READY OR NOT?
CALIFORNIA'S EARLY ASSESSMENT PROGRAM AND THE TRANSITION TO COLLEGE

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Abstract
In this paper we investigate the impact of a statewide program aimed at better aligning K-12 to higher education and improving college readiness. We replicate an earlier study focused on the effects of this program at one campus by employing detailed administrative data on the census of California students that enroll at all twenty-three campuses of the California State University (CSU) system. We evaluate whether the program has reduced remediation rates at CSU statewide and investigate whether program effects differ by student background. We find that participation in the Early Assessment Program reduces the average student's probability of needing remediation at California State University by about 2-3 percentage points overall. Investigating heterogeneous treatment effects, we find the program effects are largely concentrated among students at the margin of remediation risk.

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I. INTRODUCTION

Despite widespread calls for more U.S. students to obtain a postsecondary degree (Obama 2009), many students are unable to complete a college credential because they arrive at college unprepared for college-level work.[1] Low levels of college readiness are particularly evident at broad access institutions in both the two- and four-year sectors, where nearly 90 percent of all U.S. postsecondary students are enrolled. Data from the 2007/2008 National Postsecondary Student Aid Study indicate that one in four first-year undergraduates at broad access institutions report taking remedial courses (Sparks & Malkus, 2013), but some research suggests that the share of college students in need of remediation may be closer to 50 or 60 percent or higher (Scott-Clayton, Crosta, & Belfield, 2014; Shulock, 2010).[2] Recent studies of the collegiate outcomes experienced by these academically underprepared college students paint a bleak picture of our ability to reach national college completion goals without dramatically improving college readiness.[3]

Unfortunately, many of those who are compelled or counseled to take remedial or developmental classes after entering college were unaware of the poor state of their academic preparation prior to matriculating (Person, Rosenbaum, and Deil-Amen 2006; Rosenbaum 2001; Venezia, Kirst, and Antonio 2003). Early college readiness assessment initiatives that are

[1] College completion is not just a goal of the current administration. A variety of other organizations have published goals in recent years that range from increasing degree completion to 55% or 60% by various years, including the Southern Regional Education Board (http://publications.sreb.org/2010/10E10_No_Time_to_Waste.pdf), Complete College America (http://www.completecollege.org/docs/CCA%20Essential%20Steps%20Set%20A%20State%20Completion%20Goal.pdf), The College Board (http://media.collegeboard.com/digitalServices/pdf/advocacy/cca/12b-6368_CCAProgressReport_WR.pdf), and the Lumina Foundation (http://www.luminafoundation.org/advantage/document/goal_2025/2013-Lumina_Strategic_Plan.pdf).

[2] The differences in the rates for remediation need are in part due to measurement; transcript based reports are typically higher than self-reports.

[3] See: Bettinger, Boatman and Long (2013); Rutschow and Schneider (2012); Kurlaender and Howell (2012); Bailey (2009).

supported by cohesive state policy are one means by which policy makers seek to increase the share of students leaving high school prepared to succeed in college (Shulock, 2010).[4] These initiatives inform students about their need for additional academic preparation while there is still time for them to take action. The question of how we might improve the information on which students base their postsecondary preparation, application, and enrollment decisions has been the subject of recent research (Cabrera & La Nasa, 2001; Long, Conger, & Iatarola, 2010; Avery, 2010; Castleman & Page, 2011; Smith, Pender, & Howell, 2012). Our study focuses on efforts to improve college readiness through one such statewide intervention.

California was the first of 25 states to offer statewide early college readiness assessments to all students attending public high schools prior to their senior year of high school (Barnett, Fay, Bork, & Weiss, 2013).[5] In the 2003/2004 academic year, California launched the Early Assessment Program (EAP), an academic preparation program created jointly by representatives from K-12 and higher education. By providing students with information about their college readiness prior to the start of their senior year of high school and then guiding underprepared students toward resources to improve their college readiness, EAP seeks to reduce the barriers students must overcome to successfully make the transition to credit-bearing college coursework. A byproduct of these efforts is enhanced curricular alignment between the secondary and tertiary sectors of public education.

An earlier study analyzed the impact of the EAP at one California State University campus (Howell, Kurlaender and Grodsky, 2010). This paper extends that analysis using data

[4] There exist a whole host of complementary local and school-specific programs like Summer Bridge, Dual Enrollment, Advanced Placement, early college high schools, and learning communities that are supported by a growing body of research (see http://www.postsecondaryresearch.org/index.html?Id=Research&Info=Developmental+Summer+Bridges).

[5] In 13 additional states, early college readiness assessment initiatives are in place locally rather than statewide (Barnett et al., 2013). Additionally, the assessments under development for the Common Core State Standards will very likely be employed for this purpose by all states (Barnett & Fay, 2013).

from all 23 campuses of the California State University system over a longer time horizon. We also move beyond average treatment effects to consider variation in program effects across students, an important extension given prior evidence about the heterogeneous effects of remediation for different subgroups (Page & Scott-Clayton, 2015). As we discuss below, prior literature leads us to expect the EAP to produce a stronger reduction in remediation need among groups most at risk of underperforming on the CSU remediation screener relative to their true abilities: African American and Latino students in both English and math and women in math. We also expect those at greatest and least risk for remediation to be least affected by EAP while those predicted to be closest to the pass threshold on each remediation screener to be most affected by the EAP. These 'bubble' students stand the most to gain simply from having an additional opportunity to place out of remediation. We test for these heterogeneous EAP effects and find support only for variation across prior test scores.

In the five years since that study of a single-campus, the need for a statewide evaluation of the program has only grown. Many other states and localities have modeled their early college readiness assessments on the EAP (Barnett et al., 2013), yet we have little rigorous evidence on the impact of EAP on students' college readiness, or of the potential variation in program impacts across students.[6]

The paper is organized as follows. In section II, we review evidence on the prevalence of remedial education, the impact of remediation on students' collegiate outcomes, and some of the

[6] In several states, early college readiness programs are beginning to attract the attention of researchers. See Wathington, Barnett, Fay, Mitchell, Pretlow, and Bork (2012) on Virginia; Barnett, Corrin, Nakanishi, Bork, Mitchell, and Sepanik (2012) on Texas; Mokher (http://ies.ed.gov/funding/grantsearch/details.asp?ID=1337) on Florida; and additional information from the Southern Regional Education Board on the six state participants in its Strengthening Statewide College/Career Readiness Initiative (http://www.sreb.org/page/1618/previous_college_readiness_initiatives.html).

interventions designed to reduce the need for remediation. Section III describes the Early Assessment Program in more detail. We describe the data and analytic framework in section IV and the empirical results in section V. Section VI concludes with a discussion of how the body of evidence presented here might be used to support and/or refine alignment and college readiness efforts in other states.

II. Previous Research

Nearly one in five first-year undergraduates report enrolling in at least one remedial course at their college or university (Sparks & Malkus, 2013). Students attending two-year institutions have a higher rate of remedial course-taking (24 percent), but the remediation rate among first-year undergraduates at public four-year colleges is also very high (21 percent) (Sparks & Malkus, 2013). These self-reports substantially understate the share of students actually enrolled in remedial course, in part because many students enrolled in such courses to not recognize them as remedial (Deil-Amen & Rosenbaum, 2002). Based on their analyses of postsecondary transcripts of students who entered college for the first time in the 2003-2004 school year, Scott-Clayton, Crosta and Belfield (2014) estimate that about 50% of students take at least one remedial course in college. Rates of remedial course enrollment vary substantially across colleges and universities, with some institutions not offering remedial courses and others enrolling upwards of 80 percent of their incoming students in remedial classes. Public four-year colleges and universities spent in the range of 435 to 543 million dollars in 2004/2005 on remedial instruction; the total cost to students attending two-year or four-year institutions in the same year was about $708-886 million in remedial education tuition and fees (Strong American Schools, 2008).

Why are so many high school graduates unprepared to complete college-level work? Some posit that public secondary and postsecondary systems of education are simply misaligned (Bettinger, Boatman, & Long, 2013; Kirst & Venezia, 2004). Standards for academic success vary widely among high schools and colleges. This disjuncture poses a significant challenge to students and policy makers, the consequence of which is a great deal of confusion and even ignorance among students about the academic demands of college. It is no wonder they are confused; the average high school GPA of students requiring remediation in either math or English at one typical four-year California State University campus was just above a 3.1 (Howell et al., 2010).[7] Their high schools told them that they were successful "B" students, but their college told them that they were not ready to do college-level work.

