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Relationship of the SAT/ACT to College Performance at the University of California

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Executive Summary

For many years, high school grade-point average (HSGPA) and standardized test scores (i.e. SAT/ACT) have served as the two most important and relied upon college admissions criteria. However, there is constant debate about whether HSGPA and SAT/ACT are fair measures of college preparation and valid predictors of college success, and whether SAT/ACT should remain as a requirement for college admissions.

Supporters of standardized tests argue that SAT/ACT evaluates college-preparedness on an equal standing despite inconsistent grading systems throughout the nation's high schools. While HSGPA compares a student to the rest of his/her school, SAT/ACT scores compare the student to the rest of the country. Opponents of standardized tests argue that SAT/ACT is biased towards white, upper middle class students from high performing schools. Focusing on HSGPA in college admissions may help foster racial and socioeconomic diversity in the college student population.

Previous research generally treats standardized test results as measures of college preparation. The literature surrounding the predictive validity of standardized test scores on student success is mixed. Many studies found a statistically significant association between SAT/ACT scores and college outcomes including first-year college GPA, first-year retention, four-year graduation, and graduation GPA. On the other hand, research also shows that demographic predictors weakened the ability of SAT/ACT scores to be effective predictors of college success.

In light of previous research, this report presents the results of separate studies on the relationship among HSGPA, standardized tests, and demographics, and explanatory power of test scores for college success based on UC's application and enrollment data. Findings from this study are generally consistent with those from prior research.

Analysis of the relationship among standardized tests and high school GPA, UC's Analytical Writing Placement Exam (AWPE), and demographics shows:

- **Demographics are stronger predictors of SAT/ACT scores than of HSGPA.** The share of variance in SAT/ACT scores accounted for by demographic factors (parental income, parental education, and ethnicity) increased from a low of 26 percent in the late 1990's to 43 percent in 2016. The share of variance in HSGPA accounted for by the same demographic factors increased from 5 percent in the late 1990's to 11 percent in 2016. About one-third of the increase for SAT/ACT scores can be explained by disparities between CA high schools, with the remainder explained by changes in the composition of applicants to UC. Campus-specific estimates do not support increasing racial bias on the tests as an explanation for increase.
- **Standardized test scores are positively correlated with high school GPA but at moderate level.** When controlling for socioeconomic factors (family income and parental education), the correlations between SAT/ACT scores and high school GPA fall between .30 to .51 across high schools and fall between .31 to .56 within high schools. The lowest correlations happen between SAT/ACT writing scores and high school GPA in 2018.

From 2005 to 2018, there has been an increase in the correlations between SAT Reading/Math as well as ACT Composite with high school GPA. Overall, the SAT and ACT writing tests are less correlated with HSGPA than SAT Reading/Math or ACT Composite.

- **New SAT EBRW (**Evidence-Based Reading and Writing**) and ACT** ELA (English Language Arts) **scores have a strong association with passing UC's Analytical Writing Placement Exam (AWPE), but SAT Essay scores have only a moderate association with passing AWPE.** The analysis of the relationship between the new SAT and new ACT and UC's Analytical Writing Placement Exam (AWPE) shows that high scores on the SAT EBRW and ACT ELA are associated with passing the AWPE. However, on the SAT Essay, even at the top score of 24, only 69 percent passed the AWPE. Based on the results of data analysis, UCOPE has accepted the new ACT ELA and SAT EBRW scores but not the new SAT Essay scores as methods of meeting UC's Entry Level Writing Requirement (ELWR).

Analyses of the relationship between standardized tests and college success show that standardized tests add value to the prediction of college outcomes beyond HSGPA alone.

- **SAT/ACT scores and HSGPA are both moderate predictors of student college GPAs, and weak to moderate predictors of student retention and graduation.** Between 2001 and 2015, SAT Reading/Math scores account for 13 to 21 percent of the variance in freshman GPA, and 15 to 17 percent of the variance in graduation GPA. ACT Composite scores generally account for 14 to 22 percent of the variance in freshman GPA, and 17 to 19 percent of the variance in graduation GPA. In comparison, HSGPA accounts for 13 to 21 percent of the variance in freshman GPA, and 15 to 18 percent in graduation GPA.
- Without controlling for student demographics, SAT/ACT scores are a stronger predictor of freshman GPA when compared to HSGPA, but have almost the same explanatory power of graduation GPA, first year retention and graduation. After controlling for student demographics, HSGPA and test scores have the same explanatory power of the freshman GPA for 2015, the latest year included in this study, but HSGPA is a stronger predictor of the first year retention, graduation GPA and four-year graduation.
- **Supplementing HSGPA with SAT/ACT scores increased the explanatory power of pre-admission measures on college success metrics.** Models that combined both SAT/ACT and HSGPA account for an additional 5 to 11 percent of the total variance of first-year GPA when compared to models that only use HSGPA scores. Similarly, combined HSGPA and SAT/ACT models account for an additional 3 to 11 percent of variance associated with UC graduation GPA when compared to models that only use HSGPA.
- **Adding SAT/ACT writing to SAT/ACT scores does not increase the explanatory power of pre-admission measures on college success.** SAT and ACT writing scores account for an additional 1 to 2 percent of the variance associated with most student success metrics (i.e., freshman GPA and freshman retention), with the exception of

graduation GPA, where SAT and ACT writing scores account for just as much, if not more variance associated with graduation GPA, when compared to SAT Reading/Math and ACT composite.

- **HSGPA and SAT scores are associated with course performanc**e. They are independently important explanatory factors for first-year students' course performance relative to their peers in similar courses, with the latter growing in relative importance as SAT predictive validity improves and HSGPA variation declines.

In summary, this report presents what literature and UC data show about the validity of standardized test scores in terms of academic preparation and college success. Should UC decide to continue to use standardized test scores as part of its admissions evaluation criteria? To answer this question, a series of simulations will have to be done to further examine what admissions outcomes would look like based on new criteria to evaluate students' academic achievements. Institutional Research and Academic Planning (IRAP) at UCOP will continue to work on analyses and simulations.

I. Introduction

In 1968, the University of California (UC) introduced a new policy that required all freshman applicants to submit scores from the SAT I or the ACT and three College Board Achievement Tests (later called SAT II: Subject Tests and now called SAT Subject Tests). The original purposes of this requirement were to identify applicants' strengths and weaknesses, to improve UC's ability to identify students that are likely to succeed at the university, and to adjust for differences in high school grading practices.[1] Since then, standardized test scores have played an important role in evaluating applicants' academic preparation for college and predicting students' success at UC. One important use of test scores at UC is to create a sliding scale eligibility index along with high school Grade Point Average (HSGPA). Beginning with the Class of 1979, such an index has been used to select the top 12.5 percent of the California public high school graduating class in order to meet the guidelines of the California Master Plan for Higher Education.[2] In 2000, UC adjusted the eligibility index to include SAT II scores in the index and to weigh them more heavily relative to the SAT I/ACT scores effective for the fall 2003 entering freshman class because the SAT I was a relatively weaker predictor of academic performance in the freshman year based on UC's 1996 study.[3] UC, however, has never stopped examining the validity of standardized tests in evaluating applicants' academic preparation and predicting college success. Based on a series of studies and evaluations, UC has revised the requirement for the SAT and the ACT several times to meet its admissions goals over the years. One of the most important revisions since 2000 was eliminating the requirement for the SAT Subject Tests (formerly called SAT II: Subject Tests) effective for the 2012 entering freshman cohort.

The College Board and ACT have also changed their test structures and content several times during the time period from 2001 to 2018 covered in this study, which may have had an impact on how universities decided to use these test scores in admissions. In 2005, the College Board announced a major change to the SAT effective in 2006 to reflect the importance of clear and succinct writing, which is not only considered a skill to be used in college courses, but also one necessary for success in a wide range of careers. To meet this goal, the College Board changed the SAT I to the SAT Reasoning, which included three tests, Critical Reading, Math, and Writing (formerly a subject test called SAT II Writing), and changed the SAT II: Subject Tests to SAT Subject Tests. These changes were mainly attributed to a

Versions of the SAT

UC Academic Years 2001-2005
- SAT I: Verbal and Math
- SAT II : Writing

UC Academic Years 2006-2016
SAT Reasoning
- Critical Reading
- Math
- Writing

UC Academic Years 2017-2018
- Evidence-Based Reading and Writing
- Math
- Essay

[1] Dorothy A. Perry, Michael T. Brown, & Barbara A. Sawrey. (2004). Rethinking the Use of Undergraduate Admissions Tests: The Case of the University of California. In Rebecca Zwick (Ed.), *Rethinking the SAT: The future of standardized testing in university admissions*. (pp. 103-124). New York and London: RoutledgeFalmer.
[2] University of California Office of the President, Institutional Research and Academic Planning. California Master Plan for Higher Education. Retrieved on August 31, 2018 from https://www.ucop.edu/institutional-research-academic-planning//content-analysis/academic-planning/california-master-plan.html.
[3] University of California Eligibility and Admissions Study Group. Final Report to the President. (2004, April). https://senate.universityofcalifornia.edu/_files/committees/boars/documents/studygroup_final0404.pdf.

series of debates over aptitude versus achievement tests in college admissions sparked by UC President Richard C. Atkinson's advocacy to eliminate the SAT I in UC admissions.[4] After about a decade, the College Board made changes in the content, format, and scoring of the SAT Reasoning again in 2016. The new SAT includes three parts: 1) Evidence-Based Reading and Writing (EBRW), 2) Math, and 3) Essay with three subscores: Reading, Analysis and Writing. The new test was first administered in the spring of 2016, and currently costs $64.50 with the essay and $47.50 without it, though some school districts subsidize these fees.[5] A validity study by the College Board based on a sample of participants from 15 four-year institutions show that the redesigned SAT is as predictive of college success as the prior SAT, that redesigned SAT scores improve the ability to predict college performance beyond high school GPA alone, and that there is a strong, positive relationship between redesigned SAT scores and grades in matching college course domains.[6] However, the 2016 changes were not done without controversy. For example, the new exam's wordy math questions may unfairly penalize students because of their language burden.[7] When commenting on this, Jamal Abedi, a UC Davis professor who specializes in educational assessments stated, "The problem is going to mostly affect English-language learners."

ACT added an option of a 30-minute direct writing test to their examination beginning in February 2005. Based on an early study focusing on the value of using the ACT Writing test in placing students in composition and related courses, the writing test score added value to the accuracy of course placement decisions over and above the ACT English test.[8] Performance on the writing test in combination with performance on the English test was incorporated into the Combined English/Writing (or English with Writing) score. Ten years later, in September 2015, ACT introduced changes to the design of this writing test, with modifications to the writing task, scoring rubric, and score reports. ACT states that many elements of the writing task remain similar to those of the previous task, both emphasizing argumentative writing skills that are essential for college and career success, but the new writing task is more consistent with the writing skills emphasized in

Versions of the ACT

UC Academic Years 2001-2005
- ACT Composite

UC Academic Years 2006-2015
- ACT Composite
- ACT English with Writing

UC Academic Years 2016- 2018
- ACT Composite
- ACT English Language Arts

[4] Zwick, R. (2004). College Admissions Testing in California: How Did the California SAT Debate Arise. In Rebecca Zwick (Ed.), *Rethinking the SAT: The future of standardized testing in university admissions*. (pp. 101-102). New York and London: RoutledgeFalmer.
[5] College Board. (2018.) SAT Suite of Assessments: Test Fees. Retrieved on October 26, 2018 from https://collegereadiness.collegeboard.org/sat/register/fees.
[6] Shaw, E., Marini, J., Beard, J., Shmueli, D., Young, L., and Ng, H. (2016). The Redesigned SAT Pilot Predictive Validity Study: A First Look. Retrieved on August 31, 2018 from https://collegereadiness.collegeboard.org/pdf/redesigned-sat-pilot-predictive-validity-study-first-look.pdf.
[7] Dudley, R. (2016). Despite warnings, College Board redesigned SAT in way that may hurt neediest students. *Reuters*. Retrieved on August 31, 2018 from https://www.reuters.com/investigates/special-report/college-sat-redesign/.
[8] ACT. ACT Writing Test Technical Report. (2009). Retrieved on August 31, 2018 from https://www.act.org/content/dam/act/unsecured/documents/TechReport.pdf.

the Common Core State Standards (CCSS) and other standards developed by ACT.[9] The new writing test score is combined with scores on the English and Reading tests and reported as the English Language Arts (ELA) score. The current test costs $67.00 with the writing section and $50.50 without it, but some school districts subsidize these fees.[10]

Despite the efforts the College Board and ACT made over the years to improve the validity of their standardized tests in predicting college success, the number of colleges using Test Optional Policies (TOPs) in higher education admissions has dramatically increased in recent years. According to a study by the National Association for College Admission Counseling (NACAC), more than 1,000 institutions had officially deemphasized standardized tests in admissions by spring 2018 when the report was released.[11] The report further emphasizes that the momentum indicates that undergraduate admissions is moving away from heavy reliance on measures increasingly "deemed to provide a narrow assessment of human potential." The study also indicates that almost all institutions included in the study increased representation of underrepresented groups (URGs) among applicants and enrollees and there are no signs of academic slide in terms of college GPAs and graduation rates.

In June 2018, the University of Chicago announced that it would not require domestic freshman applicants to submit standardized test scores any more. There were several reasons for this decision, which, according to an article published in the *Chicago Tribune*, "marks a dramatic shift for the South Side university..."[12] The University's leaders have long wanted to increase diversity and hoped this decision would prevent students from assuming that anything less than an outstanding test score automatically takes them out of the running. The Undergraduate Admissions Dean at the University also said that there was a big industry of test preparation, which served higher-income students very well.

Although few universities (e.g., University of New England) have followed the University of Chicago's decision to stop requiring ACT and SAT scores for prospective undergraduates, many universities eliminated the requirement for the SAT and the ACT Writing since spring 2019. Harvard University announced it was dropping the requirement in March, followed by Dartmouth in April, Yale and the University of San Diego in June, then Princeton, Stanford, Brown, Duke, and the University of Michigan in July.[13] By November 2018, only 12 universities

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[9] The ACT College and Career Readiness Standards available online at http://www.act.org/content/dam/act/unsecured/documents/ACT_RR2015-4.pdf and the 2011 NAEP Writing Framework available online at https://www.nagb.gov/content/nagb/assets/documents/publications/frameworks/writing/2011-writing-framework.pdf.

[10] ACT. (2018). The ACT Test: Current ACT Fees and Services. Retrieved on October 26, 2018 from http://www.act.org/content/act/en/products-and-services/the-act/registration/fees.html.

[11] Syverson, S., Franks, V., Hiss, W. (2018). Defining Access: How Test-Optional Works. Retrieved on August 31, 2018 from https://www.nacacnet.org/globalassets/documents/publications/research/defining-access-report-2018.pdf.

[12] Rhodes, D. (2018.) University of Chicago to stop requiring ACT and SAT scores for prospective undergraduates. Retrieved on August 31, 2018 from http://www.chicagotribune.com/news/local/breaking/ct-university-chicago-sat-act-20180614-story.html.

[13] The Princeton Review. (2018). Who Requires SAT and ACT Essays (and why they shouldn't). *The Score (blog).* Retrieved on August 28, 2018 from https://princetonreview.blog/2018/03/18/it-is-time-to-eliminate-the-sat-and-act-optional-essays/.

still required the SAT Essay score for admissions, among which nine were UC's campuses, according to a list published by CompassPrep.[14] The other three schools requiring the SAT Essay were the United States Military Academy, Martin Luther College, and Soka University of America.

What decision should UC make? An article published by *Inside Higher Ed* in July, 2018 used an eye-catching title to emphasize that "For fate of SAT Writing Test, watch California." Is this true? Given the fact that all other research universities dropped the SAT/ACT writing requirement for admission and only three non-UC institutions continue to require the SAT or ACT Writing, there is no doubt that if UC drops this requirement, the list of institutions requiring the writing tests will be quite short. However, as Henry Sanchez, the former chair of the Board of Admissions and Relations with Schools (BOARS), noted in an interview with *Inside Higher Ed*, UC has a different situation from some of the colleges dropping the requirement recently. Nearly 200,000 high school seniors apply to UC now with UCLA receiving more than 113,000 applications for fall 2018 freshman admission, the largest number among all colleges and universities throughout the country. To make a wise and evidence-based decision about whether to sustain or drop this requirement for admissions, UC would benefit from a better understanding of what existing research tells us and what UC data show about SAT and ACT scores in terms of measuring college preparation and predicting student success nationwide and at UC specifically and whether or not SAT and ACT scores can help UC to admit students to meet its educational philosophy.

