

PUTTING THE "A" IN AP: THE EFFECT OF ADVANCED COURSE ACCESS ON AP
PARTICIPATION AND PERFORMANCE

by

Ian Andrew Callen

A thesis submitted in partial fulfillment
of the requirements for the degree

of

Master of Science

in

Applied Economics

MONTANA STATE UNIVERSITY
Bozeman, Montana

May 2022

©COPYRIGHT

by

Ian Andrew Callen

2022

All Rights Reserved

DEDICATION

”But growth has given me
more grace
than I could have imagined.
Because although we ended clumsily
and were never meant to
last,
I met more of me because of you
and I wouldn’t take that back”
- Sophie Diener

ACKNOWLEDGEMENTS

I would like to thank my thesis committee members, Dr. John Krieg, Dr. Wendy Stock, Dr. Andrew Hill, and most notably, my committee chair Dr. Christiana Stoddard. I would also like to thank the entire staff and faculty in the Department of Agricultural Economics and Economics for their everlasting support and guidance. Lastly, I would like to thank my wonderful classmates who spent countless hours listening to every new idea that ever crossed my mind.

TABLE OF CONTENTS

1. INTRODUCTION	1
2. POLICY INFORMATION AND BACKGROUND	5
Background on the Advanced Placement Program	5
Structure of Advanced Course Mandates	6
Structure of AP Funding Policies	7
3. REVIEW OF LITERATURE	8
Literature on Course Curriculum	8
Literature AP Program Demographics	10
Contributions	10
4. THEORETICAL MOTIVATION	12
5. EMPIRICAL STRATEGY	14
Data and Descriptive Statistics	14
Identification Strategy	15
6. RESULTS	20
Relationship Between State Policies and Exam Participation	20
Relationship Between State Policies and Exam Performance	22
Relationship Between State Policies and Post Secondary Behavior	23
Alternative Difference-in-Difference Specifications	24
Alternative College Preparatory Programs	25
Additional State Subsidies	26
7. CONCLUSION	28
REFERENCES CITED	31
APPENDICES	37
APPENDIX A : Main Tables	38
APPENDIX B : Figures	59
APPENDIX C : Policy Tables	71

LIST OF TABLES

Table	Page
A.1 Table Of Policy Status by Year	39
A.2 Table of Outcomes and Explanation	39
A.3 Summary Statistics of Outcome Variables.....	40
A.4 Sample Summary Statistics of Control Variables, by even- tual treatment status (mandate)	41
A.5 Sample Summary Statistics of Control Variables, by even- tual treatment status (funding)	42
A.6 Table of Covariates	43
A.7 The Effect of Advanced Course Mandates on the Log Number of Candidates and Exams	44
A.8 The Effect of Advanced Course Mandates on the Log Number of Candidates by Ethnicity Group	45
A.9 The Effect of Advanced Course Mandates on the Log Number of Exams by Ethnicity Group.....	46
A.10The Effect of Advanced Course Mandates on the Log Number of Exams By Exam Type.....	47
A.11The Effect of Advanced Course Mandates on the Pass Rate.....	48
A.12The Effect of Advanced Course Mandates on the Log Number of Candidates and Exams	49
A.13The Effect of Advanced Course Mandates on the Log Number of Exams by Score - White Students.....	50
A.14The Effect of Advanced Course Mandates on the Log Number of Exams by Score - African American Students.....	51
A.15The Effect of Advanced Course Mandates on the Log Number of Exams by Score - Asian Students	52
A.16The Effect of Advanced Course Mandates on the Log Number of Exams by Score - Hispanic Students	53

LIST OF TABLES – CONTINUED

Table	Page
A.17The Effect of Advanced Course Mandates on the Log Number of Students Sending AP Exam Scores to Universities.....	54
A.18The Effect of Advanced Course Mandates on the Log Number of Students Sending AP Exam Scores to Universities.....	55
A.19The Effect of Advanced Course Mandates on the Log Number of Students Applying to Universities.....	56
A.20The Effect of Advanced Course Mandates on the Log Number of Candidates.....	57
A.21The Effect of Advanced Course Mandates on the Log Total Candidates.....	58

LIST OF FIGURES

Figure	Page
B.1 Growth of the AP Program	60
B.2 Growth of the AP Program – By Race	61
B.3 US Map with AP Policy Status by 2019	62
B.4 Percent of AP Candidates Sending AP Exam Scores to Any University	65
B.5 Effect of AP Mandates on the Log of Total Candidates	66
B.6 Effect of AP Funding on the Log of Total Candidates.....	67
B.7 Effect of AP Mandates on the Log of Total Exams.....	68
B.8 Effect of AP Funding on the Log of Total Exams	69
B.9 Pass Rate on AP Exams by State, Year, and Mandate status.....	70

ABSTRACT

This paper investigates the effect of state-level policy regarding access to advanced course curriculum on participation and performance within the Advanced Placement (AP) program. From the early 2000's through 2019, participation in the Advanced Placement (AP) program, the most popular college-preparatory course in the United States, has nearly tripled in size. Today, nearly 20% of all high school students taking at least one AP exam per year. The AP program provides an opportunity for students to potentially earn college credit while still in high school which, at least in theory, reduces the cost of a college education. While the AP program provides many benefits to students, it also presents two major barriers – the ability to access advanced-level courses, and the monetary cost associated with taking the AP exam. We find that when states require schools to offer AP courses and when states fund AP exams, participation within the program increases drastically. For Black and Hispanic students, our estimates indicate a large increase in the number of exams that receive a passing score. These findings indicate that when states reduce the financial burden associated with taking an AP exam, students have the ability to participate and succeed in the program at higher rates than their peers in states without AP curriculum and exam funding.

INTRODUCTION

“We are true to our creed when a little girl born into the bleakest poverty knows that she has the same chance to succeed as anybody else.”

— Barack Obama

Public programs concerned with universal access to education resources and curricula seek to mitigate obstacles that hinder students from obtaining a high-quality education. This is evident in recent policy actions taken at the state level to assist students that often lack equal access to education. A central tenet to such actions is that access to education should be universal, free of structural barriers. Many argue that state efforts to encourage universal access to education would allow students otherwise left behind, a chance to participate. Others argue that these efforts are costly and only benefit a small set of students.

