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# Skipping class in college and exam performance: Evidence from a regression discontinuity classroom experiment☆

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ABSTRACT

In this paper we estimate the effect of class attendance on exam performance by implementing a policy in three large economics classes that required students scoring below the median on the midterm exam to attend class. This policy generated a large discontinuity in the rate of post-midterm attendance at the median of the midterm score. We estimate that near the policy threshold, the post-midterm attendance rate was 36 percentage points higher for those students facing compulsory attendance. The discontinuous attendance policy is also associated with a significant difference in performance on the final exam. We estimate that a 10 percentage point increase in a student's overall attendance rate results in a 0.17 standard deviation increase in the final exam score without adversely affecting performance on other classes taken concurrently.



## 1. Introduction

The National Center for Educational Statistics estimates that American colleges and universities spend $32 billion yearly on student instruction alone.[1] This is about $12,000 per full time student. Despite this, a significant fraction of students fail to attend course lectures, which are traditionally the primary means by which educational material is presented to students. Past estimates place the rate of student absenteeism as high as 40 percent (Romer, 1993). Why do students willingly forego a substantial portion of classroom time, and what price do they pay?

From a labor market perspective, the answer to this question is not trivial. The private returns to college performance are potentially high, for instance if firms view good grades as a signal of future productivity. Several studies have found a strong relationship between college performance and graduates' salaries. Jones and Jackson (1990) find that one extra point of grade point average is associated with 8.5 percent higher wages five years after graduation (see also James, Alsalam, Conaty, & To, 1989; Wise, 1975).

A growing literature has attempted to understand the causes and consequences of skipping class. Past studies have found a uniformly robust positive relationship between class attendance and performance.[2] A commonly encountered problem in the literature is the difficulty in disentangling the causal effect of class attendance from unobserved factors such as a student's intrinsic motivation or interest that are almost surely correlated with both attendance and class performance.

In this paper, we use a regression discontinuity design to investigate how attendance affects student performance

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[1] 2002–2003 NCES survey http://nces.ed.gov/programs/digest/d05/tables/dt05_347.asp accessed 28.08.06.

[2] See for instance Bratti and Staffolani (2002), Cohn and Johnson (2006), Devadoss and Foltz (1996), Dolton et al. (2003), Durden and Ellis (1995), Kirby and McElroy (2003), Marburger (2001), Park and Kerr (1990), Rodgers (2002), Romer (1993), Schmidt (1983), and Stanca (2006).

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on exams. To overcome the problems caused by unobserved variables, we implemented a novel attendance policy in three large economics classes. We made attendance mandatory for students scoring below the median on the midterm exam. Since the mandatory attendance policy is applied to students discontinuously based on their midterm exam score, we can exploit the resulting discontinuity in attendance rates to identify the effect of class attendance on performance. The resulting regression discontinuity estimates will not suffer from omitted variables bias if the unobserved student characteristics vary continuously across the policy threshold. The cost of this approach is that our estimates of the attendance effect are local to students whose midterm score was near the class median, and so may not be generalizable to the class as a whole.

The compulsory attendance policy had a significant effect on post-midterm attendance. We estimate that near the threshold, the post-midterm attendance rate was 36 percentage points higher for students facing compulsory attendance. This resulted in a 28 percentage point difference in the overall class attendance rate at the threshold. The attendance policy also resulted in a large, though only marginally statistically significant, discontinuity in student performance on the final exam. Students scoring just above the median on the midterm, and therefore not subject to mandatory attendance, on average scored 0.46 standard deviations lower on the final exam than students just below the median. The instrumental variables estimates indicate that a 10 percentage point increase in a student's overall attendance rate results in a 0.17 standard deviation increase in the final exam score.

The design we employ assumes that unobserved student characteristics vary continuously across the policy threshold. There are several reasons why this may be violated. First, students in the mandatory attendance group may adjust to the increased time spent in class by reducing the time and effort they spend on other methods for learning the material such as teaching assistant sections, homework, and tutoring sessions. Second, assignment to the treatment group could provide a signal to students about their standing in the class, which could affect time spent studying and working on homework. Third, students in the treatment group may have mistakenly believed that missing class directly affected their grade, which may lead treated students to compensate by adjusting other margins of effort. However, we find that students do not respond to mandatory attendance by altering observable effort, as measured by attendance to teaching assistant sections and homework performance.

Finally, attending class comes at an opportunity cost of lost time, which could be devoted to other activities. Of primary concern is the effect of the mandatory attendance policy on student performance in other classes, for instance through crowding out effort spent studying for other classes. We instead find that students subject to the mandatory attendance policy in fact scored slightly *higher* in other classes taken concurrently, though the estimated effect is not statistically significant. Therefore, we find that the mandatory attendance policy is on the whole a positive factor in students' academic achievement.

