THE GOVERNOR'S OFFICE of STUDENT ACHIEVEMENT

The Effects of Academic Rigor in High School on Academic Performance in College

Contents of Report

The purpose of this report is to analyze the state of Georgia's transition from the Georgia High School Graduation Test (GHSGT) to End of Course testing (EOCTs) to gauge which of these assessments is a stronger predictor of A) academic rigor in high school and
B) academic success in college.

- Section I of this report provides an introduction to the topic and defines the specific questions being addressed.
- Section II contains a description of the data gathered and the methodology employed to answer the specified research questions.
- Section III describes empirical analysis conducted.
- Section IV explains results.
- Section V contains concluding remarks.

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Any views expressed in this report belong to the author alone and do not necessarily represent the views of the Governor's Office of Student Achievement.

Introduction

Beginning in 2004, the state of Georgia began requiring students to take End of Course Tests (EOCTs) in eight core subjects. Going forward, the state will exclusively use EOCTs to evaluate student learning and no longer use the Georgia High School Graduation Tests (GHSGTs). The intent of End of Course testing is to promote uniform and higher academic standards across Georgia high schools. Also, EOCTs are administered to students immediately upon the completion of a course and are thought to provide a more accurate measure of curriculum mastery than GHSGTs which assess students on material that was covered up to two years prior to the test.

If EOCTs provide a better gauge of student learning, then student performance on the EOCTs should be a stronger predictor of success in college relative to the High School Graduation Test. Building on the work of Betts and Morrell (1999) and Clark (2009), this report analyzes the extent to which academic rigor in high school impacts success in college.

Using data from 2006 to 2008 on all Georgia high school students who matriculated to a two- or four-year University System of Georgia institution immediately upon graduation, this reports examines two issues:

1) whether academic rigor in high school has an impact on success in college and
2) whether student performance on the EOCTs is a better predictor of success in college than performance on the High School Graduation Test.

These questions were identified in order to better understand why students with identical academic credentials like high school GPAs and SAT/ACT scores and identical demographic characteristics experience differential rates of success in college and to provide additional information about the desirability of moving to End of Course testing and away from the High School Graduation Test.

I. Introduction

Parents, the business community, policymakers, researchers, and other citizens have shown great interest in improving readiness for higher education. Researchers and college admissions officers have long known that academic achievement in high school is a strong predictor of success in college. In other words, improving academic achievement in high school is an important way to improve academic achievement in college.

In addition, researchers have found that college grade point averages (GPAs) are strong predictors of subsequent labor market outcomes including earnings (Loury and Garman, 1995; Jones and Jackson, 1995; Filer, 1983; and Wise, 1975).

Students who achieve more in high school go on to achieve more in college. Those high achieving college students are subsequently more valuable to employers in the labor market and thus command higher earnings. Adults with higher labor market earnings pay more in taxes, are less likely to use social services and income transfer programs, and have more resources available for their families.

However, traditional measures of academic success are not the only predictors of success in college. Betts and Morrell (1999) showed that where one attends high school, in addition to high school GPA and SAT/ACT score, has a large effect on performance in college as measured by GPA in the freshman year of college. For example, two identical students—both the same sex, the same race, the same family income status, the same high school grade point average, and the same SAT score—have very different college outcomes and those different outcomes are related to where they both went to high school. According to the estimates in Betts and Morrell (1999), adding indicator variables for where students went to high school increased the predictive power of their models explaining freshman GPAs by 34.5 percent.

However, very little research has endeavored to understand what it is about certain high schools that make their students more or less successful in college.[1]

That attendance at individual high schools is an important predictor of success in college tells us nothing about *why* certain high schools lead to more success for their students in college.

A relatively new line of research may provide a clue as to why some high schools appear to be more successful at making their students college ready. In a report on grading alignment for the Governor's Office of Student Achievement for the state of Georgia, Clark (2009) found large disparities in grading standards across public high schools in Georgia. He wrote:

> *"there are considerable grading disparities across Georgia's High School Algebra, English Literature, Biology, Physical Science, History, Geometry, and Economics classes. Comparing student's course grades to their End of Course Test (EOCT) scores indicates that some school systems appear to be inflating course grades relative to the EOCT scores considerably while others appear to hold their students to higher standards.*
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> *These disparities are disconcerting because they may impact college success, HOPE scholarship retention rates for HOPE scholars, and the need for learning support (remedial classes) in college. Students from schools and school systems that appear to consistently inflate grades may be less likely to succeed in college courses, less likely to retain the HOPE scholarship, and more likely to need to take remedial classes after enrolling in college than students from schools and school systems that hold their students to higher standards.*
>
> *Future research should be undertaken to analyze the impact of grading disparities on later academic success. An examination of the impact that rigor in grading standards (or a lack of rigor) may have on a student's academic future should be performed once data on HOPE eligibility, HOPE*

