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How College Students useAdvanced Placement Credit

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ABSTRACT

Millions of high school students take Advanced Placement (AP) courses, which can provide college credit. Using nationally representative data, I identify a diverse set of higher education outcomes that are related to receipt of AP college credit. Institution fixed effects regression reduces bias associated with varying AP credit policies and student sorting across higher education. Results indicate college credits earned in high school are related to reduced time to degree, double majoring, and taking more advanced coursework. Bounding exercises suggest the time to degree and double major outcomes are not likely driven by bias from unobserved student characteristics. Policies used to support earning college credits while in high school appear to enhance undergraduate education and may accelerate time to degree.

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How College Students use Advanced Placement Credit

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Abstract

Millions of high school students take Advanced Placement (AP) courses, which can provide college credit. Using nationally representative data, I identify a diverse set of higher education outcomes that are related to receipt of AP college credit. Institution fixed effects regression reduces bias associated with varying AP credit policies and student sorting across higher education. Results indicate college credits earned in high school are related to reduced time to degree, double majoring, and taking more advanced coursework. Bounding exercises suggest the time to degree and double major outcomes are not likely driven by bias from unobserved student characteristics. Policies used to support earning college credits while in high school appear to enhance undergraduate education and may accelerate time to degree.

Keywords: achievement, advanced coursework, college credit, college preparation courses

How College Students use Advanced Placement Credit

There is a growing trend for high schools to offer college-level coursework through dual enrollment (DE), International Baccalaureate (IB), and Advanced Placement (AP) courses. The AP program is the most widespread with nearly 2.5 million students taking almost 4.5 million AP exams in 2015 (College Board, 2016c). Students benefit from taking these courses because they offer more rigorous material and assignments than typical high school classes (Long, Conger, & Iatarola, 2012) and the courses signal college preparation to admission offices (Geiser & Santelices, 2006). Advanced Placement courses also serve as an important and financially inexpensive pathway for receiving college credit while in high school by passing standardized exams.

College credit earned in high school serves as a valuable and flexible resource for students once enrolled in higher education, yet we know little about how many college credits students earn from taking college-level courses in high school and how students use these valuable credits once they enroll. There are a variety of ways students can use advanced credits. Students could attempt to graduate early saving time and money, or they might take a broader or deeper curriculum and use the credits either to double major or to take more advanced coursework in a field. Alternatively, students can substitute leisure time or hours of paid work for the time they would have spent earning those credits in college. This paper outlines the variety of ways students can spend their AP credits, discusses the tradeoffs students make when deciding how to use their AP credits, and empirically estimates how students use these credits using nationally representative data.

This study answers two specific research questions:

1) What is the relationship between student demographic, academic, and financial characteristics and the number of Advanced Placement college credits received?
2) Which higher education outcomes are related to receipt of Advanced Placement college credit?

From the evidence provided herein, we can infer how students use the AP credit they receive when entering higher education. By using nationally representative data on entering college students that track students for six years after enrollment, I examine long-term higher education outcomes. Although these research questions are descriptive, I use prior academic achievement and a host of demographic controls to reduce bias from observed student characteristics. Additionally, I employ institution fixed effect regressions to control for student sorting across institutions and differences in AP credit granting policy across higher education. I consider whether these estimates may be considered as causal using a bounding exercise in the discussion section.

One major contribution of this study is the simultaneous analysis of multiple college outcomes. Although several prior studies have examined how college-level high school courses are related to college outcomes, each paper focuses on only one or two outcomes such as enrollment, achievement, major, or time to degree (An, 2013; Avery, Gurantz, Hurwtiz, & Smtih, 2016; Long, Conger, & Iatarola, 2012; Klopfenstein, 2010; Klopfenstein & Thomas, 2009; Smith, Hurwitz, & Avery, 2015). While many of these prior works are instructive in identifying the effects of AP courses on a single outcome, they do not incorporate the breadth of outcomes examined in this analysis, and they ignore the potential tradeoffs in using AP credit for one purpose over another. Additionally, extant literature concentrates on course and exam taking as opposed to directly observing received college credit as I do. This paper also presents results that are nationally representative, providing a broader perspective over many prior studies relying on state level data.

I find 7.6% of first year college students enter college with AP credit. Those students average 10 credits in a 120 credit hour degree program, and there is little variation across race and gender after accounting for institution attended. Results suggest that students use their advanced credit to graduate early, double major, and take more advanced math and laboratory science courses.

This research is important as secondary education continues to expand access to college-level coursework. School districts are often faced with the decision to adopt AP curricula at the cost of teacher professional development, and some also pay for students to take AP exams. Weighing those costs against the benefits associated with positive long-term postsecondary outcomes is important. As high schools consider whether to expand Advanced Placement courses, these results suggest the adoption and promotion of college-level courses in high school is a worthwhile investment. This analysis also informs postsecondary institutions' policies of granting college credit for advanced high school coursework and exam scores. As colleges decide whether to offer AP credit, they should consider how those credits will likely affect students' decisions while enrolled. Finally, the analysis addresses whether college credits earned in high school is a viable approach to shortening time to degree in higher education. Although reducing time to degree may not maximize student learning, policymakers at both the state and national levels argue that we should promote faster time to degree, and we could potentially rely on advanced credit to encourage students to graduate more quickly (Alexander, 2009; National Science and Math Initiative, 2012). Whether these policy and institutional goals are succeeding is an important question that remains to be conclusively answered. This study informs the discussions of whether AP credits foster faster attainment of baccalaureate degrees and whether students use their AP credits for purposes other than accelerating time to degree.

Background

There are three primary ways to take college-level coursework while enrolled in high school. First, students can take dual enrollment classes in which they enroll concurrently in their high school and at an institution of higher education. Because dual enrollment programs are often a collaborative effort between individual high schools and local colleges, less is known about the extent of student participation, but one dual enrollment program in New York City served over 110,000 students between 2001 and 2006 (Karp, Calcagno, Hughes, Jeong, & Bailey, 2008). Second, a small number of high schools in the United States (1,569) offer the International Baccalaureate (IB) program, which provides an internationally recognized college-level curriculum for high school students (International Baccalaureate Organization, 2014). Third, the Advanced Placement program offered by the College Board in almost 21,600 American high schools is a common way for high school students to take college-level coursework by enrolling in an AP course of a specific subject (College Board, 2016a).

Students take these college-level courses while in high school for several reasons. They take AP courses to gain exposure to more advanced curricula and increased rigor relative to the average high school course (Hertberg-Davis & Callahan, 2008). They also increase their chances of gaining admission to a more selective university as college admission offices place substantial weight on the high school curriculum when evaluating applicants because they believe it predicts success in college (Evans, 2015). In fact, 90% of AP teachers believe the program has expanded due to student demand to improve their college applications (Farkas & Duffett, 2009).

Critical for this analysis, AP, IB, and DE courses can also yield college credit for students before they graduate from high school. Dual enrollment students can receive college credit from a postsecondary institution that is widely transferable. IB and AP courses provide the opportunity for students to take a subject exam at the end of each course, and many colleges grant credit for sufficiently high scores on each exam. Some institutions provide waivers of course requirements even if they do not grant actual credit towards graduation for high IB and AP exam scores. Because of the broad, national implementation of the Advanced Placement program, this paper focuses on AP courses, although the results likely apply to other forms of earning college credit in high school.

In 2015, almost 2.5 million high school students took almost 4.5 million exams across thirty six different AP subjects spanning the curriculum including music theory, calculus, Chinese language and culture, and human geography (College Board, 2016c). Colleges often grant credit for AP exam scores of 3 or higher on a 5 point scale, and these scores are fairly common as 57.9% of exams taken in 2015 received a score of 3 or higher across the nation (College Board, 2016b). Colleges typically set their own minimum required AP exam scores for offering college credit; however, some states, such as Florida, legislatively require colleges to grant credit for scores of 3 or higher (Lerner & Brand, 2008; Rockwell, 2011).

In order to complete a bachelor's degree, students must accumulate a certain number of institutionally mandated credits and fulfill a combination of general education and major specific requirements. Many institutions allow AP credits to count both as credits earned toward graduating and fulfilling course requirements, while other institutions allow lower scores to satisfy requirements but not apply as credits towards graduation. For example, the College of Arts & Sciences at the University of Virginia grants a course exemption for French Language for an AP French Language score of 3 and college credit for scores of 4 or 5.[1] These policies vary widely as several of the most selective institutions such as Harvard and Yale do not grant credit for individual AP scores. Instead, they provide accelerating standing for students wishing to graduate a term or year early if the student has earned a minimum number of AP exam scores of 4 or 5 in the case of Yale or 5 in the case of Harvard. A few institutions, such as Cal Tech, do not grant any credit for AP courses and exams.

