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Does Supplemental Instruction for Principles of Economics improve outcomes for traditionally underrepresented minorities?

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ABSTRACT

Principles of Economics typically have a high non-success rate and traditionally underrepresented minorities (URMs) generally have a higher non-success rate than non-URMs. This paper describes our Supplemental Instruction (SI) course and tests the effectiveness of SI on grade improvement, while accounting for self-selection bias. We find that SI improves grades by a bit less than half a letter grade in the full sample and by a larger amount for URMs and a smaller amount for non-URMs. We also find evidence that weaker URM students and stronger non-URM students are more likely to enroll in our SI course.

1. Introduction

Supplemental Instruction (SI) is a tool to help students succeed in courses that traditionally have high non-success rates (i.e., the percentage of students earning less than a C-, including D, F, and WU (unofficial withdrawal)). It was first developed in 1973 by Dr. Deanna Martin, at the University of Missouri, Kansas City and is based on a number of behavioral learning, cognitive development, and social interdependence principles (Hurley et al., 2006). Students engage in cooperative learning exercises that enhance positive reinforcement of the material, help them to break down complex tasks

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and think differently about core concepts, and work together to discover answers (Hurley et al., 2006). SI is not considered remedial because it focuses on high-risk courses rather than high-risk students (UMKC, n.d.). It is open to all students and all students are encouraged to attend SI sessions.

SI makes use of such high-impact practices as cooperative learning and other active learning techniques. These pedagogical techniques are strongly correlated with student engagement, and hence, success and retention (Kuh, 2008). Based on research about how the brain works, Doyle (2011) concludes that "one who does the work does the learning" (pg 3) and hence learner-centered teaching is essential for higher-level learning and retention of material. There is also empirical evidence that cooperative learning improves academic achievement. For example, Yamarick (2007) incorporates cooperative learning techniques into his intermediate macroeconomics course and finds that student exam grades improve by about a half a letter grade compared to students in his lecture section. Springer et al. (1999) find that small-group learning improves academic achievement in math-based disciplines. Thus, adding SI to lecture-based courses may provide an important opportunity for improved student learning.

Although there has been a plethora of studies demonstrating the effectiveness of SI in terms of grade improvement in targeted courses (see Hensen and Shelley, 2003; Congos and Schoeps, 1993), retention (see Blanc et al., 1983; Ogden et al., 2003), and graduation success (see Bowles et al., 2008; Arendale, 1997), much of the research on SI has not effectively accounted for self-selection bias. Thus, it is unclear if this effectiveness is due to the direct effect of SI, or if it is because more motivated students tend to take SI courses. Alternatively, the benefits of SI might be understated if weaker students tend to take SI courses.

Huynh et al. (2010) use a treatment effects model from the program evaluation literature to account for self-selection bias. They estimate the average treatment effect (ATE) on course grades from students participating in optional collaborative learning recitation sessions and find a positive and significant impact. Stock et al. (2013) use a similar technique and find that collaborative learning techniques in voluntary recitation courses have a positive and significant effect on outcomes in a lower-division general education economics course. Other studies use a two-stage Heckman-like endogenous treatment effects model to account for self-selection bias and find that the benefits of SI are understated by the ordinary least squares (OLS) estimator, indicating that weaker students tend to take SI (see Loviscek and Cloutier, 1997; Bowles and Jones, 2003a,b; Lewis et al., 2005).

In this paper, we focus on traditionally underrepresented minorities (URMs), including Hispanics, African Americans, and Native Americans. Specifically, we measure the impact of SI on grades in our Principles of Economics course, adjusting for self-selection bias. Following Huynh et al. (2010), we use several treatment effects models from the program evaluation literature to measure the average treatment effect (ATE) of SI. We begin by describing our SI program and how it compares to traditional SI programs.