[1] Betts and Morrell (1999) find that students have lower freshman GPAs in college, all else equal, if their high school was located in a disadvantaged neighborhood with low incomes and lower levels of adult educational attainment. However, these effects are quantitatively small. They also find that school resources such as teacher-pupil ratio and teachers' level of education do not have positive relationships with college success, as some would expect. While they find that the average experience of high school teachers has a positive effect on success in college, the magnitude is modest. In their empirical results, most of the effect of attending specific high schools on success in college remains unexplained.

retention rates, and performance in college courses become available for the students whose data were used in this study."

This research report seeks to build on the work of Betts and Morrell (1999) and Clark (2009) to analyze to what extent, if any, academic rigor in high school impacts success in college.

In addition, we also analyze the state of Georgia's transition from the High School Graduation Test to End of Course testing. The intent of End of Course testing was to promote uniform and higher academic standards across Georgia high schools. Also, tests given immediately after students were taught a given subject made more sense to educators than the graduation test, which tested some material two or three years after students were taught that material.

Beginning in 2004, the state of Georgia began requiring students to take End of Course Tests (EOCTs) in eight core subjects. Going forward, the state will exclusively use EOCTs to evaluate student learning and no longer use the High School Graduation Test. This move makes sense if and only if EOCTs provide more accurate information with regards to student learning. If EOCTs do provide a more accurate measure of student learning, then student performance on the EOCTs should be a stronger predictor of success in college relative to the High School Graduation Test. We analyze this issue below.

<u>Research Questions</u>

I) After controlling for high school GPA, SAT/ACT scores, student demographic characteristics, and high school characteristics, does academic rigor in high school have an impact on success in college?

In this report, we provide the first estimates of the impact of academic rigor in high school on outcomes in college. We use two measures of academic rigor in high school:

- Each student's raw score on the Georgia High School Graduation Test relative to his or her high school grade point average (GPA).

- Each student's raw score on three Georgia End of Course Tests relative to his or her high school GPA.

Given that where one attends high school seems to have a large influence on success in college and given the large differences in grading standards across Georgia public high schools, it is worth investigating the extent to which, if any, academic rigor impacts outcomes in college.

II) After controlling for high school GPA, SAT/ACT scores, student demographic characteristics, and high school characteristics, does

student performance on the EOCTs predict success in college better than student performance on the High School Graduation Test?

This second question provides an important piece of evidence on whether the state of Georgia's move to End of Course testing and away from the High School Graduation Test was warranted.

We use data from 2006 to 2008 on all Georgia high school students who immediately upon graduation matriculated to a two- or four-year University System of Georgia institution to address these questions. We hope that our report will shed light on why students with identical academic credentials like high school GPAs and SAT/ACT scores and identical demographic characteristics experience differential rates of success in college. We also hope that our report will provide information about the desirability of moving to End of Course testing and away from the High School Graduation Test.

II. Data

For this project, we obtained student-level data on student characteristics (race, income-status, etc.) and student outcomes in high school (SAT/ACT score, scale scores on End of Course Tests, etc.) for students who graduated from public high schools in Georgia in 2006, 2007, and 2008. These data were provided by the Georgia Department of Education (GaDOE).

For the 2006-2008 graduates who matriculated to a University System of Georgia (USG) institution immediately after high school, we also have information on their success in their first year of college, including their GPA in their freshman year of college and their HOPE Scholarship status at the end of their freshman year. In addition, we received the high school overall GPA for each student who immediately matriculated to a USG institution after high school. These data were provided by the USG.

We also merged school-level characteristics of each public high school into these student level data. We obtained mean student characteristics and mean teacher characteristics for each high school from the Governor's Office of Student Achievement (GOSA) and the GaDOE, respectively.

To conduct our analyses of the impact of high school rigor on college outcomes, we constructed two samples—each sample uses a different measure of high school rigor.