In recent years, many states have been questioning the role of remedial courses in their postsecondary institutions and developing promising models of reform intended to improve K-12 and postsecondary alignment and increase college readiness (Bettinger, Boatman, & Long, 2013). Although some believe that remedial courses in postsecondary institutions serve as an important bridge between weak K-12 schools and baccalaureate programs, others argue that remediation should be provided by secondary schools or community colleges, not baccalaureate-granting colleges and universities. Several states have stripped remedial programs from their colleges and universities (Gleason, 2000; Shaw, 1997) while others have retained remedial classes but made higher demands of students to remediate prior to entry if they do not meet college readiness standards (e.g. California State University's Early Start Program[8]). Some scholars worry that eliminating developmental education opportunities will lead to declines in

[7] See: http://www.asd.calstate.edu/remediation/07/Rem_Sys_fall2007.htm
[8] See: http://www.calstate.edu/acadaff/EarlyStart/

minority representation at four-year colleges and universities, given differences by race/ethnicity in the likelihood of needing remediation (Atwell, Lavin, Domina, & Levey, 2006).

States have developed a range of approaches to increase the share of students prepared to complete college-level course work (see American Diploma Project Network of Achieve, Inc.).[9] Many states have implemented or are considering K-16 or Pre-K-20 initiatives, albeit with a wide range of purposes, relationships, and end goals (Venezia et al., 2005). An early example is Indiana's Twenty-first Century Scholars Program, a state financial aid program that began in 1990 and promises middle school students who qualify for the federal free/reduced lunch program free tuition at Indiana public universities upon meeting college preparatory requirements. Some states', accountability systems have expanded to include postsecondary schooling, with an explicit focus on improving enrollments, reducing remediation, and increasing degree completion (Venezia, Finney, & Callan, 2007).

Many states have also raised high school curricular standards to better align with postsecondary entrance requirements. Venezia and Jaeger (2013) report that by 2015 nearly half of all states and the District of Columbia will have a default high school curriculum that includes four years of English and math, and at least three years of science, social science, or both. Michigan, for example, in 2006 adopted a comprehensive set of high school graduation requirements known as the Michigan Merit Curriculum (MMC). These requirements were designed to increase the rigor of high school course-taking and better prepare Michigan students for postsecondary success (Dynarski et al., 2012).[10] Other states have responded in a variety of ways to the broader Complete College America agenda.[11]

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[9] http://www.achieve.org/ADPActionAgenda

[10] Researchers are currently evaluating the impact of the Michigan Merit Curriculum as part of the Michigan Consortium for Educational Research, see: http://michiganconsortium.org/

[11] Access state reports at http://www.nchems.org/projects/public_agenda.php.

Most recently, many states have incorporated college readiness as part of their high school graduation requirements (Conklin & Sanford, 2007). Many states have adopted Common Core State Standards and signed on to create K-12 standards "aligned with college and work expectations" (National Governor's Association 2009).[12] Finally, several states, including California (the site of this study), have instituted college remediation assessments while students' are still in high school (Long & Riley, 2007). To date, the success of these efforts to improve college readiness (including California's Early Assessment Program) have not been sufficiently investigated.

Information constraints may help account for the large share of students in American colleges and universities requiring remediation. Students are often ill informed about what they need to do to succeed in college, beyond getting through the door. A majority of high school students, regardless of their academic performance, report that they will attend college (Rosenbaum 2001). In fact, academic performance accounts for little of the variance in students' *expected* levels of educational attainment. Reynolds et al. (2006) find that between 1976 and 2000 the percentage of high school seniors indicating that they probably or definitely would complete *at least* a baccalaureate degree increased from 50 percent to 78 percent. Over the same period the explanatory power of self-reported grades and participation in a college preparatory program for educational expectation declined appreciably (Reynolds, Stewart, MacDonald, and Sischo 2006). Given changes in the marginal distribution of academic achievement among those expecting to attend college, it should come as no surprise that the level of secondary academic

[12] At the time of submission, five states (Georgia, Pennsylvania, Oklahoma, Florida, and Maine) have pulled back from the Common Core State Standards initiative with respect to the assessments designed to test students' ability to meet the standards.

preparation among college entrants has declined over time (Bound, Lovenheim, and Turner 2007).

What happens to students who begin their postsecondary careers in remedial (developmental) courses? Students placed in remediation are less likely to persist in college and graduate; among those that do graduate, remediated students take substantially longer to complete their degree (Bettinger, Boatman, & Long, 2013; Scott-Clayton & Rodriguez, 2014; Kurlaender & Howell, 2012; Rutschow & Schneider, 2011). Of course students that end up needing remediation face many other challenges when they arrive in college. Most notably they have, on average, weaker skills than other students. Although engaging in developmental instruction may ultimately improve students' human capital, this strategy is costly to both students and colleges (Bailey, 2009). Thus, in addition to understanding what leads to college readiness, it is critical to understand how institutions can both influence students to arrive at their doors better prepared and better serve those students that enter with weak preparation (Rutschow & Schneider, 2011).

The literature on the effects of remediation on students' postsecondary outcomes is, at best, mixed. Part of the difficulty in isolating a remediation effect is the obvious (negative) selectivity of those who enroll in remedial courses. Several studies have employed a variety of methodological approaches to address the selectivity bias inherent in remediation placement. In one such study, Bettinger and Long (2009) exploit the variation in remedial placement policies across Ohio higher education institutions and proximity of college choice to instrument for remediation. They find that remediation has a positive impact on students' college outcomes; students placed in remedial courses were more likely to persist in college and more likely to obtain a degree within four to six years than observationally similar students who were not required to take such classes. In two other studies, researchers find no effects of remediation for students at the margin of passing a remediation exam attending public two-year and four-year institutions in Texas (Martorell & McFarlin, 2011), and some positive effects on early persistence and overall credits among remediated students attending public community colleges in Florida (Calcagno & Long, 2008). Both studies evaluate the impact of remediation in academic subjects on student outcomes such as total credits, persistence, subsequent performance in academic subjects, and transfer to four-year institutions among community college entrants. Applying regression discontinuity design, neither study finds much benefit to remedial instruction for students at the margin of the remediation placement test on these outcomes. Of course, these studies do not evaluate the impact of remediation for lower ability students who may be far from the remediation assignment cutoff. Moreover, studies on the impacts of specific remediation strategies on a variety of student outcomes remain quite limited (Rutschow & Schneider 2011).[13]

From existing literature we know that remediation is prevalent, costly, and potentially ineffective at improving the outcomes of unprepared students (at least as most commonly implemented). Although analysts and policymakers may disagree about the effectiveness of remediation assignment policies, there is no disagreement about the importance of increasing the share of high school graduates who are prepared to succeed in college. Alongside recent efforts to enhance readiness through alignment between academic standards at the K-12 and tertiary levels (the Common Core State Standards movement), California has engaged in an effort over the past decade to increase students' awareness of their need for college remediation and to offer students the opportunity to address that need *prior to* completing high school through the Early

[13] See new Community College Research Center evidence on other modes of developmental education delivery (http://ccrc.tc.columbia.edu/Developmental-Education-Structure-Curriculum-and-Pedagogy.html).

Assessment Program (EAP). Prior work on this program finds that participation in EAP reduces the average student's probability of needing remediation at one CSU campus by 6.2 percentage points in English and 4.3 percentage points in mathematics (Howell et al. 2010). These results provide a fruitful starting point for an expanded investigation of the statewide effects of the EAP on students' need for remediation in California.

III. The Intervention—California's Early Assessment Program

The Early Assessment Program (EAP) is an academic preparation program developed jointly by the California Department of Education (CDE), the State Board of Education, and the California State University (CSU).[14] The stated purpose of the program, now in its ninth year, is to bridge the gap between K-12 educational standards in English and mathematics and the requirements and expectations of postsecondary education at the California State University. The development of EAP was motivated by a desire to increase the English and math proficiency of entering freshmen at CSU campuses, thereby reducing high systemwide remedial course-taking rates (see Figures 1A and 1B). The information provided by EAP may reduce remedial course enrollments at CSU campuses by increasing the academic readiness of incoming students and/or reducing the likelihood that potentially remedial students choose to apply to and enroll in a CSU.

The three explicit goals of the Early Assessment Program are: (1) identify students *before* their senior year who need additional coursework or preparation in English and/or mathematics to succeed at a CSU; (2) provide students, parents, teachers, and administrators with information about their students' college readiness, and then partner with those parties to increase the quality of academic preparation; and (3) motivate students to take steps in their senior year to achieve

[14] Much of the description of the Early Assessment Program here comes from Howell et al. (2010).

readiness for college-level work.[15] The program has three components: an 11^{th} grade test to identify the need for further academic preparation, professional development to aid high school teachers in facilitating improved college readiness among their students, and supplemental preparation for students in their senior year.[16] All three components of the program are voluntary, a point to which we return below.