Prior Literature

The widespread adoption of the AP curriculum in high school and the prevalence of institutions providing college credit for high AP exam scores has led researchers to conduct numerous studies on AP for a variety of purposes. Two components of the broader literature are especially pertinent to this paper: who takes AP courses, and what is the relationship between AP course taking and exam scores with college outcomes.

Who Takes AP Courses?

Inputs such as student ability and background are critical to the analysis below because students' characteristics are related to whether they take AP courses. As expected, ability and previous academic achievement are strong predictors of taking college preparatory courses (Conger, Long, & Iatarola, 2009; Zietz & Joshi, 2005). Parental education and family income are also positively correlated with taking advanced courses in high school (Zietz & Joshi, 2005). Collectively, these results suggest students who take and receive AP courses and credit are relatively more advantaged academically and socio-economically than those that do not.

Race and gender also play a role in predicting advanced course enrollment as black and Hispanic students enroll at lower rates (Conger, Long, & Iatarola, 2009; Klopfenstein, 2004), and women are more likely to take advanced courses (Zietz & Joshi, 2005). Furthermore, men and women are not equally distributed across all advanced courses. Males were more likely to enroll in science AP courses in the 1980s (Stumpf and Stanley, 1996), but that gap may no longer exist as Conger, Long, and Iatarola (2009) provide evidence in one state of equitable gender enrollment. Females are more likely to enroll in advanced courses in languages and social sciences.

Although, the prior literature is clear on who enrolls in AP courses, it does not provide information on who receives AP credits once enrolled in college, which is dependent on AP exam score and the AP credit policy for the institution in which the student enrolls. To advance the literature, this paper provides nationally representative data on who accumulates AP credit and how many credits they earn upon college enrollment.

College Outcomes

The central analysis of this paper is understanding how students use the AP credits they earn across a wide array of possible college outcomes. Prior literature provides important evidence on the effects of AP course taking and exam scores on a subset of the outcomes I examine. Combining statewide panel data, a robust set of covariates, and propensity score matching, Long, Conger, and Iatarola (2012) provide the most compelling evidence that AP course taking actually improves college enrollment and GPA. In a similar fashion, An (2013) uses propensity score matching on nationally representative data and concludes that Dual Enrollment courses improve attainment through college degree completion with larger effects for low-income students.

Two papers use regression discontinuity on national data to causally estimate passing an AP exam at thresholds that often grant credit (although they do not observe actual credit received) on two different college outcomes: college major choice and time to degree. Avery et al. (2016) employ regression discontinuity to determine that just earning the highest score in a specific subject increases the likelihood of majoring in that subject by a statistically significant but small magnitude of 0.64 percentage points relative to students who just failed to achieve the highest score. Using a similar estimation strategy, Smith, Hurwitz, and Avery (2015) demonstrate that just receiving a high enough score to earn college credit causes a 1 to 2 percentage point increase in the probability of four year baccalaureate attainment for some subjects' exams. However, they find no effect of receiving the higher AP exam score on 6 year graduation outcomes. These findings collectively suggest that earning college credit through AP exam scores accelerates time to degree for those who would have completed a BA within 6 years.

Klopfenstein (2010) also examines the time to degree outcome using survival analysis and controls for observable characteristics. Unlike Smith, Hurwitz, and Avery, she finds that passing an AP exam has no discernable effect on graduating within four years but does find a large effect on the probability of graduating within three years and suggests this result likely applies only to students who accumulate enough AP credit to essentially enter college as sophomores. The regression discontinuity estimation strategy of Smith, Hurwtiz, and Avery provides much stronger protection from selection bias than Klopfenstein, but her assertion that time to degree may be discontinuous around the credits needed for second year standing is worthy of further study.

These prior papers lay the groundwork for the current analysis. This study enhances the literature in the following ways. First, the analysis provides results on a much wider array of outcomes than prior studies. In addition to time to degree, major choice, and performance, all of which have been explored separately, the current study examines double majoring, hours worked for pay, loan debt, advanced course taking, and graduate school enrollment. By collectively estimating these outcomes in the same analysis, I develop a much more coherent picture of how students use the AP credit they earned in high school. Second, it examines actual college credit received from AP courses, which is only assumed or estimated in the prior literature. Third, it controls for differences in AP granting policies across institutions using institution fixed effects to estimate within institution differences. While the methods employed here do not provide as strong a causal warrant as the regression discontinuity studies, these controls limit the effects of selection by comparing students who were all admitted to and attend the same institution. Furthermore, my estimates do not suffer from the local average treatment effect limitation of the regression discontinuity studies; my estimates apply for all students receiving credit rather than those just above the threshold. Fourth, it uses nationally representative college data, providing greater external validity than many of the prior studies, such as Klopfenstein, which rely on state level data.

Operationalizing Outcomes

When entering higher education, students have many resources at their disposal: time, money, background preparation and knowledge in certain subjects, etc. Those that have earned Advanced Placement credit from high school courses and exam scores have an additional resource that can be spent in a variety of ways throughout the college career. Just as there are tradeoffs in how students spend their money and time, there are tradeoffs in how students choose to employ their AP credit. The central question this study attempts to answer is: how do students use this resource? Are they accelerating time to graduation thereby saving time and money? Perhaps they do not graduate early but use AP credits to take fewer classes thereby freeing up time to allocate towards hours of paid work or leisure. In order to understand the potential tradeoffs, we must consider the different ways in which AP credit can be deployed. I divide them into several categories below and explain how each is operationalized in the study.

Enrollment, Achievement, and Completion

Before examining the outcomes of interest, I confirm findings from prior studies on the enrollment and success of AP credit recipients. Given that the highest performing high school students are typically the ones who take AP courses, I examine how AP credit accumulation is related to four-year college enrollment and performance. I measure institutional selectivity using a binary indicator for attending a very or moderately selective institution based on the selectivity measures created by the National Center for Education Statistics (NCES) used in the Integrated Postsecondary Education Data System (IPEDS). I also measure 1st year GPA as an early measure of college performance and receipt of a bachelor's degree within six years as a standard measure of college completion.

Time to Degree

Perhaps the most straightforward way of using AP credit is to accelerate time to degree. By applying credits earned in high school towards a college degree, students can attain a bachelor's degree in a shorter amount of time than otherwise possible, assuming students will take the same course load each term as they would have taken in the absence of the advanced credit. There are clear benefits to completing a degree more quickly: it reduces the direct cost of tuition and fees because the student is in school for a shorter period of time, it reduces the forgone earnings of enrolling instead of working full-time, and it increases post-college earnings as students have more time in the labor market to add to their lifetime earnings at higher wages than they could earn before or during college. I measure time to degree in two ways: months from first enrollment to degree completion and number of terms taken to complete the degree.

Employment

Alternatively, students can spend the same amount of time in college as they would have done in the absence of advanced credit and spend the time saved from accumulating the necessary graduation credits in a variety of ways. One possibility is that students with advanced credit can substitute time spent taking introductory coursework for which they already have credit with time spent on employment for pay. Although this does not reduce the direct cost of college attendance, it does reduce the cost of foregone earnings as the student can earn more money while in college than would be possible with a larger course load. Students may use AP credits this way to reduce student loan debt. I measure whether AP credits are associated with an increased likelihood of working for pay while enrolled, the number of hours per week they work, and loan debt.

Credit Accumulation

An alternative to spending time working for pay is to spend additional time on coursework. AP credit enables students to accumulate more college credit than would otherwise be possible. A student can begin with 10 credits, take a full course load each term, and graduate with 10 more credits than a fellow student who put in equal effort in college. The additional credits earned may translate into a labor market benefit as there are returns to additional college credits even after accounting for earning a degree (Kane & Rouse, 1995). Students who invest their advanced credits in this way build additional human capital without increasing time to degree. To investigate the role of AP credit on total credits earned, I examine total non-AP credits earned throughout the undergraduate career.

I also examine total non-AP credits earned in the first year of enrollment. This measure provides a test of whether students are using AP credits to substitute for college credits early in their college careers. Because the transition to college can be difficult with the greatest threat of dropout occurring in the first year (National Student Clearinghouse, 2014), it is possible a student would choose to use AP credits to ease that transition by taking fewer credits in the first year.

Major and Advanced Course Taking

Similar to the credit accumulation argument, another way in which students might use advanced credit in college is to alter their major or pursue a double major. Because advanced credits often enable students to bypass many general education requirements, more credits are available in college to focus on classes required for a major. This manifests itself in two ways. Students can select a major that requires many more credits to complete (such as engineering or another STEM field) or students can study two different majors. In either situation, a student may be able to accumulate enough credits while graduating on time. This application of advanced credits can directly improve life outcomes given the relatively higher earnings in the STEM fields, which often require a larger number of credits to complete (Carnevale, Cheah, & Strohl, 2012; Melguizo & Wolniak, 2012). There is also evidence that students who double major earn a wage premium in the labor market (Del Rossi & Hersch, 2008; Del Rossi & Hersch, Forthcoming). I observe whether students who completed a degree majored in STEM or earned a double major.