The first sample uses the following measure of high school rigor:

$$(1) \qquad Rigor\ HSGT = \frac{Total\ HSGT}{High\ School\ GPA}$$

As shown in (1), students with a higher total score on the four parts of the Georgia High School Graduation Test (HSGT) for a given high school GPA will have a higher *Rigor HSGT* index score. This high school *Rigor HSGT* index score indicates that the student has accumulated more knowledge and skills than a student with a lower total HSGT score with the same GPA. For example, a "B" student (3.0 GPA) with a 2200 total score on the HSGT would have a Rigor index equal to 733.33. Another "B" student with a 3.0 GPA and a HSGT score of 2100 would have a Rigor Index equal to 700. Thus, the first student acquired more knowledge and skills than the second student according to their performance on the HSGT. Put differently, the first student's 3.0 GPA indicates a more rigorous grading standard relative to the second student's 3.0. The first student had to acquire more knowledge and skills than the second student in order to be awarded the same GPA.

This first sample that uses *Rigor HSGT* as the measure of high school rigor includes all freshmen at USG institutions who graduated from Georgia public high schools in 2006, 2007, and 2008. This first sample contains 75,761 student observations. Summary statistics for this first sample can be found in the first column of table 1.

We analyze two college outcomes in our study—freshman GPA and HOPE Scholarship status at the end of the freshman year. As shown in the first row of table 1, the mean freshman GPA is 2.61. And, at the end of their freshman year, 37.8 percent of our sample is eligible for HOPE. Literally, this latter outcome measures what percent of students have a 3.0 GPA at the end of their freshman year—whether they came to college with a HOPE Scholarship or not. Students who earn a 3.0 in their freshman year at a USG institution either retain HOPE or receive HOPE for their second year of college.

57 percent of our sample is female, and 33.7 percent of our sample is nonwhite. Our sample scored, on average, 1037 on the critical reading and math portions of the SAT. ACT scores for reading and math were converted to their SAT equivalents using the ACT-SAT Concordance.[2]

[2] The ACT-SAT Concordance can be found at www.act.org/aap/concordance .

High school-level characteristics included in our analysis as control variables include average demographic characteristics of students and pupil-teacher ratio, percent of teachers with advanced degrees, and average years of experience of teachers.

The explanatory variable of interest is *Rigor HSGT*. The mean of *Rigor HSGT* is 691.1. There is wide dispersion in this index of rigor across students with the highest index score equal to 1536 and the low score just below 450. The standard deviation is 111. Consistent with the analyses in Clark (2009), there is a wide disparity in grading standards across public schools in Georgia.

Second Sample

The second sample uses the following measure of high school rigor:

$$(2) \qquad Rigor\ EOCT = \frac{Total\ EOCT}{High\ School\ GPA}$$

We used three End of Course Test (EOCT) scale scores to create the variable *Total EOCT*, U.S. History, Economics, and American Literature and Composition.

$$Total\ EOCT = U.S.History\ Scale\ Score + Economics\ Scale\ Score + American\ Literature\ and\ Composition\ Scale\ Score$$

We use only these three EOCTs to construct the *Rigor EOCT* index because significant percentages of students do not have EOCT scores on the other five exams—presumably because they took these courses earlier in their academic career, before EOCTs existed. For example, a student who graduated high school in 2006 would have been very likely to take freshman English, Algebra, Geometry, Physical Science, and/or Biology before the fall of 2004 when EOCTs were implemented. It is also likely that even significant percentages of students who graduated in 2008 took some of these courses, especially Algebra, Geometry, and Physical Science in middle school, before EOCTs were implemented.

By using only three courses to construct this measure of high school rigor we are able to maximize our sample size and therefore examine the largest number and widest range of students. As shown below, this rigor index is highly correlated with success in college, controlling for a large number of other factors.

As shown in (2), students with a higher total score on the three EOCTs for a given high school GPA will have a higher *Rigor EOCT* index score. This high *Rigor EOCT* index score indicates that

the student has accumulated more knowledge and skills than a student with a lower total EOCT score with the same GPA. For example, a "B" student (3.0 GPA) with an 1800 total score on the three EOCTs would have a Rigor index equal to 600. Another "B" student with a 3.0 GPA and a total score of 1600 on the three EOCTs would have a Rigor Index equal to 533.33. Thus, the first student acquired more knowledge and skills than the second student according to their performance on the EOCTs. Put differently, the first student's 3.0 GPA indicates a more rigorous grading standard relative to the second student's 3.0. The first student had to acquire more knowledge and skills than the second student in order to be awarded the same GPA.

This second sample that uses *Rigor EOCT* as the measure of high school rigor includes all freshmen at USG institutions who graduated from Georgia public high schools in 2006, 2007, and 2008 who had recorded values for the three EOCTs used to construct our *Rigor EOCT* variable. This second sample contains 55,833 student observations. Summary statistics for this second sample can be found in the second column of table 1. Importantly, none of the means of the outcome or explanatory variables for the second sample are statistically different from the means of these variables for the first sample.