Existing research typically finds that school and district level policies that encourage access to various education curricula can positively affect students. However, we know less about how state level policies can affect students. Hence, this paper investigates two questions often asked about access to education. First, are state efforts to reduce barriers associated with college-preparatory programs effective at increasing participation in those programs? Second, do students benefit from college-preparatory programs, and is the effect the same across demographic groups?

Empirically addressing these questions is often difficult to ascertain; at the very least, it requires data on outcomes from identical programs observed under varying conditions of access – a circumstance that rarely occurs in practice. The Advanced Placement (AP)

program in the United States provides a rare opportunity to examine this topic. While one in five high school students take at least one AP exam per year, seldomly is the AP program associated with universal access. This is because as not all schools offer AP courses and the fees associated with the exams are a barrier to access. This paper examines two types of state policy designed to mitigate these barriers – (1) legislation that mandates all schools (or all districts) to offer AP courses and (2) policies that pay AP exam fees for all students.

Using a data set constructed from College Board reports of AP exam performance, I use both an event study and a difference-in-differences strategy to estimate the effect of state policies that mandate the provision of AP courses and/or fund AP exams. By including data on states that do not have AP course mandates and/or AP funding (referred to as AP program policies), I control for changes that occur over time and in all states. While there is a growing literature on the benefits of advanced coursework,¹ no papers to date have estimated the effect of increased access to advanced courses on student participation and performance on college entrance exams. I examine course offering and funding effects in aggregate, for students from various racial and ethnic backgrounds, and by exam subject.

I show that state efforts to reduce barriers associated with college-preparatory programs, either through mandating the provision of courses or through funding exams, increase student participation in the AP program. For states that mandate the provision of courses, I observe a 17% increase in the number of students taking an AP exam. Estimated impacts are slightly higher in states that fund at least one AP exam. In those states, funding leads to a 19% increase in AP test-taking. The estimates are higher for traditionally underrepresented minorities, consistent with literature that suggests Black and Hispanic students have less access to college preparation than their peers (Klopfenstien, 2004).

States that mandate AP courses experience increases in the number of students earning

¹Studies on the AP program include Mattern et al. (2011), Smith et al. (2017), Avery et al. (2018), Evans (2019), Guarantz (2021).

a score of 3 or higher (the typical cutoff for college credit) by around 6%. Funding all AP exams increases the number of students earning a score of 3 by around 10%. At the same time, the number of students failing AP exams also increases, lowering the overall pass rate. I also find that the positive impact of funding AP exams is larger for Black and Hispanic students, consistent with the idea that AP exam fees act as a more substantial barrier to test taking for high ability minority students than for White or Asian students.

The event study analysis indicates no significant difference in trends between states that passed AP program policies and control states, adding greater confidence that trends between the states would have remained parallel in the absence of the AP policies. The event study analysis also does not indicate any evidence of anticipatory effects before the passage of these policies. Further, the effects are relatively uniform after the policies are enacted rather than increasing or changing over time, and consequently, newer difference-in-difference estimation approaches show similar results.

This study makes two primary contributions. First, it provides the first estimates of the short-run impact of state policies that reduce barriers to accessing the AP program. Expanding prior research of that focused primarily on limited intervention programs (Jackson, 2010) and external effects of state policies regarding AP access (Arce-Trigatti, 2018), I find that a vast number of students lack access and could benefit from state efforts to ensure more equality.² Black and Hispanic students are particularly hindered by financial barriers associated with taking AP exams, so reducing this financial burden is an impactful and potentially efficient economic mobility lever available to state policymakers.

Second, this study shows that increased access to the AP program, induced through state policies that reduce barriers associated with the program, increase the number of

²Smith et al. (2017), Avery et al. (2018), and Gurantz (2021) examine the effect of receiving a passing score on an AP exam. While I am unable to comment on the relative benefit of these programs on students outcomes directly, these papers suggest that we should expect a positive benefit for a sample of students that now receive a passing score on exams where they previously did not.

students who apply to university.

The rest of this paper is organized as follows: Chapter 2 provides a brief history of advanced course programs and the policies of interest in this study. Chapter 3 provides a discussion of relevant literature associated with this study. Chapter 4 provides a theoretical framework to motivate the empirical methodology. Chapter 5 provides the formal empirical strategy utilized in this study. Chapter 6 presents the estimation results, and Chapter 7 concludes.

POLICY INFORMATION AND BACKGROUND

Background on the Advanced Placement Program

The Advanced Placement (AP) program was the first formalized program developed to bring higher level academic curriculum to students in high school.¹ The core of the AP program was to grow and develop strong high school curriculum in preparation for college.² In 1955, the first AP exams were administered in twenty-seven schools with resulting performance on exams to be examined by major U.S. universities. Today, AP courses are taught in high schools across the country using a standardized curriculum set forth by the College Board. Each May, students have the opportunity to take the AP exam that corresponds with the AP course offered in their high school.

There is no requirement to be enrolled in an AP course to take an AP exam.³ Students who wish to take an AP exam arrange to take the exam at their school or, if their school does not administer the exam, at a local school or testing center that administers it.⁴ Students who participate in AP exams tend to be academically stronger than average college-aspiring students as shown by a higher than average performance on the SAT (Smith et al. 2017).

The choice to offer AP classes is typically done at the school or district level.⁵ College credit is earned when a student achieves a certain score on the respective course exam offered.⁶

¹Other programs were developed in a similar vein. Most notably was the International Baccalaureate (IB) program which was formalized in the early 1960's. Other curriculum of similar design include the Cambridge AICE program which was developed by the University of Cambridge in the late 1990's.

²See Rothschild (1999) for an exhaustive history of the AP program.

³This may occur for a variety of reasons. One such reason is students may be interested in subject that their school may not offer. In such a case, students have the ability to access study materials provided through the College Board to study for the exam. Students who participate in home schooling are guided in the same manner. Another reason may be students who participate in other advanced course programs may want to utilize the AP exam as a method of receiving post-secondary credit.