In this report, Institutional Research and Academic Planning (IRAP) at the University of California Office of the President (UCOP) reviews current research on the validity of the SAT and ACT and the ability of the tests to predict college success, and uses application and enrollment data from academic years 2001 to 2018 to address two sets of questions as follows:

1. How do SAT and ACT scores relate to other measures of applicants' academic preparation such as high school grades? Do socioeconomic factors unrelated to a student's academic potential affect SAT and ACT scores?

2. How well do SAT and ACT scores predict college success as measured by freshman GPA, first-year retention, four-year graduation, and graduation GPA at UC? Do the SAT and ACT writing tests add any explanatory power to predict college success at UC, above and beyond what is predicted by HSGPA and SAT Reading and Math or ACT composite? Does the ability of SAT and ACT scores to predict college success vary by student characteristics?

This report summarizes the findings of current research on relationships among standardized tests (the SAT and ACT), high school grades, and demographics, and explanatory power of the tests on college students' success, and also analyzes UC data to examine what they show about applicants' college preparation and student success in terms of the test scores. The report is organized into five sections. Section I describes the research methodology. Section II summarizes findings of the existing research on the validity of the SAT and ACT. Section III

[14] CompassPrep. (2018). ACT Writing and SAT Essay Requirements. Retrieved on May 13, 2019 from https://www.compassprep.com/act-writing-and-sat-essay-requirements/.

examines relationships between the SAT/ACT scores and high school academic preparation measured by high school weighted, capped GPA and UC's Analytical Writing Placement Exam (AWPE) scores. Section IV discusses the relative validity of the SAT and ACT in predicting student success measured by the freshman GPA, one-year retention, four-year graduation, and graduation GPA at UC. The last section summarizes the major findings of this study.

II. Methodology

This study uses UC's application and enrollment data to examine the relationship between the SAT/ACT and other college preparation measures of applicants to UC and college performance of students enrolled at UC. The analysis focuses on California resident applicants and enrollees. The SAT and ACT scores are derived from official and self-reported scores. If official scores are missing, self-reported scores are used.

The current study also examines differential impacts of both SAT and ACT by campus, intended discipline (both broad area and STEM/Non-STEM), family income, parental education level, Pell status, and high school ranking based on the Academic Performance Index (API). These analyses are conducted as previous research has indicated that the predictive validity of SAT/ACT varies by student demographics.

SAT Models

1. Sum of Reading (EBRW since 2017) and Math Scores
2. Writing (Essay since 2017)
3. Sum of Reading (EBRW since 2017) and Math Scores and Writing Score (Essay since 2017)

ACT Models

1. Composite
2. English with Writing (Writing subscore since 2017)
3. Sum of Composite and English with Writing

As noted earlier, UC accepts both SAT and ACT scores. To understand how related each of these two tests is to college preparation and performance, this study analyzes the SAT and ACT separately. In other words, two separate sets of statistical models are built, one set with the SAT predictors and the other with the ACT predictors. Also, to examine what additional variance of student success at UC the SAT and ACT Writing can explain beyond the SAT Math and Reading scores, or the ACT Composite scores, separate models in both sections are estimated with a predictor of the sum of the SAT Math and Reading or the ACT composite, the SAT/ACT Writing, or two predictors of the sum of the SAT Math and Reading and the SAT Writing, or ACT Composite and ACT Writing. The College Board and ACT have made significant changes to their test structure over time. Therefore, a longitudinal analysis was conducted to better understand how the changes of test structures, content, and scoring may have affected their validity.

To examine the relationships between standardized test scores and other measures of college preparation, this study first provides a profile of the SAT and ACT takers among UC applicants from 2001 to 2018 (see Appendix A for details), then examines the percent of variance associated with SAT/ACT scores and high school GPA that can be attributed to factors students have no control over (i.e., family income, parental education and race/ethnicity). Finally, a series of partial correlations were calculated to examine the relationship between SAT/ACT scores and

high school grades, controlling for selected demographic factors. Analyses throughout this report use high school weighted and capped GPA[15] for high school grades.

The methodology used to analyze relationships between standardized test scores and college performance at UC is similar to that used in a paper by Saul Geiser and Roger Studley published in 2002, which examined predictive validity and differential impact of the SAT I and SAT II at UC.[16] The findings in Geiser's research will be described later in this report. However, since their research included enrollment data from 1996 to 1999, this study does not replicate their research; instead, it conducts similar analyses using enrollment data from 2001 to 2015 in order to compare results with their findings. As many other studies (see Section III for a summary of previous research findings) claim that freshman GPA (or first-year GPA) is by far the most frequently used outcome variable measuring college success, this study employs the freshman GPA as a criterion to measure college success, and also examines how well the SAT/ACT predicts first-year retention, four-year graduation, and graduation GPA.

This report presents some results for all years from 2001 to 2018, and other results, especially those about relationships of the SAT and ACT to college preparation and performance for selected years including 2001, 2005, 2007, 2012, 2015, and 2018. These years were chosen because 2001 was the first year UC adopted the Eligibility in the Local Context (ELC) program, 2005 was the last year students took the old SAT and ACT, 2007 was the second year students submitted new SAT and ACT test scores, 2012 was the first year UC revised the admissions eligibility structure with top nine percent of high school graduates from a school qualified for a guaranteed admission, 2015 was the last year before the current version of the ACT, and 2018 is the third year students submitted new ACT scores and the second year students submitted new SAT scores.

III. What Previous Research Findings Show about the SAT and ACT

Although there is no single definition or measure of college preparation or college readiness, researchers, national associations of education, and test developers usually suggest that standardized test scores in conjunction with other measures available during high school can act as proxies for performance in college courses and careers. Among the possible measures are SAT/ACT test scores, high school degree completion, high school GPA, taking challenging high school courses, and performance in high school courses.[17]

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[15] High school Grade Point Average (HSGPA) used in this analysis is an honors-weighted, capped GPA where extra points up to eight semesters, no more than four in the 10th grade are added to the GPA. The UC's admission's website provides more detailed information about how a weighted, capped GPA is calculated, http://admission.universityofcalifornia.edu/freshman/requirements/gpa-requirement/index.html.

[16] Geiser, S., & Studley, R. (2002). *UC and the SAT: Predictive validity and differential impact of the SAT I and SAT II at the University of California*. Educational Assessment, 8(1), 1-26.

[17] Maruyama, Geoffrey. (2012). Assessing College Readiness: Should We Be Satisfied With ACT or Other Threshold Scores? *Educational* Researcher, 41:7, 252 – 261. Retrieved on August 28, 2018, from http://journals.sagepub.com/doi/abs/10.3102/0013189X12455095.

Green and Winters developed a measure of public high school college readiness to reflect the minimum standards of the least selective four-year college.[18] The standard includes earning a regular high school diploma, completing a minimum set of course requirements, and being able to read at a basic level (scoring at or above the basic level on the National Assessment of Educational Progress [NAEP] reading assessment).

The National Center for Educational Statistics (NCES) measured college readiness based on a student's high school GPA, senior class rank, National Education Longitudinal Study (NELS) 1992 test scores, and SAT/ACT college entrance scores.[19]

The ACT is designed to measure academic skills and knowledge taught in high school and required for first year college courses.[20] Therefore, it is not surprising that previous studies (by ACT and others) have found that factors such as high school coursework and high school GPA affect ACT scores. ACT scores are influenced by achievement in core subject areas of high school courses.[21] High school GPA accounts for 31% of the variance in ACT scores, more than high school coursework, high school characteristics, non-cognitive factors, and demographic characteristics. Non-cognitive factors such as parental involvement or perceptions of education affect ACT scores via their impact on high school GPA.[22] Completing more AP courses is associated with higher ACT scores.[23] Taking an AP math course and taking more AP courses are associated with meeting benchmark scores on the ACT.[24] Taking and passing AP exams is associated with higher ACT scores, but simply enrolling in AP courses is not.[25] The SAT is also moderately correlated with HSGPA.[26]

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[18] Green, J.P., & Winters, M.A. (2005). Public high school graduation and college-readiness rates: 1991-2002. Manhattan Institute. Retrieved on August 10, 2018, from https://www.manhattan-institute.org/html/public-high-school-graduation-and-college-readiness-rates-1991-2002-5911.html.

[19] Berkner, L., & Chavez, L. (1997). Access to postsecondary education for the 1992 high school graduates. (NCES 98-105). Washington, DC: U.S. Department of Education, National Center for Education Statistics.

[20] Ferguson, Richard. (2004). Achievement versus Aptitude in College Admissions. In Zwick, Rebecca. *Rethinking the SAT*. New York and London: RoutledgeFalmer.

[21] Allen, J. (2015). *Influence of Achievement in Core High School Courses on ACT Scores*. Retrieved on August 28, 2018 from https://www.act.org/content/dam/act/unsecured/documents/2015-Tech-Brief-Influence-of-Achievement.pdf.

[22] McNeish, D., Radunzel, J., Sanchez, E. (2015). A Multidimensional Perspective of College Readiness: Relating Student and School Characteristics to Performance on the ACT®. Retrieved on August 28, 2018 from http://www.act.org/content/dam/act/unsecured/documents/ACT_RR2015-6.pdf.

[23] Anderson, K. (2016). The Effectiveness of Advanced Placement Courses in Improving ACT® Scores for High School Students. Retrieved on August 28, 2018 from http://www.kylestevenanderson.com/uploads/7/0/5/8/70582975/kyle_anderson_edd_dissertation_pdf.pdf.

[24] Mo, L., Yang, F., Hu, X., Calaway, F., & Nickey, J. (2011). ACT test performance by Advanced Placement students in Memphis City schools, *The Journal of Educational Research*, 104, 354–359. Retrieved on August 28, 2018 from https://www.tandfonline.com/doi/abs/10.1080/00220671.2010.486810.

[25] Warne, R., Larsen, R., Anderson, B., Odasso, A. (2015). The Impact of Participation in the Advanced Placement Program on Students' College Admissions Test Scores, *The Journal of Educational Research*, 108, 400-416. https://www.tandfonline.com/doi/full/10.1080/00220671.2014.917253.

[26] Shaw, E., Marini, J., Beard, J., Shmueli, D., Young, L., and Ng, H. (2016). The Redesigned SAT Pilot Predictive Validity Study: A First Look. Retrieved on August 31, 2018 from https://collegereadiness.collegeboard.org/pdf/redesigned-sat-pilot-predictive-validity-study-first-look.pdf.

Recently, a paper was published by researcher Saul Geiser, where he examined the correlation between demographic predictors (i.e., parental education, family income and race/ethnicity) and SAT/ACT scores in UC California resident freshman admissions from 1994-2011.[27] Geiser found that demographic predictors accounted for more than a third of the variance associated with SAT/ACT scores among UC applicants, and that race/ethnicity had become the strongest of those three predictors. This report includes results of the analysis replicated based on slightly different methods than Geiser used for his analysis.

A large volume of research has also examined relationships between standardized tests and student success in college. However, findings are not always consistent across research. This could be because different research might use different measures to evaluate college success, utilize different methods to analyze data, examine different samples, and control different demographic variables in modeling. Most of the research on standardized tests and academic success focuses either on the SAT alone or combines SAT and ACT scores. Very few studies look at the tests separately. Combining scores on the two tests is often done as SAT and ACT scores are highly correlated. Based on UC's application data, the Pearson correlation coefficient between the sum of SAT Reading and Math scores and the ACT composite scores was 0.91 in 2001, 0.89 in 2006, and 0.93 in 2016.

Many studies that use first-year GPA (FYGPA) in college as a measure of college success have found a strong correlation between test scores and FYGPA. In 1960, Fishman and Pasanella reviewed 147 studies that included the SAT as a predictor of FYGPA, finding that the correlation between SAT scores and high school record with FYGPA ranged from moderate to strong (0.34 to 0.82).[28] In 1989, Morgan of the College Board analyzed the predictive validity of the SAT on first-year GPA and found that the correlation between SAT scores and FYGPA declined over the years, but there was less change for private institutions, small institutions, and more selective institutions.[29] More recently, Hezlett and colleagues performed a meta-analysis of approximately 3,000 validity studies, with more than one million students. They found that the SAT is a valid predictor of FYGPA, with correlations ranging from moderate to strong (0.44 to 0.62).[30]

A report published in 2011 by the National Bureau of Economic Research found that the English and math sections of the ACT were more strongly correlated with student success than were the reading and science sections.[31] Specifically, the ACT math and English sections only were found to be more strongly related to first-year GPA than the science and reading sections only. While

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[27] Geiser, S. (2015). The Growing Correlation Between Race and the SAT Scores. *UC Berkeley Center for Studies in Higher Education.* Retrieved from https://cshe.berkeley.edu/publications/growing-correlation-between-race-and-sat-scores-new-findings-california-saul-geiser on August 3, 2018.

[28] Fishman, J.A., & Pasanella, A.K. (1960). *College admission selection studies*. Review of Educational Research, 30(4), 298–310.

[29] Morgan, R. (1989). Analysis of the Predictive Validity of the SAT and High School Grades from 1976 to 1985. (College Board Research Report No. 1989-7). New York: The College Board.

[30] Hezlett, S.A., Kuncel, N., Vey, M.A., Ahart, A.M., Ones, D.S., Campbell, J.P., & Camara, W.J. (2001, April). The effectiveness of the SAT in predicting success early and late in college: A comprehensive meta-analysis. Paper presented at the annual meeting of the National Council on Measurement in Education, Seattle, WA.

[31] Bettinger, E.P., Evans, B.P., and Pope, D.G. (2011). Improving College Performance and Retention. The Easy Way: Unpacking the ACT Exam. *National Bureau of Economic Research.* Retrieved from http://www.nber.org/papers/w17119.pdf on August 7, 2018.

not directly challenging these findings, ACT does contest the interpretation of these findings. They argue that most students score similarly on all four tests, and those that differ may provide admissions officers with important additional information.[32]

As major fields have their own unique characteristics with different grading standards, there are likely to be differences in the predictive validity of the SAT for cumulative college GPA by academic program. Shaw and colleagues of the College Board showed that correlations between SAT and cumulative GPA were of moderate strength for most majors (0.50-0.60). The strongest correlations tended to be found in STEM (Science, Technology, Engineering, and Mathematics) fields. The weakest correlations were found for undeclared students ($r = 0.42$).[33] Bridgeman, Pollack, and Burton of the College Board further pointed out high school GPA is a slightly poorer predictor of cumulative college GPA for African American and Hispanic students. SAT scores are moderately correlated with cumulative college GPA (.50) over four or more years. For all minority group students, both male and female, SAT scores predict college success about as well as they do for white students.[34]

Some research findings indicate that a strong relationship exists between the SAT score and college retention, over the past 30 years. By analyzing a national dataset including individual level data on nearly 150,000 students from 106 colleges and universities, Mattern and Patterson of the College Board found a strong correlation between SAT performance and retention to second year.[35] They found that 64 percent of students in the lowest SAT score band returned for their second year, compared to 96 percent of students in the highest SAT score band.[36] The relationship between SAT scores and retention to the third and fourth years was also examined, and similar results were found.[37, 38]

Research has also shown that SAT scores predict graduation as well as HSGPA. Burton and Ramist[39] of the College Board found that high school record had an uncorrected correlation of .29 with college graduation, while each of the individual SAT sections had an uncorrected correlation of .27, and the best combination of the two sections had an uncorrected correlation of

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[32] Mathews, J. (2011). Report finds 2 of 4 tests in ACT Poor Predictors of College Success. *The Washington Post.* Retrieved from https://www.washingtonpost.com/blogs/class-struggle/post/report-finds-2-of-4-tests-in-act-poor-predictors-of-college-success/2011/07/19/gIQAOiPFOI_blog.html?utm_term=.f1505f48e84a on August 13, 2018.
[33] Shaw, E., Kobrin, J., Patterson, B., and Mattern K. (2012). The Validity of the SAT for Predicting Cumulative Grade Point Average by College Major (College Board Research Report No. 2012-6). New York: The College Board.
[34] Bridgeman, B., McCamley-Jenkins, L., & Ervin, N. (2000). Predictions of freshman grade-point average from the revised and recentered SAT I: Reasoning Test. (College Board Research Report No. 2000-1). New York: The College Board.
[35] Mattern, K. and Patterson, B. (2009). *Is Performance on the SAT Related to College Retention?* (College Board Research Report No. 2009-7). New York: The College Board.
[36] Mattern, K. and Patterson, B. (2009). *Is Performance on the SAT Related to College Retention?* (College Board Research Report No. 2009-7). New York: The College Board.
[37] Mattern, K. D., & Patterson, B. F. (2011a). *The relationship between SAT scores and retention to the third year: 2006 cohort* (College Board Statistical Report No. 2011-2). New York: The College Board.
[38] Mattern, K. D., & Patterson, B. F. (2011b). *The relationship between SAT scores and retention to the fourth year: 2006 cohort* (College Board Statistical Report No. 2011-6). New York: The College Board.
[39] Burton, N., & Ramist, L. (2001). *Predicting success in college: SAT studies of classes graduating since 1980* (College Board Research Report No. 2001-2). New York: The College Board.