Students may also go beyond major requirements and use advanced credit to dive deeper in a certain field than they otherwise would by taking advanced coursework in that field. By skipping the introductory level of courses for which they have already earned credit, they can proceed to take more advanced courses in a specific discipline. This would lead to an overall accumulation of more coursework in a specific area of concentration. It may even enable a student to take graduate coursework during the undergraduate years. As a proxy for taking more advanced coursework generally, I test whether the number of AP credits earned is related to earning more advanced math (calculus or above) or advanced laboratory science credits.[2]

Graduate School Enrollment

Related to the accumulation of additional credit and advanced course taking, college credit earned in high school may lead to additional education in graduate school; hence, I investigate whether AP credit predicts graduate school enrollment.

Leisure

A student with advanced credit may use the time saved from course taking for leisure activities. The student can take a lighter course load in one or more terms and spend more time in extracurricular and social activities while still graduating in the time it would have taken without any AP credit. There is evidence that college students are spending less time in the classroom and studying than they once were (Babcock & Marks, 2011) and might be spending an increasing amount of time socializing and on leisure activities to the detriment of learning (Arum & Roksa, 2011).

It is unclear whether time invested in non-academic activities is beneficial or detrimental to students' long-term outcomes. While spending more time on leisure activities could negatively affect achievement, total credit accumulation, and the probability of graduating, students may find value in the extracurricular activities. For example, perhaps securing an unpaid internship at the hospital increases the chance of admission to medical school. Socializing may also build soft skills that are valued in the labor market as well as increase students' pre-professional network that may enhance job prospects. One study shows, at least for high achieving women, a positive relationship between social activities in college and early career earnings (Hu & Wolniak, 2013).

Because time use data was not collected in my dataset, I can only indirectly test this hypothesis by examining the other observable outcomes and backing out an assumption of leisure time.

Heterogeneity across Income

It is plausible that low-income students may respond to earning AP credits differently than their higher income peers, especially because several of the above outcomes, such as employment, are directly related to finances. There may be increased pressure on low-income students to use AP credits to pursue employment or to increase the number of hours working in the labor market while enrolled. Furthermore, high-income students may have the luxury of using AP credits to double major and graduate on-time while low-income students may have a larger incentive to graduate early to save money on tuition. In addition to this theoretical motivation, prior work on college credits earned in high school has documented differential effects across income levels (An, 2013). In a subgroup analysis, I examine differences in the relationship of AP college credits earned with time to degree and employment for Pell recipients compared to non-Pell recipients.

In summary, there are many different ways in which students can use their AP credit in higher education, and these may vary across student income. I turn to empirical data to shed light on which of these pathways students actually use.

Data and Descriptive Statistics

In an effort to offer evidence on the tradeoffs facing college students actually determining how to allocate advanced credit, the study employs transcript data from the Beginning Postsecondary Students Longitudinal Study (BPS) 2004/2009. This National Center for Education Statistics (NCES) survey gathered student interview, administrative, and transcript data from a nationally representative cohort of first-time college students. NCES surveyed students at the end of their first year of college (2004), then three (2006) and six (2009) years after beginning higher education. Approximately 85% of transcripts across all institutions in which these students enrolled are available. The transcript data include AP credits earned from high school courses and exams before entering college, and the administrative and survey data provide college outcomes and demographic information. The restricted use license enables me to control for each student's institution of first enrollment. Using the transcript sample and employing the NCES transcript weights to make that sample nationally representative (sample size approximately 14,940), I further restrict the analysis to students who have a non-missing value for earned AP credits for a final analytic sample of approximately 14,830.[3]

Once the weights are applied, there are no missing demographic characteristics; however, high school GPA and SAT scores were not captured for non-traditional students (over age 24). Following the procedure outlined by Von Hippel (2007), I use multiple imputation with 100 imputations to impute these prior academic characteristics for all non-traditional students and include an indicator variable for these students in the analysis. I do not impute outcomes, hence the sample size across outcomes varies as noted in the tables below.

Table 1 provides descriptive statistics for the unweighted sample separated by Advanced Placement credits, student characteristics, and outcomes of interest. The table clearly denotes the variables that are captured from the college transcript, and all credits across institutions have been normalized based on a 120 credit four-year bachelor's degree. As seen from the table, more women attend college than men, and white students make up the majority of the sample. BPS includes only first-time college students, but not all of them are traditional students who enroll in college directly after high school as seen from the average age at first enrollment of 21 and the 13% who are over age 24. Over 43% of the sample has a father or mother with at least a bachelor's degree, and 60% receive some form of federal financial aid with an average value of about $3,500. The average SAT scores is 950 and average high school GPA is a 5.7 on a 7 point scale corresponding to roughly a 3.0-3.5 letter grade. Slightly more students attend a four-year public or private college than a two-year or for-profit college, with 43% attending a very or moderately selective institution as determined by the selectivity measure created for IPEDS by NCES.

Important for this analysis, 7.6% of the sample received at least one college credit for their Advanced Placement exam scores; the average number of credits earned from AP courses for these students is nearly 10 credits. Less than 40 students received college credit for International Baccalaureate courses in the sample, so this study focuses exclusively on Advanced Placement credit. The distribution of the number of AP credits received by gender is displayed in Figure 1 and by race in Figure 2. In both of these figures (but not for the subsequent analyses), I lump everyone with 60 or more credits together to account for the long right tails. Women are more likely to have fewer than ten AP credits, with men having slightly more AP credits in the 10-20 credit range. Black students are completely absent from the distribution in the 20-45 credit range, with Asian students having the highest number of credits.

The sample sizes in Table 1 vary across outcome variables due to missing data on a few outcome variables and conditioning on bachelor's degree completion where noted. Almost 37% of the sample received a BA within 6 years after their first enrollment with an average time to degree of over 51 months corresponding to about nine and half terms.[4] Of bachelor's degree recipients, 13.7% double majored, and more than a quarter earned degrees in a STEM field. The credits earned variables exclude any Advanced Placement credit so are interpreted as the credits earned by enrolling in and taking college courses in higher education. Two-thirds of students worked during their first year of college, and, among those, the average number of hours worked per week is 24. Exactly 10% had enrolled in graduate school by the final follow-up survey 6 years after beginning higher education.

Empirical Method

To answer the first research question of the relationship between student characteristics and number of Advanced Placement credits earned, I regress the number of earned AP credits on the available set of demographic, financial, and academic variables.[5] In the final model, I include fixed effects for institution of first attendance. To answer the second research question and assess the relationship between the number of AP college course credits and college behaviors and outcomes, I use the following estimating equation:

$$y_{is} = \beta_0 + \beta_1 APcredits_{is} + \boldsymbol{X_{is}\beta} + \Lambda_s + \epsilon_{is} \qquad (1)$$

In this equation, individual student *i* attends postsecondary institution *s*. The outcomes of interest, *y*, are sector and selectivity of institutional enrollment, first-year achievement, earning a bachelor's degree, time to degree, STEM major receipt, double majoring, total credits earned during the first year and overall, the number of advanced lab science and math credits earned, studying abroad, holding a job in the first year, hours of paid work in the first year, and enrolling in graduate school. Binary outcomes are estimated using linear probability models for ease of interpretation. Due to the large number of outcomes in the analysis, it is possible several of the coefficients may be spuriously statistically significant. I use Benjamini and Hochberg's (1995) correction for multiple hypothesis testing and present the results of considering the potential for spuriously significant coefficients by considering the false discovery rate in the discussion section below.

The main independent variable of interest, APcredits, is the number of college credits earned from AP courses and exams taken prior to enrolling in higher education. The coefficient of interest is β_1 which describes the relationship between an additional AP college credit and each outcome. As earning AP college course credit is correlated to other measures of college success, I control for academic preparation and the student characteristics listed in Table 1 in vector **X**. All standard errors are clustered at the institution level.

The inclusion of institution fixed effects, Λ_s, controls for all of the institutional factors consistent across enrolled students. I use the first institution in which each student first enrolled. Results from the fixed effects model can be interpreted as the relationship between AP credits and the outcomes within institutions. Comparing students within institutions is especially important in light of the fact that Advanced Placement credit policies vary by institution and that students sort into institutions partly due to academic ability and possibly due to AP credit policies. The fixed effects estimation strategy compares students who were admitted to and enrolled in the same institution, thereby reducing bias from differing institutional standards and policies.