⁴An exhaustive explanation of this process can be found on the College Board website.

⁵See Iatarola et al. (2011) and Gagnon and Mattingly (2016)

⁶The score a student needs to achieve to receive college credit depends on the university.

Structure of Advanced Course Mandates

Mandating advanced courses, particularly courses associated with the AP program, has recently become a popular legislative topic. Starting in 1985 and later in the early 1990s, South Carolina and Virginia passed legislation that required all schools in the state to offer AP courses. From 2005 to 2012, seven more states passed similar legislation. Nine other states have mandated that general college preparatory courses must be offered to students in every school or in every school district. The mandates allow schools to fulfill the mandate through either AP, International Baccalaureate (IB), Cambridge or other forms of college-preparatory courses.⁷

General college preparatory course mandates and AP course specific mandates, differ across states in a number of ways. For AP mandates, heterogeneity is present mostly in the magnitude of the mandates. In Arkansas, schools are required to offer an AP course in one of the four core areas⁸ - math, science, social studies, and English. In Indiana, the requirement is only for courses in math and science (i.e., two courses are required, one in math and the other in science). For more general college preparatory course mandates, some place a higher emphasis on AP or IB courses while others emphasize dual enrollment courses.

Table A.1 indicates policy status over time, which is shown visually in Figure B.3. Table A presents the mandate policies used in this study and the exact language specified in the policy.

⁷There are other advanced courses that are offered in high school curriculum however, this study focuses on the major programs often mandated at the state level. For the purposes of this study, an advanced course is a course within the AP/IB/Cambridge or Dual Enrollment programs.

⁸A core area is described by policy and is not a College Board definition. I refer to core subject areas as those defined by legislative policy.

Structure of AP Funding Policies

In 2001, the cost of an AP exam was \$77 before additional fees were applied by districts. In 2022, the cost was \$96 before additional fees – a 25% increase. In 2002, Florida became the first state to pay all student AP exam fees, regardless of household income status. Since then, nine additional states have followed suit and now pay for all exam fees for at least one student AP examination. These policies pay for all AP exams, leaving the cost to the student to be zero. Table B reports the funding policies used in this study and the exact language specified in the policy.

REVIEW OF LITERATURE

A large and growing body of research in economics and education focuses on curriculum choice and the benefits associated with education access. This chapter describes the current state of the literature and explains the contribution of this paper.

Literature on Course Curriculum

Research on the effects of different educational curricula tends to focus on high school students.¹ Altonji et al. (2012) find that the types of courses students take has a substantial impact on the economic returns to their education. They find that taking advanced courses has a substantial economic return for those who utilize those courses while vocational courses has substantial economic return for students who do not intend to go to college.² A number of papers have estimated the effect of changing course curriculum, particularly in math and science, with later high school decisions and college enrollment.³ One shortcoming of most papers concerning education access the resulting effect is they fail to identify a causal effect – without exogenous variation in course offerings, it is difficult to control for selection bias.

Arce-Trigatti (2018) is the first paper to examine the effect of mandated AP courses on curriculum offerings, enrollment and student performance on end-of-course exams. Using data from Arkansas for 2004 and 2008, she uses a difference-in-difference methodology to compare outcomes in schools in pre-compliance with the AP mandate and schools not in pre-

¹Most research has been concerned with curriculum and wages (Altonji 1995; Levine and Zimmerman 1995; Dolton and Vignoles 2002; Rose and Betts 2004; Joensen and Nielsen 2009; Goodman 2012).

²Student choice is often limited by the school-level choice to offer courses. Iatarola et al. (2011) finds that schools offer AP courses when they have enough students with high levels of prior achievement to justify forming a separate class. This suggests that schools maximize their resources based on their student body.

³Aughinbaugh (2012) found that including more rigorous high school math curriculum is associated with a higher probability of attending college. Similarly, De Philippis (2021) finds that increasing exposure to science courses increases the probability of enrolling in and graduating with a degree in STEM.

compliance. She finds that the AP mandate generated decreases in enrollment but increases in graduation rates as schools shifted away from CTE courses in order to comply with the mandate.

Even advanced courses themselves, different types of courses appear to attract different types of students. Speroni (2011) finds that when schools in Florida implement dual enrollment courses, the students who take these courses are inherently different than students who take AP courses. This is supported by Hemelt et al. (2020) who explores the impact of dual enrollment courses when such courses are introduced into a school. They find that top-performing students were more likely to enroll in AP math courses, but middle performing students were more likely to take dual enrollment math courses. Speroni (2011) finds that when schools in Florida implement dual enrollment courses, the students who take these courses are inherently different than students who take AP courses.

There remains a dimensional aspect to AP participation – while overall participation in AP course may be on the rise, participation by sociodemographic group differs drastically. Klopfenstein (2004) finds that Black and Hispanic high school students enroll in AP courses at approximately half the rate of white students.

Steps have been taken to increase student engagement to the AP program, particularly for students of low-income backgrounds. The most notable example of this is the Advanced Placement Incentive Program (APIP) which was enacted in Texas in 1996. The APIP is an incentive program that pays students and teachers and is targeted primarily to low-income, minority dominated school districts with a view toward improving college readiness. In his paper, Jackson (2010) finds that the APIP is associated with increases in the number of students taking AP courses and the number of students taking AP/IB exams. While there are no significant differences by gender, he finds the program substantially increased AP/IB exam taking for black and Hispanic students.

Literature AP Program Demographics

Different sociodemographic groups engage in the AP program at very different rates⁴ In 2000, the College Board produced a general report on the achievement of minorities (College Board, 2000). Even when positive outcomes are found to be associated with taking AP exams, the results are often found to be concentrated within a small subgroup population of students. Students who participate in the AP program tend to be from higher income families, are more likely to be white and attend suburban schools, and have better academic preparation for high school than non-AP students (Warne et al. 2015; Cisneros et al., 2014; Dougherty and Mellor, 2010; Jeong, 2009; and Moore and Slate, 2008).

