Working Paper:

Can Text Message Nudges Improve Academic Outcomes in College? Evidence from a West Virginia Initiative

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While socioeconomic disparities in college enrollment have declined over the last decade, gaps in college completion remain pronounced by income and geography. A growing body of research investigates how informational barriers and behavioral obstacles contribute to these persistent inequalities. We investigate the association between a text messaging campaign to provide lower-income college students in West Virginia with simplified information, encouragement, and access to one-on-one advising, and their subsequent academic outcomes. This is the first study of which we are aware to examine the relationship between a low-touch, behaviorally-informed messaging campaign and lower-income, rural college students' academic outcomes. Students participating in the texting campaign tend to complete more freshman year credits compared with similar students who did not have the opportunity to sign up for the text campaign by virtue of the high school they attended. These differences were most pronounced for low-income students and students enrolled at higher education institutions which delivered a supplemental, school-specific text message campaign throughout the first year in college, indicating colleges have an important role to play in communicating information about academic expectations, support resources, and community norms.

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I. Introduction

While college enrollment has increased substantially over the past few decades, there are persistent enrollment and degree attainment inequalities by family income and geography. Despite overall enrollment growth, the total share of Americans with a college degree is essentially unchanged since 1980 and socioeconomic inequalities in college completion have actually widened over time (Aud et al, 2013; Bailey & Dynarski, 2012; Bound, Lovenheim, & Turner, 2010). These gaps in college success persist even after controlling for students' academic achievement (Belley & Lochner, 2007; Kena et al, 2015; Long & Mabel, 2012). Students from rural areas are 2-16 percentage points more likely than their non-rural peers to come from lower-income families making less than $50,000 a year (Player, 2015). Even after accounting for family income and academic preparation, students from rural areas are less likely to earn a bachelor's degree than non-rural peers (Pierson & Hanson, 2015; Player, 2015). Educators and policy makers have invested substantial resources to address these inequalities; historically, these strategies focused primarily on improving academic readiness and college affordability. More recently, however, researchers have investigated how informational barriers and behavioral obstacles contribute to socioeconomic and geographic disparities in college success.

Students encounter a series of complex decisions on the path to and through college, from deciding initially where to apply and navigating the financial aid process to completing required pre-matriculation tasks, choosing which classes to take, and renewing financial aid (Castleman, 2015a; Castleman, 2015b; Ross, White, Wright, & Knapp, 2013; Scott-Clayton, 2015). Lower-income and first-generation students often lack access to professional assistance to navigate these decisions, and while their parents often want to help, they may lack the personal experience or confidence to do so (Castleman & Page, 2014; Lareau, 2003). In the face of this complexity, students may put off completing important tasks or making a decision and miss key deadlines; use simplifying strategies to decide where to apply or enroll (e.g., choosing a college that has nice dorm rooms); or stick with the status quo rather than making an active choice (Castleman, 2015a; Thaler & Sunstein, 2009). These behavioral responses can result in students not applying to well-matched colleges, completing financial aid applications, or successfully matriculating in college (Bettinger, Long, Oreopoulos, &

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Sanbonmatsu, 2012; Castleman & Page, 2014; Hoxby & Avery, 2012; Hoxby & Turner, 2013). Students living in rural areas are especially likely to "undermatch" to a less academically rigorous college than expected based on their prior academic performance – potentially because of a strong connection to family and hometown, but also possibly related to lack of information about academic options and/or access to one-on-one advising resources (Beasley, 2011; Smith, Pender, & Howell, 2013; Hoxby & Avery, 2013).

Researchers have designed and evaluated, often through randomized controlled trials, a range of behaviorally-informed strategies to help students navigate these critical junctures and follow through on their collegiate aspirations. These interventions include sending high-achieving, low-income students semi-customized information about high-quality, affordable colleges that might be a good match for their abilities; incorporating financial aid assistance into the income tax preparation process; and sending students personalized text messages about required pre-matriculation tasks (Bettinger et al., 2012; Castleman & Page, 2014; Hoxby & Turner, 2013).

While each of these—and other similar—interventions led to substantial increases in college entry or persistence, all were implemented while students were still in high school. By comparison, there is relatively little rigorous evidence about whether and how low-touch, behaviorally-informed interventions can improve college persistence and academic success for lower-income populations once they have matriculated to colleges and universities. Two prior studies include an RCT evaluation of a private college coaching program that offered phone-based coaching for college freshmen and a text messaging intervention that reminded college freshmen to renew their financial aid (Bettinger & Baker, 2013; Castleman & Page, forthcoming). Both studies found that nudges and advising can lead to improved persistence in college.

We build on this foundation and investigate whether a text messaging campaign in West Virginia that provided lower-income college students who had participated in the federally-funded Gaining Early Awareness and Readiness for Undergraduate Programs (GEAR UP) college access program with information, encouragement, and individualized assistance led to improved academic outcomes. The West Virginia Higher Education Policy Commission (WVHEPC) implemented the texting campaign; WVHEPC began texting students during the second half of senior year in high school, with messages focused primarily on financial aid applications and college choice. All graduates from the GEAR UP high schools who consented to receive texts were enrolled in the WVHEPC text messaging campaign.

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WVHEPC continued to message students during the summer after high school and into the first year of college. Students accepted to one of the two partner colleges (College A and College B) also received regular messages directly from the institutions, beginning in the spring of their senior year in high school and continuing through their first year in college.[1] Upon matriculating in college, most students received messages approximately 1-2 times per month (3-4 times a month for student at Colleges A and B) on topics ranging from meeting with an academic advisor and the availability of tutoring to financial aid renewal and course registration for the next term.

Our paper extends prior research in several important ways. First, most of the prior nudge research in education has been implemented by high schools, community-based organizations, or for-profit entities. Ours is the first study of which we are aware to investigate — in the case of Colleges A and B — a texting campaign in which colleges actively reached out to students via a low-touch texting campaign. This focus on the role of higher education institutions is important given national calls (including a White House Summit in 2014) for colleges and universities to more proactively contribute to reducing socioeconomic disparities in higher education. Second, we are able to observe a richer set of outcome measures than prior studies, which have primarily focused on fairly coarse measures of persistence from one term to the next. Using data from WVHEPC, we investigate the relationship between texting campaign participation and specific academic outcomes in college, including the number of credits students attempt and complete and their first-year GPA.

Finally, most prior work has focused on the impact of nudges on urban student populations, yet rural students face arguably greater barriers to accessing professional advising given how geographically distant they often are from school- or community-based supports. Individuals living in rural areas are also less likely to own a smartphone as their primary phone, bringing to question whether text messaging interventions would have the same positive effects as they have in urban settings (Smith, 2013). Our paper provides valuable evidence of how rural students respond to and engage with mobile-based strategies to improve college outcomes.