Despite the rich set of covariates and the inclusion of institution fixed effects, it is not clear the results can be interpreted as a causal effect of AP credits on the outcomes. There are likely other unobserved factors, such as motivation, that are only partially captured by prior academic achievement measures that are related both to the accumulation of AP credits and outcomes. Previous studies have attempted to account for possible bias using propensity score matching techniques (e.g. An, 2013; Long, Conger, & Iaratola, 2012) or regression discontinuity (e.g. Smith, Hurwtiz, & Avery 2015). While regression discontinuity provides stronger internal validity for the subset of the sample near the discontinuity, I am unware of a dataset that enables the application of this estimation technique across the host of important outcomes I consider. It would be possible to employ generalized propensity score matching techniques using the continuous nature of the number of AP credits earned as the treatment, but it is not possible to rely on this strategy within institutions given the small sample sizes within each institution in the available data. There is a tradeoff between correcting for the bias caused by differences in students sorting into institutions and institutional Advanced Placement policies against the potential bias resulting from student level characteristics that a generalized propensity score matching technique might mitigate. I believe the greater threat is at the institutional level due to the variance of AP credit policies across institutions as discussed in the Background section. Although unobserved student ability and motivation likely varies within institutions, it is reduced relative to an analysis that ignores the sorting of students into institutions by ability. I do not interpret the results to be causal; however, I conduct a bounding exercise (Altonji, Elder, & Taber, 2005; Oster, 2017) to estimate a level of bias in the unobserved variables necessary to overturn several of the most important findings. I return to the bounding results in the discussion.

I also acknowledge the selection of students into earning AP credits involves more than attending a college that grants AP credit. Students must enroll in a high school that offers AP courses, choose to take an AP course, and pass an AP exam at the end of that course. Indeed, evidence exists that magnet schools provide more AP opportunities for minority students (Conger, Long, and Iatarola, 2009), and it is generally true that high school effects can persist into college (Black, Lincove, Cullinane, and Vernon, 2015). Although accounting for high school of attendance would prove beneficial, the data from BPS does not contain high school information thereby precluding such an analysis. Incorporating high school availability of AP courses into this analysis is a direction for future research.

The estimates below describe the ways in which students use advanced credit in college given the direct tradeoffs between outcomes. This analysis is a substantial contribution to the literature, as we have little previous evidence of how college students choose to allocate their credits across a wide array of outcomes.

Results

To answer the first research question, Table 2 reports results from a multivariate regression of the number of AP credits received upon matriculation on demographic, financial, and academic variables, added sequentially across models (1) - (3). After controlling for academic characteristics, women appear to earn about one-eighth of an AP credit more than men. Black students appear to earn fewer AP credits than white students (the omitted category in the regression), but this relationship flips once prior academic achievement is added as a control. Asian students earn approximately one AP credit more than white students on average across models (1) - (3). Model (4) includes institution fixed effects to provide within institution estimates, and all of the differences across race and gender disappear. In summary, after adding controls and identifying variation from students within institutions, there is no difference in earning AP credit across gender or race. Income, as proxied by amount of Title IV aid received, appears related to earning AP credit within institution, but the magnitude of this relationship is small. Receiving an additional thousand dollars of Title IV aid is associated with a decrease of 0.023 AP credits.

Table 3 provides answers to the second research question identifying which outcomes are related to receiving AP credit by estimating equation (1). Each cell presents the coefficient and standard error on the AP credit independent variable along with the regression’s sample size from a separate regression of each outcome on AP credits earned. Outcomes are listed in the first column and grouped according to the tradeoffs in using AP credits discussed above.

Model (1) reports results from a univariate regression, Model (2) includes student level controls, and Model (3) adds institution fixed effects. There are tradeoffs between Models (2) and (3). Due to the inclusion of fixed effects, Model (3) includes the greatest number of controls and provides a within institution estimate of the relationship between AP credits and the outcomes thereby controlling for student sorting into institutions and differences in AP credit granting policy across institutions. However, Model (2) may be preferable if there is interest in considering that AP credits may be related to choice of institution of enrollment. If students choose an institution in part based on the number of AP credits received and if that choice of institution is related to the outcomes, then part of the relationship between AP credits and the outcome acts through choice of institution. As a within institution estimate, Model (3) does not observe such an effect. Due to its enhanced controls for potential sources of bias, I preference Model (3) when discussing the results below, but I provide Model (2) results in the tables for the reader's consideration.

Enrollment, Achievement, and Completion

Without any controls, AP credit receipt is highly and positively correlated with four-year college enrollment and selective college attendance, which serves as a reminder that these are relatively advantaged students. Even after controlling for prior achievement and student demographics, students with more AP credits are more likely to attend four-year institutions and attend more selective institutions. High performance on AP exams may be signaling ability to admission committees such that students with more AP credit are more likely to be admitted to selective institutions, but it is also possible that these institutions are more likely to grant AP credit. These results confirm the importance of including institution fixed effects for the remainder of the outcomes.

Receiving AP credits is positively related to increased 1st year GPA and increased likelihood of receiving a bachelor's degree within six years of initial enrollment. Given that the average number of AP credits earned is 10 among those that earn them, it is useful to interpret the coefficients for the average student. Assuming linearity, an increase of 10 AP credits is associated with a 4 percentage point increase in the likelihood of graduating within six years controlling for student characteristics and institution.

Time to Degree

One of the primary ways in which students might use AP credit is to establish advance standing and graduate earlier than they otherwise would. By regressing months from first enrollment to degree completion among those that received a BA, I find an additional 10 AP credits is associated with graduating about three-quarters of a month earlier. I also examine whether this reduction in time to degree holds for students graduating an entire term early by examining the effect of AP credit receipt on terms spent acquiring the degree for students attending institutions on semesters, quarters, and trimester systems. Across these term types, 10 AP credits is associated with a reduction of time to degree by two-tenths of a term, suggesting one out of every five students with 10 AP credits graduates a term early.

Employment

Students can finance their education in part by using advanced credits to shift time away from taking courses towards hours of paid work thereby reducing foregone earnings and likely reducing reliance on student loans. However, it does not appear that students use AP credits in this fashion. Evidence from BPS demonstrates no relationship with AP credit and being employed in the first year and a negative relationship between AP credit and hours worked with a 10 AP credit increase associated with a decline of one and a quarter hours of paid weekly work.

In the context of the previous outcome of time to degree, perhaps a small finding on hours of paid work is not surprising. When given a choice between graduating early or taking fewer units, working, and graduating on time, it may be financially preferable to invest AP credits in an effort to graduate early to save money. Given high tuition charges, it is unclear whether a student can earn enough by working during the few additional hours granted by AP credit to make up for graduating a term early.

I do, however, observe a reduction in cumulative loan debt associated with increased AP credits earned. Ten AP credits is associated with a reduction of approximately $1,000 in student loan debt. Given the small change in hours of employment, this reduction in loan debt is likely driven by reduced time to degree. The reduction in borrowing debt is also consistent with the reduced time to degree of a fifth of a term. Across the dataset, the per credit cost is approximately $265 for tuition and fees and $600 for total cost of attendance for a three credit (one fifth of 15 credits a term) cost savings between $795 and $1,800. A reduction of $1,000 in loan debt is consistent with this cost savings given not all students borrow for the full cost of attendance.

Credit Accumulation

I examine the credits earned in the first year of enrollment which excludes AP credit earned prior to college attendance. The number of credits a student takes in the first year of college indicates whether students use AP credits to take a lighter course load in their first year of college. The empirical evidence does not support the hypothesis that students use AP credit to ease the transition into college by taking a lighter load in their first year. Having 10 additional AP credits is associated with earning 1.2 more credits in their 1^{st} year. There is no relationship between AP credits and total non-AP credit earned in college, suggesting that the additional credits earned in the first year are used to take slightly fewer credits in subsequent years. However, there is no evidence that AP credit is associated with less credit from college courses taken in college throughout their collegiate careers.

Major and Advanced Course Taking

There is no observable relationship between AP credits and STEM major, but AP credits are associated with taking more advanced laboratory science and math courses. An additional 10 AP credits is associated with, on average, earning 1.6 more advanced lab science credits and 1.8 more advanced math credits. These results suggest that students are using their AP credit to bypass introductory courses and take more advanced courses, but that advanced coursework in math and science does not appear to translate into an increased likelihood of a STEM major.

Empirically, one of the primary ways in which students use AP credits is to double major. Among bachelor's degree recipients, 10 additional AP credits is associated with a seven percentage point increase in the likelihood of double majoring. This represents over a 50% increase in the probability of double majoring given the baseline of 13.7%. Advanced credit clearly eases students' path to multiple majors, and many students are availing themselves of this opportunity. Students may believe diversifying their knowledge and skill set benefits them either in the labor market or when applying to graduate school.