.33. Mattern, Patterson and Wyatt[40] of the College Board found that students with higher SAT scores are more likely to graduate, and graduate in a timely manner (i.e., four years), even after controlling for HSGPA, institutional characteristics, and institutional selectivity.

Geiser and Studley[41] examined the relationship between SAT scores and freshman GPA based on the records of 77,893 students who entered UC between Fall 1996 and Fall 1999. The study found that SAT II subject tests were better predictors of student success at UC when compared to the SAT I aptitude tests. They suggested that using the achievement tests (SAT II subject tests) for college admissions could be valuable to the prediction of college success with clarity in admissions standards and close linkage to the high-school curriculum.

However, other research has questioned the predictive validity of SAT scores as it relates to student success within the first year, and beyond. Using a dataset containing over 400,000 individual records from 176 colleges with various levels of selectivity, researchers sought to better understand if the SAT was predictive of first-year GPA.[42] Evidence suggests that the SAT, while overall predictive of first-year GPA, was less predictive across subgroups. For example, when comparing African American and White students, the SAT Critical Reading either over- or under-predicted first-year GPA at 20 percent of colleges and universities.[43]

Furthermore, using UC data, Geiser[44] found that demographic predictors weakened the ability of SAT/ACT scores to be effective predictors of five-year graduation rates, and in contrast, the explanatory power of HSGPA was not found to be affected by demographic controls. Geiser and Santelices found that HSGPA was consistently a stronger predictor of student success when compared to SAT scores, and that its power increased as students progressed through their UC career.[45]

Similar to what was found by Geiser and Santelices, recently, an article posted in *Forbes* concluded that HSGPA matters more than SAT/ACT scores when it comes to student success.[46] For example, even students with high SAT/ACT scores (above 1,100, with ACT concorded to the SAT scale) have a low expected six-year graduation rate (51 percent), if their HSGPA is

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[40] Mattern, K., Patterson, B. and Wyatt, J. (2013). *How Useful Are Traditional Admission Measures in Predicting Graduation Within Four Years?* (College Board Research Report No. 2013-1). New York: The College Board.
[41] Geiser, S., & Studley, R. (2002). *UC and the SAT: Predictive validity and differential impact of the SAT I and SAT II at the University of California*. Educational Assessment, 8(1), 1-26.
[42] Aguinis, H., Culpepper, S.A. & Pierce, C.A. (2016). Differential Prediction Generalization in College Admissions Testing. *Journal of Educational Psychology (7).* 1045-1059.
[43] Jaschik, S. (2016). Faulty Predictions? *Inside Higher Education.* Retrieved from https://www.insidehighered.com/news/2016/01/26/new-research-suggests-sat-under-or-overpredicts-first-year-grades-hundreds-thousands on October 12, 2018.
[44] Geiser, S. (2016). A Proposal To Eliminate the SAT in Berkeley Admissions. *UC Berkeley Center for Studies in Higher Education.* Retrieved from https://cshe.berkeley.edu/publications/proposal-eliminate-sat-berkeley-admissions on August 31, 2018.
[45] Geiser, S. & Santelices, M.V. (2007). Validity of High School Grades in Predicting Student Success Beyond the Freshman Year: High-School Record v. Standardized Tests as Indicators of Four-Year College Outcomes. *UC Berkeley Center for Studies in Higher Education.* Retrieved from https://cshe.berkeley.edu/sites/default/files/publications/rops.geiser._sat_6.13.07.pdf on August 31, 2018.
[46] Cooper, P. (2018). What Predicts College Completion? High School GPA Beats SAT Score. *Forbes.* Retrieved from https://www.forbes.com/sites/prestoncooper2/2018/06/11/what-predicts-college-completion-high-school-gpa-beats-sat-score/#3c6910c04b09 on August 17, 2018.

relatively low (3.00-3.32). In contrast, students with average SAT/ACT scores (900-990) and a high HSGPA (3.67-4.00) have a much higher expected graduation rate (62 percent). However, the study used a sample of students who attended a group of less selective four-year public colleges and universities. This report uses the same method to analyze timely graduation rates based on UC's longitudinal data.

In summary, studies that examined relationships between standardized tests and other college preparation measures such as HSGPA suggested positive relationships between them. The literature surrounding the predictive power of standardized test scores on student success is mixed. The College Board and supporters of standardized tests argue that they offer a check against grade inflation, assess skills needed not just for higher education, but the workplace as well, and that in combination with HSGPA provide a more "complete" assessment of students' academic potential. To support their argument, some research does suggest that both the SAT and the ACT are related to student success within the first year, and that the first year is important for student success, overall.

IV. What UC's Data Show about the SAT and ACT

Test Takers and Average Test Scores of UC California Resident Applicants

Appendix A provides a profile of UC California resident applicants who submitted SAT and/or ACT scores in their applications. From 2001 to 2013, more than 90 percent of UC CA applicants submitted SAT scores. However, there has been a declining trend in freshman applicants submitting SAT scores sine earlier 2010s. In 2018 one year after the College Board launched their new SAT, only about 86 percent of UC CA freshman applicants submitted SAT scores, including SAT Math, EBRW, and Essay scores. On the other hand, the share of CA applicants submitting ACT Composite scores increased steadily from 28 percent in 2001 to 47 percent in 2011 then fluctuated between 44 percent and 53 percent in 2012 through 2018. It is also important to note that the share submitting ACT ELA scores was substantially lower than the share submitting ACT Composite scores in 2017 and 2018 (at 46 percent and 38 percent respectively). It is hard to understand why about 15 percent of those who submitted ACT Composite scores did not submit ACT ELA scores. Were there any reasons for or obstacles to this? More analyses are needed to answer this question. However, to determine applicant's eligibility for guaranteed admissions, UC has to use SAT scores for these applicants. If they did not provide a full score of SAT tests either, they would be ineligible for guaranteed admissions under the current ETR (Entitled to Review) policy, which requires a full score of either SAT or ACT including the writing test.

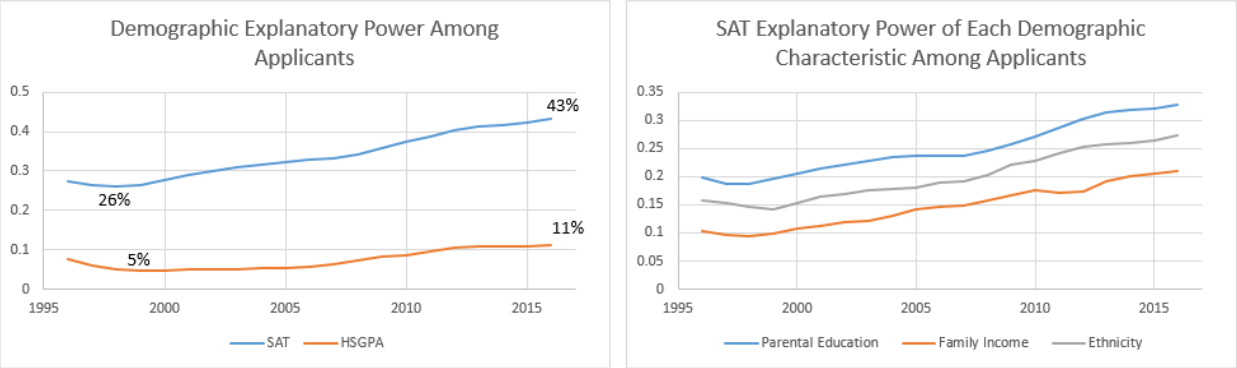
The average SAT I Verbal/Math scores ranged from 1163 to 1177 and average SAT II Writing scores ranged from 573 to 581 in 2001 to 2005 (Appendix B). The average SAT Critical Reading/Math scores dropped from 1161 in 2006 to 1117 in 2016 and the SAT Writing scores dropped as well from 572 in 2006 to 550 in 2016. Students seem to have higher new SAT Math/EBRW scores in 2017 and 2018 relative to recent SAT Critical Reading/Math averages (1203 and 1167 respectively).

Despite the changes over time to the ACT, the average ACT composite scores have stayed largely the same, at 24 or 25 in all years between 2001 and 2018 except 2017, when the average was 26. Excluding 2017 and 2018, when very few students submitted scores, English with Writing was 23 or 24 in all years (2006 through 2016). The average for the new ELA scores was 25 in 2017 and 2018 and the average writing subscore was 8 (on a 2-12 scale).

The Relationship between Demographic Characteristics and SAT/ACT Scores

Figure 1 below shows an apparently disturbing trend in the proportion of variation in UC applicants' SAT scores that are accounted for by fixed student characteristics. The left panel of the figure shows that annual linear regressions of UC applicants' SAT scores on three such characteristics—parental income, parental education, and ethnicity—show that the amount of demographically-explained variation in applicants' SAT scores (as measured by R^2) has increased from 26 percent in the late 1990s to 43 percent in 2016, suggesting that nearly half of the variation captured by the SAT score across UC applicants reflects student background characteristics, not all of which are directly observed by UC's admissions offices. Meanwhile, the proportion of explained variation of applicants' high school GPAs (HSGPAs) has remained

Figure 1: Demographics' Explanatory Power for SAT and HSGPA



Note: R^2 from annual OLS regressions of applicants' SAT score or high school GPA on comprehensive parental education indicators, ethnicity indicators, and family income (and an indicator whether family income is reported), combined (left) and one at a time (right). Sample restricted to California-resident freshmen.

at a far lower level, rising from 5 percent in the 1990s to 11 percent in 2016. Figure 1's right panel breaks out each permanent characteristic separately, showing that all three demographics each explain an additional 10 percentage points of SAT variation since the 1990s.[47]

[47] A number of modeling assumptions are necessary in the production of this chart, and our choices differ from those made by the previous version of this brief (September, 2018) as well as from Geiser (2015). First, consider the three demographic characteristics analyzed in this study:

1. Parental Income: Both our earlier version and Geiser include only log CPI-adjusted parental income as their measure of income. This technique implicitly drops two important groups of applicants from the sample: (a) applicants who report 0 parental income, since the log of 0 is non-finite (about 4% of the sample), and (b) applicants who do not report parental income on their applications, usually because they do not intend to receive financial aid, indicating high-income households (about 12% of the sample).

There are at least two well-known interpretations of this important finding. The first is that the SAT is increasingly racist, classist, or otherwise biased against students from disadvantaged backgrounds over time, such that despite their unchanged average aptitude over the past 25 years, disadvantaged applicants' SAT performance has deteriorated (unlike their HSGPA performance, which may not face the same systematic issues of bias). The second is that increased residential segregation by ethnicity and class, combined with increased educational disparities across California secondary schools, have led to actual average declines in college preparation among disadvantaged groups, as accurately reflected by their declining SAT scores (but perhaps not by HSGPAs, which are normed within increasingly-disparate high schools).

A third possible explanation is that the trend is driven by changes in the composition of youths in the estimation sample, most likely as a result of changing UC admissions policies. Expanding admissions policies that favor disadvantaged applicants, for example, could increase the explanatory power of demographic characteristics among admits by enlarging the pool of low-SAT high-disadvantage students in the sample, which would mechanically increase demographics' correlation independent of the exam's bias or changes in applicants' average latent aptitude.

Arbitrating between these alternative explanations for the **"Demographic Testing Trend", or DTT**, is crucial to understanding how the SAT's informativeness has evolved over the past 25 years. Advocates in favor of the first explanation (the "**Bias Explanation**") include Saul Geiser, who argues that the DTT invalidates use of the SAT in the absense of race-based affirmative

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Omitting these samples may mechanically decrease the correlation between income and SAT, since they represent the two extremes of income where the covariance with test scores may be highest. In order to maintain these samples, this analysis includes three measures of parental income in each regression model: log CPI-adjusted parental income (replaced as 0 when missing or infinite), an indicator for missing income, and an indicator for zero income. This change likely explains the higher proportion of SAT variation explained by the presented estimates.

2. Parental education: Our earlier version included only an indicator for whether one parent has a college degree, while Geiser may have included an ordered integer measuring the more-educated parent's highest level of education. Both of these measures simplify a high-dimensional student feature—the educational level of their parent—into a highly-parametric summary. This analysis includes indicator variables for each combination of educational background held by the applicant's parents, using the full available information set. This change may partly account for the aggregate increase in explanatory power of demographics for applicants' SAT score.
3. Ethnicity: Our earlier version and Geiser include only an indicator for whether the applicant is from an underrepresented group, including Black, Chicano/Latinx, or Native American. This analysis includes indicators for every observed ethnicity, or 15 in all. This may also contribute to the general increase in demographics' explanatory power for SAT scores.

The added value of including these multi-dimensional measures of students' background characteristics is that they more fully specify each student's background, leading to more explanatory power and avoiding possibly-important model restrictions that could challenge interpretation (especially in the case of parental income). The disadvantage of using multi-dimensional measures is that there is no longer a single standardized regression coefficient associated with each measure, making it impossible to directly compare the degree to which each contributes to their mutual absorption of SAT variation. As a result, rather than presenting regression coefficients, we show the degree to which each individual characteristic (as measured multi-dimensionally) alone can explain variation in applicants' SAT scores.

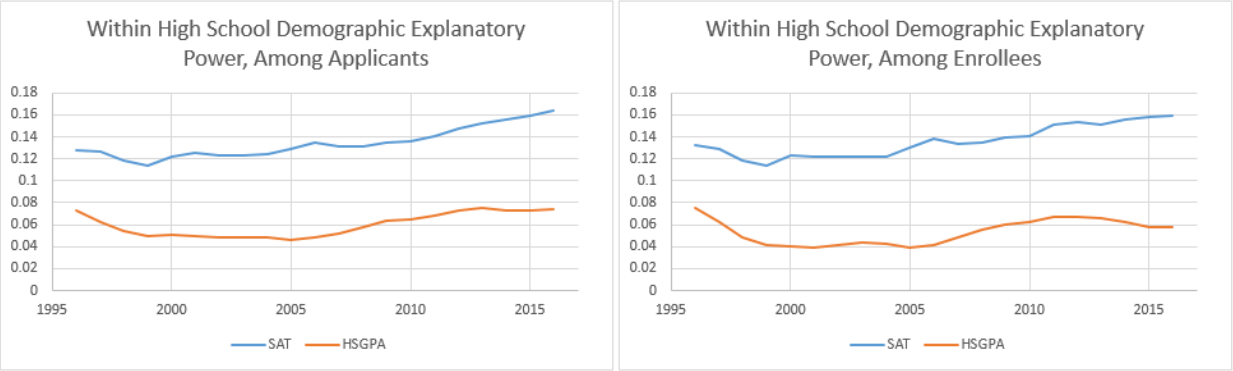
Finally, all three analyses use the same definition of applicants' SAT score: the sum of the mathematics and reading components of the SAT exam.

action because it increasingly favors White and Asian applicants (Geiser, 2015). Advocates for the second explanation (the "**Real-Disparities Explanation**") include the College Board, which argued in its recent meeting with the Task Force that "performance on the SAT differs across subgroups, which largely reflects educational differences in high schools". The third explanation (the "**Compositional Explanation**") has drawn less vocal support.