While the texting campaign began in the senior year of high school, due to data limitations we only have access to the population of students who matriculated in college. Our analyses therefore focus on the relationship between texting college freshmen and their first-year academic success. Because students were not randomly assigned to the freshman year messaging campaign, we

[1] Students at two additional partner institutions received several messages from the institutions during the spring of senior year in high school but did not receive messages from their institution after high school graduation.

are unable to make causal claims about the campaign's effectiveness. Nonetheless, given the lack of prior research on behavioral nudge strategies with college students or in rural settings, our descriptive investigation—using ordinary least squares regression to estimate the relationship between participation in the texting initiative and students' academic outcomes—provides valuable early evidence to guide research, policy, and practice. We incorporate several different comparison groups into our analyses, to test the sensitivity of our estimates; our preferred comparison group is drawn from the population of college matriculants who attended high schools that were very similar to the GEAR UP high schools, but where students did not have the opportunity to sign up for the texting campaign. Results from our preferred models indicate that students from Colleges A and B participating in the texting campaign attempt and complete about 2 more credits throughout their freshman year of college. This was most pronounced for low-income students (with an expected family contribution of $0) at these schools, who completed 3.6 more credits than untreated students their freshman year.

We organize the remainder of our paper as follows. In Section II, we provide additional background on WVHEPC and the texting campaign. In Section III, we describe our research design, including the data, sample and our empirical strategy. In Section IV, we present our results. In Section V, we conclude with a discussion of these findings and their implications for policy, practice, and further research.

II. Background and theory of action for texting campaign

The West Virginia Higher Education Policy Commission oversees public policies related to the public four-year colleges and universities within West Virginia. WVHEPC provides support and assistance to individual colleges and universities, and also pursues several statewide initiatives aimed at improving college access and success for students in the state. These include concrete resources like the College Foundation of West Virginia college web portal, through which students can apply to college and access college and career planning resources, as well as awareness campaigns such as the "15 to Finish" initiative, which encourages students to take 15 credits each semester to reduce the time it takes to earn a degree.

In fall 2013, WVHEPC received a grant from the Kresge Foundation to design and implement a text messaging campaign to support seniors at the 14 GEAR UP high schools in the state to transition to and succeed in college. The WVHEPC text campaign was designed to address several reasons why even college-intending students may not complete important enrollment tasks

(Castleman, 2015a; Castleman, 2015b; Castleman & Page, 2015; Castleman & Page, forthcoming). Students—particularly those from lower-income and first-generation college-going backgrounds—may not be aware of these tasks, either because they lack access to information or because information they receive is complex and hard to digest. Results from a survey of GEAR UP students during the 2012-13 academic year showed that 34 percent of 11th and 12th grade students did not know what the FAFSA was, and 54 percent either hadn't thought about completing a college application, or felt uncomfortable about their knowledge of what to do and where to find help (WVHEPC, 2013). Even students who are aware about what tasks have to be completed may not manage their time effectively or put off these tasks in favor of more immediate demands, and miss important deadlines. Finally, students who know what tasks have to be completed and are motivated to complete them may nonetheless struggle with the complexity of tasks such as applying for financial aid or evaluating loan options.

The theory of action underlying texting campaigns is that complex information can be broken down into concise, digestible portions, and delivered to students at relevant times in their college trajectory, through a communication channel that most young people engage with on a daily basis (Lenhart, 2012). Texts also have the unique advantage that they are accompanied by alert notifications by default (i.e., our phones chirp or vibrate when we get a text), so each message captures students' attention, at least for moment in time. Researchers can leverage this attention-grabbing feature of texts to nudge students to complete important actions before their attention is diverted elsewhere. And text message campaigns can be configured so that students simply have to write back to a message to connect one-on-one with a college or financial aid advisor, which substantially reduces barriers to help-seeking.

WVHEPC based its campaign on a prior texting initiative that sent college-intending high school graduates personalized reminders of tasks they needed to complete in order to successfully matriculate at their intended college or university. Messages were personalized to students, provided college-specific information about required tasks, and invited students to write back if they needed assistance from a college advisor. Students randomly assigned to receive these texts over the summer were substantially more likely to successfully enroll in college in the fall, with the largest impacts among lower-income and first-generation college students (Castleman & Page, 2014; Castleman & Page, forthcoming).

WVHEPC extended this prior work by beginning the text campaign earlier in senior year, when students had to apply for financial aid, and continued messaging students through the first year of college. The Commission broadly publicized the text campaign within GEAR UP high schools, and students had various avenues through which they could sign up: they could opt in to messages on their college applications, during "College Goal Sunday" FAFSA workshops, and while applying for a state merit-based scholarship application. Student opt-in dates ranged from mid-December 2013 to mid-April 2014, with about 91 percent of students signing up for the campaign by the end of December. The WVHEPC initiative shared some of the same design elements as prior interventions. For instance, messages were personalized to students and students could write back to the messages to request one-on-one assistance from a GEAR UP staff member.

An important difference in the WVHEPC campaign, however, was that the Commission actively engaged with four colleges and universities in the state frequently attended by graduates from the GEAR UP high schools. Among the population of high school seniors that decided to attend one of these institutions, colleges supplemented WVHEPC outreach with their own institution-specific text messages. All four institutions messaged students about financial aid and required pre-matriculation tasks during the spring of senior year in high school. Colleges A and B also continued to message students during the summer after high school and into the first year of college. Freshman year messages encouraged students to make use of campus-based resources, such as academic advising and tutoring; to register for courses in advance of each term; and to re-apply for financial aid. An additional set of messages provided more general encouragement and affirmation for students during their transition into college.[2] As Table 1 illustrates, Colleges A and B spend less on instruction, academic support, and student services per full-time equivalent student than other public institutions in West Virginia where students in our sample matriculate. In the absence of other resources, students at these institutions may be particularly receptive to the intervention.

III. Research Design

Data and Sample

Our sample includes students who immediately enrolled in a West Virginia public two- or four-year institution after graduating from one of the 14 GEAR UP high schools where students were offered the opportunity to sign up for the texting campaign, as well as enrollees from 14 comparison high schools where students were not offered the opportunity to sign up for the texts.

