to obtain either a terminal two year degree (associates or vocational), certificate or license, update job skills, or prepare for a new career fell from 25% in fall 2003 to 11% in fall 2007.

[4]Gill and Leigh (2003) cite two traditional goals for community colleges. One is the "transfer function" and the other and more recent is adult training services. Adult training services include vocational programs but also remedial education. However, for many students remedial education may be the first step in transferring to a four year college.

[5]See, for example, Bound, Lovenheim, and Turner (2010, 2012).

[6]See Boswell (2000).

trative records from the online enrollment system of a large college allow us to reconstruct wait list queues. We link these records to transcript data on student course schedules and grades, and to enrollment at other institutions using files from the National Student Clearinghouse.

Many studies (Grubb 1993, Kane and Rouse 1995, Hilmer 2000, Gill and Leigh 2003, Light and Strayer 2004) have followed the pioneering work of Heineman and Sussna (1977) who reported on the returns to a two year degree relative to dropping out of a four year by using data from a large urban centered community college. The main parameter of interest in this work is the labor market return to initially attending a two year college. Most notable is the work of Rouse (1995) which uses distance to closest community college as an instrument for two year college attendance. A key question concerns heterogenous treatment effects. While two year schools might have a positive effect for students who would have otherwise attainted a high school diploma, two year school may also "divert" students who would otherwise enrolled at a four year college. Observational evidence (Hilmer 2000) suggests that this may be a valid concern. Rouse finds that the causal effect of two year college attendance among students who where "diverted" is two-fold: a small negative effect on number of years of schooling, but no effect on the likelihood of completing a four year degree. Another important strand of the literature examines the effects of community college on displaced adult workers (Leigh and Gill 1997, Jacobson, LaLonde, Sullivan 2005). These studies find that the returns for adults are the same as the returns for younger workers.

These studies examine the return to education for a given amount of schooling. This paper in turn examines whether the supply of education (as measured in available courses) is a factor in the amount of time taken to transfer or complete a degree and the probability of transferring or completing a two year degree. Previous studies that have examined this question have done so at an aggregate level by using, for example, variation in the size of the cohort of graduating high school seniors in an area[7]. They find that a secular decrease in college completion is caused by what type of school students attend but it is not caused by the student teacher ratio. The aggregate analysis does not allow deeper examination into other mechanisms but they conjecture that "crowding" i.e. queuing and course enrollment constraints may be an important determinant. We used detailed administrative data to examine the effect of this type of "crowding".

[7] See, for example, Bound & Turner (2006), Card & Lemieux (2001a, 2001b), and Fortin (2006).

2 Institutional Background and Data

Tuition at two-year public/non-profit colleges is mostly a public expenditure[8]. Public schools offer lower than market tuition. 57% of tuition is paid for with grants[9]. In addition, another twenty-two percent of tuition is paid for using publicly subsidized loans.

Nationally 79% of community college students expect to earn a BA, 46% are enrolled full-time, and 75% work while enrolled[10].

Our sample comes from a panel of students who attended De Anza Community College from 2002 to 2007. Regular enrollment at De Anza is 21 thousand full time equivalent students. The number of enrolled students is higher than 21 thousand since many are not enrolled full-time. The college has three hundred full-time and six-hundred part-time unionized faculty. Classrooms are built with this enrollment cap in mind so deviations in enrollment far above 40 are rare. Online classes offered by the school, however, can be on the order of one-hundred students. Full-time tuition, including books and fees, is $2,075, larger than the corresponding figure reported for the BPS sample of $1,269[11]. The school is also relatively high performing. It is the second best (of 128 community colleges in California) for transfers to four-year schools.

The data contains three main parts. The first is a registration file with course grades, dates of attendance and degrees granted by De Anza. The second piece of data is enrollment information from other colleges and universities from the National Student Clearinghouse (NSC). Last is enrollment logs for all terms from 2002 to 2007. DeAnza operates on a quarter system with three regular terms (winter, spring and fall), but like many other two-year schools it also offers courses during a summer term. The enrollment logs contain a record of each registration attempt during a term's registration period. This for example would be a period during the summer for enrollment in Fall courses. An enrollment attempt is identified by student id, time (with precision to the second), a particular section for a course, and an outcome. Outcomes can take on one of four values: enrollment into the section, placement into a wait list for that section, withdraw from the section, or no change.

[8] In 1992 tuition accounted for ten percent of student expenditures at community colleges. In 1972 tuition accounted for 18% of student expenditures at community colleges. Author's calculations from Bound, Lowenheim, and Turner (2012) Table 3 panel F.

[9] Based on Table 2 page 156 of Deming, Goldin and Katz (2012). Calculated from reported *net tuition minus grants* and *tuition*.

[10] As reported in Deming, Goldin and Katz (2012) Table 1. Based on summary statistics from the Beginning Postsecondary Students Longitudinal Study for 2003-2004 first-time beginning postsecondary students.

[11] Deming, Goldin, Katz (2012) Table 2 page 156.

2.1 Course Enrollment

The online enrollment process we will examine takes place before the term begins and classes start. It is governed by an automated system. Students are given one of eight enrollment priority designations. Based of these designations they are given a date upon which they are granted access to the registration system. A student searches for a desired section (e.g. MWF 9-10AM) of a desired course (e.g. Econ-001 "Principles of Macroeconomics") and is told what instructor is teaching the particular section, where it meets, and how many seats are available. If there are no seats available then the student is told how many students are on the wait list and how many spots are available on the wait list. Wait lists are only allowed to reach 15 students per section.

Students are taken from the wait list as currently enrolled students drop the section. When a spot is freed the first wait-listed student is given 48 hours to enroll, if the student does not enroll, then the next student on the wait list is given permission to enroll. After enrolling students have two weeks to pay tuition for the section, if they do not pay within two weeks they are dropped from the section. We limit our analysis to enrollment before the term starts. After the term starts instructors may have some discretion with respect to who is granted enrollment in a section. Furthermore, enrollment is also conditional on section attendance.

2.2 Instrument Construction

In our first set of estimates we will use a regression discontinuity design based on a student's position on course wait lists. Here we will describe how we construct the running variable. It is important to note that the method we use accounts for the fact that a substantial number of students exit the wait list before the completion of the registration period. Attrition of this kind would otherwise result in selection at the threshold; those students who *barely* made it into the class were all students who did not drop themselves from the wait list, but among students who *almost* made it into the class are students that exited the wait list before the start of the term or before the last admission into the class.

We define RV_i, distance to the threshold for student i, as the number of additional students ahead of the student i who would have needed to drop the class section in order for student i to have successfully enrolled in the class section had student i stayed on the wait list throughout the course of the pre-registration period. Let us take a look at a hypothetical class section and describe the construction of this measure for three students. See Table 1. We can think of the distance to the threshold as a hypothetical "last wait list number".

Suppose we are interested in student number 38 and that Table 1 gives us the final set of events before the start of the term. In the previous period we can assume that 30 initial students, numbered 1 to 30, enrolled in this class without incident. Student 38 placed herself on the wait-list at 12:42PM on August 1st. At that time there were 35 students enrolled in the class and an additional 2 students on the wait list. We thus assign student 38 an initial wait list number of 3. This means that at least three people, of the 37 ahead of her (either enrolled in the class or on the wait list with an earlier entry time), must drop the class before she can successfully enroll. We further see that three students ahead of student 38 did in fact drop the class before the start of the semester. Thus student 38 is assigned a final wait list number of zero.

Take on the other hand student 39. Student 39 is assigned an initial wait list number of 4. Since three students ahead of student 39 dropped the class, student 39 is assigned a final wait list number of 1. Had student 39 stayed on the wait list she still would need one additional person to drop the class in order to successfully enroll.

Likewise, student number 40 is also assigned a final wait list number of 1. Student 40 had an initial wait list number of 5, and 4 people ahead of her dropped the class before the start of the semester. Thus at the start of the semester student 40 still needed one more person to drop before she could successfully enroll.

2.3 Sample Characteristics

Table 2 presents demographic information on race by national origin. Column one gives the number of observations of U.S. citizens broken down by race. Column two gives the percentage of each race group among Americans. The racial composition of the group has fewer African-American and Hispanic students than samples of two-year college students from IPEDS and BPS. In the De Anza sample 3.87% of American students report being African-American, while 10.9% of students in IPEDS and 14% of students in the BPS 2004-2009 samples are African-American. Relative to these samples American students at De Anza are slightly less Hispanic. Hispanics make up 13.38% of U.S. students at De Anza while they comprise 15.7% and 15.9% of the IPEDS and BPS samples respectively. Asian Americans make up a plurality (42%) of U.S. students and a majority (65%) of international students at De Anza. Whites make up a quarter of American students and 13% of international students.

Given the substantial differences in racial composition it is worthwhile to compare other summary statistics against the IPEDS and BPS samples. Table 3 presents further summary statistics for the De Anza sample. All three samples are 55% female. The De Anza sample has a higher mean age than the BPS sample, 25.97 compared to 24.4. A smaller fraction of students at De Anza have financial aid; 18%, relative to 74.9% reported having applied for aid in the BPS sample. Comparing educational goals, 33% of students in our sample declared an intent of transferring to a four-year instituiton while 79.9% of community college students in the BPS say they expect to earn a BA.

3 Identification and Reduced-Form Evidence

In this section we start by laying out the assumptions in our regression discontinuity analysis, motivate an instrumental variables model, and describe the local average treatment effect that is identified by our instrument. Next, we show that we have a strong first stage in our two stage least squares analysis. We proceed by conducting validity checks to ensure that there are no a priori discontinuities in baseline variables other than section enrollment, and that there is no sorting across wait list position à la McCrary (2008). Last we present reduce form evidence for our main results.