Contributions

To my knowledge, this study is the first to directly address the effect of state mandated AP courses and funding AP exams on the number of students taking AP exams and their performance. Using data on state-level course and funding mandates combined with state-level data on AP participation and performance, this paper examines the state AP mandates on AP-related outcomes. Additionally, I contribute to a body of literature that examines the effect of changing course curriculum on participation and performance within courses. Similar to Speroni (2011) and Arce-Trigatti (2018), I examine the effect of state intervention programs changing the curriculum available to students. Further, this paper addresses the how state efforts can increase engagement in the AP program for different sociodemographic groups. As Jackson (2010) found, intervention programs for the AP program directly impacts

⁴The benefits associated with the AP program are well studied. Studies on the benefits associated with receiving college credit through AP examination include Smith et al. (2017), Avery et al. (2017), Gurantz (2021) and Boatman et al. (2019). Studies examining the effect of AP participation on first-year college outcomes include Klopfenstien and Thomas (2009), Sadler and Sonnert (2010), Sadler and Tai (2007), Sadler and Sonnert (2018), Duffy (2010) and Geiser and Santelices (2004).

low-income students in a positive manner. Similarly, I examine the relationship between state AP course and funding mandates designed to reduce barriers to accessing the AP program and the direct outcomes within the AP program.

THEORETICAL MOTIVATION

One of the main benefits to taking an AP exam is the money saved as a result of receiving college credit. For students, the potential savings associated with passing an AP exam is nearly \$1,000 in the first year of college – equating to a %10 reduction in the average cost for a year of college tuition (Smith et al. 2017). The cost of an AP exam is both a financial cost and a time cost. The financial cost is clear – students wanting to take an AP exam must pay the associated fee for the exam which is charged to all students. The time cost however, depends greatly on the students and their resources. For example, students may need to travel or input extra effort in order to successfully learn required exam curriculum. A student chooses to take an AP exam if the marginal benefit of taking the exam exceeds the marginal cost. A marginal student is then a student who participates in the program directly as a result of an AP program policy.

The marginal student induced is different depending on the AP policy. The marginal student induced as a result of an AP funding policy is a student who was previously hindered by the financial cost of the exam. In these states, funding AP exams reduces the marginal cost of taking an exam by removing the financial cost associated with the exam. As a result, the marginal cost to all students is left as the non pecuniary costs of the exam. All else equal, it should be expected that the number of students taking the AP exam increases as a result of the funding policies.

There are two types of students affected by AP mandate policies – 1) students who had no access to AP courses in their school or district; 2) students who had access to some set of AP courses but lacked access to courses that may have been beneficial to them. In the first case, AP mandate policies reduces the marginal cost of taking an AP exam as these students now have access to an AP course when previously there were no options available.¹

¹Since students are able to take AP exams without the AP course, the marginal benefit does not change.

In the second case, the AP mandate policy increases the set of courses directly available to the student, reducing the cost of pursuing those courses otherwise. Subsequently, access in both cases is made easier, thus reducing the marginal cost associated with taking an AP exam overall.

As discussed, the marginal cost corresponding to each student differs. For higher ability students, the academic preparation needed to take an AP exam is lower than students of lower ability. The infra-marginal students are likely of higher ability – their cost to prepare for an AP exam is on average less than students of lower ability. AP program policies reduce the marginal cost for all students; so, the only remaining cost is that of time in learning exam curriculum which is less, on average, for higher ability students. It should be expected that the marginal student will be of lower ability than the infra-marginal student, on average. Consequently, the average exam score for a marginal student should be lower than the average exam score for an infra-marginal student.

EMPIRICAL STRATEGY

Data and Descriptive Statistics

To estimate the effect of state-level AP program policies on student participation and performance on AP exams, I use annual state-level data from the College Board for exams taken in 2000-2019.¹ The primary outcome variables of interest are the number of students who take at least one AP exam and the total number of AP exams taken. Previous research has found a link between participation in the AP program and enrollment in post-secondary institutions. Consequently, I estimate the effect of state-level AP program policies using data from the Integrated Postsecondary Education Data System (IPEDS). IPEDS collects information from every college that participates in federal student financial aid programs. I restrict my analysis to public four-year universities, the set of universities whose students are likely most directly affected by AP program policies (Cowan and Goldhaber, 2015). I use data on the number of students who send AP exams scores to a university, the number of students who apply to a university, and the number of students who enroll in a university. A full explanation of the outcome variables used in this analysis is found in Table A.2. Table A.3 presents descriptive statistics for the outcome measures utilized in this study.

All state policies of interest are found within Education Commission of the States publications and matched to their original source documents.² I match the policy to the year and state in which a policy is passed for the source document. Since AP exams are taken in May of each academic year, policy status is tied to the exam year.³

¹Exam data from May 2020 is excluded from the sample due to concerns of endogeneity within exam offerings and testing as a result of the COVID-19 pandemic. Results are presented with a balanced panel across all years when data is available.

²The source document is often the legislative bill passed within a states' legislative body. Using these documents, a vector of indicators for each state is created to identify each policy.

³An example of this - Arkansas passed Act 102, an AP course mandate, to take effect in the 2004-2005 school year. While the policy first effects course offerings in the fall of 2004, exams are taken in May of 2005. As a result, policy status for Arkansas turns on in 2005 instead of 2004.

I define an indicator variable, $AP\ Mandate_{st}$, for a state that enacts a policy that specifically requires schools or districts to offer at least one AP course.⁴ I define $I\{\text{AP Funding}_{st}\} = 1$ when a state implements a policy that pays for student AP exams, regardless of income status.

Additional data comes from the National Center for Education Statistics (NCES) Common Core Data (CCD), the Bureau of Labor Statistics (BLS), and the U.S. Census. I control for expenditures and revenues per student, percent rural schools, number of school districts, total enrollment, enrollment by race and grade, unemployment rates, population estimates, teacher counts, and teacher salary. Table A.6 provides an explanation of the control variables utilized in this study. Table A.5 presents descriptive statistics for the control variables.