2. Our SI program

Principles of Economics courses are "gateway" courses for both the Economics and the Business major and typically have high non-success rates. Our university has a one-semester Principles of Economics course (Econ 210) that covers both micro and macro principles in one four-unit course. There is no evidence that one-semester principles courses have higher non-success rates than two-semester principles courses. Our 2010 "Dissecting Diversity at Humboldt State University Report" found that, in AY 09-10 (prior to our implementation of SI), 19% of all students failed to succeed in Econ 210 and Students of Color (SOC) failed 35% more than White students (Webley and Yancy, 2010).

For several years prior to implementing our SI program, we offered an optional one-hour group tutoring session run by undergraduate student instructors. However, unlike SI, these students were not trained to run these sessions and were not versed in collaborative learning techniques. Most student instructors simply lectured on the more difficult material, answered questions, helped students solve homework problems, and ran review sessions before exams. Some student instructors were better than others. Furthermore, attendance was highly variable. Most weeks only one or two students would attend, whereas before an exam half the class would attend the review session. Given the high non-success rate in the Econ 210 and the ineffectiveness of our voluntary group tutoring model, we decided to implement SI in fall 2011.

The traditional SI model focuses on study skills and collaborative learning. Students are encouraged to attend regularly, but they usually do not take the course for credit and participation rates are highly variable. Student instructors attend the main course and develop their own materials under the guidance of a staff member in the Learning Center (or equivalent). The faculty role is primarily for promotion of the program and gathering data (Hurley et al., 2006).

Our program is similar to traditional SI programs in many ways. First, it is voluntary and we encourage all students to enroll, regardless of aptitude, thus targeting the high-risk course rather than the high-risk student and removing the stigma associated with remediation. Second, we hire undergraduate students (peers) to lead the SI sessions and we offer guidance and training to these student instructors. Finally, we focus on collaborative learning and the development of problem-solving skills.

However our program differs from traditional SI programs in two key ways. First, we offer our SI course for credit. Second, we house our SI program in the Economics Department rather than the University Learning Center. We elaborate on each difference below.

Econ 210 students enroll in a 1-unit course (Econ 210L: Supplemental Instruction) associated with their Econ 210 course. This SI course meets for two hours each week, usually on Friday. It is a credit/no credit course, where students must attend more than 70% of the SI sessions to earn credit.[1] One advantage of having a credit-based SI course has to do with perception. Because the course number (Econ 210L) is directly associated with the target course (Econ 210), SI gains legitimacy in that it looks official on a student's transcript and it does not appear as a remedial course. A second advantage has to do with participation rates. Our University Learning Center recently reviewed SI programs in Western states and found that those that offer SI for credit have higher and more consistent participation rates. This is indeed what we have experienced. During our first year of SI (AY 2011–12), 25% of the Econ 210 class enrolled in SI. In the second year, enrollment increased to 35%. In fall 2013, the last semester of our sample, 40% of the Econ 210 class enrolled. On average, 82% of students enrolled in SI attend enough sessions to earn credit. Many studies find that SI improves student success, however, if participation rates are very low, only a small portion of students are benefitting from this high-impact practice. Our SI enrollment target is to eventually reach 50% of Econ 210 students.

By housing our SI program in the Department of Economics rather than the University Learning Center, we were free to design a course that would best meet our needs. The SI course we designed could be thought of as a hybrid between traditional SI and traditional recitation courses. It is similar to traditional recitation courses in that it is primarily focused on deepening students' understanding of target course content. However, like traditional SI courses, a key focus is on using collaborative learning to build the problem-solving skills that are essential for success in any Principles of Economics course. The structure of the target course (Econ 210) is primarily lecture and instructors are generally not using many cooperative-learning and active-learning activities, so our SI course provides a distinctly different learning experience that complements the target course.

SI activities include documented problem-solving questions, games, experiments, and discussions, all of which help strengthen a student's understanding of the target course material. These activities have value not only for weaker students, but also for more motivated students who may be interested in exploring the course material in more depth than is possible in the main class. Furthermore, unlike traditional SI programs, if time remains, students can work on their homework and ask questions of each other or the student instructor.