We feel our design offers a significant improvement over approaches taken by previous studies in dealing with the problem of unobserved student characteristics. One approach taken in prior work is to control in an OLS regression for factors that are likely to be correlated with student motivation. For instance, Romer (1993) includes past GPA and fraction of past problem sets completed as proxies for unobserved student motivation and ability. As Stanca (2006) notes, however, these controls are likely to be only imperfectly correlated with the omitted variables, which will lead to OLS giving biased estimates. A second approach controls for student-level fixed effects. Stanca (2006) regresses student exam performance on a variable measuring attendance during the period the exam covered, using within student variation in attendance over time. Using a related approach, Marburger (2001) relates the likelihood of a student missing a question on a multiple choice exam to the student's attendance on the day that the material in the question was covered. This approach is appealing in that it is able to account for average levels of student motivation and interest; however it will not be valid if a students' interest varies across the various subjects covered within a course. In a follow-up study particularly relevant to our work, Marburger (2006) evaluates the effect of a mandatory attendance policy. He first evaluates the effect of a mandatory attendance policy on attendance, then evaluates the effect of attendance on performance using a similar strategy to Marburger (2001). By the chain rule, the total effect of the policy on performance is the multiple between these two measures. In contrast with our paper, Marburger is interested in evaluating the mandatory attendance policy itself, while we merely use the policy to identify the effect of attendance on performance. Furthermore, the aforementioned concerns regarding identification potentially faced by Marburger (2001) will be shared by Marburger (2006) as both studies use the same identification strategy. Finally, Chen and Lin (2006) perform an experiment where they randomly removed slides from the power point presentation used during lecture. They find that students scored worse on exam questions covering material on removed slides. This study suggests there is a benefit to being exposed to material in class but does not give us an estimate of the value to attending class.

The paper proceeds as follows. In Section 2, we discuss the data obtained from the policy experiment in our own classes. In Section 3, we describe the method we will use to estimate the relationship between attendance and performance. In Section 4 we discuss the results, and Section 5 concludes.

## 2. Experimental design and data

In three large intermediate level economics classes,[3] we implemented a policy where class attendance was voluntary up until the day of the midterm. After the

[3] Two of the courses were intermediate microeconomics, and the third was introduction to econometrics. The course composition was primarily sophomores, juniors, and seniors majoring in economics.

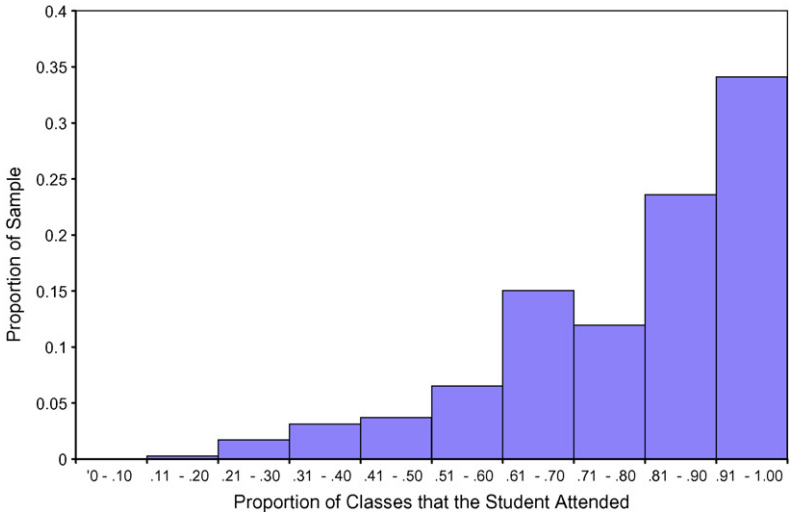


**Fig. 1.** Distribution of student attendance.

midterm, students with grades below the median exam score were required to attend class, while class attendance was still voluntary for students that scored above the midterm. The midterm for each of these courses occurred at approximately the middle of the quarter. In addition to the midterm, the course grade was based on a cumulative final exam and a series of problem sets.[4]

The policy was announced on the first day of class, and students were reminded of the policy on the day the midterms were returned. The students that scored below the median on the midterm were also reminded via e-mail that they were required to attend class. The teaching assistants recorded attendance as students arrived for lecture and insured that students that left before the end of the class were not marked down as attending.

Each class also had several weekly review sections held by teaching assistants, and the university offered a weekly group tutoring session that students could attend to obtain additional help with course material. As part of the course administration, we recorded each student's TA section attendance, tutoring sessions attended, homework scores, midterm and final exam score, gender, year in school, and major. We also obtained information on each student's cumulative GPA entering the quarter and performance in other courses taken in the same quarter as the experiment course.

[4] Exams typically consisted of long-response problems, including a true-false section where the grade was based on the student's explanation and one or more multi-part extended problems. The authors of the study were the instructors for the courses; however the exam grading was entirely carried out by between two and four teaching assistants (TA) who each graded a portion of the exam. In general, the teaching assistants who performed the grading duties were not informed which students were subject to compulsory attendance, though in two sections one of the TAs who helped grade also assisted with entering midterm scores.

## 3. Methods

The primary goal of this paper is to estimate the effect of class attendance on final exam performance. We are interested in estimating the following relationship:

$$y_i = B_0 + \beta_1 attend_i + X_i\beta_2 + \varepsilon_i \quad (1)$$

where $y_i$ is the exam score for student $i$, $attend_i$ is the attendance rate for student $i$, and $X_i$ are the observable characteristics of student $i$. The parameter of interest is the return to attending class $\beta_1$. Getting consistent estimates of this parameter is complicated by the fact that there are probably omitted variables, such as motivation, that are correlated with both class attendance and performance in the class.

To solve this problem we take advantage of the discontinuity in attendance induced by the class policy. This lets us compare students that scored just below the median on the midterm and were required to attend class with those who scored just above and were not required to attend class. These two groups are likely to be very similar in their pre-midterm characteristics, easing concerns about omitted variables bias. Furthermore, students do not know ahead of time exactly what the median score of the midterm will be. In settings with a policy threshold that is known *ex ante*, the regression discontinuity design is potentially subject to the manipulation of the running variable.