[2] Message templates available upon request

WVHEPC had identified these comparison schools for prior GEAR UP-related evaluation through a propensity matching approach. As we show in Table 2, treated and comparison students from the target GEAR UP and comparison high schools in our sample are similar across most dimensions. Treated students have higher ACT scores than the non-treated students in the target schools by about 0.8 points on a 36-point scale, higher GPAs by about 0.19 points on a 4.0 scale, and are 14 percentage points less likely to have an average expected family contribution (EFC) equal to $0. Treated students are more similar to non-treated students at the comparison high schools, with the only significant difference being treated students having lower ACT scores by 0.3 points. Most college-going students from these schools identify as White – about 93 percent – which reflects the overall state population. Overall, students have a mean 3.3 GPA, or about a B+ average, and average ACT score of 20.

We use two primary data sources to evaluate how receiving the WVHEPC text campaign related to students' college outcomes. First, we identify college matriculants who participated in the text campaign based on data from Signal Vine, the texting platform with whom WVHEPC contracted to send the messages. The Signal Vine data indicate whether a student signed up for text messaging, as well as when and how he or she signed up. We then merge that information onto a dataset provided by WVHEPC, which listed all students who matriculated into a state public university or community college for the first time for the fall 2014 semester and had attended either one of the 14 GEAR UP high schools or one of the comparison high schools.

This combined data set includes the 407 students from GEAR UP high schools who signed up for the text campaign and who matriculated at a West Virginia public college or university. Due to data limitations we do not have access to data that would allow us to compare these 407 students to students who signed up for the campaign but who did not enroll in college or who instead enrolled at a private or out-of-state institution. The combined data set also contains 1,015 non-treated students: (1) college matriculants from the GEAR UP high schools who did not sign up for the text campaign and (2) matriculants from the comparison high schools. Among the 1,015 non-treated students in the sample, we dropped 224 students who had graduated from high school prior to 2014. This resulted in a total of 1,198 observations – 407 treated students, 248 non-treated students from GEAR UP high schools, and 543 non-treated students from the comparison high schools.

Measures

The WVHEPC data includes each student's high school, race/ethnicity, gender, ACT total and sub-section scores, SAT math and verbal scores, high school GPA, FAFSA filing, and birthdate. We used concordance tables to convert all SAT scores into ACT scores since the majority of students in our sample took the ACT (1,077 students, 90 percent of our sample, report ACT scores).[3] We compute ACT scores for less than one percent of our sample (13 students), leaving us with 108 students with no observed ACT or SAT score. We retain these students in our sample using two methods of handling missing data – first, we include an indicator for missingness holding missing values at zero, and then we re-run the model imputing predicted ACT scores based on students' high school GPA, race, gender, and high school of enrollment. We similarly have missing high school GPAs for 14 students, and compare results using a missingness indicator and imputed GPAs. Below we report on models using imputed values – results do not significantly vary by method employed, and results using the missingness indicators are available upon request.

As mentioned above, our available outcomes of interest are fall and spring courses attempted and completed and GPA for students' freshman year of college. For continuous outcomes, in the fall we observe credits attempted and completed for all students. There are 11 students (less than one percent of our sample) who do not have reported fall GPAs despite having credits attempted and completed. The results from analyses of other outcomes yield similar patterns whether we include these students or not. Availability of spring outcomes are contingent on students remaining in the data sample between the fall and spring semesters, which we discuss in greater detail below.

Students' attainment of certain credit and GPA thresholds has meaningful implications for their college success. For example, broadly speaking, students who complete at least 20 credits their freshman year are more likely to persist through college, and students receiving the West Virginia PROMISE merit-based scholarship must complete at least 30 credits each 12-month enrollment period to remain eligible (Adelman, 2006; College Foundation of West Virginia, n.d.-b). Renewal eligibility for the PROMISE scholarship is also contingent on maintaining a 2.75 GPA during students' freshman year of college (College Foundation of West Virginia, n.d.-b). In addition to overall credit attainment and academic performance, we examine whether treated students are more likely to attain these "threshold" benchmarks, and specifically whether "PROMISE eligible"

[3]ACT/SAT concordance tables: https://www.act.org/solutions/college-career-readiness/compare-act-sat/

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students are more likely to meet the scholarship renewal benchmarks. While we do not observe students' actual PROMISE receipt in our data, for this subgroup analysis we limit our sample to students who meet the high school eligibility requirements – completed the FAFSA, have a 3.0 or higher GPA, and scored a 22 or higher on the ACT (College Foundation of West Virginia, n.d.-a). About 375 students in our sample have high school records meeting initial PROMISE receipt eligibility – 32 percent of our treated students and 31 percent of non-treated students.

As noted above, Table 2 summarizes student characteristics for our treated students and two comparison groups – the non-treated at target schools and non-treated at comparison schools. Non-treated students at target schools had lower ACT scores and high school GPAs and were more likely to have an EFC of $0 than treated students, while non-treated students at comparison schools had higher ACT scores than the treated students. These significant differences in academic achievement could be correlated with differences in academic performance in college, so we include baseline academic measures as key covariates in all of our analytic models. Another potential source of bias is that students within the GEAR UP high schools who did and did not sign up for the texting campaign may systematically differ on unobserved characteristics that we cannot include in our models. To account for this, our preferred estimates draw from models that compare treated students to students from the comparison schools who never had the opportunity to sign up for the campaign.

Empirical Strategy

We use ordinary least squares (OLS) regression to estimate the relationship between the text campaign participation and students' academic outcomes during their freshman year of college. Our basic model is as follows:

$$Y_i = \beta_0 + \beta_1 Treat + \beta_2 X_i + \varepsilon_i$$

where *TREAT* represents whether or not student *i* opted in to the texting treatment and X_i is a vector of all the available student-level covariates indicating race, gender, high school GPA, ACT score, and students' expected family contribution (EFC) from the FAFSA.[4]

[4] The student sample in this state is racially homogenous, with almost 93 percent of the sample identifying as White. Given this limited variation, when calculating each student's propensity score we collapsed race/ethnicity categories into a binary White/non-White variable.

Our primary modification to the core model is to allow the relationship between the texting campaign and students' outcomes to vary by whether the students' colleges sent institution-specific information and encouragement. Prior research suggests both that students may be more responsive to outreach from their own college, and that students may be more responsive to information that is personalized and salient to their personal circumstances (Castleman, 2015a; Castleman, Schwartz, and Baum, 2015; Castleman, Owen, and Page, 2014). We also explore heterogeneous relationships by students' prior academic achievement, whether or not students had an expected family contribution (EFC) of $0, and run quantile regression to examine where in the distribution of outcomes there are the largest differences between treated and non-treated students.