Students spend the first part of the SI class working on documented problem-solving questions. The student instructor displays a question in PowerPoint. The SI students solve the problem independently and write down how they solved it. They then break up into small groups to discuss their answers and approaches, thus helping to hone their problem-solving skills. Next, the student instructor asks students about their answers and they discuss any difficulties before displaying the PowerPoint slide with the answers. The second part of the SI class is activity based. For example, during the elasticity chapter, students participate in a simulation that requires them to create their own individual demand curves for some typical student products. Then they break up into groups to create a market demand for their group. After a price change, students calculate the price and cross-price elasticities. After the simulation,

[1] Many SI studies identify SI participants using a much lower participation requirement. For example, Hensen and Shelley (2003) only require attendance at one session and Congos and Schoeps (1993) only require attendance at five sessions.

students remain in their small groups to discuss several real-world scenarios where assumptions about elasticity have led policy makers to arrive at the wrong conclusions. Students discuss what assumptions are being made and whether or not those assumptions make sense. Finally, the last part of class (only if time permits) gives students an opportunity to work on their homework. As a result of our SI course configuration, many students view our SI course as a depth of study course rather than a remediation course.

Furthermore, we advertise our SI course as both a vehicle for getting an A in Econ 210 and as a key resource for students who struggle with math (see Appendix A for flyer). Advisors strongly recommend this course to all students enrolling in Econ 210, regardless of aptitude. Hence, we tend to draw students with a wide range of experiences and aptitudes. Most Economics majors take it out of interest, even though they would most likely earn a passing grade without SI. However, we also draw a disproportionate number of under-represented minorities (URMs), who tend to struggle with math-based courses.

Our SI program is also structurally different from the traditional model. In our program, the SI course materials are developed by an Economics faculty coordinator rather than the student instructor or the learning center. The student instructor is given detailed instructions on how to prepare for each activity and they meet regularly with the Econ 210 instructor and the faculty coordinator for mentoring and guidance. This ensures that the SI activities are relevant to the material covered in the target course that week.

In general, our model is relatively inexpensive. The faculty coordinator is the instructor of record for the SI course (Econ 210L) and hence compensated via the teaching units associated with the SI course. This cost is often less expensive than hiring the learning center to run these courses. The undergraduate student instructors are paid $10.50 per hour and typically spend three hours per week on preparation and teaching. In our case, the faculty coordinator has been the department chair, but it could be any tenure-line faculty member in the Economics Department. To maintain continuity and quality control, we have found it desirable to limit this role to permanent faculty. The faculty coordinator works with the instructor of the Econ 210 course to ensure that the SI activities match up with their course content for that week.

3. Data and descriptive statistics

Our SI program began in fall 2011 and our sample begins in spring 2012 and continues through fall 2013. Our data are from ten sections of Econ 210 over four semesters taught by five different instructors. Each fall, two sections of the target course (Econ 210) are offered by the same instructor. In the spring, we offer three sections of Econ 210, split between two instructors. Only one instructor has taught more than one semester in the sample period. We therefore normalize the course grades[2] and include instructor dummy variables to account for differences across instructors and semesters. The excluded dummy is the instructor who taught more than one semester. Each Econ 210 course has an enrollment of between 37 and 40 students.[3]

There were 122 students who enrolled in SI and 100 of them (82%) earned SI credit. However, the grade distribution of the 22 students who did not earn SI credit is substantially lower than either those who did not enroll in SI or those who earned credit in SI. There were no As in this group and they had a 41% non-success rate (compared to 17% for those not enrolled in SI and 4% for those who earned credit in SI). The average grade for this group is 67% (compared to 78% for those not enrolled in SI and 83% for those who earned credit in SI). The URM vs. non-URM make-up of this no-credit group is proportionately the same as those who enroll in SI, thus, it does not appear that URMs are any more or less likely to fail to earn credit in SI.