III. Empirical Analysis

Question I: *After controlling for high school GPA, SAT/ACT scores, student demographic characteristics, and high school characteristics, does academic rigor in high school have an impact on success in college?*

Given the data available to us, the outcomes of interest are two measures of success in the first year of college:

- First Year Grade Point Average (hereafter FGPA)
- HOPE Eligibility at the end of the first year of college (hereafter HOPE).

Using the data described above, our empirical models that address question I are of the form

1) FGPA = f[student demographic characteristics; student academic achievement in high school; high school characteristics; academic rigor in high school; indicator variables for individual high schools; indicator variables for individual colleges]

2) HOPE = f[student demographic characteristics; student academic achievement in high school; high school characteristics; academic rigor in high school; indicator variables for individual high schools; indicator variables for individual colleges], where

HOPE = 1, if the student earned a 3.0 GPA in his or her first year of college and is therefore eligible for Georgia's HOPE Scholarship; HOPE = 0, if the student earned below a 3.0 GPA in the first year of college.[3]

We are most interested in the relationship between academic rigor in high school and FGPA and HOPE. Put differently, after controlling for a host of other factors that influence achievement in college, do students who faced more academic rigor in high school experience more academic success in college?

As described above, we employ two measures of academic rigor in high school: Rigor HSGT (the raw score of the High School Graduation Test (HSGT) divided by high school GPA and Rigor EOCT (the raw score on three End of Course Tests (EOCTs) divided by high school GPA).

Given that we use two measures of academic rigor, we estimate two empirical models consistent with (1) above and two empirical models consistent with (2) above, each using one of the two measures of academic rigor in high school. Thus, we estimate four empirical models, and each model is estimated with indicator variables for the high school attended and indicator variables for the college attended. Each indicator variable equals "1" if the student attended the high school (or college) represented by each indicator variable and equals "0" otherwise. Each indicator variable captures unobserved and time invariant characteristics of each high school and college. For example, the indicator variable for Georgia Tech in the empirical models consistent with (1) and (2) would be negative and large (in absolute value) if it were the case that it were more difficult to earn a high grade point average in the first year at Georgia Tech relative to the difficulty of earning a high grade point average at other colleges, all else equal. (In fact, we find that this is the case.) These indicator variables allow for unobserved—and unexplained—differences from individual high schools and individual colleges.

Question II: *After controlling for high school GPA, SAT/ACT scores, student demographic characteristics, and high school characteristics, does student performance on the EOCTs predict success in college better than student performance on the High School Graduation Test?*

Using the data described above, our empirical models that address question II are of the form

[3] During the time period under study, Georgia's HOPE Scholarship covered all tuition, a significant portion of student fees, and a $300 per year book allowance for all eligible Georgia residents who attended a public college or university under the University System of Georgia. Students who earned a 3.0 GPA in seventeen core academic courses in high school were eligible to receive the HOPE Scholarship for the first year of college. To maintain HOPE in college or to receive a HOPE Scholarship for subsequent years of college, students had to obtain a 3.0 GPA in college.

3) FGPA = f[student demographic characteristics; student academic achievement in high school—High School GPA, SAT/ACT Score, EOCT scores, HSGT score; high school characteristics; indicator variables for individual high schools; indicator variables for individual colleges]

4) HOPE = f[student demographic characteristics; student academic achievement in high school—High School GPA, SAT/ACT Score, EOCT scores, HSGT score; high school characteristics; indicator variables for individual high schools; indicator variables for individual colleges], where

   HOPE = 1, if the student earned a 3.0 GPA in his or her first year of college and is therefore eligible for Georgia's HOPE Scholarship; HOPE = 0, if the student earned below a 3.0 GPA in the first year of college.

Of interest in this analysis is whether the EOCTs contain more information about future success in college relative to the High School Graduation Test. Put differently, after controlling for other measures of achievement in high school, does the High School Graduation Test add any information that predicts future success in college?

IV. Results

Question I – *Does academic rigor in high school impact success in college?*

In table 2, we report estimates from four empirical models:

(a) FGPA is the outcome of interest and HSGT Rigor is the measure of academic rigor in high school
(b) HOPE is the outcome of interest and HSGT Rigor is the measure of academic rigor in high school
(c) FGPA is the outcome of interest and EOCT Rigor is the measure of academic rigor in high school
(d) HOPE is the outcome of interest and EOCT Rigor is the measure of academic rigor in high school

The estimated effects of student demographic characteristics and achievement in high school on success in college will not be surprising to higher education researchers. Males, African Americans, students from economically disadvantaged backgrounds (as measured by eligibility for free or reduced price lunches), and students classified as disabled have lower first year GPAs

(FGPAs) in college and are less likely to be HOPE-eligible at the end of their first years of college. Each of these estimated effects are statistically significant ($p<.01$).