3.1 Identification

Consider a student who has placed herself on a section wait list. Let rv be her wait list number. Let $Y(1)$ be an educational outcome for her if she is admitted into the section, and let $Y(0)$ be the corresponding educational outcome for her if she is not admitted into the section. Denote the mean outcome for students with wait list number rv had they all been admitted into their wait listed section as $E(Y(1)|RV = rv)$, similarly denote the mean outcome for students with wait-list number rv had they not been admitted into their wait-listed section as $E(Y(1)|RV = rv)$. Conditional on having wait list number rv the effect of being admitted into the wait-listed section on the educational outcome is $E(Y(1) - Y(0)|RV = rv)$. Our identification strategy will allow us to measure the average effect for students on the cusp of being admitted from the wait-list, for whom $RV = 0$. Denote this local average treatment effect, LATE,

$$LATE \equiv E(Y(1) - Y(0)|RV = 0). \tag{1}$$

We measure this effect by estimating the four following quantities:

$$\lim_{rv \uparrow 0} E(X|RV = rv), \quad \lim_{rv \downarrow 0} E(X|RV = rv) \tag{2}$$

$$\lim_{rv \uparrow 0} E(Y|RV = rv), \quad \lim_{rv \downarrow 0} E(Y|RV = rv), \tag{3}$$

where X is an observed indicator for whether the student successfully enrolled in the wait-listed section and Y is the observed educational outcome. By definition $Y = Y(1) \iff X = 1$ so by conditional expectation we can write $E(Y|RV = rv) =$

$$E(Y(1)|RV = rv)P(X = 1|RV = rv) + E(Y(0)|RV = rv)P(X = 0|RV = rv). \tag{4}$$

Two necessary conditions are that there is a discontinuous jump in the likelihood of enrollment at the threshold, i.e. $\lim_{rv\uparrow 0} E(X|RV = rv) \neq \lim_{rv\downarrow 0} E(X|RV = rv)$. and that the functions $E(Y(j)|RV)$ are continuous at $RV = 0$ for $j = 1,0$.

Define $p_{\uparrow}^{j} \equiv \lim_{RV\uparrow 0} P(X = j|RV)$ and $p_{\downarrow}^{j} \equiv \lim_{RV\downarrow 0} P(X = j|RV)$ for $j = 1,0$. $E(Y(j)|RV)$ continous at $RV = 0$ implies $\lim_{RV\uparrow 0} E(Y(j)|RV) = \lim_{RV\downarrow 0} E(Y(j)|RV) = E(Y(j)|RV = 0)$ for $j = 1,0$.

$$\therefore \lim_{RV\uparrow 0}\{E(Y(j)|RV)P(X = j|RV)\} = E(Y(j)|RV = 0)p_{\uparrow}^{j}$$

and

$$\lim_{RV\downarrow 0}\{E(Y(j)|RV)P(X = j|RV)\} = E(Y(j)|RV = 0)p_{\downarrow}^{j}$$

for $j = 1,0$.

Now consider $\lim_{RV\uparrow 0} E(Y|RV) - \lim_{RV\downarrow 0} E(Y|RV)$

$$= E(Y(1)|RV = 0)p_{\uparrow}^{1} + E(Y(0)|RV = 0)p_{\uparrow}^{0} - E(Y(1)|RV = 0)p_{\downarrow}^{1} - E(Y(0)|RV = 0)p_{\downarrow}^{0}$$

$$= E(Y(1) - Y(0)|RV = 0) * [p_{\uparrow}^{1} - p_{\downarrow}^{1}]$$

$$= LATE * [p_{\uparrow}^{1} - p_{\downarrow}^{1}]$$

In our regression discontinuity design we estimate the following system,

$$E(Y|RV,Z) = \pi_0^1 + \pi_1^1 Z + g^1(RV)$$

$$E(X|RV,Z) = \pi_0^2 + \pi_1^2 Z + g^2(RV)$$

where

$$\pi_1^1 = LATE * [p_{\uparrow}^{1} - p_{\downarrow}^{1}]$$

and

$$\pi_1^2 = p_{\uparrow}^{1} - p_{\downarrow}^{1}$$

We estimate the following instrumental variables model

$$E(Y|X,Z,W) = X\beta + W'\delta. \tag{5}$$

$$E(X|Z,W) = Z\pi_{12} + W\pi_{22}. \tag{6}$$

Here Z is an indicator for $RV < 1$, W contains continuous functions of the running variable and demographic variables that are correlated with our set of outcomes, X is an indicator for whether the student successfully enrolled in the wait-listed section, and Y is an outcome variable. The local average treatment effect if denoted β. The *exclusion restriction* is that conditional on W and X the best predictor of Y does not include Z.

3.1.1 What is the treatment and what is the local average treatment effect?

The treatment that we measure using the wait list discontinuity is the effect of admitting one additional student into a section *holding availability in all other sections fixed*. In an ideal experiment that estimates this same parameter only the supply one one section would be reduced. The response to a treatment where a large fraction of sections are eliminated may be very different if reductions in other courses and sections raises the expected costs substitution. A policy change that reduced overall course offerings would decrease the chances of students enrolling in their most preferred sections as well as the changes of enrolling in their second and third choices. The effects on student outcomes of such a change are likely to be substantially different than the effects measured in this paper. In the natural experiment that is the focus of this paper only the chances of enrollment in one section is affected.

The local effect that we measure is for individuals who have placed themselves on the course wait-list who are on the margin of being admitted into the section during the pre-registration period. It is important to note that these students have placed themselves on wait lists where there is a substantial chance of not being admitted into the section. In the next section we will see that around the threshold the chances of not enrolling in the section are between ten and twenty percent. There may a substantial portion of students who choose not to take this chance and who therefore do not place themselves on a wait list. The effect of not enrolling in a section for these more averse students may be substantially different than the effect that we measure in the population of student that place themselves on wait lists.

3.2 First Stage

Enrollment into a section is not completely determined by whether or not a student was allowed to enroll from the wait list. Therefore our estimation will be based on a fuzzy RD design. Making the wait list cut-off produces a discontinuity in the probability of enrollment into the wait listed section but it does not completely determine enrollment. Figure 1 shows a 13.4% increase in enrollment associated with crossing the threshold from the right. Students on the right side of the red vertical line in this figure remained on the wait list at the start of the term. The running variable tells us how other students were ahead of them on the wait list ahead at the start of the term. Nonetheless, students that remained on the wait list have a greater than 50% chance of enrolling in their desired section. This can happen from enrolling in the section after the start of the term. On the left side of the figure we see that a small fraction of students that were admitted into the section did not enroll, or enrolled and later dropped the class.

Table 4 presents OLS regressions of the first stage equation. Each column presents results from a local linear regression with a square kernel. The size of the bandwidth differs across the columns. The first column uses a bandwidth of 20 on either side of the cut-off, the second column uses a bandwidth of ten, and the third column uses a bandwidth of five. The coefficient on the instrument gives the increase in probability of enrollment associated with crossing the threshold. We see that even with the smallest bandwidth the coefficient remains at about ten percentage points.

3.3 Validity Checks

We conduct two validity checks. First we check for discontinuities in baseline covariates at the threshold, next we check whether there is bunching of the running variable at the threshold.

Figures 2 and 3 plot of the average values of eight covariates conditional on wait list position. Figure 2 plots the fraction of each race and the fraction international students along the running variable. The fraction white varies between 19 and 21.5%. The fraction Asian varies between 50 and 58%. While this fraction is decreasing as a function of the running variable it does not change discontinuously at the threshold. The fraction Hispanic varies between 8 and 12% and is steady around 11% as it crosses the threshold. The fraction of international students stays between five and nine percent and while there tends to be a higher fraction of international students on the left of the threshold this change is continuous.

Figure 3 examines mean age, fraction female, fraction of students with a high school degree or less and the average number of credits earned in the sample. While the conditional mean age varies smoothly with a general trend upward from 24 to 24.6 as the running variables goes from -5 to 5, the fraction female varies downward from around .58 to .54 as the running variable goes from -5 to 5. Previous educational attainment as measured by the fraction of students with a high school education or less remains steady at around 70%. Cumulative course credits trend downward from an average of 37 to an average of 30 at the threshold and further right. One should note that the discontinuity in enrollment happens between 0 and 1 whereas the jump seem in panel d of Figure 3 occurs between -1 and 0.

3.4 No Sorting Across Wait List Position

Whereas differences in observable characteristics between individuals on either side of the threshold can be observed by examining the conditional distribution of each observable as it crosses the threshold, a similar examination of unobservable characteristics cannot be done. However, we can examine selection on unobservables due to sorting across the threshold (McCrary, 2008). Figure 4 is presented to examine differences in density across the threshold. Although the mechanical registration process restricts direct manipulation, differences in density can arise from manipulation of the running variable. Here we verify this restriction. It is rarely the case that individuals are indifferent between receiving treatment or not. In our case students would generally prefer to be enrolled in a selected section rather not.

If it *were* possible to manipulate the value of the running variable then there would be incentives to move to lower wait list values. Movement of this type would have higher payoff the closer a student is to crossing the threshold. We would then expect more of this movement to happen for students with positive but small values of the running variable. Movements of this type move mass from the positive side of the threshold to the negative side in the distribution of the running variable. Figure 4 shows no evidence of this being the case and validates the mechanical restrictions of the registration process.