Unfortunately, we do not have attendance data prior to fall 2013, thus we do not know how many SI sessions these no-credit students attended. Based on the attendance data we do have and discussions

[2] We normalize grades so that the highest student grade for each instructor in each semester is 100% and all other students' grades are relative to that highest grade.

[3] This is based on enrollment at the time of "census," which occurs at the end of the fourth week of classes. Any students who dropped the course prior to census cannot be tracked and hence are not included in this study. In addition, any students who officially withdrew from this course after census are not included.

Table 1
Variables used in the analysis.

Grade	Dependent variable: normalized percentage grade in the target course
SI	Equal to 1 if the student took the Supplemental Instruction course
UGPA	Overall GPA for courses taken at our university prior to enrolling in Econ 210
Math Ready	Equal to 1 if the student did not need to take math remediation prior to enrolling in Econ 210
Major	Equal to 1 if the student is majoring in Business or Economics
URM	Equal to 1 for traditionally underrepresented minorities (Hispanics, Blacks, Native Americans)
Female	Equal to 1 if female
Instructor	Series of instructor dummy variables

with past student instructors, it appears that the vast majority of students who do not receive credit attend 0–2 sessions, usually at the beginning of the semester. However, it is possible that a small number of these students attended several SI sessions (although fewer than required for SI credit). Because this group is so much weaker, we are concerned that we bias our results by including them with either the non-SI or the SI groups. Thus, we have chosen to eliminate these students from our sample.[4]

Table 1 lists the variables used in our analysis. These data were collected from our Institutional Research Center. The UGPA variable is the student's GPA prior to taking Econ 210. For the two first-time freshmen in the sample, we used their high school GPA. For the 41 transfer students in the sample, we used their transfer GPA. We eliminated four students because they were extended education students and did not have available GPAs. There were seven students who enrolled in Econ 210 more than once during our sample period.[5] We only include their first attempt since we cannot account for the impact on course grade associated with repeating a class.[6] There are 338 students in our sample, 100 of which are SI students.

Table 2 reports our descriptive statistics. The first three columns display the statistics for the full sample and differences between SI and non-SI students. The last six columns separate the sample into URMs and non-URMs. Across the four-semester pooled sample, 30% of our sample are "SI students" (32% of URMs and 28% of non-URMs are SI students). A difference-in-means *t*-test indicates that the uncontrolled average grades of SI students are significantly higher than non-SI students by 5.3 percentage points. This is true for both URMs and non-URMs (each are 5.5 percentage points higher). However, looking at the explanatory variables across SI and non-SI students (see columns 2–3, 5–6, and 8–9 in Table 2), we do not see significant differences in the means for most of the variables. We do see that non-URM SI students have significantly higher average GPAs compared to non-SI students, perhaps indicating that more motivated (stronger) non-URM students are drawn to SI. However, the average GPAs for URMs do not vary much between the SI and non-SI groups. In the full sample, the average GPA for SI students, although larger, is not significantly different from the average GPA for non-SI students. We also see a significant difference in the Female variable mean across all three groups, indicating that a disproportionate number of female students (both URM and non-URM) take SI. Although not statistically significant, we do see a disproportionate number of URMs and students who needed math remediation[7] (not Math Ready) take SI, perhaps indicating that students who need more help (weaker) are drawn to SI. But, we also see a disproportionate number of Business and Economics majors taking SI, perhaps indicating that more interested students take SI. Thus, it is not clear, a priori, whether our SI course attracts more motivated students or weaker students.

We do see some significant differences between URMs and non-URMs. Comparing columns four and seven of Table 2, we see that URMs have significantly lower uncontrolled means for Grade and UGPA than non-URMs. In addition, we also see a significant difference in the mean of the Math Ready variable, indicating that a disproportionate number of URMs needed math remediation prior to taking

[4] When we try to account for these students by including a dummy for NC in SI, we cannot run our treatment effects model because the maximum likelihood estimator does not converge. However, including this dummy in OLS and running OLS with the eliminated data both reduce the benefit of SI by about the same amount.