Graduate School Enrollment

Students with AP credit are more likely to enroll in graduate school. Model 3 of Table 3 shows a positive and significant relationship between AP credit and enrolling in graduate school with a magnitude of over a six percentage point increase in the probability of attending graduate school for every 10 AP credits earned. Relative to a baseline enrollment in graduate school of 10%, this is a large effect. This finding could be an extension of the positive relationship between AP credits and taking advanced classes and double majoring if those serve as a positive signal to graduate admission offices.

Subgroup Analysis for Low-Income Students

Because low-income students face stronger financial obstacles than their wealthier peers, they have a stronger incentive to use AP credits in financially motivated ways. Table 4 examines the interaction effect of receiving a Pell Grant with receipt of AP credits for four financially related outcomes: time to degree (measured in months and terms), employment during the first year of college, and hours worked during the first year conditional on having a job.

Results suggest that the relationship between earning AP credits and reduced time to degree is stronger for Pell recipients when measured in terms to degree. AP credits have no statistically significant relationship with terms to completion for non-Pell recipients, but ten additional AP credits for Pell recipients is associated with a reduction of time to degree of just under half a term. The point estimates are in the expected direction but not significant when measured in months to a degree. This suggests low-income students are driving the time to degree results observed above.

Related to the job outcomes, the interaction term for having a job shows there is no differential relationship between earning AP credits and having a job for Pell recipients relative to their wealthier peers. For hours worked, AP credits are associated with a reduction in work hours for non-Pell recipients conditional on having employment. The interaction term for Pell students is nearly identical in magnitude to the main effect for AP credits but in the opposite direction, suggesting low-income students have no relationship between AP credits and hours of work conditional on employment. In sum, it appears low-income students are using AP credits to save money by accelerating time to degree but not by using AP credits to change employment behavior.

Discussion

Findings from the first research question of student characteristics related to AP credit receipt supplement and extend the work of Conger, Long, and Iatarola (2009), who documented the unequal distribution of AP course taking in high school across race and gender, to important college outcomes. Similar to their work, I find controlling for prior academic performance eliminates any disadvantage initially observed for Black students. Results for Asian students also align with prior literature. These students are substantially more likely to enroll in AP classes in high school translating to increased AP credit earning in higher education. However, results for female students do not correspond to Conger, Long, and Iatarola (2009). They find a distinct advantage for women in enrolling in AP classes in high school, but I demonstrate that advantage does not appear in earning college credit. The difference may be explained by the increased likelihood of women enrolling in college, as the results presented here are conditional on college matriculation.

The observed achievement and attainment results also align with prior literature. Each additional AP credit corresponds to a 0.021 improvement in GPA controlling for student characteristics and institution. This result supports Long, Conger, and Iatarola's (2012) findings which suggest that AP courses improve subsequent academic performance. One possible mechanism for the observed improvement in GPA is that students use the credits to reduce their course load in their first year and spend more time on a smaller number of classes thereby increasing their chance of higher achievement in fewer credits. That hypothesis is not supported by the credits earned in the first year of college, as receiving additional AP credits is associated with an increased in first year course load. Instead of taking fewer credits in their first year and improving their performance, students with AP credit take more credits yet still experience higher achievement. My findings also support the attainment findings of An (2013) suggesting earning college credit in high school through either dual enrollment or Advanced Placement is related to improved likelihood of college completion.

Results from BPS also support prior findings of Advanced Placement credits leading to reduced time to degree from Smith, Hurwitz, and Avery (2015) and Klopfenstein (2010). The more recent study demonstrates students are more likely to graduate within four years relative to six while the older study suggests a small number of students graduate within three years. I provide a different and more direct estimate: the relationship between an increase in AP credit and reduced months and terms to BA completion. The results lead to similar conclusions that Advanced Placement credit is a viable pathway for reducing time to degree and therefore college costs as suggested by the $1,000 reduction in borrowing debt associated with an additional 10 AP credits, which is likely driven by the students graduating early.

An examination of nonlinear effects in the BPS data provides better support for Klopfenstein's assertion that students with enough AP credits to enter as sophomores explains why she observes a small number of students with AP credit graduating in three years. By using a binary measure of earning 30 or more AP credits earned in the fixed effect model instead of using a continuous measure of number of AP credits, I find having 30 or more credits is associated with nearly a full term reduction in time to graduation among students who received a BA (point estimate of -0.942 terms, statistically significant at the 5% level). Students with at least a year's worth of AP credit clearly use that advantage to graduate early.

One of the important contributions of this paper is that it provides estimates on a host of previously unexamined but important postsecondary outcomes in addition to increased achievement, increased attainment, and reduced time to degree. Earning 10 AP credits is associated with more than a 50% increase in the probability of double majoring, an increase of nearly two advanced math and advanced lab science credits, and a 60% increase in the probability of enrolling in graduate school. The evidence from the two credit accumulation results also suggest that students are using their AP credits to continue to earn more credits in their first year and the same number of in-college credit as students without AP credit. This finding suggests students do not substitute their AP credits for leisure time by taking fewer courses than non-AP students.

It is important to keep these results in context of who receives college credit for Advanced Placement. Only 7.6% of college matriculants are receiving these credits, and they are, on average, more academically and socio-economically advantaged relative to the typical college student. Recipients are more likely to be enrolled in selective four-year colleges and would likely work fewer hours while enrolled and enroll in graduate school at higher rates than the average college student. Granting AP credit to a much wider swath of the college going population may not yield the same results as it does for the highly capable and advantaged students currently receiving credit.

I also consider three sensitivity checks for the observed results. First, to ensure the results are not driven by misspecified functional form of the covariates, I include squared terms of the continuous covariates and examine their effect on the results in Table 3. Results are generally slightly attenuated (i.e. cumulative loan debt falls from $103 to $84, double major falls from

0.0071 to 0.0065), but qualitatively similar, although the coefficient on AP credits for the hours worked outcome is no longer statistically significant at the five percent level.

The second check considers multiple hypothesis testing, and the third is a bounding exercise considering the effects of possible omitted variables. Table 3 conducts 46 hypothesis tests when considering sixteen different outcomes across three regression models (with only two regression models for two outcomes). It is possible that a portion of the observed statistically significant results is due to falsely discovering a statistically significant coefficient (Schochet, 2008). I employ Benjamini and Hochberg's (1995) method for considering the false discovery rate of these 46 coefficients. Even after allowing for a conservative five percent false discovery rate, none of the statistically significant coefficients in Table 3 are likely to have been detected spuriously. See Appendix Table 1 for detailed results of this correction.

Finally, despite accounting for critical sources of bias (students sorting across institutions and different institutional AP credit granting policies), the most important limitation of this analysis is that unobserved individual student characteristics related both to AP credit receipt and the variety of outcomes examined may still bias the estimates. With no other obvious source of exogenous variation of AP credit receipt, the best remaining option is to estimate the magnitude of omitted variables bias necessary to overturn the results.

This is accomplished using a bounding technique as outlined by Oster (2017) which builds on the bounding work of Altonji, Elder, & Taber (2005). Oster's (2017) method relies on measuring changes in estimated coefficients when observable covariates are included in the estimation model along with assumptions about the relative effect on coefficient stability of including observable versus unobservable covariates, the latter of which may be causing bias. Given an assumed maximum R-squared value of 1 in a hypothetical regression including all observed and unobserved covariates, this bounding technique can estimate a ratio, δ, which suggests how large the relationship between the unobservable covariates and the treatment would need to be relative to the relationship between observable, included covariates and the treatment to drive the point estimate of the treatment effect on the outcome to zero.

By employing this bounding method, I estimate how large the relationship between unobservables and number of AP credits earned must be relative to the relationship between the observable controls and the number of AP credits earned to overturn the observed effect estimates.[6] I conduct this analysis for all of the Table 3 outcomes using the institutional fixed model, my preferred specification. Table 5 reports the coefficient from Model (3) of Table (3) and the delta value. Assuming proportionality, the delta value indicates the relative size of the relationship needed between unobserved omitted variables and AP credits relative to the relationship between observed covariates and AP credits to result in a coefficient of 0. For example, to completely eliminate any observed effect on terms to degree, the unobserved variables must have 2.5 times the size of the relationship with AP credits earned than the size of the relationship between the observable characteristics and AP credits earned. A negative sign on delta indicates the unobservables would have to be correlated to AP credits in the opposite direction of the observable characteristics to AP credits to overturn the results. For the double major outcome, this ratio is even larger at 2.9, although such high delta values are not typical across the wide range of outcomes. The smallest three deltas are for statistically insignificant coefficients from Table 3, and several other outcomes have notably smaller ratios between 0.15 and 0.30. However, given the strong set of controls included in the analysis, it is difficult to imagine unobserved characteristics with such great predictive power as to overturn the results of the three outcomes with the largest delta values (time to degree, double major, and loan debt).