Identification Strategy

The main analysis uses difference-in-differences (DiD) to estimate of the impact of AP program policies on students participation in and performance on AP exams. I take advantage of state-time variation in student exposure to AP courses during high school generated by state policies on course offerings and funding. By incorporating data on unaffected states (i.e., states that do not have policies on advanced courses), I control for changes that occur over time in all states.

I compare changes in pre-post-policy outcome for students in states with AP program policies to similar changes for their peers in states without mandates. A simple representation of my estimating equation is:

⁴AP mandates are likely more binding to a school than general advanced course mandates are. The rationale behind this is simple - when a state mandates advanced courses, schools have a wider variety of options available that allows the school to be in compliance with the mandate. Since AP mandates are specifically for one type of course, schools are forced to offer specifically that course to be in compliance with the mandate, even if that course is not the curriculum the school would choose to offer if given the opportunity to choose.

$$Y_{st} = \psi + \alpha \text{ AP Mandate}_{st} + \beta \text{ AP Funding}_{st} + \pi \mathbf{X}_{st} + \theta_t + \lambda_s + \nu_s t + \epsilon_{st} \quad (5.1)$$

Y_{st} is the outcome measure of interest (as discussed in Table A.2) where s indexes states and t indexes years. I log transform the level outcome variable because I am interested in overall percent effect of AP program policies.⁵ The variables, *AP Mandate*_{st} and *AP Funding*_{st}, indicate whether a state has an AP course mandate or AP exam funding policy in operation in time t . $\mathbf{X}_{st}$ is a vector of time-varying state-level characteristics that includes enrollment levels, teacher pay, employment, and population levels. The state fixed effects (λ_s) control for any permanent differences between states that implement state policies such as overall attitude towards college enrollment. The year fixed effects (θ_t) capture any time-varying shocks such as changes in difficulty of particular AP exams. I cluster my standard errors at the state level (Betrand, Duflo, and Mullainathan, 2004) because policy variation occurs at the state-level. With state and year fixed effects, the parameter(s) of interest, α and β , is the average difference in AP participation and performance before and after treatment relative to states that do not pass an AP policy. State level policies differ by the course/exam subject, we consider exam subject effects. To address this effect, exams are grouped by their subject identified either within state policy or by the College Board.

For causal identification, difference-in-difference methodology relies on three main assumptions - (1) common pre-policy trends in outcomes across states that do and do not implement the policy, (2) exogenous timing and implementation of AP program policies,

⁵One limitation of using log outcome measures is logged variables cannot be used if the variable takes on a zero value. While this occurs seldomly within this analysis, there are a number of instances within the panel where the outcome measure is equal to zero. From Wooldridge et al. (2012), using a log transformation, $\log(1 + y)$, is acceptable when the data on the outcome measure contains relatively few zeros which is the case in this analysis. There are four zeros in the panel and are only present when considering the number of black students taking AP exams.

and (3) no anticipation effects. The assumption of common trends is particularly important and requires that, in the absence of mandates, the difference between policy and non-policy states is constant over time. In some specifications, I control for possible differences in trends by including state time-trends ($\nu_s t$). I also present event study analysis to explore the plausibility of the parallel trends assumption.

To handle concerns regarding treatment endogeneity, my analysis first employs an exhaustive set of control variables. I address the concern that state policies are endogenous by providing regression estimates in which placebo state policies are randomly assigned to control states.⁶

In addition to the state level analysis, I estimate the effects of AP program policies on the number of AP exam scores that are sent to a university, the number of applications for enrollment received by a university, and the total in state enrollment at a university. I modify equation (5.1) to capture outcomes specific to different types of universities and to individual universities (i.e., private/public, regional/flagship universities). The estimating equation in that specification is:

$$Y_{ist} = \psi + \alpha \text{ AP Mandate}_{st} + \beta \text{ AP Funding}_{st} + \pi \mathbf{X}_{ist} + \theta_t + \lambda_i + \nu_s t + \epsilon_{ist} \quad (5.2)$$

where Y_{ist} is the outcome measure of interest and s indexes states, i indexes universities, and t indexes years. This model differs from equation (5.1) by the inclusion of university fixed effects. When applicable, equation (5.2) is conditioned on the university type to examine whether state policies affect different types of universities differently.

In (5.2), the estimated parameters of interest are $AP \text{ Mandate}_{st}$ and $AP \text{ Funding}_{st}$ but

⁶I take the approach similar to that of Luallen (2006) – assignment of the placebo "treatment" was based on a random draw from a uniform distribution.

estimated on a dataset of universities that are located in states that have an AP program policy.⁷

As noted above, identification of α and β as the causal effect of AP program policies relies on the treated and control states experiencing the same time trend in the absence of the treatment. Although the parallel trends assumption is fundamentally untestable since potential outcomes are never observed, I explore this plausibility, using an event study analysis to test for any difference in pre-treatment trends. A simple representation of my estimating equation is:

$$Y_{st} = \sum_{\substack{\tau=-4 \\ \tau \neq -1}}^4 \alpha_{\tau} \text{AP Mandate}_{st} + \sum_{\substack{\tau=-4 \\ \tau \neq -1}}^4 \beta_{\tau} \text{AP Funding}_{st} + \sum_{\substack{\tau=-4 \\ \tau \neq -1}}^4 \delta_{\tau} \text{Dual Enrollment Access}_{st} + \pi \mathbf{X}_{st} + \theta_t + \lambda_s + \epsilon_{st} \quad (5.3)$$

All variables are defined as in in equation (5.1), but here α_{τ} and β_{τ} are vectors of indicator variables for each year in the sample, with the exception of the year prior to a state policy. Due to the timing of state policies and the desired to create a balanced panel in all analysis, the event study analysis makes use of four leads and lags. Since there are a number of states that pass policies near the start or end of the panel, it is difficult to include an event study analysis that has greater than four leads and lags while maintaining a balanced panel. A reasoning for four lags/leads is best viewed using the timing of Arkansas's state policies. Since Arkansas passed both a funding and a course mandate in 2005, four years from the start of the panel, including additional leads would change the relevant comparison group utilized in the model. Even with four leads and lags, a number of states are removed

⁷Since most students attend a university in which they reside in, I consider universities within a state that passes a policy to be the most effected.

from the analysis due to the timing of their state policy and the relative length of the data panel available.