[5] All of these students failed to earn a C- or better on their first try and one student failed twice. University policy prohibits students from retaking a course if they earn a C- or better.

[6] Unfortunately, we do not have data on students prior to our sample period, thus it is possible that there may be a couple of repeat students in our sample if they first took Econ 210 prior to spring 2012.

[7] All students must have completed their math remediation prior to enrolling in Econ 210.

Table 2
Descriptive statistics: variable means with standard errors in parentheses.

Variables	Full sample			URM			Non URM		
	Total	SI	Non SI	Total URM	SI	Non SI	Total Non URM	SI	Non SI
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Grade	79.5	83.2***	77.97	75.44[a]	79.2*	73.7	81.75	85.7***	80.17
	(0.77)	(0.95)	(1.0)	(1.4)	(1.42)	(1.91)	(0.89)	(1.16)	(1.13)
SI	0.30	–	–	0.32	–	–	0.28	–	–
	(0.02)			(0.04)			(0.03)		
UGPA	2.69	2.76	2.66	2.53[a]	2.52	2.54	2.78	2.91**	2.72
	(0.03)	(0.06)	(0.04)	(0.06)	(0.09)	(0.07)	(0.04)	(0.07)	(0.05)
Math Ready	0.81	0.76	0.83	0.68[a]	0.66	0.69	0.88	0.82	0.9
	(0.02)	(0.04)	(0.02)	(0.04)	(0.08)	(0.05)	(0.02)	(0.05)	(0.02)
Major	0.77	0.83*	0.74	0.79	0.84	0.77	0.76	0.82	0.73
	(0.02)	(0.04)	(0.03)	(0.04)	(0.06)	(0.05)	(0.03)	(0.05)	(0.04)
URM	0.35	0.38	0.34	–	–	–	–	–	–
	(0.03)	(0.05)	(0.03)						
Female	0.37	0.49***	0.32	0.39	0.53**	0.33	0.35	0.47**	0.31
	(0.03)	(0.05)	(0.03)	(0.05)	(0.08)	(0.05)	(0.03)	(0.06)	(0.04)
Obs	338	100	238	119	38	81	219	62	157

Using a two-sample *t*-test, the variable means for the SI group are significantly different from the non-SI group means:
* $p<0.1$.
** $p<0.05$.
*** $p<0.01$.
[a] Using a two-sample *t*-test, the variable means for the URM group are significantly different from the non-URM group means at the 1% level.

Econ 210 (only 68% of URMs were math ready compared to 88% of non-URMs). Thus, URMs are more likely to be at risk of failing Econ 210 and access to SI is especially important for them. We have been successful in recruiting URMs into the SI courses; URMs make up 38% of the SI class and only 35% of the Econ 210 class.

Figs. 1–3 show the grade distributions by SI for the full sample and for URMs and non-URMs. We notice that the grade distribution is generally higher for SI students and there are fewer Ds and Fs in all three graphs. However, we also notice a distinction between URM and non-URM SI distributions. The disproportionate number of Cs and Bs in Fig. 2 may indicate that a large number of URM students might have failed Econ 210 without SI and that the SI course may have helped this group to succeed in the target course. For non-URMs, the disproportionate number of As in Fig. 3 may indicate that many of these students would have passed the target course even without SI and that the SI course may have helped this group increase their grades from a C to an A or a B. Thus, these graphs provide some indication that there is a difference between the URM and non-URM samples. In particular, weaker URMs and stronger non-URMs tend to become SI students. Furthermore, this indicates that our segmented marketing strategy is working, since we are attracting both stronger students interested in getting an A and weaker students who may struggle with math-based courses.