This bounding exercise suggests that for these three variables with large deltas, the results presented in the analysis in Table 3 are unlikely to be driven entirely by omitted variables bias.

Conclusion

This paper outlines how students face choices in using college credit earned in high school. Empirical results from a nationally representative dataset suggest students use those credits to increase advanced course taking, earn a double major, and reduce time to degree thereby reducing the costs of attending postsecondary education. The results do not support one prevailing theory in higher education: that college students are not challenging themselves academically (Arum & Roksa, 2011). At least for high achieving students who earn AP credit, it appears they invest their resources into useful academic activities.

These results have implications for several constituencies. First, they support the argument that students benefit from earning college credit in high school and suggest that secondary students consider the potential long term benefits of courses which enable college credit when deciding on course enrollment in high school. Second, it suggests that institutions of higher education should continue awarding credit for college-level courses taken in high school. Instead of wasting the credits, students appear to use them in a productive fashion that is likely beneficial to themselves, the institutions, and society. Finally, these conclusions support advocates of encouraging faster time to degree by relying on college credits earned in high school and state policies requiring their public institutions of higher education to accept AP and IB scores for college credit.

Endnotes

1 Most institutions have tables available such as this one (http://records.ureg.virginia.edu/content.php?catoid=42&navoid=2751#Advanced_Placement_Program) from the University of Virginia so that students can see the number of credits they will be awarded for different exams and scores.

2 Data limitations preclude an analysis of observing advanced coursework credit in other disciplines.

3 NCES regulations require sample sizes to be rounded to the nearest 10.

4 The terms to degree attainment includes only students on semester, quarter, or trimester systems, corresponding to 74%, 13%, and 2% of the sample respectively. The other 11% are on alterative systems such as 4-1-4 or clock hours.

5 Because the number of Advanced Placement credits earned is typically a non-negative integer value, it may be more theoretically appropriate to employ a count model such as negative binomial regression (which is preferred to Poisson to account for the overdispursed nature of the data); however, numerous compilations with estimating count models with multiply imputed data, fixed effects, and probability weights make such an estimation infeasible. Using unconditional fixed effect negative binomial regression produces inconsistent estimates due to the incidental parameters problem, and it is not well established how to account for weights using a conditional fixed effects estimation strategy (for example, fixed effect Negative Binomial estimations in STATA do not allow for probability weights). Treating this outcome as a continuous variable is hence a limitation of the analysis.

6 I employ the psacalc command in STATA generated by Oster (2013) to estimate the deltas.

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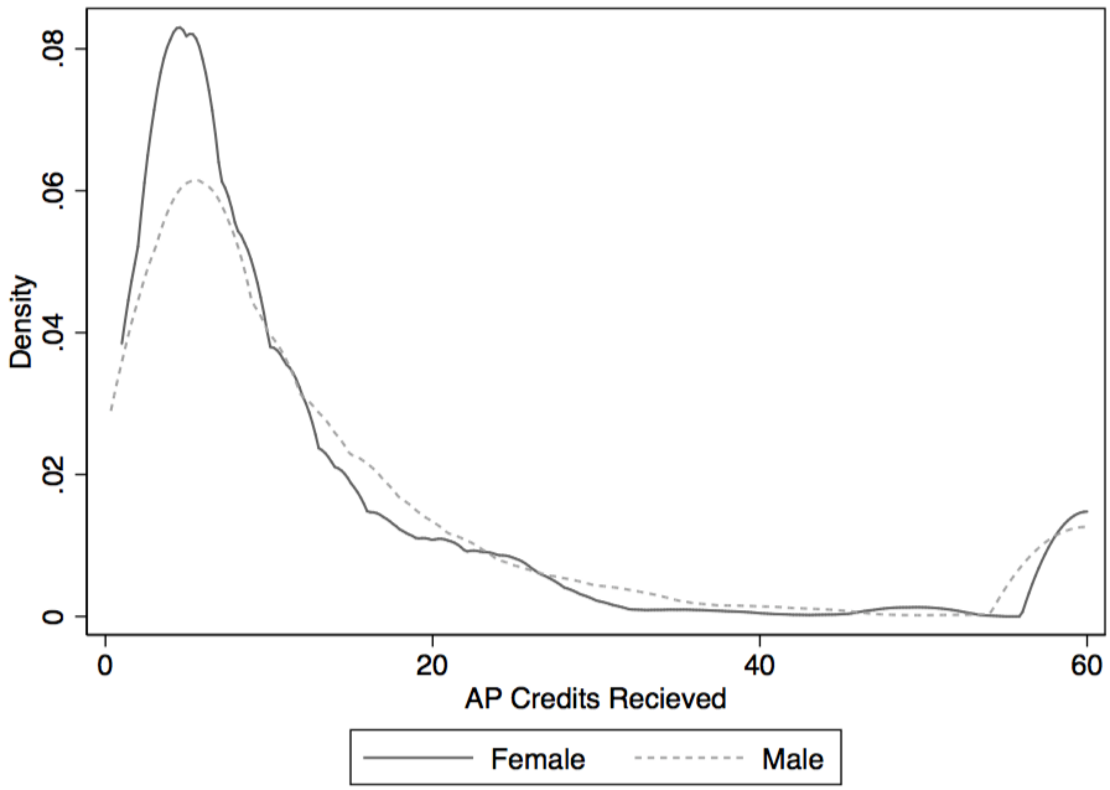
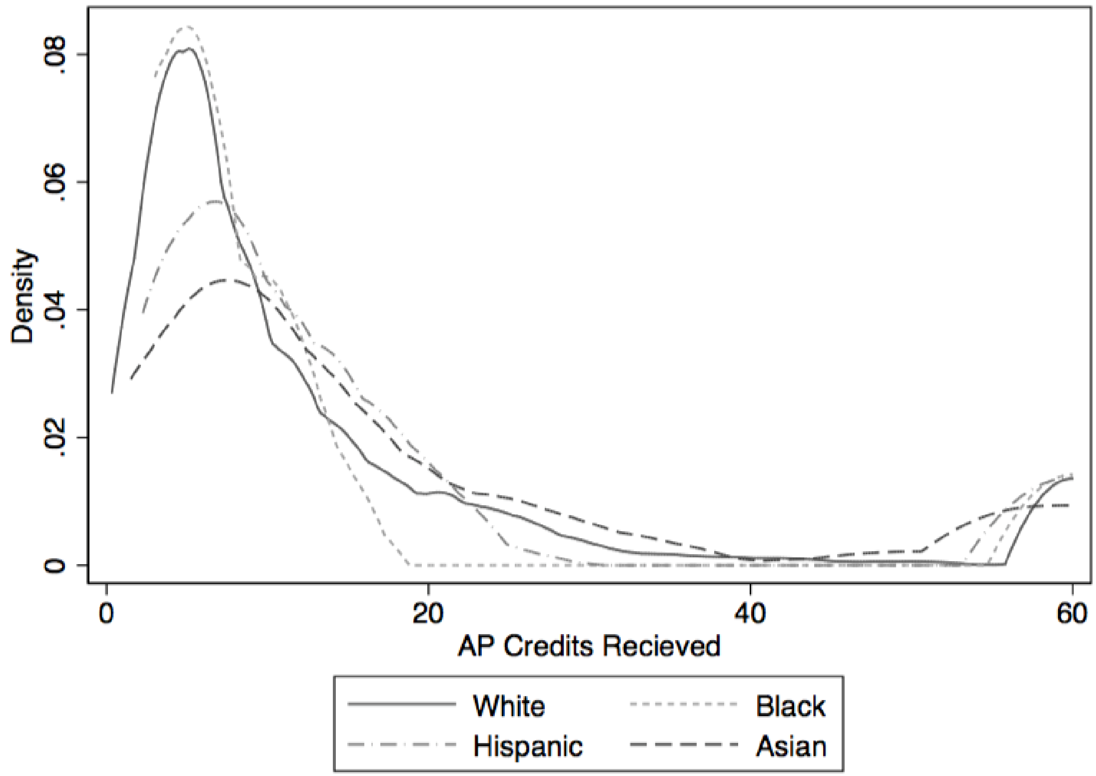
Figure 1. Distribution of AP Credits by Gender (Conditional on Having AP Credits)



Source: Authors’ calculations using BPS: 04/09.

Figure 2. Distribution of AP credits by Race (Conditional on Having AP Credits)



Source: Authors' calculations using BPS: 04/09.