The first component of the program, and the one we investigate in this paper, is an assessment of English and math skills among California 11^{th} graders that was first available statewide in the spring of 2004. The assessment supplements selected items from the mandatory California Standards Tests (CSTs) in 11^{th} grade English and mathematics with 15 optional multiple-choice questions in each subject (along with a separate 45 minute writing session for English). These additional test items were developed collaboratively by CSU and K-12 faculty to reflect both California high school standards and CSU placement standards. Composite scores from the exam are computed based on a subset of CST questions augmented with the EAP items. Based on these scores, students who elect to complete the additional test items receive a letter in the summer before their senior year in high school with information about whether or not they are ready to do college-level work. If their score exceeds an upper threshold, they are told that they are college-ready and will be exempt from the CSU placement exam should they enroll at a CSU campus. Students whose score falls below a lower threshold are told that they are not

[15] Information retrieved at http://www.calstate.edu/eap/documents/presentation_cde.ppt#302. Policy Analysis for California Education conducted a more detailed review of the goals and implementation of the EAP; this report can be found at http://www.stanford.edu/group/pace/PUBLICATIONS/PACE_EAP_March_2012.pdf

[16] The teacher development component includes CSU teacher-education faculty sponsored reading institutes and materials through which high school teachers might improve their skills in helping students to read and write effectively. The supplemental student preparation component enables students to pinpoint their individual strengths and weaknesses by using the CSU Diagnostic Writing Service or the Mathematics Diagnostic Testing Project. Students who need better skills in expository reading and writing can take a specially designed 12th grade course, developed jointly by teachers from high schools and the CSU. Students who need to upgrade their mathematics skills have access to interactive online programs called *CSU Math Success* during their senior year.

academically prepared for college and will be required to take the remediation placement exams should they attend a CSU. They are advised about what courses to take in their senior year to reduce their likelihood of needing remediation and directed to additional resources to improve their readiness for CSU coursework following high school graduation.[17]

All 11th grade public high school students in California who take the state standards test in English have the opportunity to complete the EAP items. Participation on the EAP math assessment, however, is restricted to the roughly 50 percent of students who have completed either algebra II or a more advanced math course by the end of their junior year of high school. While there is only one threshold in English to distinguish the exempt and non-exempt outcomes, the mathematics EAP also includes a middle-range for scores that yields an outcome of exempt *conditional* on completing certain courses during their senior year in high school with a grade of "C" or higher.

Although students receive important signals on both the English and math EAP, the math EAP offers more explicit guidance to nonexempt students with respect to course choices. Students who score below the exempt threshold in English are told to prepare for the English Placement Test by "reading daily, practicing your writing skills, and accessing the practice tests on this [web] page."[18] In contrast, students who score below the exempt threshold in math are told to take a math course during their senior year to sharpen their skills and to begin preparing for the CSU remedial math placement test, the Entry Level Math exam (ELM), through an online test preparation program in January of their senior year. Finally, students in math (but not English) are 'conditionally exempt' from the math placement test if they score between the non-

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[17] For additional information, see CSU-developed online resources to help students and their families make sense of their EAP results and what to do to prepare for CSU (http://www.csusuccess.org).
[18] http://www.csumathsuccess.org/exam_prep_esw

exempt and exempt thresholds. These students are counseled to earn a "C" or better in an approved year-long math course in their senior year of high school in order to earn exemption from ELM.[19] Alternatively, conditionally exempt students not enrolled in a math class their senior year may complete a "supervised e-learning course" monitored by CSU faculty to meet the ELM requirement.

IV. Data & Analytic Framework

California serves students from a tremendous range of ethnic and socioeconomic origins. The 23-campus CSU system is the largest public higher education system in the country, educating about 1 in 10 California high school graduates, roughly 5.5 percent of the undergraduates enrolled in public four-year colleges in the entire nation.[20] These students come from urban, suburban and rural areas and attended public high schools that are both among the best and among the worst in the nation. While California may not be a typical state, it reflects the student populations of other states in the U.S. and the mainstream public colleges that educate them. Given the diversity of California's students and public schools and the increasing diversity of students entering the nation's colleges and universities,[21] we argue that other states can learn important lessons from California's efforts to reduce the demand for postsecondary remediation.

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[19] Approved math courses include trigonometry and math analysis, pre-calculus and calculus. Under certain conditions, algebra II or some other course may satisfy the ELM requirement. See http://www.csumathsuccess.org/hs_course_msw for more details.

[20] This calculation is based on a published CSU enrollment of 437,000 students (http://www.calstate.edu/pa/2013Facts/documents/facts2013.pdf) and enrollment of 7.9 million student in public four year colleges nationwide in 2007 (http://nces.ed.gov/pubs2013/2013008.pdf).

[21] Between 2007 and 2018 the number of students enrolled in a college or university is expected to increase by 4 percent for whites but 38 percent for Hispanics, 29 percent for Asian/Pacific Islanders and 26 percent for African Americans (Hussar & Bailey, 2009).

Data Description

To evaluate the EAP, we construct a unique longitudinal student-level data set that includes the population of 11th grade public high school students in California and follows these same individuals as many of them enter and proceed through the California State University system. The data span the six academic years between 2000/2001 and 2005/2006, a time period that includes three years prior to and three years following the statewide implementation of EAP. We draw from several different administrative data sources to assemble the data necessary to answer our research questions. Our population consists of the census of California high school students who choose to apply to and ultimately attend a CSU campus.

In addition to data on student's gender, race/ethnicity, parental education, eligibility for free/reduced lunch, GPA and standardized test scores, the California Department of Education (CDE) provided an indicator for whether or not each student answered the supplemental EAP questions and, for those who complete the EAP items, their EAP score. We merge the CDE student data with individual-level data on all first-time freshmen applicants to a CSU campus between 2000/2001 and 2005/2006, enabling us to follow the population of high school juniors as they make a series of postsecondary choices and experience a variety of academic outcomes that involve the CSU. The CSU Chancellor's Office provided information on student application, admission, and enrollment at CSU campuses, English and math placement test results (if taken), remedial course-taking, and other background.

The key student outcome measures are binary variables indicating remediation need in English and math among CSU enrollees. All analyses incorporate a host of independent variables that may be associated with the need for remediation including race/ethnicity, gender, parental education and students' prior academic achievement (high school grade point average and standardized test scores). In addition to student-level covariates, we also include high school fixed effects to account for unobserved, commonly held attributes and experiences of students who attended the same high school. Table 1 provides descriptive statistics on all of our key variables by year.

We address two research questions: (1) Does EAP reduce the probability of needing remediation among first-time freshmen across the CSU system? and (2) Does the effect of EAP on the need for remediation vary across student gender, race/ethnicity, or prior academic achievement? As is often the case with major state educational policies, EAP was made available by the state to all public school students at the same time. We exploit the timing of the policy's introduction, as well as the wealth of administrative data available to us, to produce sound quasi-experimental estimates of the effects of this intervention on students in California based on an interrupted time series model. We also rely on a number of methods to assess the robustness of our estimates to both static and dynamic threats to validity. Static threats refer to unobserved characteristics that influence student (or school) selection into EAP at each point in time, while dynamic threats refer to unobserved changes over time in the pool of students and schools on which EAP draws.

Analytic Framework

We estimate two types of treatment effects. First, by taking advantage of the temporal disjuncture in the availability of the EAP along with measures of other covariates, we estimate the intent to treat effect (ITT) by comparing remediation rates for students eligible to participate in EAP by virtue of the year they entered11th grade (between 2003/2004 and 2005/2006) to the remediation rates of those students ineligible to participate because the program was not yet available (between 2000/2001 and 2002/2003). If the assumptions underlying this interrupted time series design are satisfied, then the post-EAP coefficient reflects program benefits that accrue directly to those who opt in to the treatment (i.e., complete the EAP assessment) and benefits that accrue indirectly to those who do not opt in to the treatment when it is available. Indirect benefits may be generated by spillover effects from the increased knowledge and more deliberate preparation of peers in the school who chose to complete the EAP test items and thus received information about their level of college readiness as well as heightened sensitivity among high schools to the levels of college readiness exhibited by their students. Second, we estimate the effect of the treatment on the treated (TT) by comparing remediation rates for those who do and do not complete the EAP among all those who were eligible for the assessment, as well as between those who complete the EAP versus similar students who did not have the EAP available to them. Finally, although EAP is available to all 11^{th} grade students in the state, it is voluntary at the individual level and schools vary widely in the proportion of their juniors who participate in EAP, with increasing participation over time. We address the potential bias associated with both individual- and school-level selection below.

Intent to Treat Model

To estimate the effect of making the EAP available statewide on remediation need (ITT), we specify a model where an individual student *i*'s probability of requiring remediation in subject *s* at CSU is a function of individual characteristics, X_i, attributes of the individual's high school, Z_i, and a variable to indicate whether individual *i* had EAP available during their junior year of high school, PostEAP_i. An identically distributed error term, ε_{is}, is permitted to be correlated within but not between campuses. We estimate the linear probability model:

$$REMED_{is} = \alpha PostEAP_i + \beta X_i + \gamma Z_i + \varepsilon_{is}, \quad (1)$$

where $REMED_{is}$ represents the probability that student *i* requires remediation in subject *s* at CSU. The individual characteristics in the vector X_i include gender, race/ethnicity, several measures of academic ability, and parental educational attainment. The β parameters capture the effects of these student characteristics on the propensity to require remediation in subject s. Although not of substantive interest in the current paper, conditioning on student background attributes addresses some potential source of confounding in the interrupted time series specification (i.e., that the quality of applicants has increased over time, leading to lower levels of remediation need). In some specifications of equation (1), we also include high school and CSU campus fixed effects. Together, these condition on any changes in the observed attributes of students over time as well as changes in the sorting of students from different high schools across CSU campuses. Holding constant all of these student and institutional factors, the parameter on $PostEAP_i$, α, identifies the effect of Early Assessment Program availability on the latent propensity that a student enters CSU in need of remediation.