3.5 Reduced Form Evidence

Before estimating our model more formally it will be helpful to examine the direct relationship between relative wait list position and important outcomes. Figure 5 plots the mean number of courses in which students successfully enrolled during the concurrent term, excluding the section that produced the wait list position. The figure shows that moving a student below the threshold is associated with a .126 increase in the number of other courses in which the student enrolled the concurrent term. Taken together with a first stage estimate of between .10 and .12 this implies that successfully enrolling in an additional course is associated with taking one fewer of the other courses available. Figure 6 shows that a similar sized jump is present when moving over the threshold for the average number of other sections in the same subject. By additivity this implies that the effect of enrolling in fewer classes due to successfully enrolling in another is driven by substitution within classes in the same subject. Enrolling in an undesirable section may have implications beyond a change in the number of courses taken. Students may perform better when enrolled in a more desired class or when enrolled in the same class at a more desired time. Figure7 plots the fraction of students who enrolled in school the next term. This figure shows very little in the way of a jump at the point of discontinuity. This leads us to conclude that enrollment in a more desired class does not effect enrollment in school the subsequent term.

4 IV Results

Now we turn to estimation of the effects of enrollment on various outcomes. First we examine the effects on course enrollment within De Anza College. We will look at the number of enrolled courses the concurrent quarter and the number of enrolled courses the next quarter. Next we turn to the effects of enrollment on GPA and persistence. We will look at grade points averaged over all courses taken the concurrent semester and the average grade point focusing on courses in the same subject. One might think that enrolling in a more desirable section can lead to better preparation, more consistent attendance, or other factors that would influence academic performance. Last we turn to enrollment and attendance at other colleges. This analysis takes advantage of a match between our registration files from De Anza College and data from the National Student Clearinghouse. Here we test whether enrolling in a more desired course is associated with a higher probability of transferring to a four year college. Alternatively we also test the hypothesis that failing to enroll in a desired course increases the likelihood of seeking resources at another two-year college.

4.1 Course Enrollment

Tables 5 and 6 present our results for the effect on course enrollment within the same college. Table 5 presents local linear two stage least square results using three alternative bandwidth choices. Table 6 presents the same set of specifications using the optimal bandwidth selection and robust standard estimation procedure of Cattaneo, Calonico, and Titiunik (2014) (CCT from here on). Our main finding is that there is a robust and significant effect of successful enrollment on substitution away from other courses in the same subject during the concurrent term. Panel A, columns one, two, and three present TSLS estimates of this effect. From column one to column three we vary the bandwidth of our local linear estimator from 20, to 10, to 5. We see that our measured coefficient on enrollment increases as we narrow the bandwidth used for estimation. Panel A, column one of Table 6 uses the CCT procedure to select optimal bandwidth for the regression. The point estimate given by the procedure is squarely in the middle of the three corresponding estimates presented in Table 5. All four estimates are lower than -1. In one case, column 3 panel A of Table 5 the estimate is significantly lower than -1. This might signal a quality/quantity trade-off in courses where students that fail to enroll in a highly desired course substitute with more than one less desired course. Columns four, five and six of panel A in Table 5 and column 2 of panel A of Table 6 present estimates of the effect of successful enrollment on enrollment in all subjects the concurrent term. Here even though the point estimates for one specification are significant at the 0.10 confidence level we do not see a consistent significant effect on total enrollment.

Panel B of Table 5 and panel B of table 6 examine the effects of enrollment on course selection the subsequent term. Columns one, two and three of panel B of table 5 and column 1 panel B of Table 6 examine the effect on taking courses in the same subject the next term. The point estimates in these regressions are each negative but none can rule out a coefficient of zero. Columns four, five and six of panel B of Table 5 and column two of panel B of Table 6 measure the effect on the total number of courses taken the subsequent school term. These regressions similarly show that there is little indication of inter temporal substitution of courses across school terms.

4.2 GPA and Persistence

Next we turn to estimates of the effect of enrollment on GPA and persistence. Table 7 presents results for three outcome measures. Column one examines the effect of successful enrollment on GPA for the current term[12]. We see a positive but statistically insignificant coefficient. Column two turns to an estimate of the effect on GPA for classes within the same subject. Again we see a slightly positive but more noisy coefficient estimate. Column three of Table 7 presents our estimate of the effect of course enrollment on an indicator for whether the student in seen in the same college one year later. This regression measures a negative but insignificant effect of later school enrollment.

4.3 Enrollment at 4-year and other 2-year colleges

Last we examine enrollment and attendance at other institutions. We first examine short term outcomes, where we look at where students are one year after the current term, then we look at longer term outcomes where we examine whether we see students at another institution within three years. Column one of Table 8 looks at the effect of enrolling in a college the next school term. Our estimate is that an additional successful enrollment into a desired course is associated with a six percentage point increase in the probability of attending a four year college the next term. However column two shows that successful enrollment is a desired course is associated with an eleven percentage point increase in the probability of attending a different two-year college. Neither of these estimate rule out no effect at all of successful enrollment into a desired course. Columns three and four of Table 8 examine longer term measures of these two outcome variables. Column three estimates that successfully enrolling in a course is associated with a fifteen percentage point increase in the probability of attending a four year school within three years. Column four gives a

[12]For simplicity from here on in this section we only present results for the CCT estimation procedure, results using alternative bandwidths are similar.

coefficient that indicates a negative effect of enrolling in a different two year school that is one one hundredth of a percentage point. Neither estimates are significantly different from zero. They are suggestive that the long term effect on four year college enrollment may be positive.

5 Subgroup Analysis and Robustness Checks

This section examines the robustness of our findings and whether there are differential effects by sub-group. The analysis looks at seven variables relating to course loads, gap, persistence and enrollment at other colleges. We make measurements for eleven subgroups based on gender, race, age, citizenship, and whether it is the student's first term in college. We check the robustness of findings by varying the number of control variables in the locally weighted regressions and by adding richer control variables. Table 9 presents our benchmark subgroup analysis. The regressions in this table estimate the following model

$$E(Y|RV,W) = \alpha + \delta' W + Z \cdot \beta + \sum_{j=1}^{3} \{\gamma_j^0 RV^j + \gamma_j^1 Z \cdot RV^j\}. \tag{7}$$

Table 9 presents estimates of the regression discontinuity estimates using two stage least squares and the method of bandwidth selection developed by Matias Cattaneo, Sebastian Calonico, and Rocio Titiunik (2013a 2013b)[13]. In simulations, CCT (2013), finds that confidence intervals have coverage that is almost correct. The estimates use a third order polynomial to approximate the underlying regression function, the expected outcome conditional on the running variable as a function of the running variable. In the CCT algorithm that selects bandwidth a fourth order polynomial is used to estimate bias due to functional form misspecification. The bandwidth selected using this method is usually between two and three.

Here we look at eleven outcome variables for the overall population and for eleven subgroups. Each entry in the table represents one estimate of the treatment effect for a separate two stage least squares local regression.

It looks like there may be an effect on GPA for males, and an effect on GPA for non-first-time students. There may be effect on whether you stayed in school 1yr for "young" students. There may be an effect on whether you enrolled in a four year college on first time students and on non-foreign students. There also seems to be an effect on whether you enrolled in another 2 year college on foreign students. There may be an effect on whether first-time students enrolled in a four year college the next major academic term.

[13] Henceforth referred to as CCT.

There may be an effect on whether foreign students enrolled in a two year college next term.

$$E(Y|RV,W) = \alpha + \delta' W + Z \cdot \beta + \sum_{j=1}^{3} \{\gamma_j^0 RV^j + \gamma_j^1 Z \cdot RV^j\} \tag{8}$$

The regressions in Table 10 allow for linear functions of the running variable with different slopes on either side of the threshold. They also control for cumulative course credits earned, cumulative number of courses taken, whether the semester is the student's first, whether the student received financial aid, gender, and whether the student declared an intention to obtain a vocational certificate or transfer to a four year college. Here we use a rectangular kernel with a bandwidth of five on either side of the threshold.

$$E(Y|RV,W) = \alpha + \delta' W + Z \cdot \beta + \gamma^0 RV + \gamma^1 Z \cdot RV \tag{9}$$

The regressions in Table 11 allow for linear functions of the running variable with different slopes on either side of the threshold. As before they control for cumulative course credits earned, cumulative number of courses taken, whether the semester is the student's first, whether the student received financial aid, gender, and whether the student declared an intention to obtain a vocational certificate or transfer to a four year college. They also control for race fixed effects, registration priority group fixed effects, term fixed effects and subject fixed effects. Here we use a rectangular kernel with a bandwidth of five on either side of the threshold.

There is a positive effect of taking classes on enrollment in a 4 yr college, the effect exists even with the addition of more extensive controls. It seems that it is driven by females and it is more pronounced for non-foreign students and older students.

The coefficient in the first row in the column titled "enrolled in 4 yr college" is the two stage least squares estimate of the effect of successfully enrolling in a wait listed section on whether the student ever enrolls in a four year college. The estimated effect of 0.203 implies that missing a section is causality associated with a 20 percentage point drop in the likelihood of attending a four year college.

The first column has a coefficient of -1.34. This means that successfully enrolling in a desired section is associated with taking 1.3 fewer courses in the same subject. Perfect substitution would a coefficient of one and this estimate is not statistically significantly different than one. An estimate smaller than -1 would mean that each section not taken is replaced with more than one other course. This implies a marginal rate of substitution greater than one and implies that wait listed courses are more useful than the courses that replace them.

The regressions in 12 allow for linear functions of the running variable with different slopes on either side of the threshold. They also control for cumulative course credits earned, cumulative number of courses taken, whether the semester is the student's first, whether the student received financial aid, gender, and whether the student declared an intention to obtain a vocational certificate or transfer to a four year college. Here we use a rectangular kernel with a bandwidth of three on either side of the threshold.

6 Conclusions

Course availability at two year colleges is a potentially important factor in the acquisition of human capital. We examined the effect of course availability on later educational outcomes using a novel administrative data set and a regression discontinuity design based on oversubscription to college courses. We find a robust and substantial substitution effect. Specifically we find that successful enrollment into a desired course section is causes students to take fewer courses in that subject the concurrent term. We find some, but limited, evidence that students trade off quality for quantity when they successfully enroll in desired courses. That is, successfully enrolling in a desired course causes students to decrease the number of other courses in the same subject taken concurrently by more than one. Future work may seek to explore these outcomes in other settings or with larger samples. Of particular interest are the labor market outcomes of students who face course scarcity.