We estimate the discontinuity that occurs at the midterm parametrically using the following model:

$$attend_i = \alpha_0 + \alpha_1 ab_i + f(midterm_i) + \Pi_1 X_i + \varepsilon_i \quad (2)$$

where $attend_i$ is the attendance for individual $i$, $ab_i$ is an indicator variable equal to 1 if individual $i$ scored above the median on the midterm, $f(midterm_i)$ is a low order polynomial of the midterm score, $X_i$ is a set of covariates, and $\varepsilon_i$ is an idiosyncratic error term. The coefficient $\alpha_1$ is the estimate of how much the mandatory attendance policy

**Table 1**
Attendance and exam performance, cross-section.

| | Dependent variable | | | | | |
|---|---|---|---|---|---|---|
| | Midterm score | | | Final exam score | | |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Pre-midterm attendance rate | 1.271 | 0.825 | 0.364 | | | |
| | [0.300] | [0.304] | [0.312] | | | |
| Total attendance rate | | | | 1.498 | 1.089 | 0.651 |
| | | | | [0.287] | [0.298] | [0.328] |
| Male | | −0.032 | −0.023 | | 0.188 | 0.202 |
| | | [0.100] | [0.100] | | [0.105] | [0.104] |
| Freshman | | 0.139 | 0.119 | | 0.467 | 0.457 |
| | | [0.310] | [0.298] | | [0.253] | [0.249] |
| Sophomore | | −0.125 | −0.078 | | −0.191 | −0.167 |
| | | [0.170] | [0.164] | | [0.172] | [0.166] |
| Junior | | −0.098 | −0.084 | | −0.11 | −0.088 |
| | | [0.154] | [0.149] | | [0.148] | [0.142] |
| Business major | | −0.081 | −0.106 | | 0.11 | 0.08 |
| | | [0.141] | [0.137] | | [0.148] | [0.145] |
| Global economics major | | −0.39 | −0.428 | | −0.192 | −0.233 |
| | | [0.262] | [0.269] | | [0.236] | [0.236] |
| Other major | | −0.197 | −0.175 | | 0.047 | 0.063 |
| | | [0.177] | [0.171] | | [0.180] | [0.178] |
| Cumulative GPA, beginning of quarter | | 0.576 | 0.447 | | 0.717 | 0.595 |
| | | [0.126] | [0.133] | | [0.112] | [0.116] |
| Pre-midterm TA section attendance rate | | | 0.374 | | | |
| | | | [0.161] | | | |
| Pre-midterm tutor attendance | | | 0.009 | | | |
| | | | [0.041] | | | |
| GPA in other courses, same quarter | | | 0.199 | | | 0.213 |
| | | | [0.084] | | | [0.070] |
| Total TA section attendance rate | | | | | | 0.021 |
| | | | | | | [0.019] |
| Total tutor attendance | | | | | | 0.292 |
| | | | | | | [0.176] |
| Constant | −1.01 | −2.171 | −2.149 | −1.174 | −3.088 | −3.117 |
| | [0.254] | [0.441] | [0.406] | [0.234] | [0.463] | [0.443] |
| Observations | 352 | 337 | 336 | 352 | 337 | 336 |
| *R*-squared | 0.06 | 0.17 | 0.20 | 0.08 | 0.25 | 0.29 |

changes the outcome $attend_i$. To determine if the mandatory attendance policy affected students' final exam scores we estimated the following model:

$$y_i = \delta_0 + \delta_1 ab_i + g(midterm_i) + \Pi_2 X_i + \gamma_i \quad (3)$$

where $y_i$ is the exam score for student $i$ and $\gamma_i$ is the idiosyncratic error term. To obtain the instrumental variables estimate of the return to attending class we examine the ratio $\delta_1/\alpha_1$.[5]

The instrumental variables estimate is still potentially subject to omitted variables bias if students respond to the compulsory attendance policy by adjusting the amount of time they allocate to other modes of learning, for instance time spent studying. While the amount of time students spend studying is unobserved, we do have several measures of outside effort, such as attendance of sections run by the teaching assistants, homework scores, and the use of university provided tutors. We will estimate specifications similar to (3), with these other forms of effort as the dependant variable, to determine if students respond to the compulsory attendance policy by altering their level of effort.

## 4. Results

In this section we start by using the discontinuity in class attendance caused by the mandatory attendance policy to obtain unbiased estimates of the return to attending class. We then evaluate whether students respond on other margins to the attendance policy, and how the policy affected performance in other classes.

### 4.1. Class attendance and performance

In the three courses with the attendance policy the average attendance rate was 78 percent in the period before attendance became mandatory. This is only slightly higher than the 75 percent attendance rate we observed campus wide in the first half of the quarter. The attendance rates of individual students varied significantly across students in the three courses where the attendance policy was implemented. As shown in Fig. 1, 12 percent of students had a pre-midterm attendance rate of less than 50 percent, while 35 percent attended at least 90 percent of the lectures.

[5] It is worth noting that the cumulative nature of the final will not lead bias in this design. The measure of attendance is for the entire quarter, which matches the coverage of the exam.