This section presents evidence that approximately one-third of the DTT is explained the Real-Disparities Explanation, with two-thirds explained by the Compositional Explanation. Figure 1 shows that the Real-Disparities Explanation explains 31 percent of the DTT. Figures 2 and 3 motivate the Compositional Explanation, showing the magnitude of UC compositional changes over the past 25 years, and Figure 4 shows that the Compositional Explanation fully explains the remaining net DTT trend. Figure 4 directly challenges the Bias Explanation as even playing a secondary role in explaining the DTT.

First, we rerun the regressions that estimate the cross-student DTT including high school fixed effects, which eliminate cross-high-school variation that likely reflects increasing educational disparities in California secondary schools. We show analysis for both the population of UC applicants and the population of UC enrollees, restricting the sample to California-resident freshman applicants. If the Real-Disparities Explanation were to be accurate in the strong sense (that is, if the real disparities were *exclusively* across high school, without increasing disparities within high school as well), then the results would show no trend in demographics' explanatory power for applicants' or enrollees' SAT scores.

Figure 2: Within High School DTT Trend



Note: R^2 (excluding fixed effects) from annual OLS regressions of applicants' or enrollees' SAT score or high school GPA on comprehensive parental education indicators, ethnicity indicators, and family income (and an indicator whether family income is reported), including fixed effects by origin high school. Sample restricted to California-resident freshmen.

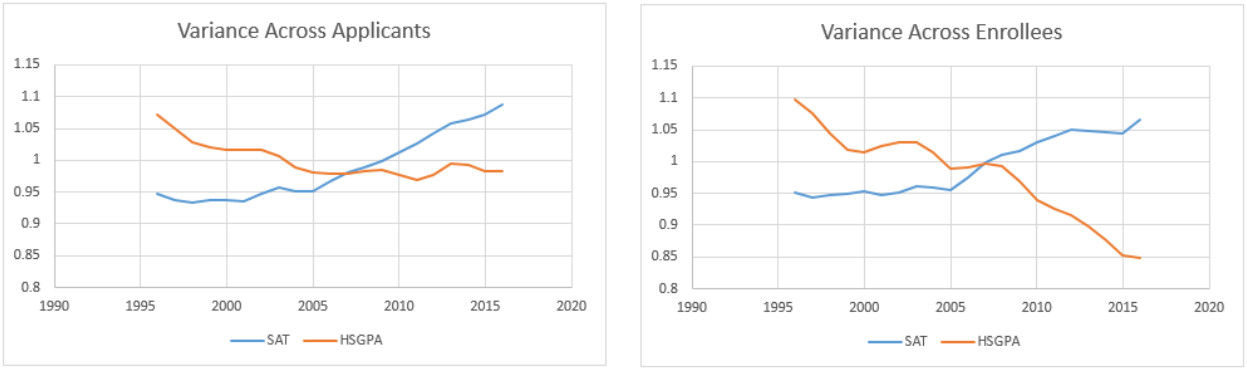
Figure 2 above shows that this is not the case. While far less variation in SAT scores can be explaned by demographics when only comparing students to others from their same high schools, there is still a notable upward trend in demographics' explanatory power, from 11.3 percent at its trough in 1999 to 16.4 percent in 2016 among UC applicants (representing a 31 percent decline in the proportional increase in explanatory power since 1996). Demographics' explanatory power for

HSGPA increased from 4.9 to 7.4 percent in the same period, suggesting even faster proportional growth (a 51 percent increase, relative to 45 percent). A similar trend holds among UC enrollees.[48]

One important feature that these figures share with the original DTT chart is the decline in demographics' explanatory power between 1995 and 1999. These declines likely reflect that period's phasing out of UC's affirmative action program, which decreased underrepresented minorities' UC enrollment by at least 700 students per year across all campuses (Bleemer, 2019) and led to parallel declines in UC URM applications. As a result, the Compositional Explanation clarifies that demographics' explanatory power in the period declined as the affirmative-acted students—who tended to have lower SAT scores that could be explained by their demographic characteristics—ceased enrolling at UC. This observation provides the first circumstantial evidence supporting the role of student composition in regulating the correlational relationship between demographics and SAT performance.

In order to further motivate the Compositional Explanation, we next plot the annual variance in SAT scores and HSGPAs across all UC campuses. Figure 3 shows that the amount of variance in SAT scores among UC applicants has been swiftly rising since about 2005, while the amount of variance in HSGPA fell in the late 1990s and early 2000s and has persisted at the lower level. The trends among UC enrollees are even more pronounced; variation in SAT scores among UC applicants has increased by more than 10 percent since 1996, while variation in HSGPAs has fallen by more than 20 percent. These trends likely reflect two important admissions policies—Eligibility in the Local Context and Holistic Review—that have substantially replaced affirmative action since the 1990s in enrolling disadvantaged applicants. As various UC campuses increase their numbers of low-SAT high-HSGPA students (the latter of which is measured relative to the lower-preparedness high schools from which the disadvantaged applicants are pulled), SAT scores are increasingly varying across the campuses' student bodies.

Figure 3: Change in Annual SAT and HSGPA Standard Deviations Since 1995



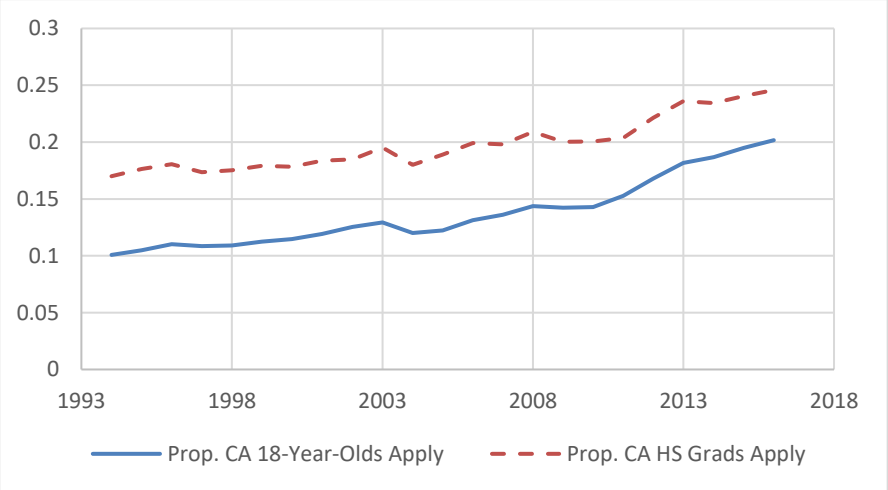
Note: Annual standard deviation in SAT and HSGPA of UC applicants and enrollees. SAT and HSGPA are normed to have standard deviation 1 on average across all years. Plot shows two-year moving averages.

[48] Figures 2 and 5 present 'projected R^2" measures from the relevant annual linear regression estimates of SAT on demographic characteristics. To be more specific, these models include high school fixed effects, which themselves (importantly) absorb some cross-school variation in SAT performance, and there's no reason to include that explanatory power in the reported R^2. Instead, I merely report the R^2 of *projected* SAT scores, after differencing out the high-school-specific averages, regressed on demographic characteristics. This is a standard technique implemented using the fixed effect linear regression package *felm* in *R*.

In other words, the increased variance is by design, an artifact of admissions policies which intentionally target lower-SAT applicants. We will return below to another explanation for the increase in SAT variation over time: the expansion of the Riverside and Merced campuses.

The next plot visualizes the proportion of California high school students who apply to at least one University of California campus. One of the chief successes—and political challenges—of UC's Comprehensive and Holistic Review admissions programs has been their encouragement of applications from high school graduates who would previously have not applied to UC because of their poor perceived likelihood of admission. Figure 4, pulled from Douglass and Bleemer (2018), shows that the proportion of 18-year-olds in California who apply to at least one UC campus has doubled since 1995, from about 10 percent to about 20 percent. Some of this

Figure 4: Proportion of California Residents Who Apply to UC



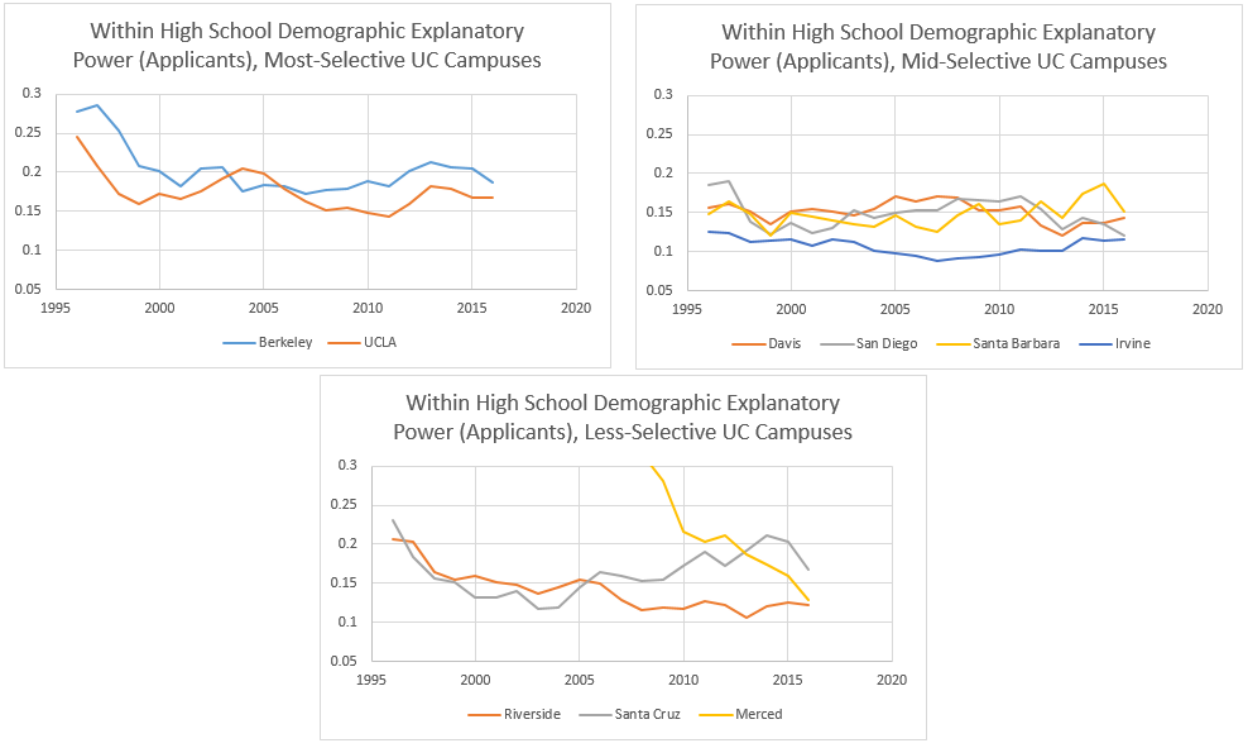
Note: The proportion of California 18-year-olds and California high school graduates who apply to at least one UC campus in each year since 1994. The annual number of California 18-year-olds is as estimated by the California Department of Finance, which also reports the annual number of high school graduates in the state.

increase comes from increasing high school graduation rates, but even among graduates the proportion of applicants has increased by about 8 percentage points, to almost 25 percent. This change in application behavior has surely dramatically altered the composition of UC applicants, and is also reflected in UC's students as a result of changing admissions policies. These charts showing increasing SAT variation and increasing broad application behavior by California youths strongly suggest that compositional changes in UC applicants and enrollees are central factors in explaining the DTT: after all, UC has spent the past 20 years bolstering admissions policies that favor the lower-SAT disadvantaged applicants who would mechanically increase the SAT-demographics correlation.

Finally, and perhaps most consequentially, we replicate Figure 2 by campus (for applicants). Under either the Bias Explanation or the Real-Disparities Explanation, we would expect that the predictive power of the SAT has increased consistently at every UC campus, either because of consistent bias or consistently-varying disparities across applicants. In fact, Figure 5 shows a

very different pattern. Only a single campus, Santa Barbara, manifests any increase in demographics-SAT correlation, and even there the increase in demographics' explanatory power for the SAT is slight (from 14.8 to 15.2 percent). Most other campuses have faced almost no change in demographics' explanatory power since the end of affirmative action in the late 1990s (like Irvine, Davis, and UCLA) or have actually experienced declines in demographics' explanatory power (San Diego, Riverside, and most notably Merced). What would cause these patterns?

Figure 5: Within High School DTT Trend by Campus



comprehensive parental education indicators, ethnicity indicators, and family income (and an indicator whether family income is reported), including fixed effects by origin high school. Estimated separately for each UC campus. Sample restricted to California-resident freshmen.

The answer is the Compositional Explanation. Campuses with high explanatory power—especially Merced, which in the late-2000s had demographic explanatory power in the 30-40 percent range—have grown, in enrollees but especially in applicants (who wouldn't otherwise have applied to UC campuses). The end of affirmative action pushed demographics' explanatory power down, especially at the Berkeley and UCLA campuses where that program was most effective, and the end of the old ELC program in 2011 also appears to have compressed demographics' explanatory power at the campuses where that program was most effective (San Diego, Davis, and Irvine). Meanwhile, all of the campuses were growing more selective on average, compressing their HSGPA distributions, but also instituting disadvantaged-focused admissions programs that purposely admitted students whose low test scores were offset by measures of disadvantage that mechanically strengthened the correlation between demographics and the SAT, both among enrollees and the applicants the the programs encouraged. These results

are very difficult to reconcile with the Bias Explanation, and strongly suggest that the net DTT after the Real-Disparities Explanation can be fully explained by the Compositional Explanation.

As a result, we conclude that about one third of the DTT can be explained by the Real-Disparities Explanation, since only comparing students who enrolled at the same high school explains 31 percent of demographics' explanatory power for SAT scores. The remainder appears to be explained by the Compositional Explanation, which is motivated by measured compositional changes within and across UC campuses in their applicant and student bodies and confirmed by the absense of a DTT trend within 7 out of 8 UC campuses, which nevertheless show patterns strongly consistent with the implementation of disadvantage-favoring admissions programs. Indeed, the recently-increasing DTT-demographics correlation at many campuses is best understood as a manifestation of their admissions policies' successes in attracting the disadvantaged lower-SAT students that they are designed to attract.

Standardized Tests and Academic Preparation

This section examines the correlations between SAT/ACT scores and high school GPA as well as the relationship between SAT/ACT scores and UC's Analytical Writing Placement Exam (AWPE) score. SAT Writing refers to the SAT II writing for 2001 through 2005, SAT Writing for 2006 through 2016, and SAT Essay for 2017 and 2018. SAT Reading/Math refers to SAT I Verbal and Math for 2001 to 2005, SAT Critical Reading and Math for 2006 to 2016, and SAT Evidence-Based Reading and Writing (EBRW) and Math for 2017 and 2018. ACT Writing refers to the ACT Combined English/Writing (CEW) scores for 2006 through 2016 and the writing (essay) subscore for 2017 and 2018. ACT Composite combines the English, Reading, Math, and Science multiple choice sections. CEW combined the English multiple choice section with the writing (essay) section. On the new ACT, the writing subscore is combined with the English and Reading multiple choice sections to produce an English Language Arts (ELA) score.

Table 1 shows the across and within school correlations between SAT/ACT and high school GPA controlling for socioeconomic status (family income and parental education). Generally, the within school correlations between SAT scores and high school GPA are slightly higher than the across school correlations. This finding is consistent with what Zwick and Green (2007) found in their analysis.[49] They concluded that one of the primary reasons is that grading stringency varies across both high schools and courses. This can potentially result in small between-school variability in high school grades. Their study also indicates that between-school variance in mean test scores is likely to be substantial than within-school variance. For both across and within correlations between SAT and HSGPA, we see an increasing trend from 2005 to 2018, except that those between SAT writing and high school GPA dropped in 2018, which might be due to the new SAT essay (starting in 2017) with a different scoring scale. Across the years, the correlations between SAT Writing/Essay and HSGPA are consistently lower than those between SAT Reading/Math and HSGPA. Overall, the correlations between SAT and HSGPA are moderate at around .50.