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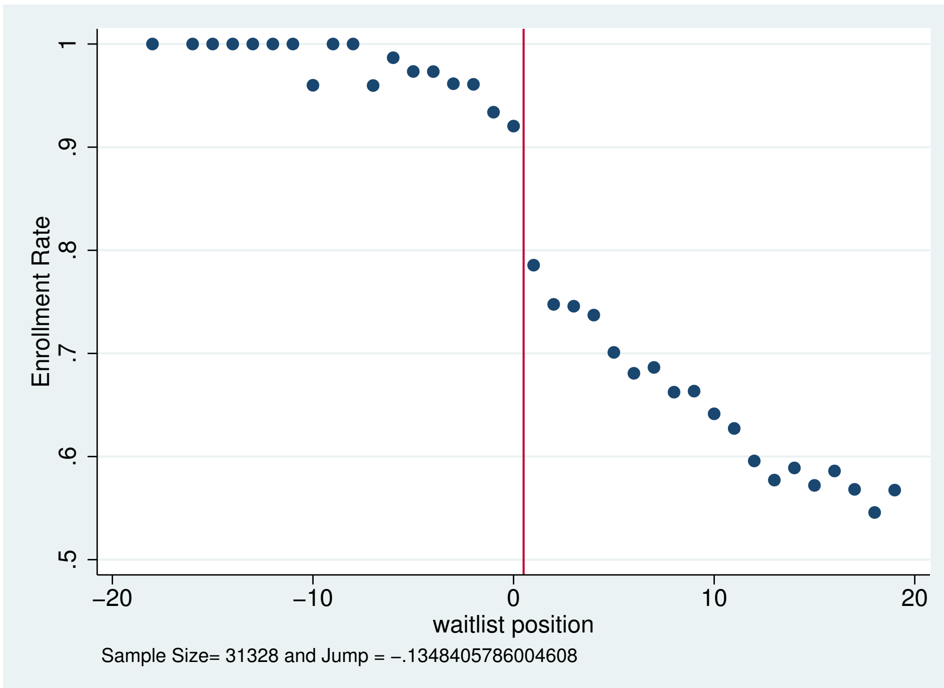
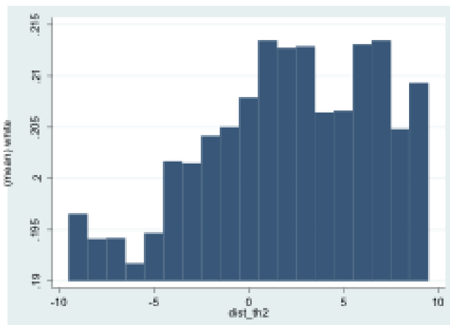
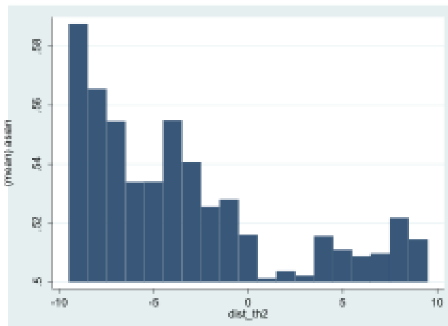
Figure 1: First Stage: Mean Enrollment in Wait-listed Section as a Function of Relative Wait List Position

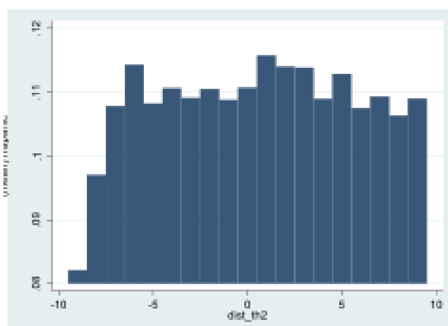




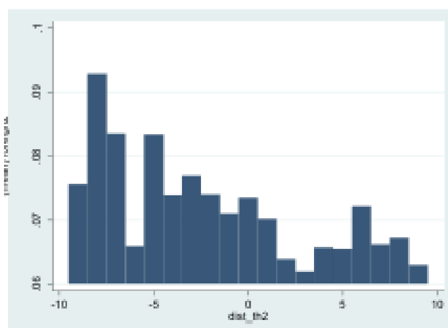
(a) White



(b) Asian

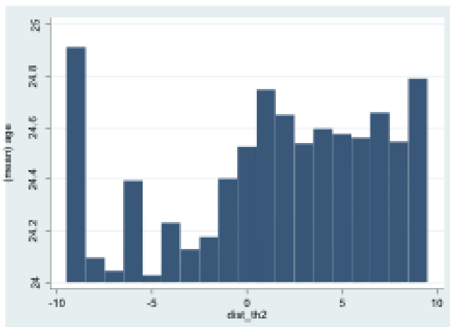


(c) Hispanic

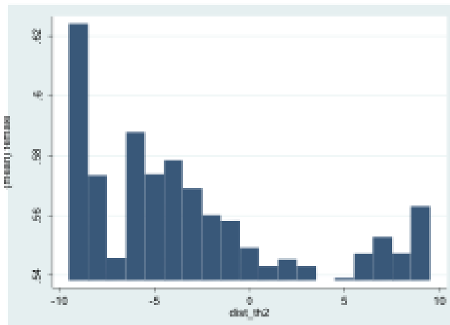


(d) International

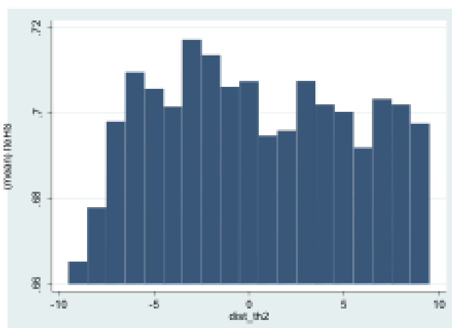
Figure 2: Smoothness on Covariates: Race and Citizenship Indicators