IV. Results

Across our main results tables, in column 1 we provide a model that regresses various academic outcomes on an indicator for whether students received texts along with student-level covariates (gender, minority status, high school GPA, and ACT scores). In column 2, we also include an indicator and interaction term for whether a student attended College A or B, where treated students received additional text messages directly from the institution. Column 3 shows a similar interaction model for whether students had an EFC of $0, as calculated by the FAFSA. Each table includes these models for the "unrestricted" sample (Panel A), comparing treated students to all non-treated students at the target GEAR UP schools and the comparison schools, and the "restricted" sample (Panel B), which compares treated students only to the ineligible-for-treatment students attending comparison high schools. We prefer estimates using Panel B because these students are more demographically similar to treated students at the target schools, although this gives us a smaller sample size and less precision in our estimates. We also ran models comparing treated students only to their non-treated peers at GEAR UP schools, and results were very similar across specifications. We include table 1A in Appendix A showing the outcomes for freshman year credit completion for panels A, B, and two variations using only GEAR UP students (one with the overall treated/non-treated comparison and one with high school fixed effects).

We first examine, in Tables 3 and 4, whether students attempt and complete more credits during their first semester in college. Using our preferred comparison group of ineligible students at comparison high schools ("Panel B"), we find that treated students attempt 0.26 additional credits more than the comparison group average of about 10 credits during their freshman fall semesters.

There does not appear to be a significant interaction between treatment and being at College A or B, but treated students with a $0 EFC attempt about half an additional credit during the fall semester.

Looking at Table 4, treated students overall do not complete significantly more credits their first semester. However, in the unrestricted sample, treated students at Colleges A and B complete almost an additional credit, and the point estimate is similar if not statistically significant in the restricted sample (0.91). It can be difficult to interpret the constant coefficient with the inclusion of multiple covariates but, for example, a non-minority male attending College A or B with an EFC of $0, a 3.1 GPA and a score of 18 on the ACTs (the average high school GPA and ACT score for students at Colleges A and B), who didn't participate in the texting campaign would be expected to complete 9.95 credits his first semester, while the same student who participated in the texting campaign would be expected to complete 10.87 credits.

There is a significant relationship between campaign participation and fall semester GPA at Colleges A and B, with texted students earning 0.31 GPA points higher than their non-texted peers (see Table 5). Using our illustrative set of non-minority male enrollees at College A or B from above, we would expect treated students to earn a GPA of about 2.24, compared to a predicted GPA of 1.93 for their non-treated peer.

Before looking at spring credits and GPA, we first examined whether and how students change enrollment between the fall and spring semester, which we detail in Table 6. Of the 407 treated students, 356 have valid records in the spring semester – either at the same school or another public West Virginia college. Only 51 treated students (12.5 percent of treated students) do not show up at any of the colleges in our sample. This could be for several reasons – students might have transferred to a private institution in West Virginia, transferred to an out-of-state institution, or taken the semester off/dropped out of college.[5] There were no statistically significant differences in retention between treated and untreated students in either our restricted or unrestricted sample.

We next assessed students' spring semester credits attempted, credits completed, and semester GPA. Treated students at Colleges A and B attempt about 1.3 credits more than their non-treated peers at those two schools, though the estimate is not significant for the smaller, restricted sample (see Table 7). Students with an EFC of $0 also attempt 1.3-1.5 additional credits during the spring semester. Treated students at Colleges A and B then go on to complete an additional 1.18-

[5] We do not observe any new enrollees in the spring semester from the treated sample, though there are two new non-treated students who show up in the spring semester file. Because the spring semester file does not have student-level characteristics to include in our model, we do not include these two new students in our analysis.

1.29 credits during the spring semester, again with imprecision in the restricted sample (see Table 8). Low-income students who participated in the texting campaign complete an additional 1.4 credits their spring semester, regardless of sample specification. There were no significant differences in spring GPA by treatment status (table 9).

The fairly similar magnitudes for fall and spring semester completion lends credence to the idea that the text messaging campaign worked throughout students' freshman year and that response to the text messaging intervention might persist over the course of a student's college career and accumulate to larger differences in treated/non-treated outcomes. If we look at credit completion overall during student's freshman year in college (in Table 10), we see that students at Colleges A and B complete about 2-2.23 additional credits over the year, compared to their non-texted counterparts in the restricted sample. Low-income students appear to have especially benefited from text message participation, as treated students with an EFC of $0 complete an additional 2.1-2.3 credits their freshman year of college.

Since low-income students and students at Colleges A and B appear to have been the main beneficiaries of the intervention, we also ran a triple interaction of being a treated student at College A or B and also having an EFC of $0, using freshman year credit completion as the illustrative outcome. We see that the combination of being a low-income student at the colleges implementing additional, institution specific messaging means you are likely to complete an additional 3.6 credits your freshman year of college, more than an entire class (table 11 – note columns 1 and 2 replicate columns 2 and 3 from table 10). If these differences persist, these students could accumulate more than a full-time semester's worth of classes over the course of a four-year college career. With additional years of data, we can observe how credit accumulation relates to retention and completion rates.

We were interested in examining where in the distribution of credit completion the most change happened – for example, were treated students more likely to enroll in 12+ credits each semester to attain full time status, or 15+ credits in response to the "15 to Finish" campaign? We ran quantile regression on overall credit completion and logistic regression for specific benchmarks, and did not find statistically significant differences on benchmarks or variance in differences between treatment and comparison students at different credit completion levels, suggesting a

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smooth impact across the credit attainment distribution.[6] Figure 1 illustrates the overall distribution of credit completion for treated and comparison students in the unrestricted and restricted samples.

V. Discussion

In this paper we report on a West Virginia initiative to provide students with personalized college guidance and access to one-on-one advising through an interactive text messaging campaign. We focus our analyses in particular on the portion of the campaign that targeted students who had matriculated at West Virginia public two- and four-year colleges and universities. Although we cannot make causal claims about our analysis, we find descriptive evidence indicating that all treated students persistently attempt and complete more credits than their non-treated peers, and that low-income students and students at Colleges A and B are particularly receptive to the texting campaign. This latter result indicates that students may be especially responsive to outreach from their own college and university, as opposed to from a statewide agency. Colleges A and B were able to adapt their messaging to target students who most needed information and address specific actions and resources, compared to the necessarily more general statewide campaign. For example, in August before students' freshman year College B programed the messaging system to contact students who had not yet registered for classes to remind them about deadlines and office hours to access in-person assistance, while the state agency messages around the same time simply conveyed excitement about the upcoming school year and encouraged students to text in any questions. This finding would be in line with recent experimental evidence which finds suggestive evidence that high school graduates are more responsive to the offer of summer assistance when it comes from a counselor working at the college where they plan to matriculate, rather than the high school from which they just graduated (Castleman, Owen, & Page, 2014).