Table 1. Descriptive Statistics

Variable	N	Mean	SD
Advanced Placement Credits			
Transcript: Received any AP credits	14830	0.076	0.265
Transcript: Total credits received for AP exams	14830	0.758	3.655
Transcript: Total credits received for AP exams (cond. on Receipt)	14830	9.973	9.154
Student Characteristics			
Female	14830	0.587	0.492
White	14830	0.653	0.476
Black	14830	0.126	0.331
Hispanic or Latino	14830	0.124	0.329
Asian	14830	0.046	0.210
Either parent has a bachelor's degree	14830	0.431	0.495
US Citizen	14830	0.950	0.217
Age	14830	20.943	6.685
Student is over the age of 24	14830	0.131	0.337
High School GPA	14830	5.73	1.25
SAT Score	14830	950	230
Received any Title 4 funding	14830	0.600	0.490
Received any Pell Grant funding	14830	0.357	0.479
Title IV aid amount in 1st year	14830	3,506.02	4,696.51
Cumulative student loan debt in 2009	14830	11,865.21	16,991.64
Outcomes			
Attended a 4-year non-profit private or public institution	14830	0.543	0.498
Attended very or moderately selective 4 year institution	14820	0.430	0.495
1st year college GPA	14240	2.739	1.014
STEM Major conditional on BA receipt	3970	0.276	0.447
Double-majored conditional on BA receipt	5240	0.137	0.343
Transcript: Advanced laboratory science credits earned	14760	3.243	8.454
Transcript: Advanced math credits earned	14810	1.739	4.408
Transcript: Credits earned in the first year excluding AP credits	14350	23.309	11.999
Transcript: Credits earned excluding AP credits	14540	87.025	52.5431
Enrolled in graduate school	14830	0.100	0.300
Employed in first year of college	14830	0.667	0.472
Weekly hours worked in first year conditional on being employed	9890	23.908	13.377
Received bachelor's degree within 6 years	14830	0.367	0.482
Time to degree - Months to bachelor's degree conditional on receipt	5450	51.328	8.888
Time to degree - Terms to bachelor's degree conditional on receipt	5050	9.450	3.068

Notes: All sample sizes are rounded to the nearest 10 in accordance with NCES regulations. Sample sizes vary across outcomes due to missing data. HS GPA and SAT scores are missing for all students over the age of 24 and are imputed using multiple imputations with 100 imputations. HS GPA is an ordinal measure from 1 to 7 with 1 representing 0.5 – 0.9 (D- to D) and 7 representing 3.5 – 4.0 (A- to A). SAT Score rounded to the nearest 10 points.

Table 2. Relationship between Number of AP Credits Received and Student Characteristics

	(1)	(2)	(3)	(4)
Female	0.029	0.031	0.125*	0.093
	(0.055)	(0.055)	(0.057)	(0.054)
Black	-0.338***	-0.327***	0.458***	0.221
	(0.075)	(0.074)	(0.104)	(0.116)
Asian	1.055**	1.054**	0.983**	0.251
	(0.365)	(0.365)	(0.342)	(0.307)
Hispanic or Latino	-0.075	-0.071	0.349***	0.165
	(0.075)	(0.075)	(0.095)	(0.085)
Age	-0.015***	-0.015***	0.036***	0.021***
	(0.003)	(0.003)	(0.009)	(0.006)
Student is over the age of 24	-0.181***	-0.177***	0.004	0.048
	(0.040)	(0.040)	(0.075)	(0.051)
Binary for either parent having a BA	0.741***	0.736***	0.272***	0.085
	(0.097)	(0.095)	(0.058)	(0.057)
Title IV aid amount in 1st year (1,000's)		-0.008	-0.011	-0.023**
		(0.007)	(0.006)	(0.008)
High School GPA			0.048*	-0.021
			(0.020)	(0.018)
Test score out of 1600			0.004***	0.003***
			(0.001)	(0.000)
Constant	0.624	0.659	-4.743	-2.737
	(0.091)	(0.101)	(0.575)	(0.444)
Institutional Fixed Effects				X
R^2	0.028	0.029	0.090	0.331
Observations	14830	14830	14830	14830

Notes: * p<0.05, ** p<0.01, *** p<0.001. All sample sizes are rounded to the nearest 10 in accordance with NCES regulations. Standard errors are clustered at the institutional level and included in parentheses. White students and other race students are the reference category for the race variables. HS GPA and SAT score are missing for all students over the age of 24 and are imputed using multiple imputations with 100 imputations. HS GPA is an ordinal measure from 1 to 7 with 1 representing 0.5 – 0.9 (D- to D) and 7 representing 3.5 – 4.0 (A- to A).

Table 3. Relationship between Number of AP Credits and College Outcomes

	(1)	(2)	(3)
Attended four-year institution	0.028***	0.008***	
	(0.003)	(0.002)	-
	<14830>	<14830>	
Attended very or moderately selective four-year institution	0.032***	0.011***	
	(0.003)	(0.002)	-
	<14820>	<14820>	
1st Year College GPA	0.041***	0.022***	0.021***
	(0.004)	(0.003)	(0.003)
	<14240>	<14240>	<14240>
Received bachelor's degree in 6 years	0.029***	0.010***	0.004***
	(0.003)	(0.002)	(0.001)
	<14830>	<14830>	<14830>
Months to completion (Conditional on BA Receipt)	-0.220***	-0.069*	-0.077*
	(0.033)	(0.032)	(0.037)
	<5450>	<5450>	<5450>
Terms to completion (Conditional on BA Receipt)	0.033	0.050	-0.020***
	(0.029)	(0.027)	(0.008)
	<5050>	<5050>	<5050>
Employed in 1st year	-0.012***	-0.008***	-0.002
	(0.002)	(0.002)	(0.002)
	<14830>	<14830>	<14830>
Hours worked per week, 1st year	-0.690***	-0.334***	-0.126*
(Conditional on employment)	(0.109)	(0.069)	(0.053)
	<9890>	<9890>	<9890>
Cumulative loan debt in 2009	-1.446	-110.467**	-103.962*
	(45.561)	(38.097)	(41.703)
	<14830>	<14830>	<14830>
Credits earned in the 1st year (Excluding AP)	0.507***	0.217***	0.119***
	(0.039)	(0.032)	(0.028)
	<14350>	<14350>	<14350>
Total credits earned (Excluding AP)	2.510***	0.637***	0.158
	(0.000)	(0.164)	(0.153)
	<14540>	<14540>	<14540>
STEM major (Conditional on BA Receipt)	0.010***	0.004	0.002
	(0.002)	(0.002)	(0.002)
	<3970>	<3970>	<3970>
Double-major (Conditional on BA Receipt)	0.007***	0.005***	0.007***
	(0.001)	(0.001)	(0.001)
	<5240>	<5240>	<5240>
Advanced laboratory science credits earned	0.398***	0.236***	0.164**
	(0.051)	(0.046)	(0.059)
	<14760>	<14760>	<14760>
Advanced math credits earned	0.337***	0.229***	0.181**
	(0.026)	(0.023)	(0.025)
	<14810>	<14810>	<14810>
Enrolled in graduate school	0.014***	0.008***	0.006***
	(0.002)	(0.002)	(0.002)
	<14830>	<14830>	<14830>
Controls		X	X
Institution Fixed Effects			X

Notes: * p<0.05, ** p<0.01, *** p<0.001. Each cell reports the coefficient on the number of Advanced Placement credits from a separate regression of the outcome listed in the first column on the number of AP credits. Standard errors are clustered at the institutional level and included in parentheses. All sample sizes are rounded to the nearest 10 in accordance with NCES regulations and are included in angle brackets. They vary due to missing data in the outcomes. Binary outcomes are estimated using linear probability models. Controls include student's high school GPA and SAT score, gender, race, citizenship status, age, amount of title IV aid, whether a student is a non-traditional (over age 24), and whether either of the student's parents hold a bachelor's degree. HS GPA and SAT scores are missing for all students over the age of 24 and are imputed using multiple imputations with 100 imputations.