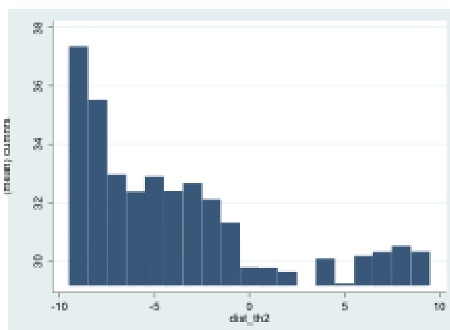
(a) Age



(b) Female



(c) HS or less



(d) Credits

Figure 3: Smoothness on Covariates: Age, Gender, a priori Education

Figure 4: No Sorting Across Wait-list position

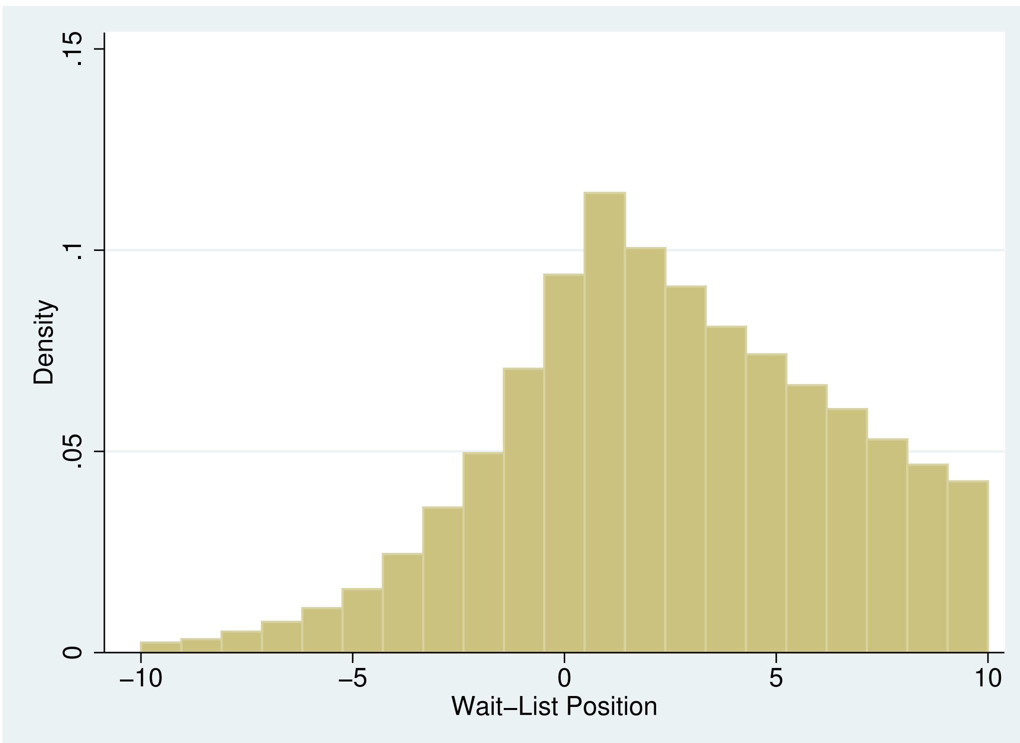


Figure 5: Enrollment in Other Sections, all subjects, concurrent term

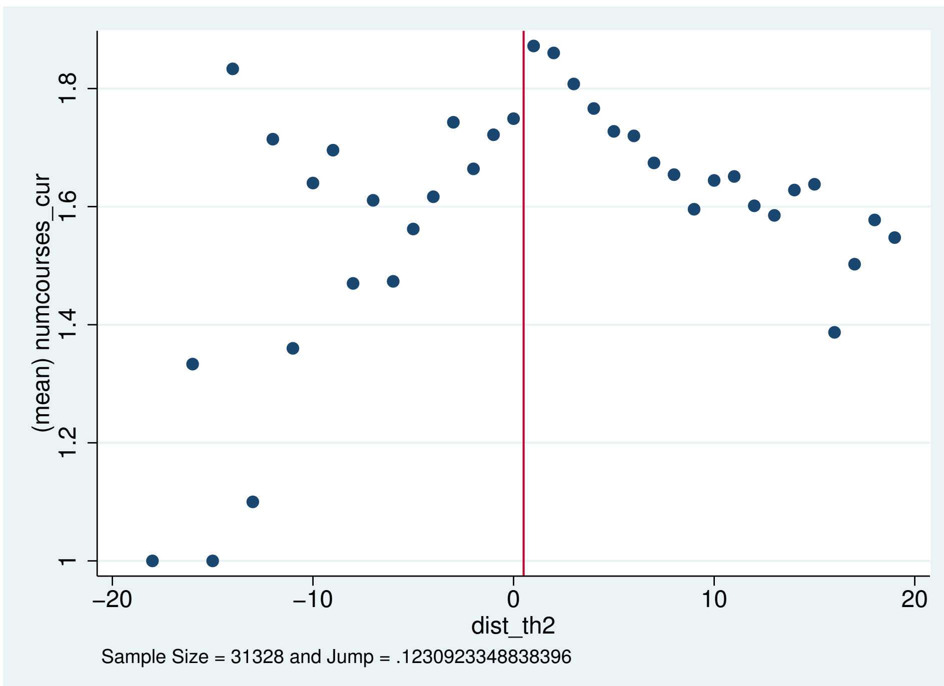


Figure 6: Enrollment in Other Sections in the same subject, concurrent term

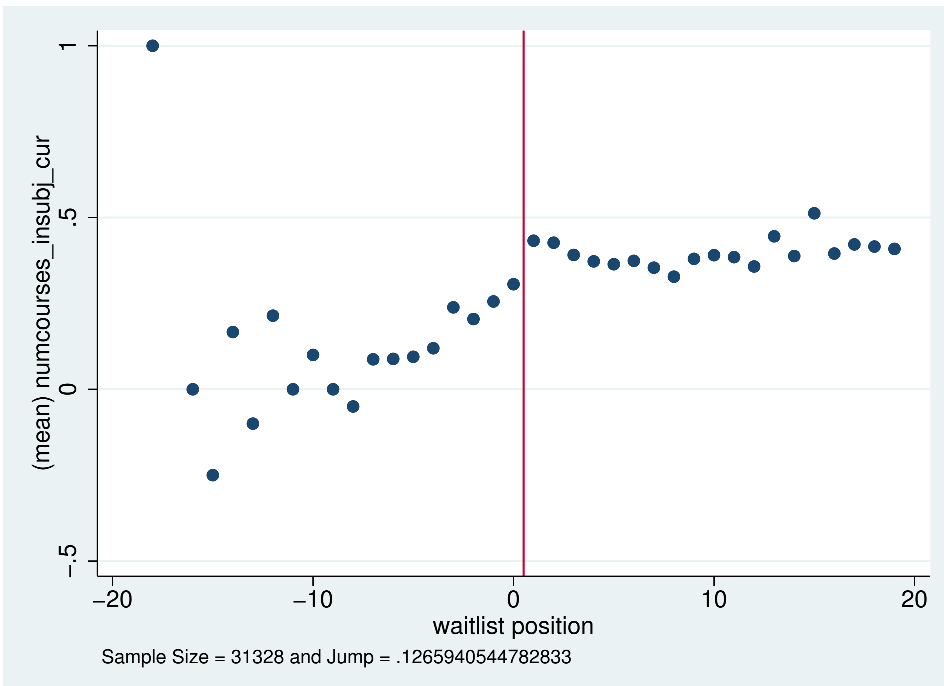


Figure 7: Stayed in School, 1 year

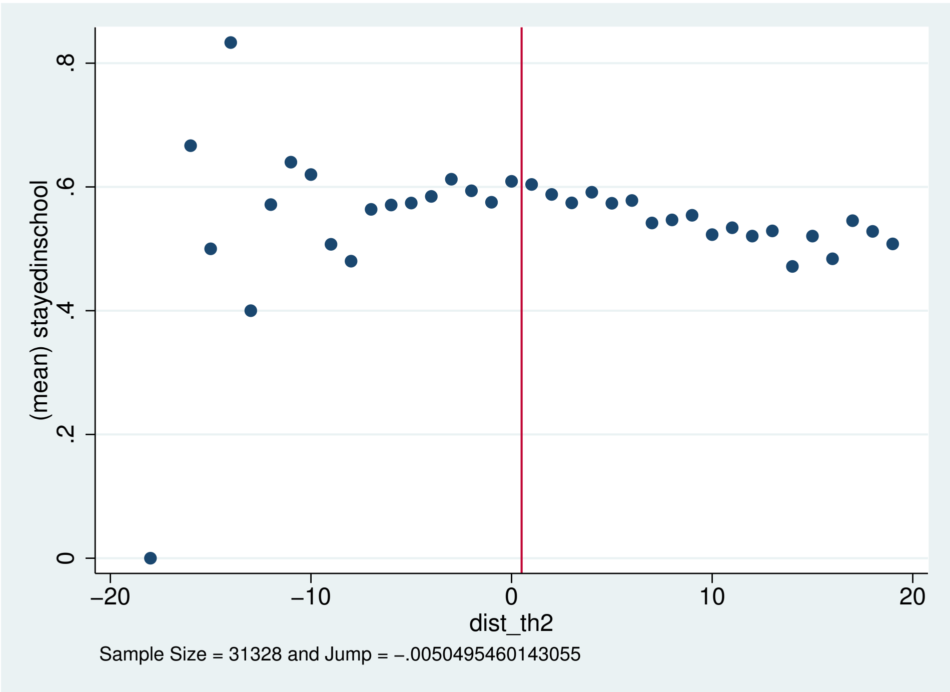


Table 1: Hypothetical Enrollment Log

student id	action	date/time
⋮	⋮	⋮
31	enroll	5:01:01 Aug 1, 2004
32	enroll	6:11:21 Aug 1, 2004
33	enroll	7:21:41 Aug 1, 2004
34	enroll	8:31:51 Aug 1, 2004
35	enroll	8:41:11 Aug 1, 2004
36	waitlist	8:51:31 Aug 1, 2004
37	waitlist	9:02:02 Aug 1, 2004
38	waitlist	11:22:12 Aug 1, 2004
39	waitlist	12:42:52 Aug 1, 2004
40	waitlist	13:32:22 Aug 1, 2004
41	waitlist	14:52:12 Aug 1, 2004
23	drop	11:32:43 Aug 14, 2004
36	enroll	11:45:32 Aug 14, 2004
13	drop	2:42:21 Aug 16, 2004
37	enroll	9:50:12 Aug 16, 2004
7	drop	5:45:33 Aug 20, 2004
38	enroll	2:01:37 Aug 21, 2004
39	drop	1:15:50 Aug 24, 2004

Table 2: Summary Statistics: Race

	U.S.		International	
	Count	Freq.	Count	Freq.
White	10,604	25.11	1,334	13.94
African-American	1,636	3.87	353	3.69
Hispanic	5,652	13.38	892	9.32
Asian	18,066	42.77	6,244	65.27
Native Am., Pac. Is., Other	1,226	2.9	185	1.93
Unknown	5,051	11.96	559	5.84
Total (n=51,802)	42,235	100	9,567	100

Table 3: Summary Statistics: Demographics

	Mean	Std. Dev.	Min	Max
Previous Enrollments	12.45	11.65	0	86
Cum. Course Hours	15.12	31.35	0	337
First Term	0.51	0.50	0	1
Financial Aid	0.18	0.39	0	1
Female	0.55	0.50	0	1
Age	25.97	8.53	18	50
Declared Certificate	0.03	0.18	0	1
Declared Transfer	0.33	0.47	0	1

Table 4: First Stage OLS Regressions

	(1) Enrollment	(2) Enrollment	(3) Enrollment
Z	0.118***	0.108***	0.101***
	(0.00714)	(0.00810)	(0.0112)
RV	-0.0113***	-0.0138***	-0.0129***
	(0.000521)	(0.00113)	(0.00343)
RVZ	0.00722***	0.00965***	0.00285
	(0.00194)	(0.00220)	(0.00509)
Constant	0.457***	0.467***	0.466***
	(0.00417)	(0.00558)	(0.00892)
Observations	51,802	41,940	27,365
R-squared	0.038	0.028	0.020
F	272.1	176.7	80.70