Also not surprisingly, students who earned higher SAT/ACT scores in high school and students who earned higher GPAs in high school experienced higher levels of academic success in college. Each of these estimated effects are statistically significant ($p<.01$).

The estimated effects of average high school characteristics tend to be small in absolute value and rarely statistically significant.

The variables of interest are the two measures of academic rigor in high school, HSGT Rigor and EOCT Rigor. In each of the four empirical specifications, academic rigor in high school has a positive and statistically significant effect on success in college. Each of these four estimated effects are statistically significant ($p<.01$). That is, using these rich data on all 2006, 2007, and 2008 Georgia public high school graduates who immediately matriculated to a public college in Georgia upon graduation and controlling for a large number of other factors, students who faced more academic rigor in high school were more successful in their first years of college.[4]

Is the effect of academic rigor big?

We use the estimates in table 2 to construct policy simulations to demonstrate the magnitudes of our estimates. We report the results of the policy simulations in table 3. In our policy simulations we consider two identical students who attended otherwise identical high schools and went to the same college. These students were the same sex, race, income status, etc. The only difference between these two students is that one faced very little academic rigor in high school, while the other faced a large degree of academic rigor. Specifically, the first student's level of academic rigor in high school was only at the 10^{th} percentile of all students in Georgia, while the second student faced a level of academic rigor in the 90^{th} percentile.

[4] We also estimated each of the four empirical models separately for each of the 34 colleges and universities in the University System of Georgia. In 87.5 percent of these regressions, the estimated effect of academic rigor in high school on college outcomes was positive, and 68 percent of these coefficient estimates were statistically significant. However, for some of the smaller institutions, these effects were not statistically significant. This lack of statistical significance at smaller institutions is not surprising given the large number of variables included in the model—estimating such a large number of coefficients with a small sample size normally leads to estimates that are not statistically significant. 75 percent of the negative coefficients were not statistically significant. In terms of magnitude, the average effect of high school rigor on FGPA was much larger in these college and university-specific regressions. Thus, the results reported in tables 2 and 3 may be understating the effects of high school academic rigor on success in college. In the interest of caution, we report the lower estimates in this report. The average effect of high school rigor on HOPE in the college and university-specific regressions was virtually identical to the results reported in tables 2 and 3.

In table 3, we report the expected difference in the two students FGPA and HOPE eligibility at the end of their respective first years of college. As shown in table 3, the student who faced more academic rigor in high school as measured by the HSGT Rigor index is estimated to have a FGPA that is 0.13 points higher in college (on a 4.0 scale) than the student who faced much less high school academic rigor. The student who faced more academic rigor in high school as measured by the EOCT Rigor index is estimated to have a FGPA that is 0.19 points higher in college than the student who faced much less high school academic rigor.

For HOPE eligibility at the end of the first year of college, both measures of academic rigor suggest that the student who faced more academic rigor in high school increases his or her chance of being HOPE-eligible by 7 percentage points at the end of the first year of college. This increase translates into an 18.5 percent increase in freshman HOPE eligibility.

Question II – *Are EOCTs better predictors of success in college?*

In table 4, we report estimates from two empirical models that seek to explain success in the first year of college:

a) FGPA is the outcome of interest

b) HOPE is the outcome of interest

These empirical models were described in (3) and (4) above.

Like the prior results reported in table 2, the estimated effects of average high school characteristics tend to be small in absolute value and rarely statistically significant. However, some measures of student achievement in high school are strong predictors of success in college such as high school grade point average and SAT/ACT score. Student demographic characteristics also have statistically significant relationships with success in college, as was the case previously.

As shown in table 4, HSGT scores are not statistically significant in the Freshman GPA regression and are only statistically significant at the 10% level in the HOPE regression. EOCT scores are strongly statistically significant in both regressions ($p<.01$). What is more important for this analysis is the magnitude of the relationships between EOCT scores and college success and HSGT scores and college success. If one of these types of pre-college tests is a stronger predictor of success in college, then we can say that one contains more information about student learning prior to college than the other. That is, one is a more accurate measure of student learning than the other.

To see the magnitudes of EOCT scores and HSGT scores on success in college, we use a standard technique called calculating "marginal effects." Specifically, we use the estimates in table 4 to calculate the effects on success in college that result from a one standard deviation increase in a given variable. The standard deviations are from table 1. For example, suppose a given student was identical to a second student in all respects but one. Suppose this first student scored one standard deviation higher on the EOCTs, but was otherwise identical to the second student. How much more success would we expect in college for this first student? That is what the marginal effects indicate, based on our estimates in table 4.