[49] Zwick, R. and Green, J.G. (2007). New Perspectives on the Correlation of SAT Scores, High School Grades, and Socioeconomic Factors. *Journal of Educational Measurement.* Retrieved from https://onlinelibrary.wiley.com/doi/full/10.1111/j.1745-3984.2007.00025.x, May 3,2019

Similarly, the within school correlations between ACT and high school GPA are higher than the across school correlations. Generally, there is an upward trend of correlations between ACT and HSGPA across years, except for 2018 when there is a drop from 2015. ACT Writing is also less correlated with HSGPA than ACT Composite.

Table 1. Partial Correlation of Standard Test Scores and High School GPA

		2001	2005	2007	2015	2018
SAT Reading/Math	Across schools	0.47	0.45	0.48	0.50	0.51
	Within schools	0.53	0.51	0.53	0.55	0.56
SAT Writing (SAT Essay for 2018)	Across schools	0.44	0.44	0.46	0.48	0.39
	Within schools	0.49	0.49	0.50	0.52	0.41
Sum of SAT Reading/Math and SAT Writing	Across schools	0.48	0.47	0.50	0.52	n/a
	Within schools	0.54	0.54	0.56	0.57	n/a
ACT Composite	Across schools	0.47	0.46	0.46	0.50	0.47
	Within schools	0.51	0.51	0.51	0.55	0.53
ACT Writing (ACT ELA for 2018)	Across schools	n/a	n/a	0.43	0.46	0.30
	Within schools	n/a	n/a	0.47	0.49	0.31
Sum of ACT Composite and ACT Writing	Across schools	n/a	n/a	0.47	0.50	n/a
	Within schools	n/a	n/a	0.52	0.55	n/a

Note: All correlations control for family income and parental education.

A previous analysis also looked at the relationship between the new SAT and new ACT and UC's Analytical Writing Placement Exam (AWPE) for the Fall 2017 incoming class.[50] The analysis found that 76 percent of those at or above a threshold of 690 for SAT Evidence Based Reading and Writing (EBRW) passed the AWPE (Table 2). On the old SAT, more than 75 percent of those meeting the old threshold of 680 on SAT Writing would have passed the AWPE. On the SAT Essay, even at the top score of 24, only 69 percent passed the AWPE, and only two percent of test-takers achieved that score.[51] For ACT, 75 percent or more of students scoring 30 or higher on ACT English Language Arts (ELA) would have passed the AWPE. This is similar to the pattern for the old threshold using the old ACT Combined English/Writing scores. The report recommended setting a threshold for passing the Entry Level Writing Requirement (ELWR) of 690 on SAT EBRW, leaving the threshold of 30 on the ACT ELA in place, and not setting a new threshold using SAT Essay.

[50] University of California Office of the President, Institutional Research and Academic Planning. (2017). New SAT and ACT tests and the Entry Level Writing Requirement.

[51] A later analysis looked at the SAT Essay sub-scores, showing that in Fall 2017, 65% of those with a top Writing score of eight passed the AWPE and only 5% of test-takers achieved this score; 73% of those with a top Analysis score of eight passed the AWPE and only 2% of test-takers achieved this score; 65% of those with a top Reading score of eight passed the AWPE and only 5% of test-takers achieved this score.

Table 2. Number of test-takers by AWPE score status and SAT EBRW, SAT Essay, or ACT ELA score, Fall 2017

SAT EBRW score	Failed AWPE		Passed AWPE		Total	
>= 690	185	24%	572	76%	757	100%
< 690	6,754	59%	4,778	41%	11,532	100%
Total	6,939	56%	5,350	44%	12,289	100%
SAT Essay score	Failed AWPE		Passed AWPE		Total	
= 24	15	31%	34	69%	49	100%
< 24	6,924	57%	5,316	43%	12,240	100%
Total	6,939	56%	5,350	44%	12,289	100%
ACT ELA score	Failed AWPE		Passed AWPE		Total	
>= 30	n/a	n/a	n/a	n/a	n/a	n/a
< 30	6,939	56%	5,350	44%	12,289	100%
Total	6,939	56%	5,350	44%	12,289	100%

Note: This table includes all incoming freshmen who submitted a statement of intent to register (SIR) and had both an AWPE score and an SAT EBRW, SAT Essay, or ACT ELA score (as applicable). Students with a 30 or higher on the ACT ELA did not have to take the AWPE.

On the basis of the data analysis described above, the University Committee on Preparatory Education (UCOPE), a committee of UC Academic Senate, approved a new threshold of 680 on SAT EBRW for passing the Entry Level Writing Requirement (ELWR), left the threshold of 30 on ACT ELA in place, and did not set a new threshold using SAT Essay. Note that SAT EBRW is based on multiple choice sections of the test while ACT ELA is based on multiple choice sections and the writing/essay section. SAT Essay is a stand-alone essay section.

In summary, the partial correlations between test scores and HSGPA after controlling for SES are moderate. This means that standardized test scores and HSGPA can both measure part of students' knowledge and skills but there are different aspects of students' academic preparations that can only be measured by test scores and HSGPA separately. In addition, the writing tests are less correlated with HSGPA than Reading/Math or composite tests, which means SAT/ACT writing tests may provide additional information about students' qualifications that HSGPA cannot provide. High scores on the SAT EBRW and ACT ELA are associated with passing the UC's AWPE writing exam, but this is not necessarily true for the SAT Essay.

Standardized Tests and Student Success

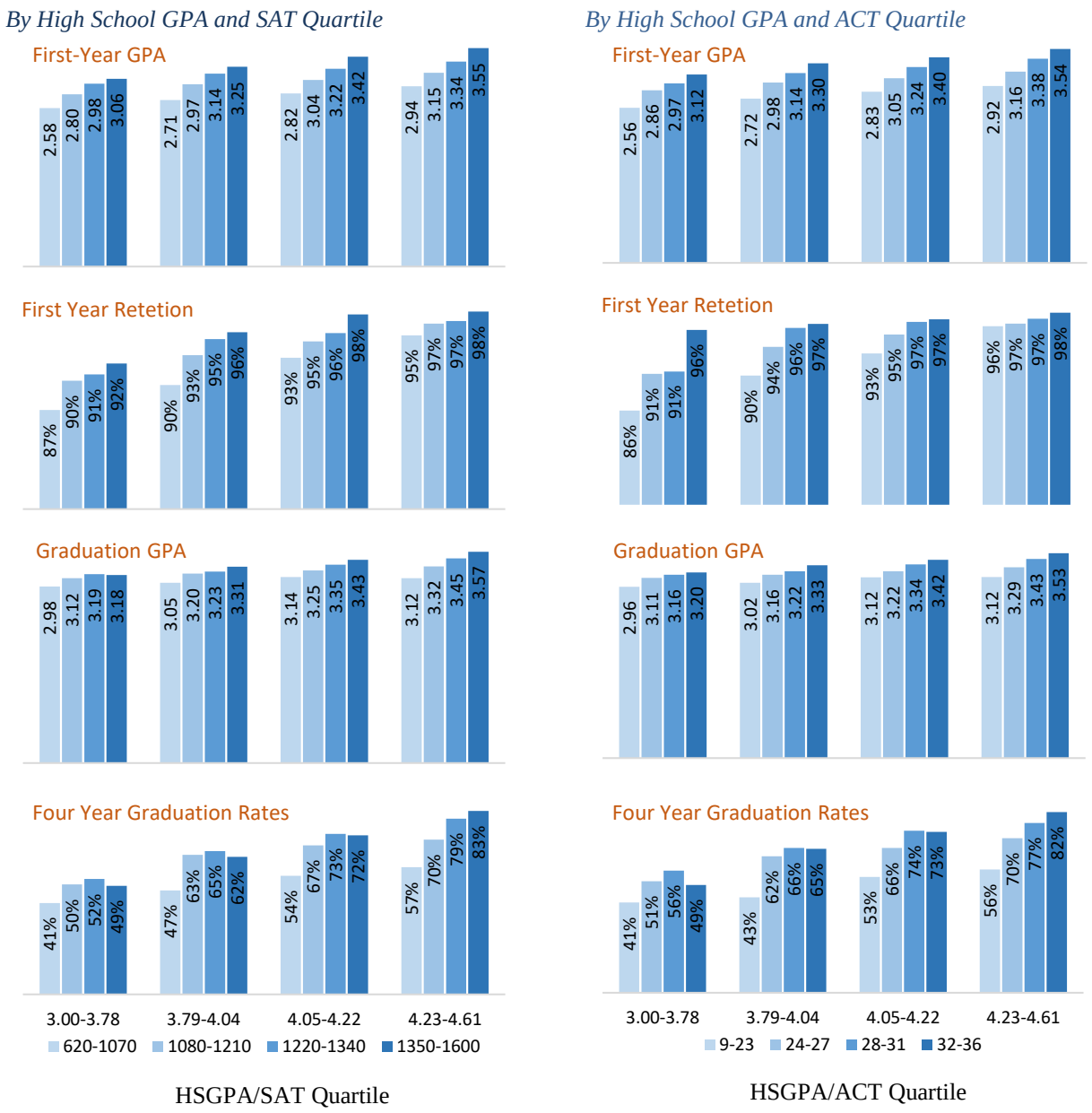
This section examines the relationship between the SAT/ACT and college success at UC through four outcome measures: (1) student first-year college GPA; (2) first-year retention; (3) four-year graduation; and (4) college graduation GPA. The section first presents results of descriptive analysis and then inferential statistics to show how well standardized test scores predict college success.

Figure 6 shows mean first-year GPA, first year retention rates, four-year graduation rates and mean graduation GPA of four-year graduates by HSGPA and SAT Reading/Math or ACT Composite quartile. Not surprisingly, students with a higher HSGPA and a higher SAT Reading/Math score or ACT Composite score (i.e., both in the highest quartiles) tend to have better performance on all four measures than students in the lowest test score and HSGPA quartiles. On average, their first-year GPA is higher than the GPA of those in the lowest HSGPA and test score quartiles by one point, or about one third; their first year retention rate is almost 100 percent, compared to about 90 percent for those in the lowest quartiles. The difference in graduation GPA between those in the highest and the lowest quartiles is smaller, but it is still about a half point. On average, students in the highest quartiles are twice as likely to graduate within four years.

In addition, Figure 6 shows that students in the same HSGPA quartile, but in a higher test score quartile are more likely to perform better, especially in terms of freshman GPA, first year retention rates, and four-year graduation rates than those in a lower test score quartile. For example, 83 percent of students in the highest HSGPA (4.23-4.61) and the highest SAT (1350-1600) quartiles graduate within four years, compared to 57 percent of those in the same HSGPA quartile, but with a lower SAT score (620-1070). This indicates that test scores do provide additional value beyond HSGPA to explain differences in students' performance at UC.

Results further show that students with a higher test score (1350-1600) and a lower HSGPA (3.00-3.78) seem to have a better freshman GPA, but a low first year retention rate when compared to students with a lower SAT/ACT score (620-1070) regardless of their HSGPA quartile. However, the first year retention rate graphs show the opposite, indicating that students in the highest HSGPA quartile and the lowest test score quartile are retained at a rate of 95 percent compared to 92 percent for those in the lowest HSGPA quartile and the highest SAT/ACT quartile. Similar to what was found for first-year GPA and retention rates, on average, students with higher test scores, but lower HSGPA, tend to have a higher graduation GPA and a lower four-year graduation rate, compared with those with a higher GPA, but a lower score on SAT Reading/Math or ACT Composite. This finding suggests that HSGPA may be slightly more predictive of first-year retention and four-year graduation, while standardized test scores may be slightly more predictive of both first-year and graduation GPA. Regression models will be developed in the following sections to further examine if this conclusion based on descriptive statistics holds and how HSGPA and test scores are related to college success.

Figure 6. First-Year GPA, First-Year Retention Rates, Four-Year Graduation GPA, and Four Year-Graduation Rate by HSGPA and SAT Reading/Math or ACT Composite Quartile



Standardized Tests and Academic Preparation: Aggregate First-Year GPA

Table 3 shows the percent of variance in freshman GPA accounted for by HSGPA and test scores based on a series of regression models. Results indicate that HSGPA, SAT Reading/Math, SAT Writing, ACT Composite, and ACT Writing are all moderate predictors of freshman GPA at UC. HSGPA accounted for 17 to 20 percent of variance in the freshman GPA prior to 2007, and then 15 percent in 2012 and 13 percent in 2015, the lowest ever while the variance accounted for by test scores has increased over the time from 13 percent in 2001 to 20 percent in 2015.

Table 3: Percent of Variance in Freshman GPA Accounted for by HS GPA and the SAT/ACT

Model	2001	2005	2007	2012	2015
(1) HSGPA	17%	18%	20%	15%	13%
(2) SATRM	13%	17%	19%	21%	20%
(3) SAT Writing	15%	18%	19%	20%	19%
(4) SAT TOTAL (SATRM + Writing)	17%	19%	21%	22%	22%
(5) HSGPA + SATRM	22%	26%	27%	26%	25%
Standardized Coefficients: HSGPA	*0.31*	*0.32*	*0.29*	*0.24*	*0.23*
SATRM	*0.25*	*0.29*	*0.31*	*0.36*	*0.36*
(6) HSGPA + SATTOTAL (SATRM + Writing)	24%	27%	28%	27%	26%
Standardized Coefficients: HSGPA	*0.30*	*0.30*	*0.30*	*0.22*	*0.22*
SATTOTAL	*0.28*	*0.32*	*0.33*	*0.38*	*0.38*
(7) ACT Composite	16%	21%	20%	23%	22%
(8) ACT Writing	n/a	n/a	19%	18%	19%
(9) ACT Total (Composite + Writing)	n/a	n/a	22%	23%	22%
(10) HSGPA + ACT Composite	22%	27%	27%	27%	26%
Standardized Coefficients: HSGPA	*0.28*	*0.31*	*0.29*	*0.22*	*0.23*
ACT CMP	*0.29*	*0.30*	*0.33*	*0.38*	*0.39*
(11) HSGPA + ACT Total (ACT CMP and ACT Writing)	n/a	n/a	29%	27%	26%
Standardized Coefficients: HSGPA	n/a	n/a	*0.28*	*0.22*	*0.22*
ACT Total	n/a	n/a	*0.35*	*0.38*	*0.38*
(12) HSGPA + SAT Total + Demographics	30%	32%	34%	32%	32%
Standardized Coefficients: HSGPA	*0.39*	*0.39*	*0.38*	*0.34*	*0.34*
Standardized Coefficients: SATTOTAL	*0.25*	*0.26*	*0.28*	*0.34*	*0.34*

There are multiple reasons for the declining trend in explanatory power of HSGPA. Since 2001, more and more campuses have adopted a comprehensive review process in admissions, including several that have adopted holistic review.[52] Using this process, campuses look beyond grades and test scores to evaluate students' qualifications for admission. However, several aspects of UC admissions policy still emphasize high school grades and test scores. The minimum requirement for UC admissions eligibility is to complete a minimum of 15 college-preparatory courses with a letter grade of C or better; the Eligibility in the Local Context (ELC) program purely replies on HSGPA in UC-approved coursework completed in the 10th and 11th grades; the statewide eligibility indices were created based on test scores and HSGPA; UC Regents increased the minimum HSGPA required for UC freshman eligibility from 2.80 to 3.00, effective for the fall 2007 entering class. Therefore, HSGPA still plays a significant role in eligibility in admissions at

[52] All campuses have used comprehensive review since 2002 and six campuses have adopted holistic review as their method of implementing comprehensive review: Berkeley (starting 2002), Los Angeles (2007), Irvine (2011), San Diego (2011), Davis (2012), Santa Cruz (2012).

UC. In addition, rapid growth of the qualified applicant pool pushed up the overall selectivity at all UC campuses. Analyses showed that recent UC admits have higher HSGPA than admits in prior years. All these together may have led to less variability in HSGPA of enrolled students. This change along with more variability in test scores caused by educational disparity among California K-12 schools, and constant variability in the freshman GPA at UC over the years may be some of many reasons that may have contributed to the change in the explanatory power of HSGPA and test scores in the freshman GPA at UC. (See the previous section "The Relationship between Demographic Characteristics and SAT/ACT Scores.")