Table 5: TSLS Estimates of Effects on Course Enrollment

	Other Courses in Same Subject			Total Courses in All Subjects		
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A:			Concurrent Term			
Enrolled	-1.022***	-1.582***	-2.023***	0.294*	-0.00513	-0.391
	(0.210)	(0.237)	(0.311)	(0.179)	(0.218)	(0.329)
RV	-0.00479*	-0.0214***	-0.0416***	-0.0215***	-0.0344***	-0.0546***
	(0.00287)	(0.00420)	(0.00898)	(0.00305)	(0.00553)	(0.0133)
RVZ	0.0296***	0.0448***	0.0695***	0.0347***	0.0463***	0.0582***
	(0.00373)	(0.00486)	(0.0118)	(0.00526)	(0.00644)	(0.0150)
Constant	1.467***	1.862***	2.178***	2.595***	2.766***	2.981***
	(0.139)	(0.159)	(0.211)	(0.0897)	(0.114)	(0.175)
R-squared	0.293	0.226	0.065	0.000	0.004	
Reduced Form p-val	0	0	0	0.0990	0.981	0.230
Panel B:			Subsequent Term			
Enrolled	-0.0149	-0.325	-0.230	0.129	0.240	0.560
	(0.277)	(0.374)	(0.499)	(0.297)	(0.367)	(0.538)
RV	0.00113	-0.0117	-0.00161	-0.0125**	-0.00945	0.00694
	(0.00523)	(0.0103)	(0.0200)	(0.00565)	(0.00942)	(0.0202)
RVZ	0.0150*	0.0269**	0.0103	0.0158**	0.0130	0.00662
	(0.00843)	(0.0110)	(0.0218)	(0.00736)	(0.00984)	(0.0215)
Constant	1.519***	1.702***	1.636***	2.926***	2.863***	2.691***
	(0.145)	(0.204)	(0.276)	(0.150)	(0.191)	(0.284)
R-squared	0.000					
Reduced Form p-val	0.957	0.374	0.640	0.664	0.510	0.285
Observations	51,429	41,631	27,193	51,429	41,631	27,193
Bandwidth(spots)	20	10	5	20	10	5

*** p<0.01, ** p<0.05, * p<0.1

Table 6: TSLS Estimates of Effects on Course Enrollment (CCT)

	Other Courses, Same Subject	Total Courses, All Subjects
	(1)	(2)
Panel A:	Concurrent Term	
RD_Estimate	-1.545***	0.123
	(0.334)	(0.421)
Observations	15,156	21,688
Panel B:	Subsequent Term	
RD_Estimate	-0.270	1.113
	(1.069)	(0.840)
Observations	4,462	12,108

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 7: TSLS Estimates of Effects on GPA and Persistence (CCT)

	(1) GPA overall cur. term	(2) GPA in subj. cur. term	(3) Enrolled 1 yr later
RD_Estimate	0.150	0.0696	-0.174
	(0.366)	(0.558)	(0.199)
Observations	18,317	10,993	16,049

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 8: TSLS Estimates of Effects on Four-Year College and Two-Year College Enrollment (CCT)

	Enrollment at other Colleges			
	(1)	(2)	(3)	(4)
	4 yr nxt term	other 2 yr nxt term	4 yr nxt 3 yrs	other 2 yr nxt 3 yrs
RD_Estimate	0.0612	0.112	0.150	-0.000126
	(0.0852)	(0.0795)	(0.156)	(0.139)
Observations	16,049	16,049	16,049	16,049

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 9: Cubic Local Polynomial Results, (CCT)

	Number of Enrolled Courses				ex-post GPA			Enrolled in College			
	all courses in subj	other courses	in same subj	all courses	overall	in subj	stayed in school 1yr	in 4-yr college	in other 2-yr college	in 4-yr college	in other 2-yr college
	in Current Term		Next Term					w/ in 3 yrs		Next Term	
overall	-1.769***	0.071	3.558	-0.0550	-0.306	-0.0486	-0.107	0.0805	0.0305	-0.0448	-0.0319
s.e.	(0.397)	(0.377)	(18.99)	(0.439)	(0.246)	(0.894)	(0.136)	(0.119)	(0.0948)	(0.0681)	(0.0504)
Obs.	23,138	34,004	9,298	23,132	22,033	17,507	34,127	34,127	34,127	34,127	34,127
Males	-1.180***	0.635	1.025	-0.101	-0.769**	0.383	0.151	-0.0974	-0.0312	-0.0485	-0.0477
s.e.	(0.454)	(0.417)	(1.492)	(0.482)	(0.389)	(1.239)	(0.154)	(0.135)	(0.106)	(0.0774)	(0.0572)
Obs.	11,321	16,632	4,670	11,391	14,919	8,557	16,682	16,682	16,682	16,682	16,682
Females	-2.429***	-0.931	1.582	0.0796	-0.280	-0.574	-0.525*	0.417	0.156	-0.0239	0.000487
s.e.	(0.803)	(0.842)	(1.598)	(0.913)	(0.691)	(1.366)	(0.303)	(0.258)	(0.192)	(0.132)	(0.0983)
Obs.	11,763	17,300	4,599	11,688	15,280	8,911	17,373	17,373	17,373	17,373	17,373
Non-First Time	-1.620***	0.232	1.725	-0.207	-0.587**	-0.573	-0.0530	-0.0229	0.0665	-0.108	-0.0604
s.e.	(0.621)	(0.419)	(4.716)	(0.476)	(0.292)	(1.897)	(0.151)	(0.136)	(0.105)	(0.0808)	(0.0560)
Obs.	18,956	27,591	7,676	18,722	17,835	14,640	27,692	27,692	27,692	27,692	27,692
Fist-Time	-1.926***	-0.573	0.406	0.725	0.652	0.372	-0.324	0.526*	-0.141	0.231*	0.0814
s.e.	(0.446)	(0.899)	(6.470)	(1.243)	(0.741)	(0.642)	(0.321)	(0.292)	(0.230)	(0.140)	(0.122)
Obs.	4,182	6,413	1,844	4,410	5,674	2,867	6,435	6,435	6,435	6,435	6,435
Non-foreign	-1.690***	0.0269	0.0757	0.0726	-0.236	1.188	-0.0819	-0.156	0.198*	-0.0547	0.0195
s.e.	(0.399)	(0.406)	(1.737)	(0.466)	(0.373)	(1.286)	(0.150)	(0.455)	(0.114)	(0.0747)	(0.0595)
Obs.	15,986	23,910	5,804	15,688	21,017	11,941	24,008	34,042	24,008	24,008	24,008
Foreign	-1.885**	0.156	0.719	-0.355	-1.593*	-2.308	-0.185	-0.102	-0.463**	-0.0170	-0.183*
s.e.	(0.870)	(0.860)	(0.619)	(1.065)	(0.920)	(1.881)	(0.298)	(0.262)	(0.233)	(0.154)	(0.106)
Obs.	7,152	10,094	2,874	7,444	9,248	5,566	10,119	10,119	10,119	10,119	10,119
Minority	4.483	0.0434	-1.274	0.849	-1.028	-0.401	-0.524	1.234	0.0781	0.188	-0.0459
s.e.	(6.973)	(1.990)	(2.903)	(1.306)	(2.376)	(1.142)	(0.761)	(0.960)	(0.638)	(0.267)	(0.278)
Obs.	3,874	5,821	1,537	3,664	4,913	3,223	5,847	5,847	7,134	5,847	5,847
Asian	-1.118***	0.397	0.635	-0.220	-0.619	-0.434	-0.100	-0.164	0.0278	-0.0570	-0.0231
s.e.	(0.367)	(0.514)	(1.364)	(0.614)	(0.431)	(0.776)	(0.187)	(0.175)	(0.131)	(0.0987)	(0.0662)
Obs.	11,497	16,678	5,145	12,125	15,188	8,838	16,721	16,721	16,721	16,721	16,721
White	-1.637***	-0.825	-0.0257	-0.246	-0.603	0.953	-0.101	0.162	-0.391	-0.0798	0.0297
s.e.	(0.559)	(0.630)	(1.505)	(0.631)	(0.662)	(1.147)	(0.687)	(0.193)	(0.541)	(0.118)	(0.0805)
Obs.	4,884	7,108	2,241	4,555	6,339	3,842	8,696	7,139	8,696	7,139	7,139
Old	-3.722	0.619	1.002	-0.292	-0.818	7.654	0.267	0.325	-0.0371	-0.170	-0.0207
s.e.	(3.731)	(0.885)	(1.501)	(0.966)	(0.659)	(30.53)	(0.292)	(0.255)	(0.192)	(0.159)	(0.107)
Obs.	7,920	11,481	3,963	6,680	9,782	7,414	11,544	11,544	11,544	11,544	11,544
Young	-1.475***	-0.191	1.140	0.0154	-0.413	0.155	-0.260*	-0.0193	0.0509	0.00273	-0.0361
s.e.	(0.306)	(0.397)	(2.455)	(0.479)	(0.402)	(0.795)	(0.156)	(0.136)	(0.109)	(0.0742)	(0.0565)
Obs.	15,218	22,523	7,138	16,452	20,483	11,501	22,583	22,583	22,583	22,583	22,583

This table presents estimates of the regression discontinuity estimates using two stage least squares and the method of bandwidth selection developed by CCT(2013a 2013b). The estimates use a third order polynomial to approximate the underlying regression function, the expected outcome conditional on the running variable as a function of the running variable. In the CCT algorithm that selects bandwidth a fourth order polynomial is used to estimate bias due to functional form misspecification. The bandwidth selected using this method is usually between two and three.