We report marginal effects for four key variables in table 5. As shown in table 5, if a student has a one standard deviation higher high school GPA, he or she can expect to have a 0.535 higher GPA in the first year of college relative to an otherwise identical student. That would be the difference between a 2.5 and a 3.0 GPA, for example. He or she would also be much more likely to retain HOPE at the end of the first year of college. This difference in HOPE retention is estimated to be 26.5 percentage points, which means that the student with the higher high school GPA has a 70 percent higher likelihood of retaining HOPE than the student with the lower high school GPA, all else equal.

End of Course Test scores and scores on the SAT and ACT also are statistically significant predictors of success in college ($p<.01$), but the magnitudes are smaller. A one standard deviation increase in EOCT scores is associated with a college GPA that is almost 0.12 points higher, all else equal. A one standard deviation increase in SAT or ACT scores is associated with a college GPA that is 0.025 points higher, all else equal. First year HOPE retention is 3.6 percentage points higher (9.5 percent higher) for students who earned higher EOCT scores. First year HOPE retention is 1.8 percentage points higher (4.8 percent higher) for students who earned higher SAT or ACT scores. Each of these effects is statistically significant.

As readers will notice, these estimated effects of EOCT scores and SAT/ACT scores on success in college are small relative to the effect of high school GPA. Nevertheless, the magnitude of the effect of EOCT on Freshman GPA and HOPE Eligibility is considerably larger than the effect of the HSGT score. After controlling for high school grade point average, SAT/ACT score, and End of Course Test scores, the High School Graduation Test provides almost no information about the likelihood of student success in college. While students who perform better on EOCTs experience more success in college, all else equal, there does not seem to be any additional predictive information that comes from scores on the High School Graduation Test. Specifically, students who score one standard deviation higher on the HSGT are estimated to have college GPAs that are only 0.002 points higher than otherwise identical students. Again, this result is not statistically significant. While the effect of HSGT scores on the likelihood of retaining HOPE

is marginally statistically significant, the magnitude of this effect is small. Students who score one standard deviation higher on the HSGT are estimated to have only a 0.6 percentage point (1.6 percent) higher HOPE retention rate relative to otherwise identical students.

Taken together, these results indicate that the three tests used to construct our EOCT score are significantly stronger predictors of college success than the High School Graduation Test. Further, after controlling for high school grade point average, SAT/ACT score, and EOCT scores, the High School Graduation Test does not add any predictive information regarding success in the first year of college.

V. Conclusion

A large volume of research, college admissions officials, and common sense suggests that academic success in high school is an important determinant of academic success in college and that academic success in college has an impact on future labor market earnings. This report adds to our understanding of the relationship between high school and college success. Specifically, our estimates suggest that academic rigor in high school contributes to academic success in college.

Students who gained more knowledge and skills in high school—for a given high school grade point average—were held to a higher level of academic rigor relative to students who gained less knowledge and skills. And, these students who faced more academic rigor in high school had higher GPAs in their first year of college and were more likely to be eligible for Georgia's HOPE Scholarship at the end of their first year. Specifically, our estimates suggest that students held to the 90th percentile in academic rigor in high school had 0.13 or 0.19 higher first year grade point averages relative to otherwise identical students who were held to the 10th percentile in academic rigor. The students held to more rigor increased their likelihood of being HOPE-eligible at the end of their first year of college by 7 percentage points. This increase translates into an 18.5 percent increase in HOPE eligibility.

These results suggest that more academic rigor in high school leads to more academic success in college, even after controlling for a large number of other factors. Combined with the research on human capital, more academic success in college will lead to more labor market success later in life for Georgia students.

Per our second research question, we find strong evidence that End of Course Test (EOCT) scores are a much stronger predictor of college success than performance on the High School Graduation Test. Specifically, a student who scored one standard deviation higher on his or her EOCTs earns a college GPA that is almost 0.12 higher than an otherwise identical student—same high school GPA, same SAT/ACT score, same race, sex, and income status, etc. However, students who score higher on the High School Graduation Test have roughly the same college GPA as students who scored much lower.

A student who scored one standard deviation higher on his or her EOCTs is 9.5 percent more likely to retain HOPE in the first year of college than an otherwise identical student—same high school GPA, same SAT/ACT score, same race, sex, and income status, etc. However, students who score one standard deviation higher on the High School Graduation Test have only a 1.6 percent higher likelihood of retaining HOPE.