**Table 2**
Comparison of mandatory and non-mandatory attendance groups.

| | Relative to median | | | | | | |
|---|---|---|---|---|---|---|---|
| | All students | | Within 1.5 SD | | Within 1.0 SD | | Within 1.0 SD |
| | Man. | Not Man. | Man. | Not Man. | Man. | Not Man. | RD coefficient |
| *Attendance* | | | | | | | |
| Pre-midterm lecture rate | 0.762 | 0.818 | 0.783 | 0.814 | 0.785 | 0.800 | −0.135 |
| | [2.659] | | [1.386] | | [0.600] | | [1.89] |
| Pre-midterm TA section | 0.340 | 0.477 | 0.353 | 0.464 | 0.348 | 0.449 | 0.033 |
| | [3.852] | | [2.983] | | [2.458] | | [0.26] |
| Post-midterm lecture | 0.850 | 0.703 | 0.853 | 0.698 | 0.848 | 0.680 | −0.360 |
| | [6.323] | | [6.243] | | [6.057] | | [4.07] |
| Post-midterm TA section | 0.253 | 0.291 | 0.268 | 0.274 | 0.266 | 0.268 | −0.067 |
| | [1.047] | | [0.157] | | [0.031] | | [0.53] |
| *Performance* | | | | | | | |
| Post-midterm hw, normed | −0.037 | −0.036 | −0.017 | 0.015 | −0.063 | −0.076 | −0.561 |
| | [0.689] | | [0.287] | | [0.100] | | [1.28] |
| Pre-midterm hw, normed | −0.241 | 0.233 | −0.166 | 0.180 | −0.121 | 0.098 | 0.248 |
| | [4.591] | | [3.323] | | [1.819] | | [0.65] |
| Final exam, normed | −0.307 | 0.296 | −0.161 | 0.240 | −0.103 | 0.177 | −0.427 |
| | [5.944] | | [3.937] | | [2.487] | | [1.48] |
| *Student characteristics* | | | | | | | |
| Cumulative GPA | 2.912 | 3.164 | 2.956 | 3.127 | 2.981 | 3.086 | 0.003 |
| | [4.49] | | [2.953] | | [1.74] | | [0.02] |
| Male | 0.642 | 0.620 | 0.628 | 0.619 | 0.659 | 0.641 | 0.100 |
| | [0.417] | | [0.170] | | [0.296] | | [0.55] |
| Business major | 0.566 | 0.603 | 0.581 | 0.595 | 0.577 | 0.586 | −0.159 |
| | [0.701] | | [0.254] | | [0.139] | | [0.82] |
| Economics major | 0.145 | 0.145 | 0.142 | 0.137 | 0.146 | 0.125 | −0.050 |
| | [0.02] | | [0.127] | | [0.492] | | [0.43] |
| Global economics major | 0.081 | 0.073 | 0.054 | 0.077 | 0.057 | 0.063 | 0.019 |
| | [0.292] | | [0.829] | | [0.186] | | [0.20] |
| Other major | 0.208 | 0.179 | 0.223 | 0.190 | 0.220 | 0.227 | 0.190 |
| | [0.695] | | [0.711] | | [0.134] | | [1.09] |
| Freshman | 0.023 | 0.034 | 0.014 | 0.036 | 0.016 | 0.039 | 0.129 |
| | [0.586] | | [1.253] | | [1.095] | | [1.34] |
| Sophomore | 0.260 | 0.235 | 0.277 | 0.244 | 0.285 | 0.242 | 0.233 |
| | [0.553] | | [0.666] | | [0.760] | | [1.35] |
| Junior | 0.572 | 0.547 | 0.568 | 0.554 | 0.545 | 0.570 | −0.417 |
| | [0.467] | | [0.249] | | [0.407] | | [2.14] |
| Senior | 0.145 | 0.184 | 0.142 | 0.167 | 0.154 | 0.148 | 0.056 |
| | [1.006] | | [0.606] | | [0.133] | | [0.43] |
| *N* | 352 | | 316 | | 241 | | 241 |

*Notes:* *T*-statistic of difference in means in brackets. Normed exam and homework scores are calculated by subtracting the within class mean and dividing by the within class standard deviation. The final column is the estimate from a parametric regression discontinuity specification, only considering students within 1 standard deviation of the mandatory attendance cutoff.

Consistent with prior studies, student attendance rates are positively associated with exam performance in the cross-section. In Table 1, we display the results of OLS estimates of the correlation between attendance and exam scores conditional on observable student characteristics. In the first three columns we show the relationship between the midterm score and student attendance rates prior to the midterm, and in columns (4)–(6) we display the results of regressing the final exam score on the attendance rate for the entire course. The exam scores are normalized by subtracting the class median and then dividing by the class standard deviation. The results show that a 10 percentage point increase in the pre-midterm attendance rate is associated with a 0.13 standard deviation increase in the midterm score. Similarly, a 10 percentage point increase in the total course attendance rate is associated with a 0.15 standard deviation increase in the final exam.