Two sets of models with the sum of SAT Reading/Math and SAT Writing (Model 4) or the sum of ACT Composite and ACT Writing (Model 9) were developed to examine how much additional variance writing scores accounted for beyond SAT Reading/Math or ACT Composite. The reason to use the sum of scores on two tests is because SAT Reading/Math (ACT Composite) and SAT Writing (ACT Writing) are highly correlated (e.g., r=.85 for the freshman entering cohort in 2015). Therefore, there would be a collinearity issue if two measures were entered in the same regression model. Results indicate that in 2001, adding SAT Writing to SATRM increased the variance explained from 13 percent to 17 percent, or by four percentage points, but since 2005, it has only increased the explained variance by about two percentage points (difference in the explained variance between Model 2 and Model 4). Similarly, adding ACT Writing scores to ACT Composite scores does not increase the explanatory power at all (e.g., the difference in variance between Models 7 and 9). It is concluded that in the most recent year, adding writing scores to reading/math or composite scores does increase the explanatory power in explaining variation of freshman GPA, but the increase is not substantial.

In addition, four models were developed to examine how much additional variance in the freshman GPA standardized test scores account for beyond HSGPA. As showed by Models 5, 6, 10, and 11, adding SAT Reading/Math or ACT Composite to the model in recent years (e.g., in 2015) doubled the variance accounted for by HSGPA alone. However, adding SAT Total or ACT Total to the HSGPA models hardly changed the variance accounted for by the HSGPA and SATRM or ACT Composite models (difference in variance between SAT Models 5 and 6, and ACT Models 10 and 11). Similar to what has been found previously, it is concluded that writing scores do not add any additional value in predicting student's freshman GPA beyond HSGPA and SAT Reading and Math tests or the ACT composite test. Also, the standardized coefficients in these multivariate regression models indicate that test scores are stronger predictors for freshman GPA than HSGPA, especially for the 2012 and 2015 entering cohorts.

The analysis in previous sections of this report indicates that student characteristics (parental education, family income and race/ethnicity) account for 26 percent variation in applicants' SAT scores in the late 1990s and more than 40 percent in recent years. The explanatory power of these three factors in HSGPA has also increased from five percent in 2000 to 11 percent in recent years. Thus, it is helpful to examine the relationship between HSGPA and/or SAT Total and freshman GPA after controlling for student demographics. We ran regression models adding in student demographics such as campus affiliation, major discipline, first-generation status, family income, and high school API quintile (Model 12 in Table 3). Results show that controlling for demographics increased explained variation of freshman GPA by six percentage points (difference between Model 6 and Model 12). Results further show that after controlling for

demographics, the explanatory power of HSGPA increased from 0.22 to 0.34 in terms of standardized coefficients in the 2015 model. The standardized coefficients of the SAT total decreased from 0.38 to 0.34 in the 2015 model, which indicates a decrease of the explanatory power of the SAT total in freshman GPA. This implies that SAT scores are more associated with the demographics than HSGPA, consistent with earlier findings.

The influence of varying student characteristics on the relationship between HSGPA and SAT/ACT scores on first-year GPA is further examined based on 2015 entering students. Detailed model coefficients are presented in Appendix C. Results are generally consistent with those from the overall models (Table 3), indicating that standardized test scores were generally the stronger predictor of first-year GPA than high school GPA by campus, discipline, race/ethnicity, first generation, family income, and CA API ranking. For some groups, HSGPA predicted first year GPA better. For example, HSGPA appeared to be a stronger predictor than test scores for African American students, White students, students with family income over 161k, and etc.

We also examined the explanatory power of the SAT Essay score and subscores on each of three components (Reading, Analysis, and Writing), using the most recent 2017 freshman entering cohort data. Results (Table 4) show that the Essay score only accounts for nine percent of variation in freshman GPA, which is much less explanatory power than SATRM (21 percent) and the SAT Writing score (20 percent) in earlier years. Each of the three components accounts for six to eight percent of variation in freshman GPA with the Essay Analysis being the strongest predictor. Adding the Essay Total to HSGPA only increased the explanatory power by one percentage point. With limited explanatory power added by the Essay scores, it is worth considering the social costs of additional writing tests. It is not ideal that students spend lots of time preparing for various tests while they could be focusing their energy on more important academic and social activities that could benefit them in the future.

Table 4: Percent of Variance in Freshman GPA Accounted for by HSGPA and the SAT

Model	2017
(1) HSGPA	16%
(2) SATRM	21%
(3) Essay Total	9%
(4) Essay Reading	6%
(5) Essay Analysis	8%
(6) Essay Writing	7%
(7) HSGPA + Essay Total	19%

Standardized Tests and Academic Preparation: First-Year Course-Level Performance

The previous analyses of the relationship between application components and freshman GPA are limited by the substantial variation in average grades across campuses, departments, and even individual professors. For example, students enrolled in first-year courses in Engineering departments tend to have higher-than-average SAT scores but earn lower-than-average grades,

not as a result of poor performance but rather due to the higher standards and lower grade curve enforced by Engineering departments nationwide. As a result, Engineering departments decrease the positive correlation between SAT scores and freshman grades, though the decrease is uninformative about actual student performance.

In order to "control for" students' freshman course selections, we disaggregate our analysis from the level of freshman GPAs to the individual-course level. The resulting data contains the numerical grades (from 0 to 4) received by each student in each course. Courses are weighted by their number of units, and each student is given equal (total) weight. Unlike the analysis above, these "within-course" estimates condition on the specific courses taken by each student (that is, each linear regression is estimated using course-semester fixed effects). The resulting estimates can be interpreted as the amount of variation *within each course a student completes in their first year*—that is, only comparing the student's performance to that of the other students in their same class—that can be explained by each application component. As a result of data availability, we estimate course-level results from 2001 to 2016 for students at only three UC campuses: Berkeley, Davis, and Riverside. These regressions do not control for any fixed student characteristics, though controlling for characteristics like race and gender hardly changes the findings.

Table 5: Percent of Within-Course Freshman GPA Explained by HS GPA and SAT (3 Campuses)

Model	2001	2005	2009	2013	2016	Full Sample
(1) HSGPA	7.9%	7.0%	7.6%	5.4%	5.1%	6.8%
(2) SATRM	8.6%	8.3%	9.8%	10.6%	11.9%	9.2%
(3) SATW (Writing)	7.0%	6.6%	7.5%	8.1%	8.8%	7.3%
(4) SAT TOTAL (SATRM + SATW)	9.0%	8.7%	10.3%	11.1%	12.2%	9.7%
(5) HSGPA + SATRM	14.3%	14.1%	15.3%	14.5%	15.8%	14.5%
Standardized Coefficients: HSGPA	*0.23*	*0.24*	*0.25*	*0.24*	*0.24*	*0.19*
SATRM	*0.24*	*0.25*	*0.26*	*0.29*	*0.30*	*0.17*
(6) HSGPA + SAT TOTAL	14.4%	14.2%	15.5%	15.0%	16.2%	14.7%
Standardized Coefficients: HSGPA	*0.22*	*0.23*	*0.24*	*0.23*	*0.24*	*0.18*
SAT TOTAL	*0.25*	*0.25*	*0.27*	*0.3*	*0.31*	*0.20*

Note: Reported R^2 from the projected performance outcome net course-specific fixed effects, which also capture campus effects. Courses are weighted by units earned and then normalized to give each student equal weight.

Table 5 shows the percent of within-course freshman grade variation that can be explained by high school GPA (HSGPA) and SAT scores. In 2001, HSGPA and SAT each explained about 8-9 percent of within-course performance variation, but reflecting a similar trend in the aggregate GPA results, the two slowly diverge over the following years; by 2016, HSGPA only explains about 5 percent of variation (likely reflecting the decline in cross-student HSGPA variation as UC becomes more selective), while SAT explains 12 percent of variation. Moreover, HSGPA and SAT strongly complement each other; the inclusion of both nearly sums to two R^2 values, implying that they explain independent components of students' first-year course performance (see Model 6 compared to sum of Model 1 and Model 4). The SAT Writing exam has lower explanatory power that has only slightly increased in the past 15 years. Estimates of standardized

coefficients show that both HSGPA and SAT explain separate components of first-year course performance, with a one-standard-deviation increase in SAT scores correlating to a 0.3 point increase (almost a full grade step, e.g., A- to A) in each course taken by first-year students.

We conclude from this analysis that both HSGPA and SAT scores are independently-important explanatory factors for first-year students' course performance relative to their peers in similar courses, with the latter growing in relative importance as SAT predictive validity improves and HSGPA variation declines.

Disaggregating freshman GPAs to the course level also enables more precise analysis of the explanatory power for student performance in different academic disciplines, which might provide further insight into the specific values of each measure of students' academic preparedness. We identify first-year courses taught in four areas—Humanities, Social Sciences, Natural Sciences, and Engineering—and estimate the proportion of variation in course performance across areas that can be explained by SAT and HSGPA.

Table 6: Percent of Within-Course 2016 GPA Explained by HSGPA and SAT by General Area

Model	Humanities	Social Sciences	Natural Sciences	Engineering
(1) HSGPA	4.8%	6.5%	4.7%	2.3%
(2) SATR (Reading)	7.4%	12.6%	6.9%	3.5%
(3) SATM (Math)	5.0%	10.2%	13.5%	7.4%
(4) SATW (Writing)	7.5%	11.6%	7.9%	5.3%
(5) HSGPA + SATR + SATM	12.2%	19.1%	18.9%	11.4%
Standardized Coefficients: HSGPA	*0.19*	*0.24*	*0.30*	*0.26*
SATR	*0.17*	*0.21*	*0.10*	*0.07*
SATM	*0.05*	*0.12*	*0.35*	*0.27*
(6) HSGPA + SATR + SATM + SATW	13.1%	19.7%	19.1%	12.0%
Standardized Coefficients: HSGPA	*0.19*	*0.24*	*0.30*	*0.26*
SATR	*0.11*	*0.16*	*0.06*	*0.02*
SATM	*0.03*	*0.10*	*0.33*	*0.24*
SATII	*0.10*	*0.10*	*0.07*	*0.10*

Note: Reported R^2 from the projected performance outcome net course-specific fixed effects, which also capture campus effects. Courses are weighted by units earned and then normalized to give each student equal weight.

Table 6 shows expected explanatory patterns. Disaggregating the SAT into its Reading and Mathematics components, we find that the Reading component explains more variation in Humanities and Social Science course performance (7-13%) while the Mathematics component explains more variation in Natural Science and Engineering course performance (7-14%). SAT scores explain substantially more variation than HSGPA alone; in Engineering, for example, high school GPA explains 2.3 percent of performance, but its combination with the SAT components explains more than 12 percent of performance. The SAT Writing out-performs HSGPA in all four areas, explaining between 5 and 12 percent of variation, but its addition to HSGPA and the two primary SAT components only explains substantial variation (almost 1%) in the Humanities.

The scaled coefficients reported in Table 6 show that a one standard deviation increase in HSGPA is associated with increases in students' performance in each of their first-year courses by 0.19 grade points in the Humanities and 0.30 grade points in the Natural Sciences. A one standard deviation increase across students' SAT scores yields even stronger correlations when holding HSGPA fixed, by 0.22 points in the Humanities and 0.45 points in the Natural Sciences, with non-negligible contributions by each SAT component in the areas of their respective strengths. We conclude that both HSGPA and SAT are independently-important explanatory factors for first-year students' course performance across academic disciplines, with SAT particularly important in cases like Engineering courses where HSGPA alone has lower explanatory power.

Finally, we identify two course types of particular interest: freshman writing courses, which are required for most enrollees (unless they satisfy their Entry Level Writing Requirement via examination), and Organic Chemistry, the key gatekeeper course for the popular pre-medical track at each campus. Data for these courses is available at all campuses for 2016, though noise in the nine-campus course data results in lower R^2 values across the board.

Table 7: Percent of Within-Course 2016 GPA Explained by HSGPA and SAT

Model	Freshman Writing	Organic Chemistry
(1) HSGPA	1.7%	3.7%
(2) SATR (Reading)	2.0%	3.0%
(3) SATM (Math)	0.9%	5.8%
(4) SATW (Writing)	2.1%	3.4%
(5) HSGPA + SAT TOTAL	3.8%	8.3%
Standardized Coefficients: HSGPA	0.14	0.22
SAT TOTAL	0.16	0.27

Note: Reported R^2 from the projected performance outcome net course-specific fixed effects, which also capture campus effects. Courses are weighted by units earned and then normalized to give each student equal weight.

Table 7 shows that, unsurprisingly, the SAT Reading and Writing components each explain substantial variation in freshman writing course performance, while the SAT Math component explains the largest share of variation in Organic Chemistry performance. High school GPA also explains a significant share of performance variation in each course type, and when both admissions components are included simultaneously, once again high school GPA and the SAT scores explain similar amounts of variation in course performance. As in the full course analysis, these results suggest that each of the four admissions components—HSGPA, SAT Math, SAT Reading, and SAT Writing—provide valuable and differentiated information about expected UC student performance in their chosen first-year coursework.

Standardized Tests and Academic Preparation: Longer-Run Outcomes

Table 8 presents the percent of variance in graduation GPA accounted for by HSGPA and test scores. Results show that HSGPA and test scores are weak predictors of graduation GPA. They have almost equal explanatory power, each accounting for less than 20 percent of variance in graduation GPA. Adding SAT or ACT writing scores to SAT Math/Reading scores does not increase predictive value of Graduation GPA beyond SAT Reading/Math or ACT Composite scores. For example, for 2010 entering cohort, SAT Reading/Math accounts for 16 percent of variance in graduation GPA, while the sum of SAT Reading/Math and Writing scores (SAT Total) accounts for 18 percent, up by only two percentage points.

When HSGPA and SAT Reading/Math or ACT Composite scores were entered into the same models, the percent of variance accounted for by the two predictors together increased about five percentage points or one third of explanatory power by the HSGPA model alone. However, replacing SAT Reading/Math or ACT Composite scores with the sum of SAT Reading/Math and SAT Writing scores (SAT Total) or the sum of ACT Composite and ACT Writing scores (ACT Total) in these models does not change explanatory power. For example, for the 2010 entering cohort, the HSGPA and SATRM model accounts for 23 percent of variance in graduation GPA, while the HSGPA and SAT Total model accounts for 24 percent of variance. The two models are basically the same. This means that again writing scores do not contribute to predictive value of graduation GPA beyond HSGPA and SAT Math/Reading or ACT Composite. This is largely due to a high correlation between SAT Reading/Math and SAT Writing scores or ACT Composite and ACT Writing scores.

After controlling for campus and student characteristics including campus affiliation, major discipline, first-generation status, family income, and high school API quintile, HSGPA has more explanatory power of UC graduation GPA than the SAT Total in terms of standardized coefficients (Model 12 in Table 8). This means that SAT scores are more associated with the demographics than HSGPA, consistent with previous findings.

The influence of varying student characteristics on the relationship between HSGPA and SAT/ACT scores on graduation GPA is also examined based on 2010 entering students. Detailed model coefficients are also presented in Appendix D. Similar results were found that standardized test scores were the stronger predictor of graduation GPA than high school GPA by campus, discipline, race/ethnicity, first generation, family income, and CA API ranking. However, the difference in the explanatory power between HSGPA and SAT/ACT scores became smaller for graduation GPA than for first year GPA. For some groups, HSGPA predicted graduation GPA better. For example, HSGPA appeared to be a stronger predictor of graduation GPA than test scores for students at Davis, students majored in Arts, White students, not first generation students, students with family income over 107k, and etc.