The larger differences in outcomes for treated students at Colleges A and B may also be related to the relative availability of other student support resources at those institutions. As noted above, Table 1 shows that these schools spend fewer institutional resources per student on instruction and academic support, and these low-cost messages may address shortages in student services. Previous research has found text messages sent by a college access agency to students during high school had a greater impact on students who did not have extensive existing support

[6] Tables available upon request

systems, and our findings suggest similar responsiveness at the college level (Castleman & Page, 2014).

There are several outstanding analyses that we will conduct and report on in future versions of this paper. We do not yet have access to the detailed text messaging interaction data, which will allow us to explore mechanisms through which the campaign may have influenced students' outcomes. For instance, do the results seem to be driven by students responding to the texts and getting advising assistance from a staff member at their college or from WVHEPC, or are response rates low, which might indicate that the message content itself is motivating students to reach out for additional supports on campus or to invest more time into their studies? Going forward, we plan to obtain additional years of credit and GPA data from West Virginia, so that we can investigate whether the initial findings we observe on students' academic outcomes persist into subsequent years of college.

In its current form, our paper provides the first suggestive evidence of which we are aware that low-touch, behaviorally-informed outreach to underrepresented college freshmen from rural areas can lead to improvements in students' first-year academic performance. These results are particularly salient as public colleges and universities across the country face a daunting challenge of supporting a growing population of non-traditional students with dwindling resources, as state appropriations to higher education continue to decline over time. Messaging campaigns offer a cost-effective strategy that colleges and universities can use to provide students with simplified information, encourage them to make use of campus-based resources, and directly connect them to advising if they need additional assistance.

TABLES

Table 1: Comparison of High-Text vs. Other Public Colleges in West Virginia

	Colleges A & B	*Other Institutions*
Student body composition		
Undergraduate enrollment	2051	3863
	(271.529)	(5192)
% Students studying full-time	0.785	0.69
	(0.171)	(0.166)
% Students studying part-time	0.215	0.31
	(0.171)	(0.166)
% Black	0.04	0.069
	(0.042)	(0.039)
% White	0.89	0.83
	(0.057)	(0.107)
Graduation rate, total cohort	0.23	0.278
	(0.156)	(0.138)
Full-time retention rate, 2014	0.58	0.569
	(0.127)	(0.116)
Tuition and financial aid		
Tuition and fees, 2014-15	$4814	$5047
	(2498)	(1540)
Average net price-students receiving grant or scholarship aid, 2013-14	$6900	$7898
	(458.205)	(2753)
Percent of full-time first-time undergraduates receiving Pell grants	0.555	0.57
	(0.092)	(0.153)
Percent of full-time first-time undergraduates receiving student loan aid	0.365	0.527
	(0.474)	(0.169)
Average amount of student loan aid received by full-time first-time undergraduate	$3773	$5599
	(2396)	(1997)
Institutional expenditures		
Instruction expenses per FTE	$5021	$6021
	(30)	(2193)
Academic support expenses per FTE	$695	$1084
	(80)	(546)
Student service expenses per FTE	$1183	$1197
	(2.828)	(465)

Notes: Standard deviations in parentheses. Compares institutional resources and costs at Colleges A and B and other public West Virginia two- and four-year institutions where students in our sample matriculate. Data from the Integrated Postsecondary Education Data System (IPEDS). Unless otherwise noted, data is as of fall 2014, percentages rounded to three decimal points, monetary amounts and student body counts rounded to nearest whole number.
***p<0.01, **p<0.05, *p<0.1

Table 2: Comparison of First-Year College Students from Target and Comparison High Schools

	Treated	Non-Treated at Target School	Non-Treated at Comparison School
% Black	0.029	0.024	0.018
	(0.169)	(0.154)	(0.135)
% Asian	0.002	0.012	0
	(0.050)	(0.110)	(0.000)
% Hispanic	0.005	0	0.007
	(0.070)	(0.000)	(0.086)
% White	0.929	0.927	0.928
	(0.258)	(0.260)	(0.258)
% Female	0.59	0.597	0.569
	(0.492)	(0.492)	(0.496)
% EFC of $0	0.371	0.512 ***	0.324
	(0.484)	(0.501)	(0.468)
N of students in sample	*407*	*248*	*543*
ACT Score	20.449	19.694 ***	20.755 **
	(3.685)	(3.776)	(4.242)
N of students with observed ACT score	*374*	*209*	*507*
High School GPA	3.352	3.16 **	3.268
	(0.532)	(0.604)	(0.590)
N of students with observed HS GPA	*404*	*241*	*539*

Notes: Standard deviations in parentheses. Compares average student-level characteristics for target students and two comparison groups – non-treated students at the targeted GEAR UP high schools who did not opt-in to receive text messages and non-treated students at comparison high schools who were never offered the treatment. There are no missing data points for student race and gender, and below those measures we note the total number of observations for each category (407 treated students, 241 non-treated at target schools, and 543 non-treated at comparison schools). Some students do not have recorded ACT scores or high school GPAs – table reports averages for students with observed values for each students characteristic. Below ACT scores and high school GPA we note how many observations are non-missing for each measure. Significant values in columns 2 and 3 indicate significant differences from the treated group in column 1. ***p<0.01, **p<0.05, *p<0.1

Table 3: Fall Credits Attempted

	Panel A: Unrestricted			Panel B: Restricted		
	(1)	(2)	(3)	(1)	(2)	(3)
Treated	0.30***	0.41***	0.16	0.26**	0.40***	0.096
	(0.12)	(0.13)	(0.14)	(0.13)	(0.14)	(0.15)
Colleges A & B		-0.38*			-0.26	
		(0.21)			(0.29)	
Colleges A&B*Treated		-0.17			-0.31	
		(0.28)			(0.34)	
EFC of $0			-0.25			-0.34*
			(0.17)			(0.20)
$0 EFC*Treated			0.37			0.46*
			(0.25)			(0.28)
Total treatment (at Colleges A/B or for EFC==$0)		0.23	0.53**		0.10	0.55**
p-value		*0.34*	*0.01*		*0.74*	*0.02*
Constant	9.7	10	9.76	9.7	9.96	9.77
	(0.57)	(0.58)	(0.57)	(0.60)	(0.59)	(0.60)
Student Level Covariates	X	X	X	X	X	X
Observations	1,198	1,198	1,198	950	950	950
R-squared	0.148	0.155	0.149	0.147	0.154	0.150

Notes: Robust standard errors in parentheses. The sample in Panel A includes treated students and all non-treated students. The sample in Panel B includes treated students and non-treated students who graduated from comparison high schools. The dependent variable in all estimates is the number of academic credits attempted by students during the fall 2014 semester, with most courses carrying three academic credits. All columns include controls for students' gender, race, high school GPA (imputed for missing) ACT score (imputed for missing), whether the student completed the FAFSA, and if the student has an EFC of $0. The “total treatment” row tests whether the linear combination of the treatment and interacted terms is significant, with p-value on the F-test reported below.
*** p<0.01, ** p<0.05, * p<0.1