A general threat to the validity of interrupted time series models such as these is unobserved changes that occur at the same time as the intervention and affect the same outcome of interest. To address concerns about changes between pre- and post-EAP periods that are orthogonal to high school fixed effects and observed student characteristics, we conduct a difference-in-differences analysis that compares temporal changes in remediation need for students enrolled at CSU that attended private high schools in California (around 11% of CSU students) and those who attended public schools. Because EAP is only made available to California public schools, students attending private schools serve as a useful control group to evaluate overall changes in the probability of remediation need for the periods under question. Both public and private school students would be subject to temporally varying influences on attendance that could bias our effect estimates (including changes in course availability, admissions criteria, financial add and mandatory tuition and fees), but only public students would be subject to the EAP effect we seek to identify. Although we found results consistent with our other estimates, we believe this is a useful robustness check on our ITT estimates.[22]

Treatment on the Treated Model

To test the effect of actually participating in EAP on remediation need, or the treatment on the treated (TT) effect, we specify a model very similar to equation (1) where an individual student's probability of requiring remediation in subject *s* is a function of individual characteristics, X_i, the individual's high school, Z_i, a variable to indicate whether individual *i* had EAP available to them as juniors in high school, $PostEAP_i$, along with an interaction term between EAP availability and EAP participation $(PostEAPi * EAPPartic_{is})$. An identically distributed error term, ε_{is}, is permitted to be correlated within but not between campuses. We estimate the model:

$$REMED_{is} = \alpha_1 PostEAP_i + \alpha_2(PostEAPi * EAPPartic_{is}) + \beta X_i + \gamma Z_i + \varepsilon_{is}. \quad (2)$$

The parameter α_1 captures the differences in remediation rates between the pre-EAP period and the post-EAP period among non-participants (i.e., the secular trend in remediation need), α_2 captures the marginal effect of participating in EAP on remediation need relative to those

[22] A similar strategy was used by Howell et al. (2010)

students who had EAP available but did not participate, and the combined α_1 and α_2 capture the difference in remediation need between participants and those who did not have EAP available.[23] All other β and γ parameters can be interpreted as discussed in equation (1). Again, in some specifications we include high school and campus fixed effects.

Our strategy for testing for heterogeneous effects of EAP extends the models above to include a series of interaction terms. The addition of interactions between EAP proxies (*PostEAP* in the ITT models and *EAPpartic* in the TT models) and other covariates is straight forward. We evaluate differences in estimated effects by gender, race/ethnicity and propensity for remediation (as a function of academic background).

It is important to note that our empirical methodology is not a difference-in-difference strategy, but simply a treatment-control identification strategy. We have perfect compliance among the control group for our ITT estimates since no high school junior could have participated in EAP prior to the 2003/2004 school year and no student who had been a junior prior to the EAP program could have participated at a later date since the EAP is attached to the California Standards Test taken by high school juniors. Likewise, the treatment is, at least in principle, available to every public high school junior in the state beginning in the 2003/2004 school year and beyond, giving us some justification for interpreting the effects of EAP participation as treatment effects on the treated. However, it may be the case that student access to EAP is differential *de facto* as a result of differences in the availability of information about EAP at the individual student or school level. Moreover, as a result of the voluntary nature of the program, one might be concerned that our primary analytic strategy suffers from selection bias.[24]

[23] Only those who complete the EAP are considered here as participants. Students who complete part but not all of the assessment (i.e., do not complete the essay for the English exam) are not considered EAP participants.
[24] More specifically, *static selection bias* refers to sources of bias that affect each cohort of EAP participants, including selection by schools to inform students about EAP and perhaps urge or require them to participate and

We address selection into EAP participation as a function of both individual and school characteristics by estimating a separate set of models in which we restrict the sample to high schools with near-universal EAP participation (e.g., over 90 percent participation by students). We then estimate equation (1) (the ITT model) on this subset of schools. By truncating the distribution on EAP participation rates we virtually eliminate school-level noncompliance and individual self-selection from the model. Although these schools may be different from others in the unobserved attributes that led to their near-universal participation in EAP, they are nonetheless instances in which student self-selection is nearly absent. These schools therefore serve as an additional check on our main ITT estimates from equation (1).

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selection by students who complete the EAP assessment. *Dynamic selection bias* refers to temporal changes in the school and student population of participants. It may be the case that early adopters of EAP are those who are most inclined to attend a CSU or most proactive in their college planning. Either of these unobserved differences between participants and non-participants could bias our TT estimate of the effect of EAP participation on remediation need in college (α in equation (2)). By taking time trends into account, we may be able to estimate and reduce this sort of bias.

V. RESULTS

Intent to Treat Effects

Based on equation (1), we find a small statistically significant effect of EAP availability on remediation need in both English and math, controlling for a variety of individual-level covariates and school and campus fixed effects. The top panel of Table 2 presents the English ITT results, and the bottom panel of Table 2 presents the results for math. Columns 1-3 in Table 2 evaluate the program three years after its inception and columns 4-6 compare remediation need for the last cohort before EAP began and the first cohort when the EAP was available.[25] In specifications 1 and 4, we present the unconditional model, for English and math, respectively. In specifications 2 and 5, we add a host of individual covariates to address changes in cohort composition, and in specifications 3 and 6 we add high school and campus fixed effects. These models reduce the threat that changes in the attributes of students on key observable characteristics or the sorting of students across high school or CSU campuses contaminates our intent-to-treat estimates. Comparing three cohorts before the program to the three cohorts right after the program, we estimate that the availability of EAP reduced the probability of remediation need by 1.8 percentage points in English and 2.0 percentage points in math net of individual predictors and high school and CSU campus fixed effects. Results are robust (albeit smaller in magnitude) when comparing just two cohorts in math (1.8), and quite small and nonsignificant in all but the fixed effects models in English (.07).

We also test the intent to treat effect by comparing the difference in public schools before and after the EAP to the difference in private schools before and after the EAP. This difference in difference strategy suggests little change was brought about in English, however the policy

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[25] We fit additional specifications comparing two years pre and two years post-EAP and obtain similar results to those presented here.

may have brought about a change in math (Table 3). The interaction between whether a student was in a private high school and whether students were in the post-EAP period is not statistically different than zero across all specifications, suggesting that the pre-EAP to post-EAP differences were the same for public schools, where the EAP was offered, and private schools, were the EAP was not offered. This finding suggests that the decrease seen in the post-EAP period may have been a result of a state-wide decrease in remediation need, regardless of whether students were able to take the EAP. In math, the two-cohort analysis shows no difference in difference for public and private schools. The six-cohort analysis, however, suggests that the pre-EAP to post-EAP decrease in remediation was about 2.2 percentage points smaller for private schools than it was for public schools, even when controlling for some student characteristics.

Overall, we conclude that the existence of the EAP—regardless of participation in the program—contributed to a modest *reduction* in the need for remediation at CSU. It is important to note, however, that the ITT results in English are less robust across the various specifications than the results in math.

Treatment on Treated Effects

Table 4 presents the marginal effects of EAP *participation* on the probability of remediation need at CSU by subject, following the same layout as the ITT results presented in Table 2. Here we can distinguish between participants and non-participants in the post-EAP period. We find statistically significant effects of EAP participation on remediation need in both English and math. Looking at English first, the unconditional model estimated on all six years of data (specification 1) predicts a 5.1 percentage point reduction in English remediation need, on average, for EAP participants, when compared to non-participants in the post period, and a 3.1

percentage point reduction comparing participants to those in the pre-EAP cohorts who did not have EAP available to them (combining the *Post-EAP* and *Participation* coefficients). Moving across the specifications in English, we see that the TT effects are attenuated upon control for individual covariates (specification 2; see bottom panel of Table 4 for a list of controls and temporal bound on the sample). Estimates are virtually unchanged with the inclusion of high school and campus fixed effects (specification 3). Results comparing participants in the first year of EAP to the prior pre-EAP cohort (columns 4-6) also reveal statistically significant reductions in the probability of English remediation, but smaller in magnitude. Thus, we conclude, participating in EAP reduces the probability of needing remediation in English at CSU by roughly 2 to 2.5 percentage points when comparing non-participants to participants in the post-period, and comparing EAP participants to similar students from pre-EAP cohorts.