For both specifications involving the midterm and final exam, the estimated coefficients are lower when student controls are included in the specification. In columns (2) and (5), we include in the specifications of the midterm and final exam scores controls that are exogenous to student effort in the quarter of the class experiment. We see that the estimated attendance coefficient falls by one-third in both the midterm and final specifications. An important factor in exam performance is student GPA, as each additional point is worth 0.58 standard deviations on the midterm and 0.72 standard deviations on the final. The specifications shown in columns (3) and (6) include covariates related to student effort within the quarter, such as the TA section attendance rate, attendance to university provided tutors, and the GPA in other courses. These additional controls have a noticeable effect on the estimated attendance coefficient, as they are positively related with both lecture attendance

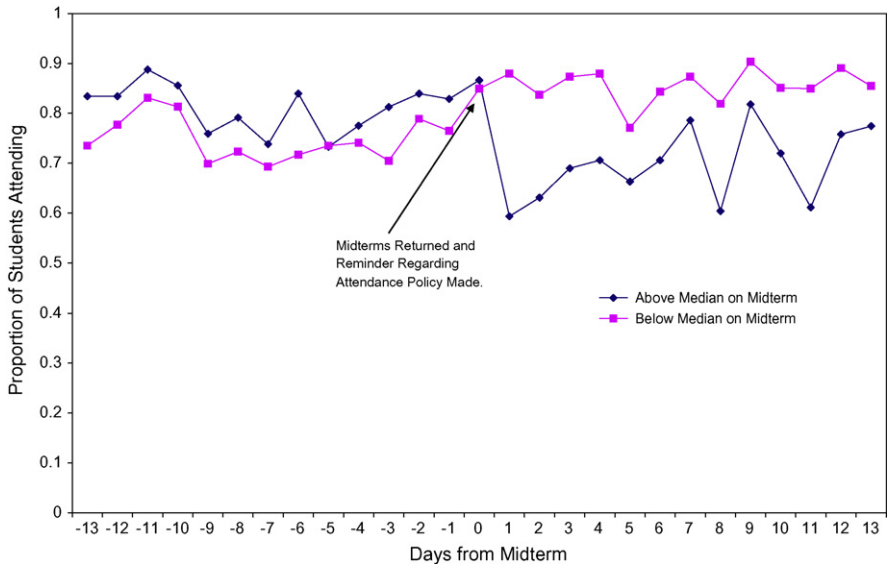


**Fig. 2.** Percent of students present on each day in classes with attendance policy.

and performance on the final exam. These results demonstrate that the strong correlation between attendance and exam performance is due in part to observable student characteristics.

In Table 2, we compare the characteristics of the group of students scoring below the median on the midterm exam and therefore subject to the mandatory attendance policy with those that scored above the median. We begin by comparing the characteristics of all students. Consistent with the OLS regression results, we see that students who are in the poorer performing mandatory attendance group attended class somewhat less often in the pre-midterm period. These students attended fewer TA sections pre-midterm and scored worse on homework assignments. Also, lower achieving students, as measured by cumulative GPA, are likely to find themselves in the mandatory attendance group. This suggests that the OLS estimates are very likely to suffer from omitted variables bias. On other dimensions such as gender, major, and year in school, the compulsory and voluntary attendance groups are similar. Finally, the mandatory attendance policy has a significant impact on attendance. Even when considering the entire class, which includes very high and very low performing students, the post-midterm attendance rates are fifteen percentage points higher in the compulsory attendance group.

**Table 3**
Regression results for class attendance and final exam scores.

| | First stage: proportion of classes attended | | | Reduced form: standardized score on final exam | | | IV Estimate: standardized score on final exam | | |
|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| Above cutoff | −0.245 | −0.285 | −0.277 | −0.427 | −0.413 | −0.457 | | | |
| | [0.071] | [0.068] | [0.062] | [0.288] | [0.275] | [0.258] | | | |
| Proportion of classes Attended | | | | | | | 1.743 | 1.452 | 1.653 |
| | | | | | | | [1.051] | [0.830] | [0.840] |
| Diff. | −0.017 | −0.055 | −0.124 | 1.895 | 1.513 | 1.347 | 1.925 | 1.592 | 1.551 |
| | [0.198] | [0.191] | [0.165] | [0.936] | [0.899] | [0.912] | [0.919] | [0.917] | [0.964] |
| Diff. squared | −0.062 | −0.094 | −0.152 | 1.637 | 1.235 | 1.129 | 1.745 | 1.371 | 1.38 |
| | [0.226] | [0.218] | [0.185] | [1.067] | [1.055] | [1.116] | [1.135] | [1.133] | [1.208] |
| Absolute diff. | 0.721 | 0.918 | 0.919 | −0.889 | −0.255 | −0.074 | −2.145 | −1.588 | −1.592 |
| | [0.348] | [0.326] | [0.286] | [1.435] | [1.419] | [1.362] | [1.349] | [1.342] | [1.341] |
| Absolute diff. squared | −0.53 | −0.656 | −0.523 | −2.181 | −2.249 | −2.085 | −1.257 | −1.296 | −1.221 |
| | [0.355] | [0.329] | [0.286] | [1.485] | [1.495] | [1.492] | [1.157] | [1.164] | [1.249] |
| Constant | 0.825 | 0.467 | 0.385 | 0.266 | −2.045 | −2.407 | −1.173 | −2.723 | −3.044 |
| | [0.034] | [0.100] | [0.088] | [0.163] | [0.563] | [0.502] | [0.796] | [0.569] | [0.528] |
| Demographics | No | Yes | Yes | No | Yes | Yes | No | Yes | Yes |
| Other participation | No | No | Yes | No | No | Yes | No | No | Yes |
| Observations | 251 | 244 | 243 | 251 | 244 | 243 | 251 | 244 | 243 |
| *R*-squared | 0.07 | 0.24 | 0.42 | 0.05 | 0.19 | 0.25 | 0.12 | 0.23 | 0.24 |

*Notes:* All regressions are estimated from the part of the population that is within 1 standard deviation of the mandatory attendance cut off. Demographics include indicator variables for male, freshman, sophomore, junior, business major, global economics major and GPA as a continuous variable. Other participation includes total MSI (tutoring) attendance, section attendance rate and GPA in other courses taken concurrently.