Table 4: Fall Credits Completed

	Panel A: Unrestricted			*Panel B: Restricted*		
	(1)	(2)	(3)	(1)	(2)	(3)
Treated	0.44*	0.32	0.16	0.22	0.096	-0.049
	(0.26)	(0.30)	(0.30)	(0.27)	(0.31)	(0.31)
Colleges A & B		-0.60			-0.75	
		(0.43)			(0.57)	
Colleges A&B*Treated		0.61			0.82	
		(0.61)			(0.71)	
EFC of $0			-1.42***			-1.35***
			(0.37)			(0.44)
$0 EFC*Treated			0.76			0.75
			(0.57)			(0.62)
Total treatment (at Colleges A/B or for EFC==$0)		0.94*	0.92*		0.91	0.71
p-value		*0.08*	*0.05*		*0.15*	*0.18*
Constant	-1.01	-0.66	-0.89	-1.58	-1.26	-1.45
	(0.96)	(1.01)	(0.96)	(1.08)	(1.12)	(1.09)
Student Level Covariates	X	X	X	X	X	X
Observations	1,198	1,198	1,198	950	950	950
R-squared	0.266	0.267	0.267	0.285	0.286	0.286

Notes: Robust standard errors in parentheses. The sample in Panel A includes treated students and all non-treated students. The sample in Panel B includes treated students and non-treated students who graduated from comparison high schools. The dependent variable in all estimates is the number of academic credits completed by students during the fall 2014 semester, with most courses carrying three academic credits. All columns include controls for students' gender, race, high school GPA (imputed for missing) ACT score (imputed for missing), whether the student completed the FAFSA, and if the student has an EFC of $0. The “total treatment” row tests whether the linear combination of the treatment and interacted terms is significant, with p-value on the F-test reported below.
*** p<0.01, ** p<0.05, * p<0.1

Table 5: Fall GPA

	Panel A: Unrestricted			*Panel B: Restricted*		
	(1)	(2)	(3)	(1)	(2)	(3)
Treated	0.056	0.0055	0.034	0.029	-0.043	-0.0065
	(0.062)	(0.071)	(0.074)	(0.066)	(0.074)	(0.077)
Colleges A & B		-0.045			-0.21	
		(0.11)			(0.14)	
Colleges A&B*Treated		0.17			0.35**	
		(0.15)			(0.18)	
EFC of $0			-0.28***			-0.32***
			(0.089)			(0.11)
$0 EFC*Treated			0.056			0.100
			(0.13)			(0.14)
Total treatment (at Colleges A/B or for EFC==$0)		0.18	0.09		0.31*	0.09
p-value		*0.17*	*0.41*		*0.06*	*0.45*
Constant	-0.24	-0.24	-0.24	-0.49	-0.42	-0.47
	(0.30)	(0.31)	(0.30)	(0.34)	(0.35)	(0.34)
Student Level Covariates	X	X	X	X	X	X
Observations	1,187	1,187	1,187	941	941	941
R-squared	0.267	0.268	0.267	0.294	0.297	0.295

Notes: Robust standard errors in parentheses. The sample in Panel A includes treated students and all non-treated students. The sample in Panel B includes treated students and non-treated students who graduated from comparison high schools. The dependent variable in all estimates is fall 2014 semester GPA. All columns include controls for students' gender, race, high school GPA (imputed for missing) ACT score (imputed for missing), whether the student completed the FAFSA, and if the student has an EFC of $0. The "total treatment" row tests whether the linear combination of the treatment and interacted terms is significant, with p-value on the F-test reported below.
*** p<0.01, ** p<0.05, * p<0.1

Table 6: Spring Retention Rates

			Fall Enrollment	Spring Enrollment - Same Institution	Spring Enrollment - Different Institution	Spring Enrollment - Not Enrolled
				(1)	(2)	(3)
Treated Students	All Schools	Count	407	340	16	51
		Percent		*0.84*	*0.04*	*0.13*
	Colleges A & B	Count	130	110	4	16
		Percent		*0.85*	*0.03*	*0.12*
Non-Treated Students (Panel A)	All Schools	Count	791	645	23	123
		Percent		*0.82*	*0.03*	*0.16*
	Colleges A & B	Count	158	124	2	32
		Percent		*0.78*	*0.01*	*0.20*
Non-Treated Students (Panel B)	All Schools	Count	543	447	16	80
		Percent		*0.82*	*0.03*	*0.15*
	Colleges A & B	Count	71	55	1	15
		Percent		*0.77*	*0.01*	*0.21*

Notes: Tabulates the number and percent of fall enrollees by treatment status who (1) re-enroll at the same institution in the spring, (2) enroll in a different WV public two- or four-year college in the spring, or (3) do not enroll at any of the colleges in our sample in the spring semester. The sample in Panel A includes treated students and all non-treated students. The sample in Panel B includes treated students and non-treated students who graduated from comparison high schools.

Table 7: Spring Credits Attempted

	Panel A: Unrestricted			*Panel B: Restricted*		
	(1)	(2)	(3)	(1)	(2)	(3)
Treated	0.35	0.017	-0.26	0.20	-0.072	-0.51
	(0.34)	(0.39)	(0.40)	(0.36)	(0.40)	(0.42)
Colleges A & B		-0.90*			-0.92	
		(0.52)			(0.75)	
Colleges A&B*Treated		1.38*			1.40	
		(0.78)			(0.95)	
EFC of $0			-1.23***			-1.60***
			(0.43)			(0.54)
$0 EFC*Treated			1.61**			2.02***
			(0.71)			(0.78)
Total treatment (at Colleges A/B or for EFC==$0)		1.39**	1.35**		1.33	1.52**
p-value		*0.04*	*0.02*		*0.13*	*0.02*
Constant	-1.11	-0.67	-0.87	-1.29	-1.01	-0.94
	(1.52)	(1.56)	(1.52)	(1.66)	(1.71)	(1.66)
Student Level Covariates	X	X	X	X	X	X
Observations	1,198	1,198	1,198	950	950	950
R-squared	0.135	0.138	0.139	0.144	0.146	0.150

Notes: Robust standard errors in parentheses. The sample in Panel A includes treated students and all non-treated students. The sample in Panel B includes treated students and non-treated students who graduated from comparison high schools. The dependent variable in all estimates is the number of academic credits attempted by students during the spring 2015 semester, with most courses carrying three academic credits. All columns include controls for students' gender, race, high school GPA (imputed for missing) ACT score (imputed for missing), whether the student completed the FAFSA, and if the student has an EFC of $0. The "total treatment" row tests whether the linear combination of the treatment and interacted terms is significant, with p-value on the F-test reported below.
*** p<0.01, ** p<0.05, * p<0.1