Table 10: Local Linear TSLS, with control variables (BW of 5)

	Number of Enrolled Courses				ex-post GPA			Enrolled in College			
	all courses in subj	other courses	in same subj	all courses	overall	in subj	stayed in school 1yr	in 4-yr college	in other 2-yr college	in 4-yr college	in other 2-yr college
	in Current Term		Next Term					w/ in 3 yrs		Next Term	
overall	-1.943***	0.138	0.0864	0.448	-0.0662	0.422	-0.0828	0.273**	0.0780	0.0576	0.00205
s.e.	(0.470)	(0.338)	(0.441)	(0.435)	(0.329)	(0.831)	(0.110)	(0.122)	(0.0941)	(0.0683)	(0.0496)
Obs.	27,403	40,442	8,930	27,363	36,058	20,881	40,593	40,593	40,593	40,593	40,593
Males	-1.852***	0.0719	-0.694	0.596	-0.292	0.0525	-0.0955	0.0658	0.0322	0.0171	-0.0483
s.e.	(0.564)	(0.416)	(0.720)	(0.557)	(0.420)	(1.026)	(0.140)	(0.149)	(0.120)	(0.0863)	(0.0653)
Obs.	13,375	19,719	4,461	13,420	17,685	10,156	19,781	19,781	19,781	19,781	19,781
Females	-2.044**	0.327	0.877	0.368	0.215	0.729	-0.0525	0.520**	0.137	0.0975	0.0616
s.e.	(0.798)	(0.568)	(0.736)	(0.695)	(0.541)	(1.407)	(0.177)	(0.220)	(0.154)	(0.112)	(0.0797)
Obs.	14,028	20,723	4,469	13,943	18,373	10,725	20,812	20,812	20,812	20,812	20,812
Non-First Time Students	-1.653	0.482	0.280	0.463	-0.329	0.989	-0.105	0.287*	0.0824	0.0189	-0.0284
s.e.	(1.043)	(0.432)	(0.614)	(0.535)	(0.419)	(1.974)	(0.143)	(0.158)	(0.117)	(0.0905)	(0.0616)
Obs.	22,326	32,611	7,301	21,991	29,122	17,339	32,733	32,733	32,733	32,733	32,733
Fist-Time Students	-2.079***	-0.679	-0.305	0.466	0.629	0.197	0.000616	0.229	0.0635	0.140*	0.0677
s.e.	(0.377)	(0.542)	(0.608)	(0.717)	(0.536)	(0.589)	(0.142)	(0.172)	(0.154)	(0.0831)	(0.0851)
Obs.	5,077	7,831	1,629	5,372	6,936	3,542	7,860	7,860	7,860	7,860	7,860
Non-foreign Students	-2.164***	-0.0154	-0.391	0.275	0.0409	1.592	-0.119	0.353**	0.152	0.0402	0.0365
s.e.	(0.544)	(0.408)	(0.856)	(0.502)	(0.394)	(1.142)	(0.138)	(0.156)	(0.124)	(0.0839)	(0.0658)
Obs.	18,945	28,486	5,585	18,586	25,080	14,225	28,607	28,607	28,607	28,607	28,607
Foreign Students	-1.696*	0.350	0.292	0.686	-0.399	-2.524	-0.0551	0.0911	-0.0601	0.0916	-0.0587
s.e.	(0.931)	(0.606)	(0.501)	(0.849)	(0.595)	(2.193)	(0.179)	(0.196)	(0.142)	(0.118)	(0.0716)
Obs.	8,458	11,956	3,345	8,777	10,978	6,656	11,986	11,986	11,986	11,986	11,986
Minority Students	-1.706***	0.812***	0.155	-0.698*	0.158	-0.549	-0.175*	0.0662	0.0609	-0.0145	-0.00835
s.e.	(0.661)	(0.305)	(0.281)	(0.424)	(0.303)	(2.686)	(0.0982)	(0.0845)	(0.0835)	(0.0458)	(0.0497)
Obs.	7,173	11,569	2,147	7,105	9,782	5,166	11,639	11,639	11,639	11,639	11,639
Asian Students	-1.227**	0.140	0.258	0.563	0.282	0.325	-0.0830	-0.0231	0.100	0.0435	0.0723
s.e.	(0.555)	(0.538)	(0.943)	(0.722)	(0.498)	(0.967)	(0.172)	(0.193)	(0.149)	(0.112)	(0.0765)
Obs.	13,683	19,982	4,934	14,407	18,182	10,587	20,031	20,031	20,031	20,031	20,031
White Students	-1.554***	-0.0181	0.534	0.829	-0.596	0.404	-0.370**	0.303*	0.151	-0.0121	0.0609
s.e.	(0.527)	(0.497)	(0.548)	(0.533)	(0.503)	(0.935)	(0.182)	(0.184)	(0.142)	(0.105)	(0.0759)
Obs.	5,729	8,343	1,658	5,336	7,454	4,513	8,377	8,377	8,377	8,377	8,377
Old Students	-4.058	0.284	0.445	0.0430	-0.277	3.184	0.485*	0.651**	-0.0210	0.0641	-0.0641
s.e.	(7.204)	(0.772)	(0.647)	(0.948)	(0.673)	(13.49)	(0.288)	(0.309)	(0.195)	(0.159)	(0.106)
Obs.	9,360	13,606	2,954	7,995	11,658	7,126	13,682	13,682	13,682	13,682	13,682
Young Students	-1.849***	0.126	-0.591	0.609	0.108	0.418	-0.245**	0.170	0.0997	0.0589	0.0211
s.e.	(0.363)	(0.360)	(0.648)	(0.484)	(0.372)	(0.720)	(0.120)	(0.133)	(0.107)	(0.0723)	(0.0561)
Obs.	18,043	26,836	5,976	19,368	24,400	13,755	26,911	26,911	26,911	26,911	26,911
Cum. Course credits	×	×	×	×	×	×	×	×	×	×	×
Cum. Enrolled courses	×	×	×	×	×	×	×	×	×	×	×
First Time Status	×	×	×	×	×	×	×	×	×	×	×
Received Fin. Aid	×	×	×	×	×	×	×	×	×	×	×
Female	×	×	×	×	×	×	×	×	×	×	×
Goal Voc. Cert.	×	×	×	×	×	×	×	×	×	×	×
Goal 4-yr Degree	×	×	×	×	×	×	×	×	×	×	×

These regressions allow for linear functions of the running variable with different slopes on either side of the threshold. They also control for cumulative course credits earned, cumulative number of courses taken, whether the semester is the student's first, whether the student received financial aid, gender, and whether the student declared an intention to obtain a vocational certificate or transfer to a four year college. Here we use a rectangular kernel with a bandwidth of five on either side of the threshold.

$$E(Y|RV,W) = \alpha + \delta' W + Z \cdot \beta + \gamma^0 RV + \gamma^1 Z \cdot RV$$

Table 11: Local Linear TSLS, with more extensive control variables (BW of 5)

	Number of Enrolled Courses				ex-post GPA			Enrolled in College			
	all courses in subj	other courses	in same subj	all courses	overall	in subj	stayed in school 1yr	in 4-yr college	in other 2-yr college	in 4-yr college	in other 2-yr college
	in Current Term		Next Term					w/ in 3 yrs		Next Term	
overall	-1.340***	0.261	0.242	0.436	-0.0656	0.565	-0.0897	0.203*	0.0357	0.0662	-0.0117
s.e.	(0.337)	(0.343)	(0.342)	(0.449)	(0.344)	(0.825)	(0.101)	(0.122)	(0.0966)	(0.0703)	(0.0514)
Obs.	27,398	40,431	8,929	27,355	36,047	20,876	40,582	40,582	40,582	40,582	40,582
Males	-1.327***	0.174	0.0253	0.703	-0.292	0.235	-0.0213	-0.0358	-0.0235	0.00410	-0.0738
s.e.	(0.484)	(0.444)	(0.487)	(0.601)	(0.470)	(1.203)	(0.133)	(0.159)	(0.129)	(0.0930)	(0.0715)
Obs.	13,373	19,714	4,460	13,416	17,680	10,154	19,776	19,776	19,776	19,776	19,776
Females	-1.293***	0.436	0.457	0.207	0.233	0.550	-0.148	0.460**	0.117	0.143	0.0545
s.e.	(0.474)	(0.542)	(0.491)	(0.691)	(0.523)	(1.123)	(0.156)	(0.205)	(0.150)	(0.111)	(0.0777)
Obs.	14,025	20,717	4,469	13,939	18,367	10,722	20,806	20,806	20,806	20,806	20,806
Non-First Time Students	-0.583	0.552	0.530	0.450	-0.376	0.791	-0.0803	0.200	0.0279	0.0376	-0.0402
s.e.	(0.645)	(0.435)	(0.493)	(0.541)	(0.440)	(1.483)	(0.130)	(0.155)	(0.119)	(0.0923)	(0.0633)
Obs.	22,321	32,600	7,300	21,983	29,111	17,334	32,722	32,722	32,722	32,722	32,722
Fist-Time Students	-1.915***	-0.238	-0.442	0.379	0.835	0.765	-0.0929	0.184	0.0426	0.113	0.0730
s.e.	(0.345)	(0.506)	(0.442)	(0.767)	(0.562)	(0.745)	(0.127)	(0.169)	(0.156)	(0.0815)	(0.0861)
Obs.	5,077	7,831	1,629	5,372	6,936	3,542	7,860	7,860	7,860	7,860	7,860
Non-foreign Students	-1.389***	0.0774	0.525	0.210	0.0483	1.679	-0.129	0.284*	0.0977	0.0457	0.0198
s.e.	(0.359)	(0.412)	(0.686)	(0.522)	(0.417)	(1.093)	(0.126)	(0.154)	(0.125)	(0.0857)	(0.0674)
Obs.	18,942	28,478	5,584	18,581	25,072	14,222	28,599	28,599	28,599	28,599	28,599
Foreign Students	-1.360*	0.460	0.0781	0.899	-0.493	-2.600	-0.0439	0.0311	-0.0688	0.0930	-0.0572
s.e.	(0.731)	(0.627)	(0.423)	(0.933)	(0.605)	(2.083)	(0.167)	(0.203)	(0.150)	(0.124)	(0.0754)
Obs.	8,456	11,953	3,345	8,774	10,975	6,654	11,983	11,983	11,983	11,983	11,983
Minority Students	-1.373***	0.636**	0.0452	-0.511	0.189	-0.00798	-0.0999	0.0550	0.0178	-0.00944	-0.0167
s.e.	(0.323)	(0.271)	(0.229)	(0.363)	(0.273)	(1.067)	(0.0805)	(0.0778)	(0.0765)	(0.0422)	(0.0461)
Obs.	7,172	11,566	2,147	7,103	9,780	5,165	11,636	11,636	11,636	11,636	11,636
Asian Students	-1.030**	0.167	0.162	0.618	0.312	0.447	-0.113	-0.122	0.0803	0.0806	0.0710
s.e.	(0.433)	(0.582)	(0.619)	(0.852)	(0.557)	(0.999)	(0.164)	(0.211)	(0.163)	(0.123)	(0.0838)
Obs.	13,680	19,975	4,933	14,401	18,175	10,584	20,024	20,024	20,024	20,024	20,024
White Students	-1.341***	0.0994	0.631	0.740	-0.675	0.156	-0.373**	0.258	0.0803	-0.0291	0.0398
s.e.	(0.446)	(0.481)	(0.475)	(0.518)	(0.521)	(0.853)	(0.163)	(0.176)	(0.137)	(0.103)	(0.0738)
Obs.	5,728	8,341	1,658	5,336	7,452	4,512	8,375	8,375	8,375	8,375	8,375
Old Students	-0.426	0.636	0.414	0.124	-0.219	1.508	0.356	0.592**	-0.0725	0.0657	-0.0819
s.e.	(1.174)	(0.731)	(0.484)	(0.910)	(0.688)	(2.508)	(0.235)	(0.279)	(0.186)	(0.151)	(0.102)
Obs.	9,359	13,603	2,954	7,993	11,655	7,125	13,679	13,679	13,679	13,679	13,679
Young Students	-1.601***	0.146	0.0849	0.537	0.117	0.642	-0.238**	0.0933	0.0637	0.0854	0.00949
s.e.	(0.324)	(0.372)	(0.460)	(0.509)	(0.390)	(0.873)	(0.112)	(0.137)	(0.112)	(0.0763)	(0.0590)
Obs.	18,039	26,828	5,975	19,362	24,392	13,751	26,903	26,903	26,903	26,903	26,903
Race FEs	×	×	×	×	×	×	×	×	×	×	×
Reg. Priority Group FEs	×	×	×	×	×	×	×	×	×	×	×
Year × Term FEs	×	×	×	×	×	×	×	×	×	×	×
Subj. FEs	×	×	×	×	×	×	×	×	×	×	×