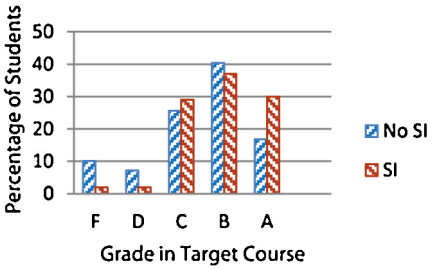

Fig. 1. Grade distributions by SI: full sample.

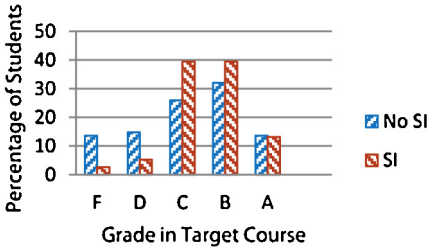

Fig. 2. Grade distribution by SI: URMs.

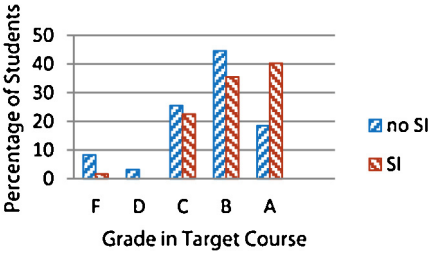

Fig. 3. Grade distribution by SI: non-URMs.

Table 3 shows the non-success rates across semesters by SI and URM status. In general, we see lower non-success rates for SI students in each semester regardless of URM status.[8] In fact, in the four-semester average, we see significantly lower non-success rates for SI students in all three samples. In the full sample, only four SI students, out of 100 (4%), failed to earn a C- or better in Econ 210.[9] This compares to a non-success rate of 17.2% for non-SI students. Although URMs in SI still experienced a 7.9% non-success rate, URM students who did not take SI experienced a significantly larger non-success rate of 28.4%. We also note that the overall non-success rates have fallen for all students over the four-semester period.

Table 3
Non-success rates (% of students with D, F, or WU) by semester, SI, and URM.

Semester	Full sample			URM			Non-URM		
	All	SI	No SI	All	SI	No SI	All	SI	No SI
S12	19.6%	9.1%	22.5%	33.3%	18.2%	40.9%	13.0%	0%	15.5%
F12	12.9%	0%**	19.6%	21.1%	0%*	36.4%	9.8%	0%	14.3%
S13	10.4%	6.7%	12.1%	21.2%	9.1%	27.3%	4.8%	5.3%	4.5%
F13	8.6%	0%*	13.0%	11.8%	0%	15.4%	5.6%	0%	10.0%
4-sem avg	13.3%	4%***	17.2%	21.8%	7.9%**	28.4%	9.9%	1.6%**	11.5%

Using a two-sample *t*-test, the variable means for the SI group are significantly different from the non-SI group means:
* $p<0.1$.
** $p<0.05$.
*** $p<0.01$.

[8] Many of the difference in means by semester are large but not significant due to small sample size. In S13, a very small number of non-URM students failed and one of them was an SI student (the only one over the 4-semester time period).
[9] Three of them were URMs.

4. Empirical methods and results

When students take SI, they are considered part of the treatment group. We wish to determine whether or not getting the treatment affects the students' grade in the target course. Because students are not randomly placed in the treatment group, there is the potential for self-selection bias when certain students choose to take SI and others do not. Because some of the same characteristics that determine grades in the target course are also characteristics that might compel a student to choose SI, the outcome and the treatment are not independent and this introduces bias into the OLS estimator (StataCorp, 2013).