Table 8: Spring Credits Completed

	Panel A: Unrestricted			*Panel B: Restricted*		
	(1)	(2)	(3)	(1)	(2)	(3)
Treated	0.43	0.27	-0.18	0.22	0.13	-0.43
	(0.35)	(0.40)	(0.42)	(0.37)	(0.42)	(0.45)
Colleges A & B		-1.33**			-1.32*	
		(0.52)			(0.70)	
Colleges A&B*Treated		1.02			1.05	
		(0.80)			(0.92)	
EFC of $0			-1.81***			-1.96***
			(0.45)			(0.54)
$0 EFC*Treated			1.63**			1.84**
			(0.73)			(0.79)
Total treatment (at Colleges A/B or for EFC==$0)		1.29*	1.45**		1.18	1.41**
p-value		*0.06*	*0.02*		*0.15*	*0.03*
Constant	-8.41	-7.57	-8.17	-8.86	-8.21	-8.54
	(1.51)	(1.55)	(1.51)	(1.61)	(1.67)	(1.61)
Student Level Covariates	X	X	X	X	X	X
Observations	1,198	1,198	1,198	950	950	950
R-squared	0.256	0.260	0.259	0.267	0.270	0.272

Notes: Robust standard errors in parentheses. The sample in Panel A includes treated students and all non-treated students. The sample in Panel B includes treated students and non-treated students who graduated from comparison high schools. The dependent variable in all estimates is the number of academic credits completed by students during the spring 2015 semester, with most courses carrying three academic credits. All columns include controls for students' gender, race, high school GPA (imputed for missing) ACT score (imputed for missing), whether the student completed the FAFSA, and if the student has an EFC of $0. The "total treatment" row tests whether the linear combination of the treatment and interacted terms is significant, with p-value on the F-test reported below.
*** p<0.01, ** p<0.05, * p<0.1

Table 9: Spring GPA

	Panel A: Unrestricted			*Panel B: Restricted*		
	(1)	(2)	(3)	(1)	(2)	(3)
Treated	0.058	0.063	0.0084	0.013	0.036	-0.024
	(0.066)	(0.077)	(0.077)	(0.070)	(0.080)	(0.080)
Colleges A & B		-0.15			-0.059	
		(0.11)			(0.16)	
Colleges A&B*Treated		0.049			-0.037	
		(0.16)			(0.20)	
EFC of $0			-0.28***			-0.25**
			(0.094)			(0.12)
$0 EFC*Treated			0.14			0.11
			(0.14)			(0.16)
Total treatment (at Colleges A/B or for EFC==$0)		0.11	0.15		0.00	0.09
p-value		*0.41*	*0.23*		*1.00*	*0.54*
Constant	-8.41	-7.57	-8.17	-8.86	-8.21	-8.54
	(1.51)	(1.55)	(1.51)	(1.61)	(1.67)	(1.61)
Student Level Covariates	X	X	X	X	X	X
Observations	1,024	1,024	1,024	819	819	819
R-squared	0.280	0.282	0.281	0.281	0.282	0.281

Notes: Robust standard errors in parentheses. The sample in Panel A includes treated students and all non-treated students. The sample in Panel B includes treated students and non-treated students who graduated from comparison high schools. The dependent variable in all estimates is spring 2015 semester GPA. All columns include controls for students' gender, race, high school GPA (imputed for missing) ACT score (imputed for missing), whether the student completed the FAFSA, and if the student has an EFC of $0. The "total treatment" row tests whether the linear combination of the treatment and interacted terms is significant, with p-value on the F-test reported below.
*** p<0.01, ** p<0.05, * p<0.1

Table 10: Academic Year 2014-15 Credits Completed

	Panel A: Unrestricted			*Panel B: Restricted*		
	(1)	(2)	(3)	(1)	(2)	(3)
Treated	0.88*	0.60	-0.019	0.43	0.22	-0.48
	(0.53)	(0.62)	(0.64)	(0.56)	(0.64)	(0.67)
Colleges A & B		-1.93**			-2.07*	
		(0.84)			(1.12)	
Colleges A&B*Treated		1.63			1.87	
		(1.22)			(1.43)	
EFC of $0			-3.23***			-3.32***
			(0.73)			(0.86)
$0 EFC*Treated			2.39**			2.60**
			(1.13)			(1.22)
Total treatment						
(at Colleges A/B or for EFC==$0)		2.23**	2.37**		2.09~	2.12**
p-value		*0.04*	*0.01*		*0.10*	*0.04*
Constant	-9.42	-8.22	-9.07	-10.4	-9.47	-9.99
	(2.15)	(2.25)	(2.15)	(2.37)	(2.46)	(2.37)
Student Level Covariates	X	X	X	X	X	X
Observations	1,198	1,198	1,198	950	950	950
R-squared	0.312	0.315	0.314	0.330	0.333	0.334

Notes: Robust standard errors in parentheses. The sample in Panel A includes treated students and all non-treated students. The sample in Panel B includes treated students and non-treated students who graduated from comparison high schools. The dependent variable in all estimates is the number of academic credits completed by students during the spring 2015 semester, with most courses carrying three academic credits. All columns include controls for students' gender, race, high school GPA (imputed for missing) ACT score (imputed for missing), whether the student completed the FAFSA, and if the student has an EFC of $0. The "total treatment" row tests whether the linear combination of the treatment and interacted terms is significant, with p-value on the F-test reported below.
*** p<0.01, ** p<0.05, * p<0.1