Equations (5.1) and (5.3) both rely on a two-way fixed effects (TWFE) methodology that compares outcomes in states that take efforts to increase access to the AP program to outcomes in states that have not taken such efforts, have already taken efforts, or never take such efforts. A growing literature shows that TWFE models with variation in treatment timing can be biased from the true treatment effect if the counterfactual group relies on the comparison between early treated states and late treated states (Callaway and Sant’Ana, 2021; de Chaisemartin and D’Haultfoeuille, 2020; Goodman-Bacon 2021). Thus, I also estimate an alternative specification proposed by Callaway and Sant’Anna (2021). This specification relies on the comparison of states to states that are either never treated or states that are not yet treated.

RESULTS

Relationship Between State Policies and Exam Participation

Figure B.5 and Figure B.6 present the event study results for the effect of AP course mandates and AP funding policies on the number of students who take at least one AP exam. These figures provide strong support for parallel pre-trends, suggesting that states without AP program policies may be a reasonable comparison group for states that do have policies. Results indicate a significant effect the year a policy is enacted as evidenced by the increase in total candidates the year a policy is passed.¹

Table A.7 presents OLS estimates of the relationship between AP state policies and the number of students that take at least one AP exam (listed in Columns 1 - 3) and the number of exams taken (listed in Columns 4-6).² The results indicate that both course mandates and funding for exams increase student participation in the AP program.³

I first consider the effect of state policies on the number of students who take at least one AP exam. The baseline estimates, Column (1) of Table A.7, suggest that AP program policies increase the number of students taking AP exams and the number of exams. Mandating the provision of AP courses is associated with an 18.2% increase in the number of candidates while funding AP exams is associated with an 24.6% increase in the number of candidates. I include time-varying controls, presented in Column (2) to control for inherent differences as a result of state enrollment, population, or relevant funding that is inherent to a state. In

¹It is important to note that the effect of funding policies is more precisely estimated than mandate policies. For mandate policies, very few states pass policies at the same time while three states pass a funding policy in 2017 alone. As a result, the effect of funding policies are more statistically significant throughout our analysis.

²*Total Candidates* provides a unique measure of participation – this represents the number of students (referred to as candidates) who take at least one exam. Since students have the ability to take multiple exams, the variable *Total Exams* measures the total exam volume in a state and year.

³All outcome variables are presented in a log specification. As a result, coefficients are interpreted as percent change. Results are also included in the appendix that include results shown in percentage point change.

this specification, mandates and funding policies individually increase overall participation by 22.4 and 19.8%, respectively. Column (3) includes state-specific linear time trends⁴ mandates and funding increase overall participation on AP exams by 17.3 and 19.4%, respectively. The coefficient in Column (3) is of smaller magnitude than the parameter estimated in Column (1) without time-varying controls and state-specific linear time trends, although they are not statistically different. This indicates that the inclusion of additional observable controls has little effect on the estimates, supporting the exogeneity of AP program policies.

In a given year, students have the ability to take multiple AP exams. As a result, the number of candidates and the number of exams students taken are different. Figure B.7 and Figure B.8 present the event study results for the effect of AP course mandates and AP funding policies on the number of exams taken. Event study analysis provide strong support for parallel pre-trends, suggesting that other states without AP course and/or funding policies may be a reasonable comparison group for states that do have policies. Results indicate a significant effect the year a policy is enacted, as evidenced by the increase in total candidates the year a policy is passed.

Column (4) provides a baseline estimate of the effect of state policies on the total number of AP exams taken. Without time-varying controls and state-specific linear time trends, mandating AP courses is associated with a 16.6% increase in overall exam volume while funding AP exams is associated with a 24.1% increase in overall exam volume. The magnitude of these estimates decreases only slightly with the inclusion of time-varying controls and state-specific linear time trends however, they are not statistically different.

5

⁴State-specific linear time trends capture any state-specific deviations from the national trend affecting participation in the AP program. This is important given that states that implement policies may have higher rates of involvement with the AP program that may not be captured with the time-varying controls or fixed effects.

⁵Due to the nature of this analysis, it is difficult to determine why the magnitude of estimates for exams is smaller than the estimates found for candidates (although, not statistically different from one another). Running a model that examines the average number of exams taken per student finds that mandates increase

Results reported in Table A.8 examine potential heterogeneous effects of different racial/ethnic groups.⁶ These results indicate that there is no difference in the impact of the mandates across race/ethnicity. Table A.9 examines this relationship instead with exam volume as the dependant variable. Again, we find that the largest increases are concentrated within Black and Hispanic exams. These estimates are found to be similar in magnitude to that found for candidate estimates found in Table A.8.⁷

Table A.10 reports estimates of the effect of AP program policies on participation in different AP exam categories. Increases in participation appear to be concentrated in science exams for course mandates and across all the core subjects (math, science, social studies, and English) for state policies concerning exam funding (see Table A.10). The effect of funding policies is larger in magnitude for all exam subjects and are greatest for science and social studies exams.

Relationship Between State Policies and Exam Performance

More students take AP exams as a result of state policies. However, does this translate into more college credit? Or, are marginal takers those who are least likely to pass AP exams regardless of state policy?

Table A.19 reports the relationship between state policies and the AP pass rate across all exams. As specified by the College Board, the AP pass rate is the total number of exams receiving a score of 3 or greater divided by the total number of exams taken. Mandating AP courses is associated with a 3.4% decrease in the pass rate while AP funding policies are

the average number of exams taken by .01 exams. No statistically significant effect is found for funding policies.

⁶Racial/ethnic groups are reported by the student. Prior to 2015, the College Board provided exam data for a variety of different ethnicities. For the sake of comparison across years, data is pooled based on the ethnicity classification set forth by the NCES.