Table 8. Percent of Variance in UC Graduation GPA Accounted for by HSGPA and the SAT/ACT

Model	2001	2005	2007	2010
(1) HSGPA	16%	17%	18%	16%
(2) SATRM	15%	15%	17%	16%
(3) SAT Writing	18%	19%	19%	18%
(4) SAT Total (SATRM + Writing)	18%	18%	19%	18%
(5) HSGPA + SATRM	22%	24%	25%	23%
Standardized Coefficients: HSGPA	*0.29*	*0.32*	*0.31*	*0.27*
SATRM	*0.27*	*0.28*	*0.28*	*0.29*
(6) HSGPA + SATTOTAL (SATRM + Writing)	27%	26%	26%	24%
Standardized Coefficients: HSGPA	*0.27*	*0.29*	*0.29*	*0.26*
SATTOTAL	*0.31*	*0.32*	*0.31*	*0.32*
(7) ACT Composite	18%	19%	18%	17%
(8) ACT Writing	*n/a*	*n/a*	20%	17%
(9) ACT Total (Composite + Writing)	*n/a*	*n/a*	19%	23%
(10) HSGPA + ACT Composite	23%	26%	25%	22%
Standardized Coefficients: HSGPA	*0.24*	*0.27*	*0.28*	*0.25*
ACT CMP	*0.33*	*0.34*	*0.31*	*0.31*
(11) HSGPA + ACT Total (ACT CMP and ACT Writing)	n/a	n/a	26%	23%
Standardized Coefficients: HSGPA	*n/a*	*n/a*	*0.26*	*0.24*
ACT Total	*n/a*	*n/a*	*0.34*	*0.33*
(12) HSGPA + SAT Total + Demographics	32%	33%	34%	31%
Standardized Coefficients: HSGPA	*0.38*	*0.40*	*0.40*	*0.37*
Standardized Coefficients: SATTOTAL	*0.31*	*0.29*	*0.29*	*0.32*

As shown in Table 9, both HSGPA and test scores are very weak predictors of first year retention and four year graduation. The models with HSGPA and test scores only account for about 2.5 percent of variance in first year retention and eight percent of variance in four year graduation. In addition, the standardized coefficients show that there is no significant difference in explanatory power of predicting first year retention and four year graduation between HSGPA and test scores. The percent of variance accounted for by these predictors has remained about the same since 2001, so the results from the logistic regression models based on 2015 entering cohort for first year retention and 2010 for four year graduation are presented here in the table.

Again after controlling for student demographics, HSGPA is still a stronger predictor for first year retention and four-year graduation, with more explanatory power than SAT scores in terms of standardized coefficients (Model 5 in Table 9). This finding further indicates that SAT scores are more associated with the demographics than HSGPA, consistent with previous findings.

Table 9. Statistics of Logistic Regression Models Predicting First Year Retention and Four Year Graduation by HSGPA and SAT/ACT Scores

Model	First Year Retention (2015 Entering Cohort)	Four Year Graduation (2010 Entering Cohort)
(1) HSGPA + SATRM (R-squared)	2.3%	7.5%
Standardized Coefficients: HSGPA	*0.22*	*0.23*
SATRM	*0.22*	*0.17*
(2) HSGPA + SATTOTAL (SATRM + Writing, R-squared)	2.4%	7.9%
Standardized Coefficients: HSGPA	*0.20*	*0.21*
SATTOTAL	*0.22*	*0.19*
(3) HSGPA + ACT Composite (R-squared)	2.5%	7.7%
Standardized Coefficients: HSGPA	*0.20*	*0.19*
ACT CMP	*0.23*	*0.20*
(4) HSGPA + ACT Total (ACT CMP and ACT Writing, R-squared)	2.4%	8.1%
Standardized Coefficients: HSGPA	0.20	0.18
ACT Total	0.22	0.22
(5) HSGPA + SAT Total + Demographics	3.0%	12.0%
Standardized Coefficients: HSGPA	*0.19*	*0.25*
Standardized Coefficients: SATTOTAL	*0.14*	*0.16*

Conclusion

This study reviewed literature about the validity of the SAT and ACT and examined the relationship between these tests and college preparation of UC California resident applicants and college performance of enrolled students at UC.

The following conclusions emerged from the literature review:

- High school GPA and test scores are moderately correlated. Previous research also indicates that socioeconomic status is associated with SAT and ACT scores.

- SAT/ACT test scores are positively associated with college success in terms of freshman GPA, graduation GPA, first-year retention, and graduation. In addition, research demonstrates the increment in the predictive validity afforded by the SAT/ACT over HSGPA. On the other hand, evidence also suggests that standardized test scores are less predictive across certain subgroups.

Analysis based on UC data shows that:

- The majority of UC applicants submit SAT scores, while more and more students submit ACT scores. The average test scores changed slightly over years. SAT/ACT scores are more associated with demographic factors than HSGPA. The explanatory power of parental education, the URG status, and parents' income has been growing with parental education continuing to be the strongest predictor of SAT/ACT scores. This possibly could be a problem as the UC seeks to find race neutral ways to achieve racial diversity at selective campuses.[53] SAT/ACT scores may have a disproportionate effect on admit rates for URG students.

- Similar to what previous research findings show, test scores are moderately correlated to high school GPA. Apparently, there is some overlap between what the tests measure and what HSGPA measures, but not that much. The College Board and ACT hold that SAT and ACT scores are designed to measure knowledge and skills in high school subject areas and readiness for first year college courses. High school GPA likely represents both knowledge and skills and also behavior (such as completing homework).

- The analysis of the relationship between the new SAT and new ACT and UC's Analytical Writing Placement Exam (AWPE) shows that high scores on the SAT EBRW and ACT ELA are associated with passing the AWPE. However, on the SAT Essay, even at the top score of 24, only 69 percent passed the AWPE. Based on the results of data analysis, UCOPE has accepted the new ACT ELA and SAT EBRW scores but not the new SAT Essay scores as methods of meeting UC's Entry Level Writing Requirement (ELWR).

- Regarding college success, findings from UC's data analysis are generally consistent with those from previous research. SAT scores and HSGPA are both moderate predictors of student first-year GPA and graduation GPA. They are weak predictors of student retention and graduation. HSGPA predicted first-year GPA slightly better than SAT scores from 2001 to 2005 before controlling for student characteristics. Over the years, the explanatory power of HSGPA has been decreasing. For graduation GPA, HSGPA and test scores have the same explanatory power. HSGPA and test scores are not strong predictors of first-year retention and four-year graduation. However, after controlling for student characteristics, HSGPA and test scores have the same explanatory power of freshman GPA, but HSGPA is a stronger predictor of the first year retention, graduation GPA and four-year graduation.

- Models that combine HSGPA along with standardized test scores predict student success better than ones that only use one or the other. In contrast, the addition of the SAT/ACT writing tests did little to improve the prediction of student success above and beyond HSGPA and SAT Reading/Math and ACT composite scores.

[53] UC Office of the President. (2015). UC Files Amicus Brief in Affirmative Action Case. Retrieved from https://www.universityofcalifornia.edu/press-room/uc-files-amicus-brief-affirmative-action-case on October 16, 2018.

In summary, this report presents what literature and UC data show about the relationship between standardized test scores and high school GPA, and predictive value of HSGPA and test scores in student success as measured by freshman GPA, first year retention, graduation GPA and four-year graduation. IRAP will do a series of simulations to further examine what eligibility pool and admissions outcomes would look like if UC used different measures to determine eligibility and admit students.

Appendix A: Test Takers and Average Test Scores of UC California Applicants from 2001 to 2018

Table A1: Test Takers and Average Test Scores, UC California Applicants, 2001 to 2018

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
CA Freshman Applicants	59,747	62,903	66,774	63,852	65,851	71,011	74,509	80,029	81,113	82,341	85,187	93,460	99,447	100,077	103,259	105,547	111,869	120,026
% Submitted Scores																		
SAT I Verbal Math	98.4%	98.4%	98.4%	98.3%	98.3%	88.4%	0.8%											
SAT II Writing	96.9%	96.8%	96.1%	96.0%	94.8%	48.5%	0.2%											
SAT I & SATII Writing	96.0%	95.8%	95.0%	94.9%	93.8%	48.1%	0.1%											
SAT Verbal Math						98.3%	97.9%	97.5%	97.0%	94.6%	94.0%	93.2%	91.5%	89.3%	86.7%	84.6%	19.5%	0.8%
SAT Writing						98.5%	97.9%	97.5%	97.0%	94.6%	94.0%	93.2%	91.5%	89.3%	86.7%	84.6%	20.4%	0.8%
SAT Reading Math Writing						98.1%	97.9%	97.5%	97.0%	94.6%	94.0%	93.2%	91.5%	89.3%	86.7%	84.6%	73.2%	86.4%
SAT Math and EBRW (Evidence-Based Reading and Writing)																	73.2%	86.4%
SAT Essay																		
ACT Composite	27.6%	27.7%	32.7%	32.9%	33.2%	34.9%	35.1%	39.4%	44.0%	46.2%	47.3%	45.5%	46.4%	49.1%	52.2%	53.4%	52.5%	44.3%
ACT English with Writing						29.5%	32.8%	37.8%	43.1%	45.4%	46.9%	45.0%	45.9%	48.7%	51.7%	50.2%	0.2%	0.0%
ACT ELA (English Language Arts)																	45.5%	37.6%
ACT Writing subscore																	27.9%	37.4%
Average Scores																		
SAT I Verbal Math	1171	1163	1164	1172	1177	1162	1144											
SAT II Writing	575	578	573	581	579	649	559											
SAT I & SATII Writing	1751	1746	1744	1760	1766	1816	1727											
SAT Verbal Math						1161	1159	1153	1154	1157	1153	1137	1135	1136	1128	1117	1241	1327
SAT Writing						572	570	569	571	573	572	566	560	562	556	550	610	643
SAT Reading Math Writing						1734	1729	1722	1725	1729	1725	1703	1695	1698	1684	1667	1845	1952
SAT Math and EBRW (Evidence-Based Reading and Writing)																	1167	1203
SAT Essay																	16	16
ACT Composite	24	24	24	24	24	24	24	25	25	25	25	25	25	25	25	25	26	25
ACT English with Writing						24	24	24	24	24	24	23	23	24	24	24	29	27
ACT ELA (English Language Arts)																	25	25
ACT Writing subscore																	8	8

Appendix B: Average Test Scores of UC California Applicants by Demographic Characteristics, Selected Years

Table B1: SAT Reading/Math and Writing by Parents' Highest Level of Education

Year	No High School		Some High School		High School Graduate		Some College		2 Year College		4 Year College		Post Graduate Study		Unknown	
	SAT RM	SAT W	SAT RM	SAT W	SAT RM	SAT W	SAT RM	SAT W	SAT RM	SAT W	SAT RM	SAT W	SAT RM	SAT W	SAT RM	SAT W
2001	978	479	1008	492	1079	526	1105	542	1125	550	1182	577	1249	617	1221	602
2005	981	483	1008	491	1082	528	1107	543	1135	555	1191	582	1264	625	1229	604
2007	967	472	998	485	1069	522	1087	533	1107	542	1177	578	1253	620	1210	594
2012	949	471	977	485	1049	519	1068	528	1104	544	1183	588	1271	637	1118	549
2015	952	468	973	479	1040	510	1061	522	1091	536	1181	583	1279	635	1114	544
2018	1052	15	1069	15	1126	15	1145	15	1179	16	1260	17	1342	17	1192	16

Table B2: SAT Reading/Math and Writing by Parents' Income (2001 dollars)

Year	$0-$56k		$56k up to $112k		$112k up to $169k		$169k+		Unknown	
	SATRM	SATW	SATRM	SATW	SATRM	SATW	SATRM	SATW	SATRM	SATW
2001	1140	559	1180	578	1222	601	1251	617	n/a	n/a
2005	1084	531	1184	581	1236	608	1255	619	1248	616
2007	1068	521	1167	573	1213	599	1243	617	1244	616
2012	1049	520	1185	588	1243	620	1280	644	1208	607
2015	1042	512	1184	583	1249	619	1297	647	1205	601
2018	1127	15	1251	17	1311	17	1358	18	1256	16

Table B3: SAT Reading/Math and Writing by Race/Ethnicity

Year	African American		American Indian		Hispanic/Latinx		Asian/Pacific Islander		White	
	SATRM	SATW	SATRM	SATW	SATRM	SATW	SATRM	SATW	SATRM	SATW
2001	1035	520	1169	570	1047	521	1182	566	1215	603
2005	1042	526	1184	587	1049	524	1198	575	1230	610
2007	1027	516	1160	576	1032	514	1187	570	1213	603
2012	1015	509	1164	581	1013	507	1206	594	1215	607
2015	1025	512	1149	569	1008	499	1214	595	1217	602
2018	1120	15	1225	16	1099	15	1298	17	1288	17

Note: SAT Writing refers to SATII Writing for 2001 and 2005 and SAT Writing for 2007, 2012 and 2015, and SAT Essay for 2018. International students are included in each racial/ethnic category based on their self-reported race/ethnicity.

Table B4: ACT Composite and Writing by Parents' Highest Level of Education

Year	No High School		Some High School		High School Graduate		Some College		2 Year College		4 Year College		Post Graduate Study		Unknown	
	ACT CMP	ACT W	ACT CMP	ACT W	ACT CMP	ACT W	ACT CMP	ACT W	ACT CMP	ACT W	ACT CMP	ACT W	ACT CMP	ACT W	ACT CMP	ACT W
2001	19	n/a	20	n/a	22	n/a	23	n/a	23	n/a	25	n/a	26	n/a	25	n/a
2005	20	n/a	20	n/a	22	n/a	23	n/a	24	n/a	25	n/a	26	n/a	26	n/a
2007	20	19	20	20	22	22	23	23	23	23	25	25	27	26	26	25
2012	20	19	21	19	22	21	23	22	24	23	26	25	28	26	25	23
2015	20	19	21	19	23	21	23	22	24	23	27	25	29	27	25	23
2018	20	19	21	20	23	21	24	22	25	23	28	26	30	28	26	24

Table B5: ACT Composite and Writing by Parents' Income (2001 dollars)

Year	$0-$56k		$56k up to $112k		$112k up to $169k		$169k+		Unknown	
	ACT CMP	ACT W	ACT CMP	ACT W	ACT CMP	ACT W	ACT CMP	ACT W	ACT CMP	ACT W
2001	23	n/a	24	n/a	25	n/a	26	n/a	n/a	n/a
2005	22	n/a	25	n/a	26	n/a	26	n/a	26	n/a
2007	22	21	25	24	26	25	27	26	27	26
2012	22	21	26	25	28	26	29	27	27	25
2015	22	21	27	25	28	27	29	28	27	26
2018	23	22	27	26	29	27	30	29	29	27

Table B6: ACT Composite and Writing by Race/Ethnicity

Year	African American		American Indian		Hispanic/Latinx		Asian/Pacific Islander		White	
	ACT CMP	ACT W	ACT CMP	ACT W	ACT CMP	ACT W	ACT CMP	ACT W	ACT CMP	ACT W
2001	21	n/a	25	n/a	21	n/a	24	n/a	26	n/a
2005	21	n/a	25	n/a	21	n/a	24	n/a	26	n/a
2007	21	21	25	25	21	21	25	24	26	26
2012	22	21	26	25	22	20	26	24	27	26
2015	22	22	26	25	22	21	27	25	28	27
2018	23	22	27	26	22	21	29	27	29	27

Notes: ACT Writing refers to ACT English with Writing for 2007, 2012, and 2015 and ACT English Language Arts for 2018. International students are included in each racial/ethnic category based on their self-reported race/ethnicity.