Thus, the EOCTs provide significant information about student learning prior to college—students who score higher on the EOCTs experience better success in college. The High School Graduation Test, however, does not appear to provide much additional information about student learning beyond the information that is obtained from high school grade point averages, SAT/ACT scores, and End of Course Test scores.

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Table 1: Summary Statistics for Rigor Regressions

	HSGT Sample Mean (Std. Dev.)	EOCT Sample Mean (Std. Dev.)
Freshman GPA	2.607	2.612
	(0.965)	(0.966)
HOPE Spring	0.378	0.375
	(0.485)	(0.484)
Female	0.570	0.567
	(0.495)	(0.496)
African-American	0.253	0.256
	(0.435)	(0.437)
Asian	0.044	0.048
	(0.206)	(0.215)
Hispanic	0.023	0.024
	(0.151)	(0.154)
Other Race	0.016	0.017
(White Omitted)	(0.127)	(0.130)
Economically Disadvantaged	0.185	0.182
	(0.388)	(0.386)
Disabled	0.018	0.018
	(0.132)	(0.135)
Limited English Proficient	0.003	0.003
	(0.051)	(0.054)
Graduation Class	2007.0	2007.2
	(0.820)	(0.774)
SAT Score	1037.1	1040.4
(or ACT converted)	(170.9)	(172.1)
Total HSGT/EOCT Score	2155.9	1718.9
	(62.6)	(188.7)
High School GPA	3.199	3.187
	(0.513)	(0.516)
HSGT/EOCT Rigor Index	691.1	551.8
	(110.8)	(99.0)
Student Teacher Ratio	17.6	17.5
	(2.1)	(2.0)
Pct Teachers w/ Advanced Degree	0.617	0.617
	(0.071)	(0.068)
Average Teacher Experience	12.6	12.4
	(2.2)	(2.2)

	HSGT Sample Mean (Std. Dev.)	EOCT Sample Mean (Std. Dev.)
Pct School Economically Disadvantaged	34.6	33.7
	(20.4)	(20.8)
Pct School Disabled	10.2	10.1
	(2.9)	(2.8)
Pct School Asian	3.549	4.049
	(5.055)	(5.514)
Pct School Other Race	1.983	2.068
	(1.236)	(1.228)
Pct School African-American	32.9	33.1
	(26.5)	(26.7)
Pct School Hispanic	6.095	6.279
	(7.059)	(7.081)
Sample Size (# of Students)	75,761	55,833

Table 2: Determinants of Freshman GPA and Hope Eligibility

	HSGT Rigor Measure		EOCT Rigor Measure	
	Freshman GPA	HOPE Eligibility	Freshman GPA	HOPE Eligibility
Female	0.108***	0.040***	0.119***	0.039***
	(0.006)	(0.003)	(0.007)	(0.004)
African-American	-0.073***	-0.035***	-0.073***	-0.034***
	(0.010)	(0.005)	(0.011)	(0.006)
Asian	0.021	-0.023***	0.017	-0.028***
	(0.015)	(0.007)	(0.017)	(0.008)
Hispanic	0.007	-0.031***	0.009	-0.035***
	(0.019)	(0.010)	(0.022)	(0.011)
Other Race	-0.114***	-0.053***	-0.109***	-0.050***
(White Omitted)	(0.023)	(0.011)	(0.025)	(0.013)
Economically Disadvantaged	-0.090***	-0.027***	-0.079***	-0.028***
	(0.009)	(0.004)	(0.010)	(0.005)
Disabled	-0.069***	-0.025**	-0.087***	-0.023*
	(0.022)	(0.011)	(0.025)	(0.012)
Limited English Proficient	0.087	0.019	0.125**	0.043
	(0.056)	(0.028)	(0.062)	(0.031)
Graduation Class	-0.012**	-0.018***	0.109***	0.025***
	(0.005)	(0.003)	(0.011)	(0.005)
SAT Score	0.0002***	0.0001***	0.0001***	0.0001***
(or ACT converted)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Total HSGT or EOCT Score	0.0001	-0.0006***	0.0002***	-0.0006***
	(0.0001)	(0.0000)	(0.0001)	(0.0000)
High School GPA	1.305***	1.116***	1.256***	1.009***
	(0.035)	(0.017)	(0.036)	(0.018)
HSGT or EOCT Rigor Index	0.0011***	0.0026***	0.0012***	0.0026***
	(0.0001)	(0.0001)	(0.0002)	(0.0001)
Student Teacher Ratio	0.001	0.000	0.002	0.002
	(0.004)	(0.002)	(0.005)	(0.002)
Pct Teachers w/ Advanced Degree	-0.021	0.033	0.141	0.118*
	(0.110)	(0.055)	(0.140)	(0.070)
Average Teacher Experience	0.006	0.004*	0.003	0.002
	(0.005)	(0.003)	(0.006)	(0.003)
Pct School Economically Disadvantaged	0.0009	0.0003	-0.0019	0.0004
	(0.0015)	(0.0008)	(0.0020)	(0.0010)
Pct School Disabled	-0.003	-0.005**	0.001	-0.001
	(0.004)	(0.002)	(0.005)	(0.003)
Pct School Asian	0.013**	-0.003	0.017**	-0.006
	(0.007)	(0.003)	(0.008)	(0.004)