One way to correct for this bias is to use a treatment effects model, which is an econometric technique from the program evaluation literature (Huynh et al., 2010). This method uses a potential outcomes (or counterfactual) framework, where the unobserved outcome is estimated using the explanatory variables in the model (StataCorp, 2013). Effectively, the selection bias is an omitted variable bias because, we cannot observe the grade that SI students would have earned if they had not had not taken SI, or the grades that non-SI students would have earned if they had taken SI (StataCorp, 2013). These unobserved grades are the potential grades that are estimated by the treatment effects estimator. The average treatment effect (ATE) is the expected effect of SI on grades in the target course. It is estimated by taking the average of all the observed and potential grades for SI students and subtracting it from the average of all the observed and potential grades for non-SI students (StataCorp, 2013). A key assumption of this model is conditional independence.[10] This means that once all of the observable variables are controlled for, our outcomes (grades) are independent of whether or not students chose to enter the treatment group (SI) (StataCorp, 2013).[11]

We use four treatment effects models to estimate the potential outcome mean (POM) and the average treatment effect (ATE). The first is the Regression Adjustment (RA) model that uses a linear regression of grades on the explanatory variables for each group to predict the potential grades for students in each group (StataCorp, 2013). The second model is Inverse-Probability Weighting (IPW) that uses the regression of SI on the explanatory variables (a Probit in our case) to determine the weights that should be used to counteract the omitted variable bias when regressing grades on the explanatory variables (StataCorp, 2013). The next two models are "double-robust" models in that they combine the outcome modeling focus of RA and the treatment modeling focus of IPW (StataCorp, 2013). An advantage of these doubly robust estimators is that we can still get a correct estimate for ATE even when only one of the models (output or treatment) is correctly specified, since each corrects for a misspecification in one of the models (StataCorp, 2013). The Augmented Inverse Probability Weighting (AIPW) estimator augments the IPW model with an extra term that corrects for a misspecification of the treatment model (StataCorp, 2013). The Inverse Probability Weighting Regression Adjustment (IPWRA) estimator uses the estimated inverse probability weights to correct for a misspecification of the output model. However, if both models are specified correctly, then these extra corrections do not affect the ATE estimate (StataCorp, 2013).

Table 4 reports the potential outcome mean (POM) without SI and the average treatment effect (ATE) for the full sample, URMs, and non-URMs, using each of the above mentioned estimators. We also report the OLS results for comparison purposes. We see very similar estimates regardless of the estimator and all ATE estimates are significant at either the 1% or the 5% level. For the full sample, the benefit of SI is a bit less than a half a letter grade (between 3.96% and 4.21%), bringing the potential average grade up about 4.1 percentage points from about 78.25% without SI to about 82.35% with SI. For URMs, the benefit is larger (6.49–6.69%), increasing the POM about 6.6 percentage points from about 73.5–80.1%. For non-URMs the benefit is smaller (2.94–3.75%), increasing the POM about 3.4 percentage points from about 80.7% to 84.1%. These results indicate that, after accounting for self-selection bias, the impact of SI has a positive and significant impact on grades in the target class. Furthermore, the benefit of SI for URMs is

[10] The other two assumptions are (1) overlap, meaning that students with the same characteristics could appear in either the treated or untreated group; (2) independent and identically distributed sampling assumption, meaning that the outcome and treatment status of students does not affect other students.

[11] The conditional independence assumption would not hold if there are unmeasurable or unobservable characteristics (such as motivation) that are correlated with both the students' decision to take SI and the dependent variable (Grade). However, it is possible our UGPA and Major variables are good proxies for motivation and that our Math Ready variable is a good proxy for ability. Thus, it is possible that conditional independence is a reasonable assumption in our model.

Table 4
Potential outcome means (POM) and average treatment effect (ATE) (robust standard error in parentheses).