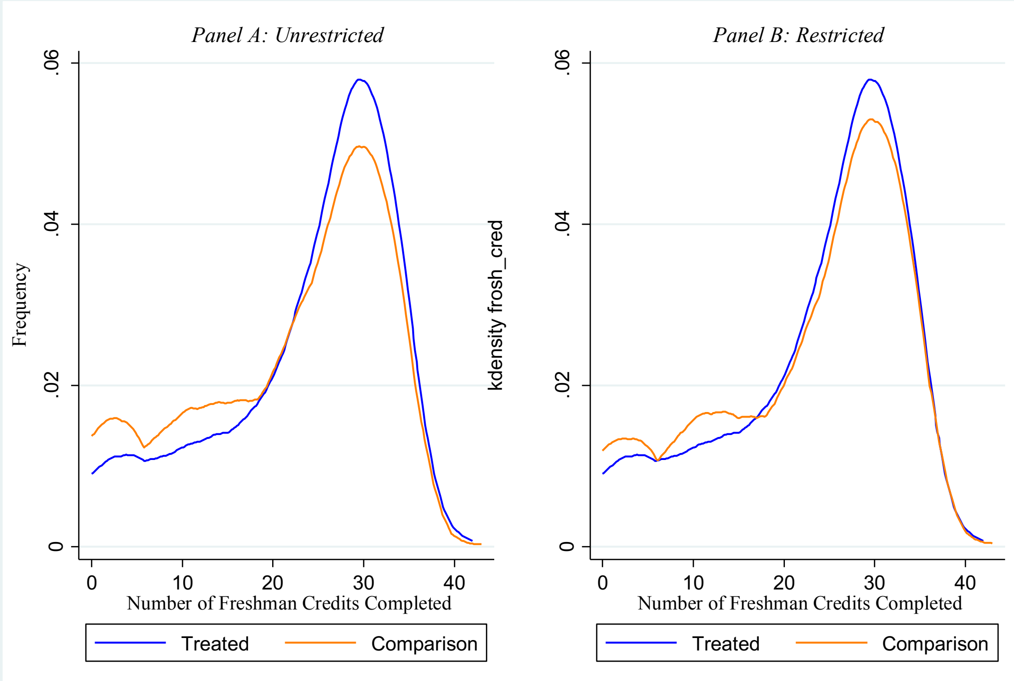
Table 11: Academic Year 2014-15 Credits Completed, including EFC*Treat*College A or B interaction

	Panel A: Unrestricted			*Panel B: Restricted*		
	(1)	(2)	(3)	(1)	(2)	(3)
Treated	0.60	-0.019	-0.16	0.22	-0.48	-0.56
	(0.62)	(0.64)	(0.73)	(0.64)	(0.67)	(0.75)
Colleges A & B	-1.93**		-1.79**	-2.07*		-1.88*
	(0.84)		(0.84)	(1.12)		(1.13)
Colleges A&B*Treated	1.63		1.41	1.87		1.55
	(1.22)		(1.39)	(1.43)		(1.58)
EFC of $0		-3.23***	-3.04***		-3.32***	-3.16***
		(0.73)	(0.74)		(0.86)	(0.88)
$0 EFC*Treated		2.39**	2.10		2.60**	2.32*
		(1.13)	(1.27)		(1.22)	(1.37)
$0 EFC*A/B*Treated			0.26			0.34
			(1.93)			(1.94)
Total treatment (at Colleges A/B, EFC==$0, or both)	2.23**	2.37**	3.60**	2.09	2.12**	3.65**
p-value	*0.04*	*0.01*	0.02	*0.10*	*0.04*	0.034
Constant	-8.22	-9.07	-7.99	-9.47	-9.99	-9.16
	(2.25)	(2.15)	(2.25)	(2.46)	(2.37)	(2.47)
Student Level Covariates	X	X	X	X	X	X
Observations	1,198	1,198	1,198	950	950	950
R-squared	0.315	0.314	0.317	0.333	0.334	0.336

Notes: Robust standard errors in parentheses. The sample in Panel A includes treated students and all non-treated students. The sample in Panel B includes treated students and non-treated students who graduated from comparison high schools. Within each panel, columns (1-2) reproduce columns (2-3) or the corresponding panel in table 10. The dependent variable in all estimates is the number of academic credits completed by students during the 2014-15 academic year, with most courses carrying three academic credits. All columns include controls for students' gender, race, high school GPA (imputed for missing) ACT score (imputed for missing), whether the student completed the FAFSA, and if the student has an EFC of $0. The “total treatment” row tests whether the linear combination of the treatment and interacted terms is significant, with p-value on the F-test reported below.
*** p<0.01, ** p<0.05, * p<0.1

FIGURES

Figure 1: Treated & Comparison Student Credits Completed



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APPENDIX A: Variation in results by comparison group sample

Table 1A: Variance in Results by Comparison Group (showing academic year 2014-15 credits completed)

	Panel A: Unrestricted			*Panel B: Restricted*			*Panel C1: Within School*			*Panel C2: Within School*		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Treated	0.88*	0.60	-0.019	0.43	0.22	-0.48	1.83**	1.48	1.11	1.56**	1.18	0.73
	(0.53)	(0.62)	(0.64)	(0.56)	(0.64)	(0.67)	(0.76)	(0.92)	(0.94)	(0.76)	(0.91)	(0.93)
Colleges A & B		-1.93**			-2.07*			-1.39			-1.75	
		(0.84)			(1.12)			(1.31)			(1.40)	
Colleges A&B*Treated		1.63			1.87			1.07			1.22	
		(1.22)			(1.43)			(1.57)			(1.56)	
EFC of $0			-3.23***			-3.32***			-2.59**			-2.85**
			(0.73)			(0.86)			(1.29)			(1.28)
$0 EFC*Treated			2.39**			2.60**			1.60			1.83
			(1.13)			(1.22)			(1.52)			(1.51)
Total treatment (at Colleges A/B or for EFC==$0)		2.23**	2.37**		2.09	2.12**		2.55*	2.70**		2.40*	2.56**
p-value		*0.04*	*0.01*		*0.10*	*0.04*		0.05	0.03		0.07	0.04
Constant	-9.42	-8.22	-9.07	-10.4	-9.47	-9.99	-10.0	-8.96	-9.54	-8.80	-7.36	-8.27
	(2.15)	(2.25)	(2.15)	(2.37)	(2.46)	(2.37)	(3.79)	(3.97)	(3.81)	(3.79)	(3.96)	(3.81)
Student Level Covariates	X	X	X	X	X	X	X	X	X	X	X	X
High school fixed effects										X	X	X
Observations	1,198	1,198	1,198	950	950	950	655	655	655	655	655	655
R-squared	0.312	0.315	0.314	0.330	0.333	0.334	0.274	0.275	0.275	0.312	0.314	0.314

Notes: Robust standard errors in parentheses. The sample in Panel A includes treated students and all non-treated students. The sample in Panel B includes treated students and non-treated students who graduated from comparison high schools – panels A and B reproduce panels from table 10. The sample in Panel C1 includes treated students and non-treated students from GEAR UP high schools. The sample in Panel C2 is the same as C1, but includes high school fixed effects. The dependent variable in all estimates is the number of academic credits completed by students during the spring 2015 semester, with most courses carrying three academic credits. All columns include controls for students' gender, race, high school GPA (imputed for missing) ACT score (imputed for missing), whether the student completed the FAFSA, and if the student has an EFC of $0. The "total treatment" row tests whether the linear combination of the treatment and interacted terms is significant, with p-value on the F-test reported below.
*** p<0.01, ** p<0.05, * p<0.1