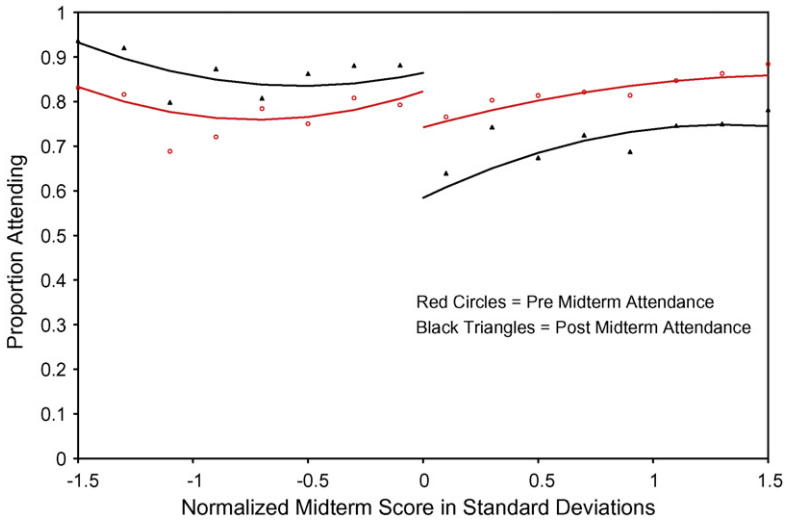


**Fig. 3.** Class attendance over support of midterm score.

We then narrow the sample window to compare only students close to the median. For students scoring within one standard deviation of the median, the pre-midterm differences in performance and attendance narrow between the mandatory and non-mandatory groups. Important differences remain, however, as the students in the non-mandatory group score higher on the final exam despite their lower rates of attendance post-midterm. This is likely due to the fact that the window is wide enough that we are still comparing students of differing abilities, as witnessed by the difference that remains between the groups in cumulative GPA.

The final column displays the coefficient on a mandatory attendance dummy from a regression of each variable on the quadratic control function from Eq. (2) without the covariates. These estimates describe how each variable differs between the mandatory and non-mandatory attendance groups at the policy threshold. We see that at the threshold, the post-midterm attendance rate is 36 percentage points higher in the mandatory attendance group. At the threshold, we fail to find a significant difference in most of the other outcomes or characteristics. Notably, we now begin to see the difference in the final exam scores between the mandatory and non-mandatory groups take on the expected sign.

In Fig. 2, we show how attendance varied across days during the quarter. In the thirteen class lectures prior to the midterm, the students that ended up scoring below the median on the midterm had consistently lower attendance. Attendance started out high in the first week and then tapered off, picking back up as the midterm approached. On the day the midterms are returned, attendance is near the highest for the entire quarter. On this day, students find out their scores and learn whether they are in the compulsory attendance group. On the day of the following lecture, the attendance rate of the voluntary group drops substantially

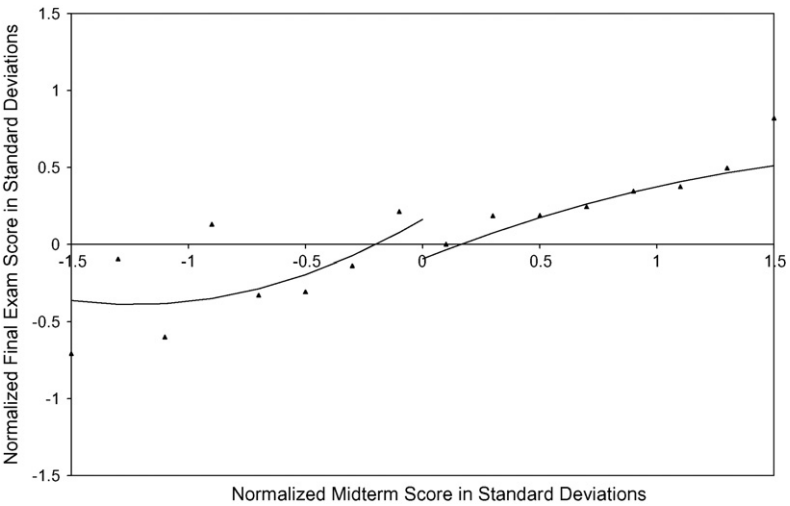


**Fig. 4.** Final exam over support of midterm score.

to only 60 percent, while the attendance rate of the mandatory group increases to 85 percent and hovers there for the remainder of the quarter. The pattern seen in the voluntary group resembles that observed in other classes on campus, where after the midpoint of the quarter, attendance drops off noticeably. It appears that the primary effect of the mandatory policy is in preventing the post-midterm attendance decline.

### 4.2. Compulsory attendance and attendance rates

We now employ the parametric specification from Eq. (2) to investigate the effect of the mandatory attendance policy on total attendance rates and final exam scores. In columns 1–3 of Table 3, we display the results of estimating the parametric regression discontinuity specification for the attendance rate variable. The sample we consider includes those students scoring within one standard deviation of the median of the midterm exam. This allows for a better fit of the polynomial control function to the exam score-attendance rate profile. We estimate that the total attendance rate is 27.7 percentage points higher at the threshold for the mandatory attendance group.