Treatment models	Full sample	URM	Non URM
Regression Adjustment			
POM w/out SI	78.29%	73.47%	80.78%
ATE	3.96***	6.49***	2.94**
(robust std. err.)	(1.2)	(1.95)	(1.49)
Inverse-probability weighted			
POM w/out SI	78.19	73.53	80.57
ATE	4.21***	6.69***	3.75***
(robust std. err.)	(1.18)	(1.94)	(1.4)
Double robust augmented inverse probability weighted			
POM w/out SI	78.25%	73.41%	80.73%
ATE	4.08***	6.61***	3.26**
(robust std. err.)	(1.19)	(1.94)	(1.46)
Double robust inverse probability weighted regression adjustment			
POM w/out SI	78.25%	73.43	80.74
ATE	4.15***	6.6***	3.6**
(robust std. err.)	(1.19)	(1.93)	(1.42)
OLS (for comparison)			
Coefficient on SI	4.19***	6.21**	3.47**
(std error)	(1.45)	(2.75)	(1.71)
Avg. POM w/out SI	78.25%	73.5%	80.7%
Avg. POM w/SI	82.35%	80.1%	84.1%
Avg. ATE	4.1	6.6	3.4

The potential outcome mean (POM) is the estimated potential average grade for all students without SI. It is based on the observed non-SI student grades and the estimated SI student grades if they had not taken SI.
The average treatment effect (ATE) is the expected effect of SI on Grades in the target course.
Significant at:
* $p < 0.1$
** $p < 0.05$.
*** $p < 0.01$.

larger than for non-URMs. For those committed to helping URMs be successful in difficult gateway courses, these results provide support for using SI programs to achieve this goal.

Comparing the OLS estimates with our average ATE, we see some additional evidence that stronger non-URMs and weaker URMs tend to take our SI course. The average ATE is slightly smaller than the OLS estimate for the non-URM sample, indicating a possible positive selection bias that would imply that more motivated non-URM students tend to take SI. Meanwhile, the ATE for the URM sample is slightly larger than the OLS estimate, indicating a possible negative selection bias that would imply that weaker URM students tend to take SI.

5. Conclusions

In an attempt to improve student success in Principles of Economics, especially among traditionally underrepresented minorities (URMs), we implemented Supplemental Instruction (SI) in fall 2011. We began collecting data during the second semester of our SI program and have thus far collected four semesters worth of data. A means analysis on the uncontrolled means and an OLS regression both indicate a positive impact of SI on students' grades in the target course for all students. Because of self-selection bias, OLS regression results are likely to be biased. We use several treatment effects models to correct for the self-selection bias. Consistent with Huynh et al. (2010) and Stock et al. (2013), our estimated ATE indicates that SI has a positive and significant impact on target course grades for all students. Furthermore, we find that the increase in grades attributed to SI is larger for URMs than for non-URMs, indicating that SI can play an important role in improving URM success in difficult gateway courses.

We also find evidence that our SI course tends to attract weaker URMs and stronger non-URMs. Past studies found that weaker students tended to be attracted to SI and hence the self-selection bias was negative. Our URM sample seems consistent with past studies in that weaker URM students take SI. However, contrary to past studies, our non-URM sample indicates that more motivated non-URM students take SI. We believe that the difference in our results stems from our SI course structure and advertising strategy that induces a larger than expected proportion of stronger non-URM students to take SI.

Appendix A. Promotional flyer for SI

Interested in getting an A in ECON 210?

Enroll in ECON 210L and increase your chances!

Supplemental Instruction will help you be successful in ECON 210

This **1-unit, credit/no credit course** strengthens understanding of key micro and macroeconomic principles needed for your business or economics major.

ALL students will benefit from this Supplemental Instruction course, but if you generally struggle with math, then you will find the extra problems, examples and activities, especially valuable.

For [Instructor name] Econ 210 sections, sign up for either:
ECON 210L (CRN 27275) that meets R 6-7:50pm
ECON 210L (CRN 27276) that meets F 10-11:50am

For [Instructor name] Econ 210 section, sign up for:
ECON 210L (CRN 27277) that meets F 12-1:50pm

If you have any questions, please email [Beth Wilson], Economics Department Chair, at

[bwilson@humboldt.edu].

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