Table 4. Subgroup Analysis for Low-Income Students

	Months to Completion			Terms to Completion			Employed in 1st year			Hours worked per week, 1st year		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
AP Credits	-0.203***	-0.053	-0.055	0.035	0.051	-0.010	-0.015***	-0.010***	-0.003	-0.803***	-0.408***	-0.191***
	(0.037)	(0.038)	(0.045)	(0.033)	(0.032)	(0.010)	(0.002)	(0.002)	(0.002)	(0.073)	(0.055)	(0.049)
Pell	1.776***	0.903*	0.611	0.570**	0.172	0.128	-0.035*	-0.057***	-0.036*	0.331	-0.633	-0.987
	(0.429)	(0.417)	(0.430)	(0.182)	(0.175)	(0.081)	(0.014)	(0.014)	(0.014)	(0.498)	(0.492)	(0.509)
AP Credits X Pell	-0.045	-0.082	-0.103	0.001	-0.002	-0.046*	0.012**	0.011**	0.005	0.395*	0.247*	0.190*
	(0.111)	(0.085)	(0.081)	(0.031)	(0.029)	(0.021)	(0.004)	(0.004)	(0.003)	(0.195)	(0.105)	(0.074)
Controls		X	X		X	X		X	X		X	X
Institution Fixed Effects			X			X			X			X
Adjusted R^2	0.021	0.119	0.298	0.009	0.045	0.762	0.008	0.022	0.134	0.019	0.184	0.296
Observations	5450	5450	5450	5050	5050	5050	14830	14830	14830	9880	9880	9880

Notes: * p < 0.05, ** p < 0.01, *** p < 0.001. Robust standard errors, clustered at the institution level, are in parentheses. Hours worked per week is conditional on employment. Months to completion and terms to completion are conditional on BA receipt. Controls include student's high school GPA and SAT score, gender, race, citizenship status, age, amount of title IV aid, whether a student is a non-traditional (over age 24), and whether either of the student's parents hold a bachelor's degree. HS GPA and SAT score are missing for all students over the age of 24 and are imputed using multiple imputations with 100 imputations. HS GPA is an ordinal measure from 1 to 7 with 1 representing 0.5 – 0.9 (D- to D) and 7 representing 3.5 – 4.0 (A- to A).

Table 5. Bounding Analysis

Outcome	Coefficient	Delta
1st Year College GPA	0.021	0.787
Received bachelor's degree in 6 years	0.004	0.169
Months to completion (Conditional on BA Receipt)	-0.077	0.441
Terms to completion (Conditional on BA Receipt)	-0.020	-2.492
Employed in 1st year	-0.002	0.055
Hours worked per week, 1st year (Conditional on employment)	-0.126	0.159
Cumulative loan debt in 2009	-103.962	-1.410
Credits earned in the 1st year (Excluding AP)	0.119	0.302
Total credits earned (Excluding AP)	0.158	0.074
STEM Major (Conditional on BA Receipt)	0.002	0.098
Double Major (Conditional on BA Receipt)	0.007	2.943
Advanced laboratory science credits earned	0.164	0.204
Advanced math credits earned	0.181	0.454
Enrolled in graduate school	0.006	0.208

Notes: The table provides estimates of the magnitude of omitted variables bias necessary to overturn results employing the method of Oster (2017). Cells in the Coefficient column report the coefficient on Advanced Placement credits from a separate regression of the outcome listed in the first column on AP credits using institutional fixed effects and student level controls (high school GPA and SAT score, gender, race, citizenship status, age, amount of title IV aid, whether a student is a non-traditional student (over age 24), and whether either of the student's parents hold a bachelor's degree). They are consistent with the coefficients in Model (3) of Table 3. Binary outcomes are estimated using linear probability models. HS GPA and SAT scores are missing for all students over the age of 24 and are imputed using multiple imputations with 100 imputations. Delta reports the relative size of the relationship between unobserved omitted variables and number of AP credits relative to the relationship between observed covariates and number of AP credits needed to result in a coefficient of 0.

Appendix Table 1. Benjamini and Hochberg Multiple Hypothesis Testing Correction

Variable	P-value	P-value Rank	Significant without Correction at α = 0.05	New Critical Value for 0.05 FDR	Significant after BH Correction
Model 1: Total credits earned (Excluding AP)	0	1	Yes	0.001087	Yes
Model 1: Advanced math credits earned	1.5052E-35	2	Yes	0.002174	Yes
Model 1: Credits earned in the 1st year (Excluding AP)	1.9333E-34	3	Yes	0.003261	Yes
Model 1: Received bachelor's degree in 6 years	1.0189E-27	4	Yes	0.004348	Yes
Model 1: Attended very or moderately selective four-year institution	8.9413E-26	5	Yes	0.005435	Yes
Model 1: 1st Year College GPA	5.4752E-24	6	Yes	0.006522	Yes
Model 1: Attended four-year institution	2.216E-23	7	Yes	0.007609	Yes
Model 2: Advanced math credits earned	1.0857E-21	8	Yes	0.008696	Yes
Model 3: 1st Year College GPA	1.2302E-15	9	Yes	0.009783	Yes
Model 1: Advanced laboratory science credits earned	1.2914E-14	10	Yes	0.010870	Yes
Model 2: 1st Year College GPA	3.2674E-14	11	Yes	0.011957	Yes
Model 1: Enrolled in graduate school	7.0756E-13	12	Yes	0.013043	Yes
Model 3: Advanced math credits earned	1.2945E-12	13	Yes	0.014130	Yes
Model 2: Credits earned in the 1st year (Excluding AP)	3.0895E-11	14	Yes	0.015217	Yes
Model 1: Months to completion (Conditional on BA Receipt)	5.6543E-11	15	Yes	0.016304	Yes
Model 1: Employed in 1st year	1.081E-10	16	Yes	0.017391	Yes
Model 1: Hours worked per week, 1st year	3.9874E-10	17	Yes	0.018478	Yes
Model 2: Received bachelor's degree in 6 years	4.8931E-10	18	Yes	0.019565	Yes
Model 2: Attended very or moderately selective four-year institution	6.0538E-09	19	Yes	0.020652	Yes
Model 1: Double-major (Conditional on BA Receipt)	1.849E-08	20	Yes	0.021739	Yes
Model 2: Advanced laboratory science credits earned	2.8739E-07	21	Yes	0.022826	Yes
Model 2: Attended four-year institution	3.8602E-07	22	Yes	0.023913	Yes
Model 3: Double-major (Conditional on BA Receipt)	5.0705E-07	23	Yes	0.025000	Yes
Model 1: STEM major (Conditional on BA Receipt)	9.3225E-07	24	Yes	0.026087	Yes
Model 2: Hours worked per week, 1st year	1.471E-06	25	Yes	0.027174	Yes
Model 2: Enrolled in graduate school	4.7673E-06	26	Yes	0.028261	Yes
Model 2: Employed in 1st year	1.0253E-05	27	Yes	0.029348	Yes
Model 3: Credits earned in the 1st year (Excluding AP)	2.899E-05	28	Yes	0.030435	Yes
Model 2: Total credits earned (Excluding AP)	0.000117	29	Yes	0.031522	Yes
Model 2: Double-major (Conditional on BA Receipt)	0.000167	30	Yes	0.032609	Yes
Model 3: Enrolled in graduate school	0.000356	31	Yes	0.033696	Yes
Model 3: Received bachelor's degree in 6 years	0.001118	32	Yes	0.034783	Yes

Model 2: Cumulative loan debt in 2009	0.003853	33	Yes	0.035870	Yes
Model 3: Advanced laboratory science credits earned	0.005252	34	Yes	0.036957	Yes
Model 3: Cumulative loan debt in 2009	0.012901	35	Yes	0.038043	Yes
Model 3: Terms to completion (Conditional on BA Receipt)	0.014976	36	Yes	0.039130	Yes
Model 3: Hours worked per week, 1st year	0.016898	37	Yes	0.040217	Yes
Model 2: Months to completion (Conditional on BA Receipt)	0.029372	38	Yes	0.041304	Yes
Model 3: Months to completion (Conditional on BA Receipt)	0.035539	39	Yes	0.042391	Yes
Model 2: STEM major (Conditional on BA Receipt)	0.065886	40	No	0.043478	No
Model 2: Terms to completion (Conditional on BA Receipt)	0.069011	41	No	0.044565	No
Model 3: Employed in 1st year	0.182859	42	No	0.045652	No
Model 1: Terms to completion (Conditional on BA Receipt)	0.266087	43	No	0.046739	No
Model 3: Total credits earned (Excluding AP)	0.304293	44	No	0.047826	No
Model 3: STEM major (Conditional on BA Receipt)	0.514505	45	No	0.048913	No
Model 1: Cumulative loan debt in 2009	0.974699	46	No	0.050000	No

Notes: This table reports results from the Benjamini and Hochberg multiple hypothesis testing correction procedure. The p-values are taken from the regression results in Table 3 adjusting for degrees of freedom. The coefficients are rank ordered from the lowest to the highest p-values across the three models and statistical significance corresponds to the significance stars in Table 3. The new critical values are calculated using a False Discovery Rate of 0.05, and statistical significance after the correction is determined by deeming statistically significant every coefficient of lower or equal rank to the coefficient with the largest p-value that remains lower than the new critical value.