While the dependent variable in the above regression is the student's attendance rate for the entire quarter, the effect of the mandatory attendance policy comes from its impact on post-midterm attendance rates, as shown by Fig. 3.[6] In this figure, we plot the average pre- and post-midterm attendance rates in each of a series of 0.02 standard deviation wide midterm score bins. We see that there is virtually no discontinuity in pre-midterm attendance, while there is a large discontinuity in post-midterm attendance. This figure also shows that the quadratic functional form of the running variable fits the data well.

### 4.3. Compulsory attendance and final exam score

We next estimate how the final exam score varies across the policy threshold. Fig. 4 illustrates how the final exam changes over the support of the midterm. In this figure, we plot the mean final exam scores over a set of midterm score bins. Those students whose midterm score fell just below the median score noticeably higher than those students scoring just above the median. Interestingly, while there is a strong positive relationship between the midterm and final exam score, there is also significant mean reversion in the final exam scores. Students scoring 1 standard deviations above the median on the midterm only score just over 0.3 standard deviations above the median on the final exam.

In columns (4)–(6) of Table 3 we present the corresponding regression results. For those students scoring within one standard deviation of the cutoff, the estimated effect of compulsory attendance is 0.457 standard deviations higher on the final exam. The inclusion of other controls in addition to the quadratic control function seems to have a small effect on the results. With no controls, the discontinuity coefficient is −0.427. Adding controls for student characteristics such as gender, year in school, major, and cumulative GPA brings the coefficient to −0.413. The final coefficient of −0.457 is obtained when also controlling for TA section attendance, tutor attendance, and GPA in other courses in the same quarter.

### 4.4. Instrumental variables estimates

In columns (7)–(9) of Table 3, we present the instrumental variables results implied by specifications (2) and (3). In the full specification considering only those students within one standard deviation of the cutoff, we estimate a coefficient on the attendance rate variable of 1.653. This indicates that increasing the rate of attendance by ten percentage points would increase student performance on the final exam by 0.17 standard deviations.

### 4.5. Endogenous effort

The key identifying assumption in the regression discontinuity design is that unobserved factors affecting both attendance and performance are continuous across the policy threshold. We have presented evidence that immutable characteristics such as gender and year in school vary smoothly across the threshold. Student incentives, however, may change discontinuously as a direct result of the policy's implementation. Unobserved factors such as student effort outside class could as a result be discontinuous across the policy threshold.

There are several mechanisms through which the mandatory attendance policy can affect effort aside from class attendance. First, students may substitute effort across alternative forms of learning, so that students in the compulsory attendance group may respond to induced attendance by reducing effort in other ways. Second, assignment to the treatment group may provide a signal that a student's grade is inadequate, and conversely not being assigned to the treatment group may send a positive signal. Finally, students in the treatment group may incorrectly assume that missing class will directly result in a deduction from their course grade, leading them to compensate by studying harder and scoring higher on the exam.

To investigate the extent to which endogenous effort outside of class may be biasing our results, we examine the response of observable measure of effort to the mandatory attendance policy. While we do not observe time spent studying outside class, we do observe attendance to teaching assistant review sections, attendance to a university provided tutor service, and performance on homework assignments. While performance on homework assignments may in part reflect knowledge of the material, we suspect that it largely reflects effort on the part of the student.

In columns (1)–(3) of Table 4, we present estimates of how TA section attendance varies at the median of the midterm score. As in prior specifications, we focus on students scoring within 1 standard deviation of the midterm median. The regressions presented here suggest

[6] The regression is estimated off the individual data but to make the figure more interpretable we plot the averages for the cells rather than the underlying data.

**Table 4**
Other forms of effort and spillover effects on performance in other courses.

| | Section attendance | | | Homework scores | | | GPA other courses, same quarter | | |
|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| Above cutoff | −0.016 | −0.047 | −0.073 | −0.142 | −0.239 | −0.355 | −0.249 | −0.343 | −0.260 |
| | [0.102] | [0.106] | [0.105] | [0.417] | [0.373] | [0.351] | [0.330] | [0.327] | [0.332] |
| Diff. | 0.276 | 0.178 | 0.135 | 0.294 | −0.044 | −0.240 | 0.283 | 0.084 | 0.219 |
| | [0.362] | [0.355] | [0.352] | [1.003] | [0.915] | [0.918] | [1.046] | [1.022] | [1.023] |
| Diff. squared | 0.282 | 0.181 | 0.120 | 0.178 | −0.204 | −0.483 | −0.153 | −0.334 | −0.142 |
| | [0.403] | [0.393] | [0.390] | [1.126] | [1.006] | [1.021] | [1.111] | [1.094] | [1.104] |
| Absolute diff. | −0.152 | 0.053 | 0.215 | 0.259 | 1.105 | 1.837 | 1.329 | 1.957 | 1.443 |
| | [0.535] | [0.527] | [0.532] | [1.979] | [1.781] | [1.733] | [1.541] | [1.544] | [1.552] |
| Absolute diff. squared | −0.394 | −0.402 | −0.442 | −0.483 | −0.720 | −0.902 | −1.342 | −1.635 | −1.501 |
| | [0.556] | [0.573] | [0.568] | [1.956] | [1.700] | [1.665] | [1.524] | [1.542] | [1.543] |
| Constant | 0.350 | 0.040 | 0.030 | −0.027 | −2.679 | −2.727 | 2.902 | 1.263 | 1.295 |
| | [0.062] | [0.170] | [0.166] | [0.168] | [0.612] | [0.587] | [0.203] | [0.480] | [0.474] |
| Demographics | No | Yes | Yes | No | Yes | Yes | No | Yes | Yes |
| Other participation | No | No | Yes | No | No | Yes | No | No | Yes |
| Observations | 0.35 | 0.04 | 0.03 | 251 | 244 | 244 | 250 | 243 | 243 |
| *R*-squared | [0.062] | [0.170] | [0.166] | 0.01 | 0.27 | 0.3 | 0.04 | 0.14 | 0.18 |