Pct School Other Race	0.012	0.005	0.026**	0.012*
	(0.009)	(0.004)	(0.011)	(0.005)
Pct School African-American	0.000	-0.001	0.003	-0.001
	(0.002)	(0.001)	(0.002)	(0.001)
Pct School Hispanic	0.010**	-0.002	0.011*	-0.002
	(0.005)	(0.002)	(0.006)	(0.003)
College Fixed Effects	Yes	Yes	Yes	Yes
High School Fixed Effects	Yes	Yes	Yes	Yes
R-squared	0.357	0.358	0.372	0.376
Sample Size (# of Students)	75,761	75,770	55,833	55,839

*** Indicates statistical significance at the 1% level. ** Indicates statistical significance at the 5% level. * Indicates statistical significance at the 10% level.

Table 3: Increase in High School Rigor from the 10th to 90th percentile

	Freshman GPA	HOPE at End of First Year
HSGT Rigor Index	0.13	7 percentage points*
EOCT Rigor Index	0.19	7 percentage points*

*This increase translates to an 18.5% increase in freshman hope eligibility.

Table 4: High School Graduation Test Vs. End of Course Tests

	Freshman GPA	HOPE Eligibility
Female	0.1191***	0.0393***
	(0.0072)	(0.0037)
Black	-0.0696***	-0.0325***
	(0.0112)	(0.0057)
Asian	0.0178	-0.0238***
	(0.0167)	(0.0085)
Hispanic	0.0099	-0.0343***
	(0.0220)	(0.0112)
Other Race	-0.1095***	-0.0518***
(White Omitted)	(0.0257)	(0.0130)
Economically Disadvantaged	-0.0817***	-0.0305***
	(0.0105)	(0.0053)
Disabled	-0.0854***	-0.0188
	(0.0250)	(0.0126)
Limited English Proficient	0.1251*	0.0326
	(0.0652)	(0.0330)
Graduation Class	0.1086***	0.0230***
	(0.0113)	(0.0057)
SAT Score	0.0001***	0.0001***
(or ACT converted)	(0.0000)	(0.0000)
Total EOCT Score	0.0006***	0.0002***
	(0.0000)	(0.0000)
Total HSGT Score	0.00002	0.0001*
	(0.00010)	(0.0001)
High School GPA	1.0364***	0.5143***
	(0.0096)	(0.0048)
Student Teacher Ratio	-0.0001	0.0002
	(0.0052)	(0.0026)
Pct Teachers with Advanced Degree	0.1588	0.1118
	(0.1409)	(0.0714)
Average Teacher Experience	0.0023	0.0049
	(0.0065)	(0.0033)
Pct School Economically Disadvantaged	-0.0022	0.0000
	(0.0020)	(0.0010)
Pct School Disabled	0.0008	-0.0025
	(0.0053)	(0.0027)
Pct School Asian	0.0177**	-0.0044
	(0.0080)	(0.0040)
Pct School Other Race	0.0255**	0.0105*
	(0.0107)	(0.0054)

Table 4: High School Graduation Test Vs. End of Course Tests

	Freshman GPA	HOPE Eligibility
Pct School Black	0.0030	-0.0014
	(0.0025)	(0.0012)
Pct School Hispanic	0.0100*	-0.0023
	(0.0059)	(0.0030)
College Fixed Effects	Yes	Yes
High School Fixed Effects	Yes	Yes
R-squared	0.3644	0.3595
Sample Size (# of Students)	54,896	54,902

*** Indicates statistical significance at the 1% level. ** Indicates statistical significance at the 5% level. * Indicates statistical significance at the 10% level.

Table 5: Marginal Effects of Key Variables

	Freshman GPA	HOPE at End of First Year
HSGT	0.002	0.6 Percentage points
EOCT	0.116	3.6 Percentage points
HSGPA	0.535	26.5 Percentage points
SAT/ACT	0.025	1.8 Percentage points