For math, the unconditional model (specification 1) predicts a 4.7 percentage point reduction in math remediation need as a function of EAP participation when comparing participants to non-participants in the post period, and a 1 percentage point reduction comparing participants to those in the pre-EAP cohorts who did not have EAP available to them. Not surprisingly, the effects in math are also reduced upon the inclusion of controls for individual covariates (specification 2) and then high school and campus fixed effects (specification 3). Similar to English, EAP effects in math still persist and maintain their statistical significance net of covariates. Compared to English, however, EAP effect estimates for math are somewhat less stable across the time spans employed in these different specifications. Overall, we find that participating in EAP reduces the probability of needing remediation in math at CSU by only about 1-2 percentage points comparing participants to non-participants in the post-EAP period, and by slightly over 2 percentage points comparing participants to those in the pre-EAP cohorts who did not have EAP available to them.[26]

Examining Selection Bias

At the most general level, one might worry that our estimates of EAP effects are biased by selection into the sample itself. Recall that we can only observe the impact of EAP on remediation form those who choose to apply to and enroll at a CSU campus. What if EAP impacted patterns of enrollment by reducing the odds of enrollment among those most likely to require remediation? While this additional causal pathway is plausible and perhaps even desirable, other research finds little to no impact of EAP on either application to a CSU or attendance at a CSU (Jackson 2014), a point we return to in the discussion section of the paper.

Evaluating the effects of EAP is further complicated for two reasons. On the one hand, the intervention was rolled out to the entire state at once, precluding the possibility of a contemporary control group. On the other hand, participation in EAP was voluntary, opening up the possibility that the results presented above might suffer from bias due to student self-selection into the program.[27] In particular, our treatment on the treated estimates may be biased to the extent that student or school characteristics, unrelated to the covariates we include in our models, may influence both a student's probability of participating in the EAP and her probability of requiring remediation. To address the potential influence of student self-selection, we repeat the TT analyses on a subsample of students attending schools in which self-selection is largely absent: schools with EAP participation at, or over, 90 percent of eligible students. This

[26] Full model results are available upon request from the first author.
[27] In the early years of implementation student participation was variable. While still technically voluntary, participation in EAP today is nearly universal among eligible students.

virtually eliminates student-level noncompliance from the model, but does so at the potential cost of focusing on a sub-set of schools that may differ in systematic ways from other schools in the population. We present the estimates of the effect of EAP participation on remediation need under these different specifications in Table 5; with the exception of the sample restriction, the models in Table 5 are identical to those we present in Tables 2 and 4. We note that in all cases (save for the fully specified model in math), our estimates of the effect of EAP participation on remediation need are similar in this restricted sample, suggesting that school selection is not likely driving the results. The general findings remain the same however—EAP contributes to a modest reduction in student demand for remediation and one that appears more reliably estimated in math than in English.

Beyond Average Treatment Effects

Prior work did not explore the potentially variable effects of the EAP on different types of students. However, there are several reasons to believe that the effects of the EAP may vary across student subgroups. First, past research suggests that *stereotype threat* may lead to anxiety and performance degradation on exams, particularly higher stakes exams, for groups about whom negative academic stereotypes exist (Steele & Aronson, 1999). Since the EAP is appreciably lower stakes for students than the actual remediation placement exam, we might expect that discrepancies on EAP performance and performance on the remediation placement exam would be greater for girls than boys in math (but not necessarily English) and greater for African American and Latino students than for white students in both subjects. Thus, we might expect girls (in math), and African American and Latino students to benefit more from EAP than male and white students.

Second, demographic groups may vary in their average perception of risk and risk aversion. Aversion to risk may increase students' sensitivity to diagnostic information like the EAP and lead them to take steps to reduce the chances that they are compelled to take remedial courses at college. There is a fairly well-developed literature in both behavioral economics and psychology that highlights gender differences in risk aversion; women are typically more risk-averse than men (for reviews of these literatures see Byrnes, Miller, and Schafer 1999; Croson and Gneezy 2009). Although the literature on racial/ethnic differences in risk assessment is not as well developed, there is some empirical evidence consistent with the notion that African American students are more sensitive to school inputs than are white students (Ferguson 1998), including, for example, teacher evaluations (Jussim, Eccles, and Madon 1996). We suggest that this risk aversion and sensitivity to negative outcomes may lead women and African Americans (along with other underrepresented groups) to be more responsive to the information about college readiness conveyed by the Early Assessment Program, leading ultimately to greater reductions in their need for remediation.

Finally, we anticipate that the effects of EAP will vary across the distribution of prior academic achievement. Assigning students to remediation based on a single exam, while attractive from an analytic point of view (lending itself to Regression Discontinuity Design), is problematic from a psychometric point of view in that it can lead to misclassification. Students perform poorly on assessments for many reasons other than their skill levels in the domains on which they are tested, including performance anxiety, effort, fluctuation in affect and focus and luck of the draw on what specific items from the broader domain of subject knowledge are or are not included on the assessment. Recent research suggests that up to one in four students are 'severely mis-assigned' to remediation based on the single-test approach to assignment (Scott-

Clayton, Costa, & Belfield 2014). We anticipate that by giving students an additional criterion on which to demonstrate their competence, the EAP will reduce the demand for remediation most among those with relatively low levels of predicted need for remediation and that the discrepancy in assignment will be higher closer to the predicted assignment threshold.

Analytic Strategy

To explore racial/ethnic and gender differences respectively, we simply add students' gender, race/ethnicity, and an interaction term with EAP participation to equation (2). To estimate heterogeneous treatment effects by academic achievement levels we first predict the probability of taking a remedial course in the years prior to EAP as a function of quadratic transformations of subject-specific CST scores (in the case of math, interacted with indicators of the subject of the CST). We then apply the parameter estimates from this model to the data for students in the post-EAP period. This procedure yields predicted probabilities of requiring remediation for each student in our data (or a "predicted risk of remediation" measure).[28]

Next, to determine the impact of the EAP on students with differing probabilities of needing remediation, we model whether a student required remediation as a function of being in a post-EAP cohort interacted with the probability of requiring remediation. Specifically, we fit the following model:

$$REMED_{is} = \alpha \boldsymbol{PostEAP}_i \times \boldsymbol{PrRemed}_{is} + \beta X_i + \gamma Z_i + \varepsilon_{is} \qquad (3)$$

[28] Figure A1 in the Appendix shows the distribution of the probability of needing remediation in English and math, as predicted by CST scores. The first panel shows that the CST is a good predictor of students' likelihood of English remediation, as shown by the respective concentration of students toward 0 (not likely to need remediation) and toward 1 (likely to need remediation). The second panel shows the distribution of the probabilities of requiring remediation in math, where the model predicts a high proportion of students that do not require remediation (as expected given the CST level of the test necessary to be eligible for CSU enrollment).

where the vector $\boldsymbol{\alpha}$ captures the association between the indicator of student *i* is in a post-EAP cohort and a vector including the 11^{th} grade predicted probability of needing remediation in subject *s*, along with its quadratic and cubic transformations. This specification allows us to test whether the intent to treat effect of the EAP varies nonlinearly across different values of predicted remediation need. We include all of the covariates in the main models presented earlier, as well as campus fixed effects, and apply this strategy to both the intent-to-treat model and the treatment on treated (90 percent) model.

Results

Looking across racial/ethnic groups, we find virtually no evidence that participating in EAP has differential effects on remediation need.[29] We do, however, find notable differences in the responsiveness to EAP by gender and by predicted risk of remediation. In the TT model, women are predicted to benefit more from participating in EAP in both English (by about one percentage point) and math (by about two percentage points). In fact, although men who participate in the English EAP are about 1.5 percentage points less likely to require remediation than men who do not participate, conditional on other attributes, men who participate in the EAP math assessment appear no more or less likely to need remediation than men who do not participate. These results, however, are not replicated in our analyses of the subset of schools that consistently participate in EAP at levels above 90 percent. The discrepancy in findings may reflect differential selection into high and low participation schools or gender differences in the

[29] Estimates available upon request from the authors.

motivations of students who choose to participate in the EAP. Regardless of the source of the discrepancy, we view the evidence of gender differences as suggestive rather than definitive.

While gender differences in the predicted impact of EAP participation are sensitive to sample, achievement differences are less so. Recall, the intent to treat results for all students three years after the establishment of EAP is -1.8 percentage points in English and about -2.0 percentage points in math. However, those overall estimates of the decline in remediation post-EAP are not the same for all students. We display the ITT results across the 11th grade predicted probability of requiring remediation in Figure 2. The line represents the estimated EAP effect on the probability of needing remediation from being in a post-EAP cohort (bounded by 95% confidence intervals), across different propensities for remediation. Students who are among the least likely to need remediation—based on their 11th grade CST score—are the students who appear to benefit most from the presence of the program, while students who are very likely to need remediation appear to benefit very little or not at all. The pattern exists for both English (left panel) and math (right panel). Students who received an exempt on the EAP likely had the highest CST scores and, although they were unlikely to need remediation in the first place, we estimate that they had a reduction in the probability of needing remediation of around 2 to 3 percentage points. However, few students overall receive an exempt signal, suggesting that high achieving students (based on the CST) who thought they were ready for college, but were informed by the EAP that they were not, are perhaps most likely to benefit from the program. Interestingly, the students who were the most likely to need remediation based on their 11th grade standardized test scores did not appear to benefit from the presence of the program.