*Notes:* The sample the regressions are estimated from include only individuals scoring within one standard deviation of the median on the midterm exam. Demographics include indicator variables for male, freshman, sophomore, junior, business major, global economics major and GPA as a continuous variable. Other participation includes total MSI (tutoring).

that there is no statistically detectable response of TA section attendance to the mandatory attendance policy. At the policy threshold, we estimate only a 1.6 percentage point reduction in the rate of TA section attendance. In columns (2) and (3), we show the results of including in the specification controls for demographics and attendance to tutoring sessions. In each case, the discontinuity in TA section attendance is estimated to be small and statistically insignificant.

Another measure of student effort is performance on the homework. In columns(4)–(6) of Table 4, we present estimates of how homework scores vary across the policy threshold. While this measure may be problematic since homework performance may be directly influenced by attendance, we feel that the largest component is student effort. Again, we see little evidence of a discontinuity in performance across the threshold. In the full specification, we find that students scoring just below the policy threshold in fact score 0.355 points *higher* on homeworks than students scoring just above the policy threshold. The homework score in this regression has been converted to a standard normal variable, so this estimated effect is quite modest in addition to being statistically insignificant.

These results also cast doubt on a separate source of endogeneity that may bias the results. Since course grades are determined by a student's relative standing in the class, mandatory attendance for those scoring below the median may have an equilibrium effect on the effort of students scoring above the median. First, the untreated students may anticipate the higher performance of the treated group and increase their effort to keep up, thereby biasing downward the estimated effect of attendance. On the other hand, untreated students may think there will be a penalty assessed on the treated students who fail to attend class and will feel that less effort is required, thereby biasing our estimates upward. However, we find no difference in measures of effort across the threshold. This would seem to rule out such equilibrium effects except in the unlikely case that the attendance policy effects effort equally for the treated and untreated students.

### 4.6. Spillover effects

The mandatory attendance policy is estimated to have significantly improved exam performance for affected students. However, this will not fully describe the policy's effects if it has spillover effects on academic performance in other classes. The policy could have an adverse spillover effect if attendance crowds out studying for other classes. On the other hand, it could have positive spillover effects if, for instance, there are fixed costs in traveling to campus, resulting in increased attendance in both the experiment class as well as other classes held on the same day. Spillover effects are not likely to be large in any case, as on average the policy induces students to attend one extra 70 min class per week.

To investigate this question, we examine students' GPA in other classes taken in the same quarter as the experiment class. In columns (7)–(9) of Table 4, we display the estimated discontinuity of other course GPA at the mandatory attendance threshold. With or without controls for student characteristics, student performance in other courses is not statistically significantly related to the class attendance policy. The estimated discontinuity coefficients are in fact negative, implying that students subject to mandatory attendance perform slightly better. However, in addition to being statistically insignificant, the estimated effect is quite small. In the full specification, we estimate that the mandatory attendance policy results in a 0.26 point increase in other course GPA for a student near the policy threshold. This is less than one-third of a standard deviation in GPA for the estimation sample. While these results do not rule out the possibility of adverse spillovers on other activities students engage in such as socializing or

extracurricular activities, they do suggest that the mandatory attendance policy has a positive effect on students' overall academic achievement.

## 5. Conclusion

In this paper, we provide evidence suggesting that class attendance significantly improves student performance. We rely on variation induced by a mandatory attendance policy, where students scoring below the median on the midterm were required to attend lecture during the second half of the course. This has potential policy implications for faculty looking for ways to improve student performance. First, our results suggest that attendance can be improved by instituting a mandatory attendance policy. Second, this improved attendance has the potential to boost learning, at least by moderately underperforming students, without adversely affecting their performance on other classes. However, it is worth noting that our results are a local estimate of class attendance returns, and it is likely that the return to class attendance varies across the distribution of students.

In light of the large estimated returns to attendance, our results raise the question as to why students tend to miss class. Are factors within the instructor's control to blame? What tradeoffs are students making when they skip class, and, as a result, might we make students worse off by requiring attendance? To answer these questions, we followed up our experiment by conducting two campus-wide surveys of lecture attendance.[7] First, we sent four research assistants to survey all large lecture courses taught at the UC Santa Cruz campus in the spring quarter of 2006. The research assistants counted the number of students attending and recorded various class characteristics. We find that immutable course characteristics, such as the time the course starts, play the largest role in determining attendance, and aside from making lecture attendance mandatory, factors within the instructor's control play little role in determining attendance rates. Next, we conducted a web survey of students across campus asking how many classes they missed in the prior week, why they missed those classes, and how they intended to make up for the absences. The majority of students missed at least one class, and the primary reason students do not attend class is that they slept in. Putting it all together, our results suggest that if the instructor's objective is to increase academic achievement, then it is worth considering a mandatory attendance policy.

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[7] More detailed results from these surveys are available from the authors on request.