These regressions allow for linear functions of the running variable with different slopes on either side of the threshold. As before they control for cumulative course credits earned, cumulative number of courses taken, whether the semester is the student's first, whether the student received financial aid, gender, and whether the student declared an intention to obtain a vocational certificate or transfer to a four year college. They also control for race fixed effects, registration priority group fixed effects, term fixed effects and subject fixed effects. Here we use a rectangular kernel with a bandwidth of five on either side of the threshold.

Table 12: Local Linear TSLS, with more extensive control variables (BW of 3)

	Number of Enrolled Courses				ex-post GPA			Enrolled in College			
	all courses in subj	other courses	in same subj	all courses	overall	in subj	stayed in school 1yr	in 4-yr college	in other 2-yr college	in 4-yr college	in other 2-yr college
	in Current Term		Next Term					w/ in 3 yrs		Next Term	
overall	-1.469**	0.283	2.648	0.460	-1.111	-0.0263	-0.193	0.392	-0.0437	0.0861	-0.0961
s.e.	(0.579)	(0.726)	(8.075)	(0.843)	(0.787)	(1.257)	(0.217)	(0.271)	(0.201)	(0.146)	(0.110)
Obs.	18,046	26,276	5,840	17,897	23,375	13,530	26,372	26,372	26,372	26,372	26,372
Males	-1.067*	0.685	-27.74	0.359	-1.357	-0.547	0.0224	-0.0248	-0.101	0.0259	-0.0768
s.e.	(0.645)	(0.745)	(1,026)	(0.789)	(0.894)	(1.812)	(0.217)	(0.259)	(0.212)	(0.151)	(0.116)
Obs.	8,840	12,850	2,955	8,773	11,520	6,613	12,891	12,891	12,891	12,891	12,891
Females	-2.048	-0.780	8.599	0.731	-0.847	0.414	-0.781	1.431	0.166	0.235	-0.144
s.e.	(1.437)	(2.078)	(36.20)	(2.879)	(1.760)	(2.071)	(0.773)	(1.199)	(0.522)	(0.398)	(0.286)
Obs.	9,206	13,426	2,885	9,124	11,855	6,917	13,481	13,481	13,481	13,481	13,481
Non-First Time Students	-1.321	0.643	-42.70	0.146	-1.995	0.0493	-0.0767	0.229	-0.0932	0.0493	-0.188
s.e.	(1.187)	(0.948)	(1,261)	(1.065)	(1.407)	(3.439)	(0.278)	(0.333)	(0.255)	(0.195)	(0.150)
Obs.	14,650	21,127	4,738	14,352	18,831	11,225	21,205	21,205	21,205	21,205	21,205
Fist-Time Students	-1.585***	-0.316	-2.381	0.929	0.385	0.528	-0.452	0.719	0.0373	0.155	0.134
s.e.	(0.520)	(1.065)	(5.395)	(1.387)	(0.889)	(0.908)	(0.319)	(0.460)	(0.319)	(0.175)	(0.181)
Obs.	3,396	5,149	1,102	3,545	4,544	2,305	5,167	5,167	5,167	5,167	5,167
Non-foreign Students	-1.526**	0.167	0.184	0.0895	-0.578	1.338	-0.226	0.598	0.231	0.0542	-0.00124
s.e.	(0.619)	(0.866)	(1.027)	(0.993)	(0.883)	(1.527)	(0.271)	(0.366)	(0.268)	(0.176)	(0.139)
Obs.	12,429	18,378	3,615	12,072	16,139	9,174	18,453	18,453	18,453	18,453	18,453
Foreign Students	-1.598	0.182	1.107	1.675	-2.536	-4.523	-0.110	-0.0872	-0.617	0.135	-0.274
s.e.	(1.353)	(1.400)	(1.091)	(2.052)	(2.102)	(5.185)	(0.378)	(0.455)	(0.455)	(0.278)	(0.215)
Obs.	5,617	7,898	2,225	5,825	7,236	4,356	7,919	7,919	7,919	7,919	7,919
Minority Students	-1.296***	0.679**	-0.0293	-0.569	0.227	-0.0645	-0.0822	0.0770	0.0146	-0.0222	-0.0334
s.e.	(0.332)	(0.279)	(0.236)	(0.392)	(0.283)	(1.096)	(0.0828)	(0.0800)	(0.0786)	(0.0435)	(0.0480)
Obs.	6,820	11,013	2,047	6,768	9,300	4,915	11,080	11,080	11,080	11,080	11,080
Asian Students	-0.621	0.174	1.078	0.403	-0.527	0.130	-0.390	0.164	-0.0877	0.225	-0.130
s.e.	(0.554)	(0.923)	(1.260)	(1.168)	(0.783)	(1.133)	(0.295)	(0.341)	(0.258)	(0.211)	(0.136)
Obs.	8,996	12,926	3,205	9,422	11,755	6,841	12,965	12,965	12,965	12,965	12,965
White Students	-2.315**	0.0505	-1.460	-0.124	-1.648	-0.989	-0.227	0.473	0.0383	-0.199	0.00674
s.e.	(1.088)	(0.943)	(3.053)	(0.801)	(1.229)	(1.536)	(0.294)	(0.369)	(0.261)	(0.212)	(0.142)
Obs.	3,784	5,440	1,086	3,473	4,833	2,935	5,464	5,464	5,464	5,464	5,464
Old Students	5.820	4.409	0.550	0.467	-4.924	-1.575	0.0641	0.886	0.373	-0.113	-0.466
s.e.	(65.07)	(5.816)	(0.861)	(2.422)	(6.449)	(7.490)	(0.804)	(1.233)	(0.784)	(0.572)	(0.596)
Obs.	6,084	8,808	1,883	5,134	7,512	4,593	8,855	8,855	8,855	8,855	8,855
Young Students	-1.214***	-0.359	-0.322	0.455	-0.246	0.210	-0.258	0.362	-0.120	0.186	-0.0205
s.e.	(0.391)	(0.676)	(1.142)	(0.912)	(0.685)	(0.965)	(0.202)	(0.261)	(0.200)	(0.141)	(0.105)
Obs.	11,962	17,468	3,957	12,763	15,863	8,937	17,517	17,517	17,517	17,517	17,517
Cum. Course credits	×	×	×	×	×	×	×	×	×	×	×
Cum. Enrolled courses	×	×	×	×	×	×	×	×	×	×	×
First Time Status	×	×	×	×	×	×	×	×	×	×	×
Received Fin. Aid	×	×	×	×	×	×	×	×	×	×	×
Female	×	×	×	×	×	×	×	×	×	×	×
Goal Voc. Cert.	×	×	×	×	×	×	×	×	×	×	×
Goal 4-yr Degree	×	×	×	×	×	×	×	×	×	×	×

These regressions allow for linear functions of the running variable with different slopes on either side of the threshold. They also control for cumulative course credits earned, cumulative number of courses taken, whether the semester is the student's first, whether the student received financial aid, gender, and whether the student declared an intention to obtain a vocational certificate or transfer to a four year college. Here we use a rectangular kernel with a bandwidth of three on either side of the threshold.

Table 13: Summary Statistics: Course Subject

Subject	Freq.	Percent	Cum.
MATH	10,804	12.69	12.69
EWRT	10,308	12.11	24.79
BIOL	6,967	8.18	32.97
SPCH	5,141	6.04	39.01
P E	4,987	5.86	44.87
ESL	4,196	4.93	49.80
ACCT	3,485	4.09	53.89
CHEM	3,456	4.06	57.95
PSYC	2,859	3.36	61.30
HUMA	2,760	3.24	64.55
HIST	2,749	3.23	67.77
ECON	2,465	2.89	70.67
POLI	1,812	2.13	72.80
SOC	1,575	1.85	74.65
BUS	1,537	1.80	76.45
ANTH	1,491	1.75	78.20
PHIL	1,266	1.49	79.69