Students scoring higher on the CST were more likely to participate in the EAP in the first place, so the differential impacts in Figure 2 could be a result of differential participation rates.

In order to account for differential rates of program participation, we also test for differential effects within our sample of schools where 90 percent or more students participated in the EAP, essentially the treatment on treated estimates. Figure 3 shows the treatment on treated effect size across predicted remediation need. As in the intent to treat results, we find that students who are less likely to need remediation benefit more (a reduction in the probability of needing remediation of about 4 percentage points) than those more likely to need remediation; this is true for both English and math.

VI. Possible Mechanisms for the EAP effect

There are three primary mechanisms by which we would expect the introduction of the Early Assessment Program to reduce remediation at California State University. Two of these operate by directly influencing student behavior while the third may more fundamentally alter the provision of instruction across secondary schools in California. We can bring available data to bear on those processes that operate through the choices students make, but have appreciably less analytic leverage with which to identify systemic change across schools.

After receiving information about their college readiness the summer after their junior year in high school, students who fall below the exemption threshold may choose to address their academic preparation for college in two ways. First, they must decide what courses, if any, to take their senior year of high school to strengthen their academic skills. Second, they must decide whether or not to apply for admission to a CSU campus. Policymakers hope to influence the first of these decisions by providing timely guidance on what courses students might take to become college ready. Increasing the number of college ready students coming out of high school reduces the need for remediation and increases the likelihood that students will successfully complete a postsecondary credential. On the other hand, students who are told late in high school that they are not college ready may simply opt out of college entirely, or at least opt out of the CSU system. Whether this is a good or bad thing is unclear, but it is likely not the response policymakers hope to trigger by improving the quality of the information on which students make their postsecondary educational decisions.

From other work investigating the effect of the EAP signal on coursetaking behavior of California high school seniors, we find no significant change in the share of students taking advanced math in 12th grade (when comparing students at the exemption thresholds), and conclude that student math course selection is on average unresponsive to the EAP college readiness signal (Authors, in preparation).

Even if students fail to make course selections based on the EAP, they may nonetheless make postsecondary enrollment decisions in response to an external assessment of their readiness for college. Prior evidence suggests that high school students update their college-going trajectories based on information that they receive during secondary school (Jacob & Wilder, 2011). In fact, students respond to labels assigned to them by standardized tests. Papay, Murnane, and Willet (2011) show that the labels assigned to students through state standardized testing impact college going decisions. A “Needs Improvement” label causes urban, low-income students to be more likely to enroll in college than a “Warning” label. Moreover Papay and colleagues (2011) show that urban, low-income students update their educational attainment expectations based on standardized test result labels as early as 8th and 10th grade.

Early information from college assessments, which are intended to motivate students towards their postsecondary goals, could be discouraging students. Students taking state assessments who are told that they may require remediation upon entering a particular college may feel that they do not fit well with that college, and decide to enroll elsewhere, or not at all. Research on responses to early assessment for college remediation is scarce, but as the popularity of such programs rises, there are a few studies that shed light on the potential unintended consequences of early information on remediation need. In Texas, Martorell, McFarlin, and Xue (2013) used regression discontinuity to find that failing an entrance exam and being required to enroll in remediation did not dissuade students from enrolling in college. Importantly, prior work on the EAP has found that the early signal of “not ready” did not dissuade students from applying or enrolling at the CSU system (Jackson, 2014; Howell et al., 2010). Although the evidence is fairly limited, we see no indication in previous work on this or other projects to indicate that students alter their enrollment plans in response to information about their level of preparation for college-level work.

Finally, the Early Assessment Program may have influenced California schools to change their practice more generally in favor of a greater focus on college-readiness. For example, the EAP also included a robust teacher training and professional development in expository reading and writing, which hundreds of high school English teachers participated in. Moreover, there is some evidence that schools with higher levels of EAP adoption experienced greater achievement gains post program implementation when compared to schools with lower levels of EAP participation (Kurlaender, Howell, and Jackson, 2012). Finally, Common Core reform discussions were pervasive during this time in the state of California, culminating in the implementation of Smarter Balanced college and career-readiness standards. Where a handful of other states have chosen to abandoned the Common Core, California has stayed the course. Thus, overall improvements in college readiness emphasis and information may have contributed to the reductions in remediation that came about from the EAP.

V. CONCLUSION

Research on college persistence has consistently demonstrated that students with better academic preparation in high school are more likely to complete college. Postponing college preparation to the postsecondary level is both controversial and costly. Critics raise important questions about the appropriateness of colleges taking on the task of remediation. EAP responds to those questions by seeking to reduce the demand for postsecondary remediation without curtailing the supply of remedial courses. The results presented here suggest that the Early Assessment Program did offer a useful path forward for California and possibly other states to reduce the demand for remedial courses among baccalaureate entrants. But, the EAP by itself also did not dramatically alter the share of students in need of remediation in college, likely the result of both little movement in coursetaking patterns in 12^{th} grade and static application rates to CSU among unprepared students.

The evidence from the intent to treat models reveal modest reductions in students' need for remediation once at CSU, simply as a function of the availability of the program to students and schools. When we explore the effects on students who actually received the information provided by the EAP (treatment on treated), we also find overall favorable effects of the program in reducing the probability of remediation need in both English and mathematics. Importantly, our results statewide are substantially smaller than those obtained by an earlier study of the effects of the EAP at one CSU campus (Howell et al. 2010). It is therefore useful to think about the magnitude of these statewide effects for the CSU system as a whole. What does a 2-3 percentage-point decline in remediation need translate to in terms of students? A typical cohort of first-time freshmen across the CSU is currently about 56,000, which translates into about

1,200-1,400 fewer students in remedial math or remedial English annually.

A closer analysis of heterogeneous treatment effects of the EAP revealed that these reductions are not distributed equally across all types of students. In fact, the program's largest impact is on students with a low—albeit not the lowest—risk of needing remediation to begin with. Specifically, we find program effects of -3.0 to -3.8 percentage points in math among students with a predicted probability of needing remediation in math of between of 0.1 and 0.3. These larger program effects are attenuated by the smaller-to-zero effects we find among students with higher predicted math remediation risk. We find a similar trend in English, though less pronounced; program effects are largest among students with less than a 0.5 probability of needing remediation in English (-2.0 to -2.5 percentage points).

Why do the greatest benefits of EAP accrue to those least likely to need postsecondary remediation? Although we are not certain, we suspect that one reason is because these are students who would have been at risk of misclassification prior to EAP. Even adequately prepared students have bad testing days, and some do poorly on high-stakes tests. Such students may benefit from having additional opportunities to demonstrate their proficiency or lower-stakes opportunities to do so. To the extent that this is true it suggests that the savings incurred by EAP are substantial in terms of both human resources (in faculty and student time) and associated costs.

Of course, this leaves open the question of whether and why less academically prepared students failed to benefit from the program. While they are certainly the intended beneficiaries of the EAP, it's possible that the information they receive from the assessment arrives too late for them to make effective use of it during high school or that it arrives in such a way that they fail to appreciate the import of the information or the paths they could pursue to better prepare themselves for college. It is also possible that EAP does improve preparation efforts at the individual or school level for those with the greatest need, but not enough—at least at the time of this investigation—to push more students out of remediation exemption. In our view each of these potential explanations merit serious consideration but are beyond the scope of the data we employ in this paper.

These results have important implications for California students and the CSU campuses that serve them. Although the models presented employed campus fixed effects, we do not present formal tests of whether the program has had a differential impact across each of the 23 CSU campuses. The California State University system has uniform eligibility requirements, remediation assessments and cutoffs scores across the system, but the 23 campuses differ considerably in their selectivity and in the types of students they enroll. As a result, we expect that the program effects are likely largest for the campuses with the greatest number of students who are at the margin of needing remediation, and likely smaller at the campuses with large numbers of students who are at a higher risk of needing remediation. For example, Sacramento State—the site of an earlier study of EAP—enrolls students, on average, with lower rates of remediation need than other CSU campuses such as Los Angeles or Dominguez Hills.

The Early Assessment Program is a statewide intervention designed to improve the quality of information students possess regarding the California State University's standard for minimally acceptable levels of academic preparation in math and English. By providing this information to high school juniors, the architects of the EAP intended to give students the opportunity to make more informed decisions about their secondary school curriculum and postsecondary pathways. Instead of informing *students*, however, EAP may have done a better job of informing CSU of the academic needs of the students it serves. By giving students an additional opportunity to demonstrate their skills, EAP may have reduced the demand for remediation not by increasing levels of academic preparation among matriculating students but by reducing assignment errors imposed by CSU's own relatively crude system of compelling students to take remedial courses. Although not free to tax payers, the EAP program is much less costly to the state or the student than compulsory remediation.