⁷Additional results examine the effect specific to gender. For both male and females, the effect of state policies is similar to that found across all races and genders, even after including time-varying controls and state time trends.

associated with 5% decrease in the pass rate. These estimates, coupled with results found in Table A.7, suggest that the share of students earning a score of 3 or higher is increasing at a slower rate than the total participation rate. This is shown visually in Figure B.9.

To estimate the effects of AP program policies on specific exam scores (i.e., exams that receive a score of 1, 2, 3, ect.), I condition equation (5.1) by the exam score of interest. Table A.12 reports the relationship between AP state policies and the distribution of scores by examining the log of the number of exams receiving a certain score. Exams receiving a score of 1 and 2 see the largest magnitude increases, particularly in states that fund AP exams (22.7 and 36.5%, respectively). For states that fund exams, we also observe a statistically significant increase in the number of exams receiving a 3 or 4 (which is considered a passing score by the College Board) while we observe no significant increase in the number of exams receiving a 5. These findings are consistent with the theory that a set of marginal students previously lacked the ability to participation in the program that likely would have succeeded previously.

Tables A.13 - A.16 report score distributions by race/ethnicity. For all races, there is a statistically significant increase in the number of exams receiving a score of 1 and 2 (consistently for funding policies, often for mandate policies). For Black and Hispanic students, the estimates also indicate a large increase in the number of exams that receive a score of 5 with Hispanic students observing an increase across all passing scores. These results imply that when states reduce the financial burden associated with taking an AP exam, students that are from traditionally low-income communities have the ability to participate and succeed in the program in a manner that they were previously unable to.

Relationship Between State Policies and Post Secondary Behavior

When students apply or attend a post-secondary institution, a student both use an application and send their AP exam scores to the institution. If increased access to the

AP program is linked to increased post-secondary attendance, we would expect that the AP program policies also generate increases in the number of students sending their scores, submitting applications, and enrollment should be observed.

Table A.17 examines the relationship between AP exam score sending to universities, to universities inside n and outside students' state of residence.⁸ Column (1) presents the effect of state policies on the overall number of students who send their AP scores to any university. Column (2) presents the effect of state policies on the total number of exams sent to universities. I find that for states that fund at least one exam, the number of students submitting their scores to a university increases by 26.1%, which is similar in magnitude to the number of students who take exams as a result of the state policy.

I investigate this further by examining the effect of AP state policies on the log number of students who apply and enroll to individual universities in Table A.19. Column (1) shows that universities in states that mandate the provision of AP courses and/or fund at least one AP exam have an increase of 11 and 11.4%, respectively, in applications. Including time-varying controls and a state-time trend in Column (2), the magnitude of these effects falls to 4.1 and 1.9 percent, respectively. These results imply that when states increase access to AP courses and exams, more students apply to in state universities. This suggests that AP exams may serve as a tool in preparing students for college. Further, Column (3) and Column (4) shows that universities do not observe higher levels of enrollment following the policies.

Alternative Difference-in-Difference Specifications

As discussed in Chapter 5, 14 states pass some form of AP program between 2000 and 2019. This variation in treatment timing can bias the main DiD estimates if there are

⁸AP exam score send data is collected by the College Board. State aggregate data on AP exam score sends include students sending to two-year universities as well as four-year universities.

heterogeneous treatment effects across treatment cohorts. To assess the extent to which such bias is a concern in my empirical strategy, Table A.21 compares my main DiD estimated with TWFE to alternative specifications for the outcome variable of total candidates. I utilize the estimator proposed by Callaway and Sant’Anna (2021) which allows the DiD coefficients to be weighted by a counterfactual group of states have not yet adopted a AP policy or states that never enacted an AP policy. This specification relies on the comparison of treated units (i.e., states that enacted AP policies) to clean control units (i.e., states that have yet to enact a policy or never enact a policy) to prevent negative weighting of some effects that may occur in a traditional TWFE model (Goodman-Bacon, 2021). Comparing the TWFE estimates to the estimator proposed by Callaway and Sant’Anna (2021), the results are nearly identical and none of the estimates are statistically different from one another.

Alternative College Preparatory Programs

Analysis up until this point has considered states that have AP program policies as "treated" states while treating all other states as control states. While the focus of this analysis is still on AP program policies, nine states have general college preparatory course mandates that this paper has previously excluded in the analysis. If general college preparatory course mandates have an effect on the number of students taking exams or the performance on AP exams, the exclusion of these mandates have bias the estimates presented thus far. I define an indicator variable, *Advanced Course Mandate_{st}*, for a state that enacts a policy that specifically requires schools or districts to offer at least one advanced course. If students benefit differently by having access to a broader range of curriculum, it should be expected to observe changes in participation in the AP program as differing curriculum are introduced to students.⁹ I additionally define an indicator variable, *Dual Enrollment*

⁹The estimates for advanced course mandates represent an average treatment effect since all states with an AP mandate also have an advanced course mandate. The estimate indicated for AP mandates is a differential treatment effect relative to the advanced course mandates. All other estimates follow from

$Access_{st}$ to pick up access specifically to the dual enrollment program.¹⁰

Table A.20 examines the effect of advanced course mandates on the total number of students who take at least one AP exam. In this specification, a state having an advanced course mandate is only statistically significant when all treatment indicators are included in the model. Even so, the inclusion of advanced course mandates does not change the estimated effect as originally presented in Table A.7. Overall, the increase in the number of students taking at least one exam and the total exam volume caused by the state policies indicates that an expanded set of students now participate in the AP program. No specification finds increasing access to dual enrollment has a statistically significant effect on participation in the AP program. This implies dual enrollment does not appear to be a close substitute for AP courses.

Additional State Subsidies

In an effort to reduce the cost of an AP exam to low-income students, the College Board provides a fee reduction for low-income students. Moreover, a number of states further reduce the cost of AP exams for low-income students (referred to as AP exam subsidies). Depending on the state, the cost of an exam is a few dollars or zero for a qualified student. Analysis in this paper has excluded AP exam subsidies due to difficulties with policy timing determination. By excluding AP exam subsidies in this paper, the estimates presented throughout are likely downward biased. Since AP exam subsidies reduce the cost of an AP exam for low-income students and are negatively correlated with states that have AP funding policies, the estimates in this analysis are likely downward biased from the true

previous specifications.