Appendix C: Standardized Regression Coefficients for HSGPA and SAT/ACT Scores in UC Freshman GPA Models, 2015 Freshman Entering Cohort

	SAT Models			ACT Models		
	HSGPA	SAT_RM	% Variance Explained	HSGPA	ACTCMP	% Variance Explained
UC System	0.23	0.36	25%	0.22	0.38	26%
By Campus						
Berkeley	0.20	0.36	22%	0.22	0.32	19%
Davis	0.18	0.44	27%	0.17	0.44	27%
Irvine	0.31	0.36	28%	0.32	0.38	30%
Los Angeles	0.16	0.39	23%	0.17	0.41	25%
Merced	0.29	0.29	18%	0.29	0.28	18%
Riverside	0.24	0.25	11%	0.22	0.28	12%
San Diego	0.24	0.38	21%	0.22	0.39	21%
Santa Barbara	0.29	0.32	21%	0.28	0.36	24%
Santa Cruz	0.22	0.31	16%	0.22	0.34	18%
By Enrolled Majors						
Arts	0.21	0.28	15%	0.15	0.40	22%
Engineering/Computer Sciences	0.16	0.42	26%	0.17	0.40	25%
Humanities	0.30	0.35	31%	0.32	0.35	33%
Life Sciences	0.25	0.42	31%	0.23	0.44	31%
Physical Sciences/Math	0.28	0.36	27%	0.26	0.37	28%
Professional Fields	0.24	0.38	26%	0.22	0.39	25%
Social Sciences/Psychology	0.29	0.34	26%	0.26	0.39	29%
Undeclared/All Others/Unknown	0.25	0.31	20%	0.25	0.33	21%
By Race/Ethnicity						
African American	0.27	0.25	18%	0.28	0.26	20%
Asian	0.22	0.35	22%	0.19	0.38	22%
Latino(a)	0.23	0.24	14%	0.23	0.25	15%
White	0.28	0.23	18%	0.28	0.22	28%
By First Generation Status						
Not First Generation	0.26	0.29	21%	0.24	0.29	20%
First Generation	0.22	0.29	22%	0.22	0.30	17%
By Family Income						
$0-$53,999	0.22	0.30	18%	0.22	0.32	19%
$54,000-$106,999	0.22	0.31	19%	0.21	0.32	20%
$107,000- $160,999	0.26	0.28	20%	0.24	0.28	19%
$161,000 or higher	0.27	0.26	20%	0.27	0.25	19%
Missing	0.24	0.27	19%	0.07	0.01	16%
By High School API Quintile (2013)						
1 through 3	0.22	0.20	12%	0.25	0.20	13%
4 through 7	0.25	0.26	19%	0.25	0.27	19%
8 and higher	0.30	0.26	22%	0.26	0.28	21%
Private	0.27	0.26	21%	0.30	0.23	20%
Public Missing	0.21	0.34	22%	0.23	0.36	24%
Missing Other	0.17	0.25	11%	0.18	0.15	8%

Appendix D: Standardized Regression Coefficients for HSGPA and SAT/ACT Scores in UC Graduation GPA Models, 2010 Freshman Entering Cohort

	SAT Models			ACT Models		
	HSGPA	SAT_RM	% Variance Explained	HSGPA	ACTCMP	% Variance Explained
UC System	0.27	0.29	23%	0.25	0.31	22%
By Campus						
Berkeley	0.20	0.30	18%	0.20	0.33	20%
Davis	0.34	0.30	23%	0.33	0.32	24%
Irvine	0.24	0.27	14%	0.22	0.26	12%
Los Angeles	0.20	0.32	18%	0.17	0.31	16%
Merced	0.26	0.33	17%	0.34	0.32	23%
Riverside	0.25	0.25	13%	0.21	0.27	13%
San Diego	0.29	0.32	20%	0.25	0.34	20%
Santa Barbara	0.27	0.28	17%	0.24	0.32	18%
Santa Cruz	0.31	0.30	21%	0.29	0.34	23%
By Enrolled Majors						
Arts	0.35	0.19	20%	0.29	0.22	17%
Engineering/Computer Sciences	0.30	0.28	24%	0.27	0.31	24%
Humanities	0.29	0.30	26%	0.28	0.34	28%
Life Sciences	0.30	0.35	30%	0.27	0.36	27%
Physical Sciences/Math	0.30	0.33	26%	0.28	0.36	27%
Professional Fields	0.29	0.27	23%	0.30	0.31	27%
Social Sciences/Psychology	0.30	0.29	25%	0.26	0.32	24%
Undeclared/All Others/Unknown	0.24	0.32	22%	0.24	0.31	21%
By Race/Ethnicity						
African American	0.22	0.25	16%	0.26	0.22	16%
Asian	0.29	0.26	21%	0.26	0.26	18%
Latino(a)	0.24	0.27	18%	0.24	0.28	18%
White	0.30	0.19	17%	0.27	0.20	15%
By First Generation Status						
Not First Generation	0.31	0.20	19%	0.29	0.21	18%
First Generation	0.24	0.27	18%	0.23	0.28	17%
By Family Income						
$0-$53,999	0.25	0.28	19%	0.23	0.29	18%
$54,000-$106,999	0.27	0.25	18%	0.25	0.25	18%
$107,000- $160,999	0.30	0.19	17%	0.29	0.21	18%
$161,000 or higher	0.36	0.16	20%	0.31	0.17	17%
Missing	0.32	0.21	21%	0.31	0.20	19%
By High School API Quintile (2013)						
1 through 3	0.24	0.23	15%	0.24	0.21	14%
4 through 7	0.26	0.26	19%	0.23	0.28	19%
8 and higher	0.34	0.18	20%	0.32	0.19	20%
Private	0.31	0.25	24%	0.29	0.29	24%
Public Missing	0.21	0.39	26%	0.12	0.40	22%
Missing Other	0.31	0.20	19%	0.34	0.26	25%

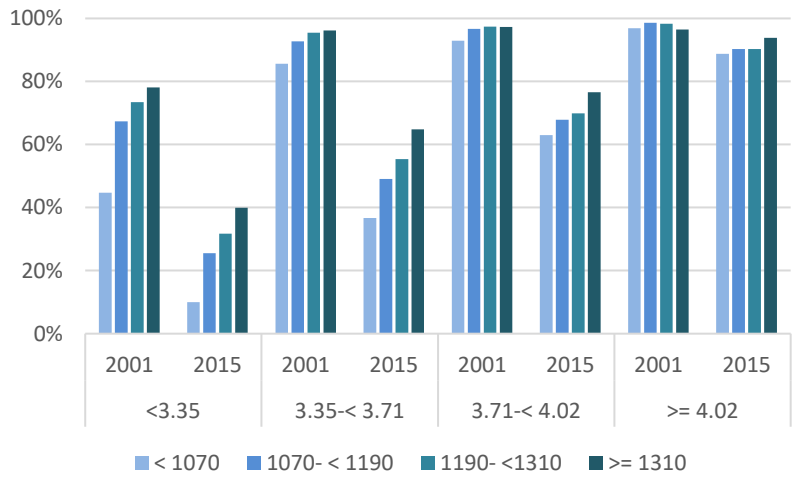
Appendix E: Explanation for Change of Variance in Freshman GPA Accounted for by High School GPA and Test Scores

Over the past 10 years, the amount of freshman GPA variation explained by high school GPA (HSGPA) has fallen significantly. Table 3 shows that, in terms of aggregate freshman GPA, HSGPA's explanatory power fell from 17% in 2001 and 20% in 2007 to 13% in 2015. There are a large number of possible explanations for this decline. This section provides the results of some preliminary analysis conducted to examine the change.

Change of the Admit Pool

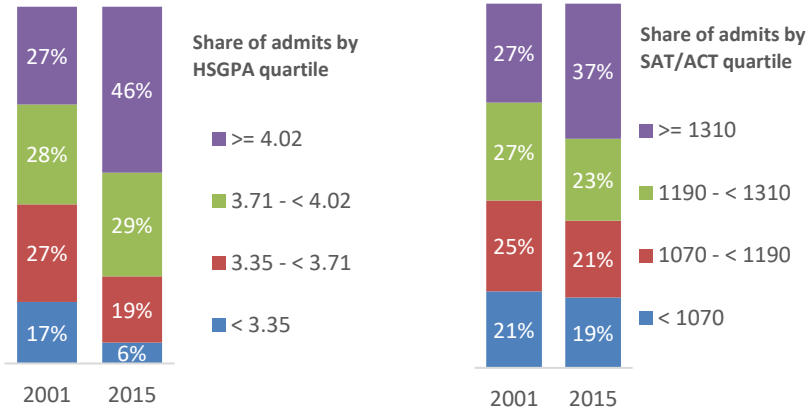
The change of variation in HSGPA and test scores may be related to the admit pool. While always skewed toward the top quartiles of SAT/ACT and HSGPA, the distribution of admits has changed over time (Figures E1 and E2). In particular, admits became more concentrated in the top quintiles of HSGPA between 2001 and 2015. This change has definitely resulted in less variation in HSGPA and may be related to the diminishing power of HSGPA to predict UC freshman GPA during this time period. Almost all applicants with high HSGPA are admitted, but the admit rates of those with high SAT/ACT depend on HSGPA. This also suggests that HSGPA is given more weight in the admission process than SAT/ACT.

Figure C1. Admit Rate by HSGPA and SAT/ACT Quartiles



Note: Thresholds for HSGPA and SAT/ACT quartiles were constructed from 2001 data and used for all years for consistency.

Figure C2. Share of Admits by HSGPA and SAT/ACT Quartiles



Note: Thresholds for HSGPA and SAT/ACT quartiles were constructed from 2001 data and used for all years for consistency.

High School Grade Inflation, Enrollment in Low-Grade and Larger Freshman Courses

There are a large number of possible explanations for the decline in the explanatory power of HSGPA over time, many of which can be adjudicated between using course-level grade performance.

Table C1 shows that at the freshman course level, HSGPA explanatory power has fallen by 18.8 percent since 2012, from 4.3 percent to 3.5 percent (note that the SAT and HSGPA explain less

Table C1: Changes in Explanatory Power of HSGPA for Freshman Grades

	2012-2013		2016-2017		Δ	
	FE R^2	GPA R^2	FE R^2	GPA R^2	FE R^2	GPA R^2
Overall		**4.3%**		**3.5%**		**-18.8%**
High School	5.6%	**5.3%**	5.8%	**4.0%**	3.5%	**-25.0%**
SAT	5.2%	**2.6%**	4.5%	**2.2%**	-12.8%	**-15.3%**
Course Department	9.4%	**5.8%**	11.5%	**5.1%**	23.2%	**-12.6%**
Course Size	4.5%	**4.9%**	4.4%	**4.0%**	-2.1%	**-18.1%**

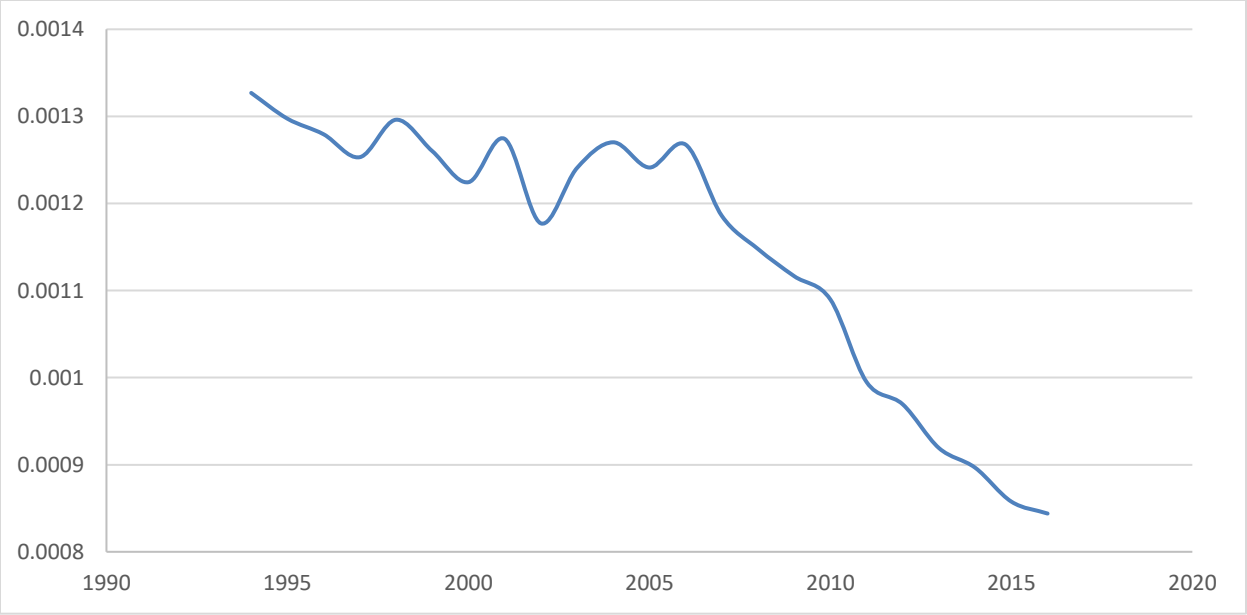
Note: "FE R2" measures the percent of variation explained by each additional group of fixed effects (FE), like FE's for every high school or every SAT score. "GPA R2" measures the percent of remaining variation explained by HS GPA. "Δ" shows the percent change from 2012 to 2016. Valid explanations for the decline in HS GPA explanatory power for freshman grades should decrease the GPA R2, since some of the decline would be explained away by the FEs.

course-specific variation than they do freshman aggregate GPA variation, since the latter are averaged over many courses and thus present a smoother and more-easily-modeled distribution of student performance). This baseline decline is conditional on gender, ethnicity, and campus. Each row of Table C1 adds an additional set of controls, removing one dimension of grade variation and testing how that information's removal impacts the degree to which HSGPA's explanatory power has declined since 2012. Controls that lead to a decline in the change in HSGPA's R^2 are interpreted as playing a role in HSGPA's explanatory decline.

The second row of Table C1 tests the hypothesis that HSGPA's explanatory power is declining because UC is enrolling students from a wider range of high schools with varying GPA standards, muddying the informational content of HSGPA. Indeed, Figure C3 shows that the concentration of high schools from which UC has enrolled students (as measured by a Normalized Herfindahl Index) has indeed been declining since about 2007 after a period of relative stability, implying that UC has been taking students from increasingly-dispersed high schools, likely as a result of its Eligibility in the Local Context program and the expansion of its Merced campus. However, when the relationship between HSGPA and freshman GPA is measured conditional on high school fixed effects—that is, only comparing students who attended the same high school—the decline in the explanatory power of HSGPA grows to 25.0 percent. We conclude that the wider distribution of UC students' high schools plays no role in the decline in HSGPA's explanatory power, since the within-high-school decline is even larger than the across-high-school decline.

The third row tests the hypothesis that HSGPA has less variance among students with the same SAT score, which would likely arise if the distribution of HSGPAs was increasingly compressed as a result of high schools' grade inflation. Controlling for fixed effects for every SAT score, the

Figure C3: High School Concentration of First-Year UC Students



Note: Annual Normalized Herfindahl Index of high schools attended by freshman California-resident UC students, measuring the degree to which students come from a concentrated set of schools.

decline in HSGPA explanatory power falls slightly to 15.3 percent. We conclude that a small part of HSGPA's decline in explanatory power results from its diminished relationship with SAT score, likely resulting from high schools' grade inflation.

The fourth row of Table C1 tests whether the decline in HSGPA explanatory power is the result of which departments freshmen choose to enroll in. If high-HSGPA students are increasingly enrolling in low-grade courses like Engineering and Economics, then HSGPA's explanatory power would decline (since it would appear that high-HSGPA students were performing poorly, when in fact they're merely taking courses that award lower grades). Indeed, this appears to be the largest identified factor in the decline in HSGPA's explanatory power, explaining about 1/3 of the decline. Moreover, a full 10 percent of freshman grade variation can be explained by the department in which each course was taken, and the explanatory power of departments has increased by 25 percent since 2012. Cross-department variation is a key explanation for changes in freshman GPA evaluation in the past five years.

Finally, if students have tended towards taking larger freshman courses with more formal test-based examination (like multiple choice exams), then HSGPA would lose explanatory power because student performance would increasingly resemble SAT examination as opposed to the multi-modal examinations provided in high school. The UC Accountability Report shows that the availability of small classes at UC has fallen dramatically over the past 5 years, limiting freshman course options. Indeed, controlling for course size shows that size explains a small part of the decline in HSGPA explanatory power.

Overall, we conclude that almost half of the decline in HSGPA's ability to explain freshman course performance can be attributed to changes in freshman course enrollment across departments (the largest observed factor), HSGPA compression as a result of grade inflation and increased UC selectivity, and increases in the average size of freshman courses. While about half of the explanatory decline remains unexplained, we conclude that increased dispersion in the high schools sending students to UC does not play a role in HSGPA's explanatory decline, since within-high-school explanatory power has fallen even faster than overall explanatory power (leaving no room for a decline across high schools).

In summary, the change of admit pool and thus enrollment may result in less variability of HSGPA and a slightly greater variability of test scores. This change may be related to increase of eligible applicants, admission process, and student enrollment behavior. Further analyses need to be conducted to test this hypothesis. Regardless of how it happened, it definitely explains part of HSGPA's decline and test scores' increase in explanatory power. In addition, high school grade inflation and enrollment in low-grade course and large freshman courses also explain part of the decline in HSGPA explanatory power in course performance.