California's effort to reform State standards and assessments in response to Common Core in many ways builds on the Early Assessment Program. The State's implementation of the Smarter Balanced college and career-readiness standards involves collaboration on these standards by K-12 and higher education, new assessments will hopefully be up to the challenge of measuring student progress on core curriculum, and professional development for teachers who are in the classrooms implementing these standards. The results presented here indicate that college readiness standards, when measured appropriately by well-aligned assessments and conveyed to students and schools in a timely fashion, could have the power to improve student and school outcomes.

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Table 1
Sample Summary Statistics, by year

	2000-2001	2001-2002	2002-2003	2003-2004	2004-2005	2005-2006	Overall
English Remediation Need	0.49	0.48	0.46	0.46	0.46	0.46	0.47
Math Remediation Need	0.38	0.40	0.36	0.35	0.38	0.37	0.37
Male	0.41	0.40	0.40	0.40	0.41	0.41	0.41
Black	0.06	0.06	0.06	0.07	0.07	0.07	0.06
Hispanic	0.23	0.23	0.26	0.27	0.28	0.29	0.26
Asian	0.14	0.13	0.13	0.14	0.13	0.13	0.13
Other Race	0.18	0.17	0.15	0.15	0.15	0.15	0.16
HS GPA	3.27	3.30	3.30	3.28	3.25	3.24	3.27
SAT Verbal	482.6	488.7	493.4	493.8	487.5	487.7	489.00
SAT Math	509.2	511.7	516.7	514.6	507.9	509.6	511.46
Mom College Grad	0.27	0.30	0.31	0.30	0.30	0.31	0.30
Dad College Grad	0.30	0.33	0.34	0.33	0.32	0.32	0.32
N	24,767	24,807	25,781	29,355	32,190	33,712	170,612

Table 2

Marginal effects from intent to treat (ITT) model predicting remediation need as a function of EAP availability, by subject

	English Remediation Need					
	6 cohorts (3 years pre/post)			2 cohorts (1 year pre/post)		
	(1)	(2)	(3)	(4)	(5)	(6)
	Unadjusted	Covariates	Fixed Effects	Unadjusted	Covariates	Fixed Effects
Post-EAP	-0.014 ***	-0.017 ***	-0.018 ***	0.000	-0.004	-0.007 *
	(0.002)	(0.002)	(0.002)	(0.004)	(0.003)	(0.003)
Observations	173,107	173,107	173,107	55,920	55,920	55,920
R-Squared	0.000	0.542	0.556	0.000	0.555	0.571
	Math Remediation Need					
	6 cohorts (3 years pre/post)			2 cohorts (1 year pre/post)		
	(7)	(8)	(9)	(10)	(11)	(12)
	Unadjusted	Covariates	Fixed Effects	Unadjusted	Covariates	Fixed Effects
Post-EAP	-0.000	-0.020 ***	-0.020 ***	-0.016 ***	-0.018 ***	-0.018 ***
	(0.003)	(0.002)	(0.002)	(0.004)	(0.003)	(0.003)
Observations	132,643	132,643	132,643	45,241	45,241	45,241
R-Squared	0.000	0.527	0.543	0.000	0.527	0.549
Cohorts	6	6	6	2	2	2
Covariates	N	Y	Y	N	Y	Y
Campus Fixed Effects	N	N	Y	N	N	Y
High School Fixed Effects	N	N	Y	N	N	Y

Table 3

Marginal effects from the public-private difference in difference ITT model predicting remediation need as a function of EAP availability, by subject

	(1)		(2)		(3)		(4)	
A. English Remediation Need								
Post EAP	0.003		-0.007	*	-0.011	***	-0.017	***
	(0.004)		(0.003)		(0.002)		(0.002)	
Private	-0.107	***	-0.023	***	-0.116	***	-0.029	***
	(0.008)		(0.006)		(0.004)		(0.003)	
Private X Post EAP	-0.004		-0.003		0.010		0.002	
	(0.011)		(0.008)		(0.006)		(0.005)	
r2	0.005		0.448		0.005		0.442	
N	78,654		72,150		246,109		224,482	
B. Math Remediation Need								
	(1)		(2)		(3)		(4)	
Post EAP	-0.012	**	-0.008	**	-0.017	***	-0.015	***
	(0.004)		(0.003)		(0.002)		(0.002)	
Private	0.006		0.077	***	-0.010	*	0.066	***
	(0.007)		(0.006)		(0.004)		(0.003)	
Private X Post EAP	0.007		0.007		0.031	***	0.022	***
	(0.010)		(0.008)		(0.006)		(0.005)	
	0		0.405		0		0.409	
	78,007		71,576		244,531		223,172	
Cohorts	2		2		6		6	
Covariates	N		Y		N		Y	

Table 4:
Marginal effects from treatment on the treated (TT) model predicting remediation need, by subject

	English Remediation Need											
	(1)		(2)		(3)		(4)		(5)		(6)	
	Unadjusted		Covariates		Fixed Effects		Unadjusted		Covariates		Fixed Effects	
Post-EAP	0.021	***	0.001		-0.001		0.023	***	0.009	*	0.008	
	(0.003)		(0.002)		(0.002)		(0.005)		(0.004)		(0.004)	
Participation	-0.051	***	-0.025	***	-0.025	***	-0.036	***	-0.021	***	-0.023	***
	(0.003)		(0.002)		(0.003)		(0.006)		(0.004)		(0.004)	
Observations	173,107		173,107		173,107		55,920		55,920		55,920	
R-Squared	0.001		0.542		0.556		0.001		0.556		0.571	
	Math Remediation Need											
	(7)		(8)		(9)		(10)		(11)		(12)	
	Unadjusted		Covariates		Fixed Effects		Unadjusted		Covariates		Fixed Effects	
Post-EAP	0.037	***	-0.009	**	-0.011	***	0.016	*	-0.004		-0.004	***
	(0.004)		(0.003)		(0.003)		(0.007)		(0.005)		(0.005)	
Participation	-0.047	***	-0.014	***	-0.011	***	-0.040	***	-0.018	***	-0.019	***
	(0.004)		(0.003)		(0.003)		(0.007)		(0.005)		(0.005)	
Observations	132,643		132,643		132,643		45,241		45,241		45,241	
R-Squared	0.001		0.527		0.543		0.001		0.527		0.549	
Cohorts	6		6		6		2		2		2	
Covariates	N		Y		Y		N		Y		Y	
Campus Fixed Effects	N		N		Y		N		N		Y	
High School Fixed Effects	N		N		Y		N		N		Y	

Table 5

Marginal effects from treatment on the treated (TT) models at schools with universal (90%+) EAP participation

	(1)	(2)	(3)	(4)	(5)	(6)
English Remediation Need						
	Unadjusted	Covariates	Fixed Effects	Unadjusted	Covariates	Fixed Effects
Post-EAP	-0.036 ***	-0.022 ***	-0.022 ***	-0.010	-0.012	-0.014
	(0.010)	(0.005)	(0.005)	(0.014)	(0.009)	(0.009)
Observations	21,861	21,861	21,861	7,351	7,351	7,351
R-Squared	0.001	0.533	0.542	0.000	0.548	0.558
Math Remediation Need						
	(7)	(8)	(9)	(10)	(11)	(12)
	Unadjusted	Covariates	Fixed Effects	Unadjusted	Covariates	Fixed Effects
Post-EAP	-0.010	-0.028 ***	-0.026 ***	-0.027 *	-0.029 ***	-0.030 **
	(0.011)	(0.006)	(0.006)	(0.012)	(0.008)	(0.009)
Observations	17,037	17,037	17,037	6,009	6,009	6,009
R-Squared	0.000	0.495	0.508	0.001	0.513	0.529
Cohorts	6	6	6	2	2	2
Covariates	N	Y	Y	N	Y	Y
Campus Fixed Effects	N	N	Y	N	N	Y
High School Fixed Effects	N	N	Y	N	N	Y

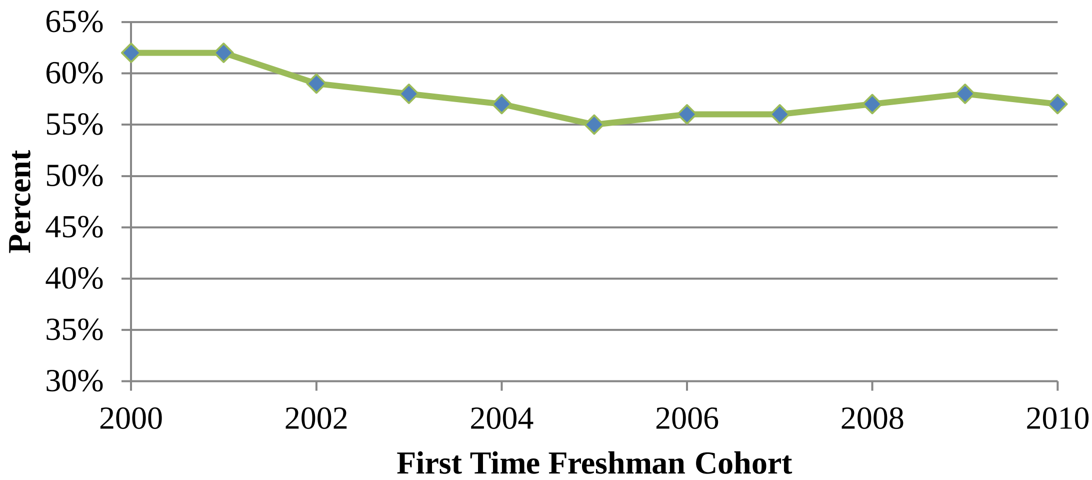

Figure 1A. **Remediation rates at CSU in English/Math (or both) by cohort**

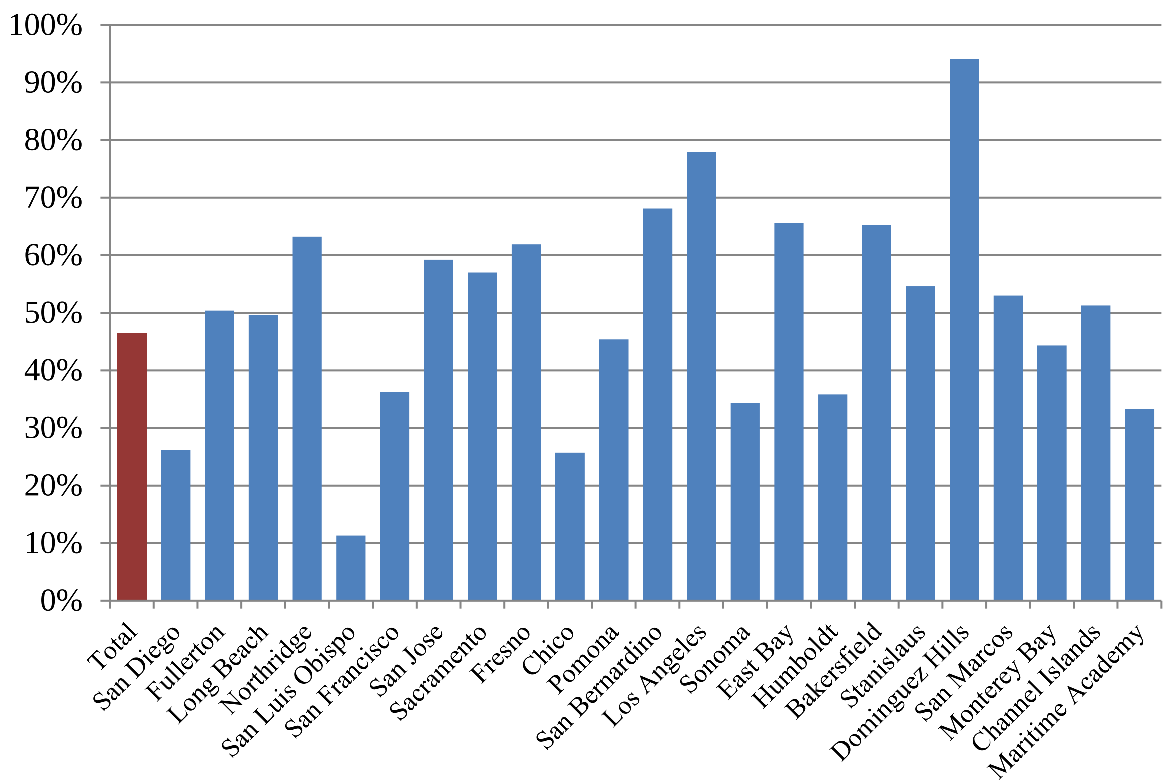

Figure 1B. **English remediation rates for first time freshmen in 2004, by campus**

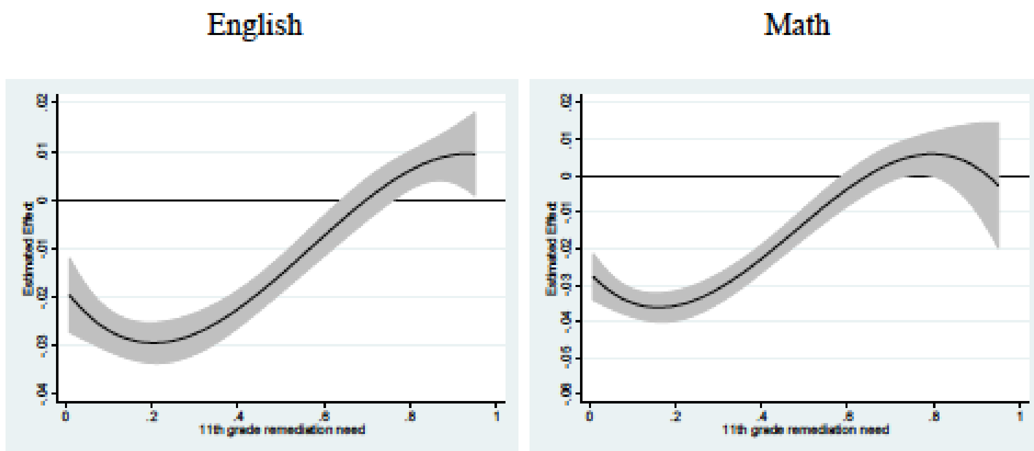

Figure 2. **Intent to treat results across 11th grade predicted remediation need**
Note: Models associated with these graphs are based on equation 3; results are for 6 cohorts (3 pre-EAP years and 3 post-EAP years). Covariates include: race, gender, high school gpa, SAT/ACT score, and campus fixed effects.

English Math

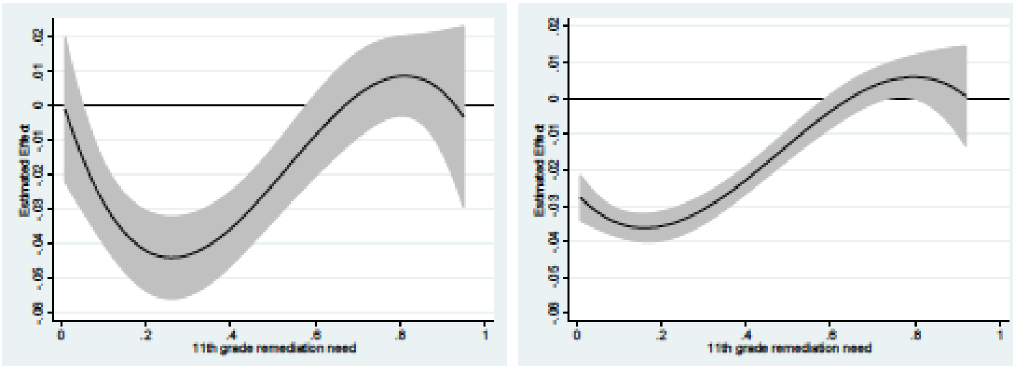

Figure 3. **Treatment on Treated (90% Schools) across 11th grade predicted remediation.**
Note: Models associated with these graphs are based on equation 3; results are for 6 cohorts (3 pre-EAP years and 3 post-EAP years). Covariates include: race, gender, high school gpa, SAT/ACT score, and campus fixed effects.

Appendix

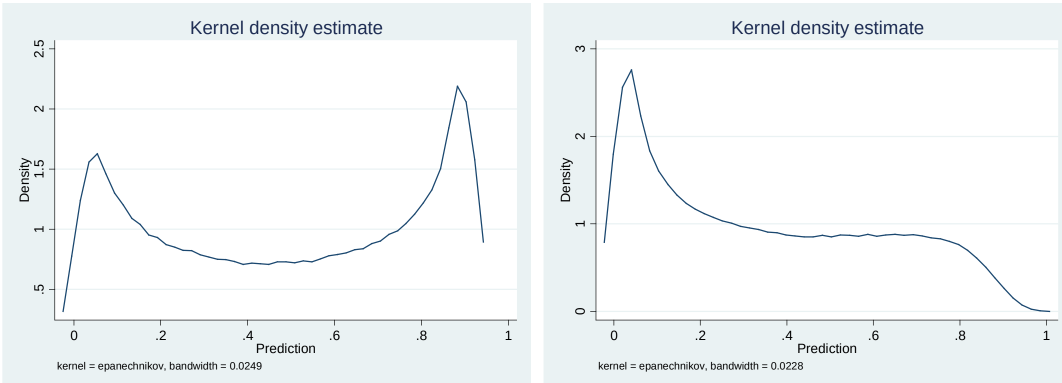

Figure A1. **Predicted Probability of requiring remediation in English (Panel A) and Math (Panel B) using CST scores**