¹⁰For additional information on dual enrollment programs, see Cowan and Goldhaber (2015). Access to the dual enrollment program is defined differently than for other advanced courses. Unlike in states with AP mandates or advanced course mandates, no states specifically mandate dual enrollment. I define a state mandating access to dual enrollment when they requires schools to inform students of dual enrollment opportunities are available to them.

relationship.

CONCLUSION

From the early 2000s through 2019, participation in the AP program has nearly tripled in size. Nearly 20 percent of all high school students take at least one AP exam per year. To date, 16 states and the District of Columbia have passed legislation to increase access to AP exams, by either requiring that AP courses be offered or by paying AP exam fees (or both). Despite public interest, state policies regarding AP courses and exams have received little attention from researchers.

This study examines the impact of AP policies on the number of students who take at least one AP exam, the total number of AP exams, the AP exam pass rate, and the distribution of AP scores. The analysis takes advantage of state-time variation in AP policies to utilize both difference-in-differences strategy and event study models.

I find that when states mandate AP courses or fund AP exams, the number of students taking exams and the number of exams taken, increases. The estimates show an increase in the number of students taking AP exams of around 20% for both mandate and funding policies with Black and Hispanic groups experiencing the largest increases. This translates to a 2.5 percentage point increase in the number of high school students who take at least one AP exam or, an average increase of 2 additional students, per school now taking at least one AP exam.

Performance on exams also changes as a result of AP program policies. States that mandate AP courses experience increases in the number of students earning a score of 3 or higher by around 6 percentage points. The effect of funding AP exams increases the number of students earning a score of 3 or higher increases by about one and a half times as much as the course mandates—around 10 percentage points. However, the number of students failing AP exams also increased as a result of the mandates, lowering the overall pass rate. When disaggregating racial and ethnic groups, Black and Hispanic students' exams see relatively

larger increases in the number of exams that receive a passing score.

We also observe an increase in the number of students submitting AP scores and applying to universities. However, I find no statistically significant increase in the number of students enrolled in universities as a result of these policies.

I believe these findings have positive implications for states and students. From the perspective of states, the positive effects of mandating and funding AP exams may reflect higher participation in AP course taking as well, indicating that more students have access to higher level curricular content in high school. Further, the number of students passing AP exams increases in absolute terms due to the mandates, although the number who score below a 3 increases by even more, lowering the overall pass rate. While the marginal exam takers induced by the mandates appear to be less proficient on the exams, the mandates increase the number of students scoring highly enough to receive college credit, potentially reducing college costs. Finally, the larger effects for Black and Hispanic students is indicative of disparities in access to college preparation for these students in the absence of state efforts to ensure more equity.

Taking and passing AP exams can reduce the total costs associated with obtaining a post-secondary education. For the typical student, passing (and more importantly, receiving academic credit at a post-secondary institution) an AP exam corresponds a potential savings of \$914 per year – a near 10% reduction in the costs of a year of college (Smith et al. 2017). Taking into account the estimated number of marginal students effect by state efforts to increase access, the potential savings available with increased access to the AP program is in excess of 3 million dollars.

From a cost perspective, mandating the provision of AP courses and funding AP exams are vastly different. For funding exams, states provide the funds for students to take the exam, likely for students who are already engaged with the program (directly or indirectly). As a result, much of the administrative costs are contained within the state funds with schools

and teachers largely unaffected. For students, removing the financial barriers associated with the exam may decrease the perceived risk of the exams. This may induce students who were perceiving the cost of the exams to be too much to risk the financial burden to now take the exam.

The cost for states and other agents is vastly different when states mandate the provision of AP courses. As described by Dutkowsky et al. (2009), the decision to offer advanced courses is endogenous — schools offer advanced courses when the benefits fit the students that the school serves. When states mandate the provision of AP courses, this effects schools that were not offering AP courses for some inherent reasons, likely because the courses are beneficial to the overall student body. Further, mandating these courses forces schools to provide additional training for teachers to teach these courses or more hiring of teachers, incurring a higher administrative cost to the school. For students, the increased access to the AP program may be a double-edged sword. For a set of students, increased access to the program may be beneficial. However, as shown by Arce-Triggatti (2018), to accommodate these mandate schools must reallocate resources, often removing CTE courses. For students that benefited from having access to these courses, mandating AP courses has a negative effect on these students.

Importantly, the estimates for states that mandate AP courses may represent a lower bound on the total number of potential effects for students. Mandate policies effect students at the course level, not the exam level in which the outcome measure in this study uses. When students take an AP course, they are not required to take the corresponding AP exam¹ thus understating the overall effect of access. A thorough examination of course offerings and enrollment should reveal participation increases greater than what is found in this study.

¹Past estimates suggest that 30% of students who take an AP courses, do not take the AP exam (Gollub et al. 2002).

REFERENCES CITED

- Altonji, Joseph.** 1995. "The Effects of High School Curriculum on Education and Labor Market Outcomes on JSTOR."
- Altonji, Joseph G., Erica Blom, and Costas Meghir.** 2012. "Heterogeneity in Human Capital Investments: High School Curriculum, College Major, and Careers." *Annual Review of Economics*, 4(1): 185–223.
- Altonji, Joseph G., Lisa B. Kahn, and Jamin D. Speer.** 2016. "Cashier or Consultant? Entry Labor Market Conditions, Field of Study, and Career Success." *Journal of Labor Economics*, 34(S1): S361–S401.
- Angrist, Joshua, Daniel Lang, and Philip Oreopoulos.** 2009. "Incentives and Services for College Achievement: Evidence from a Randomized Trial." *American Economic Journal: Applied Economics*, 1(1): 136–163.
- Angrist, Joshua D., Sarah R. Cohodes, Susan M. Dynarski, Parag A. Pathak, and Christopher R. Walters.** 2016. "Stand and Deliver: Effects of Boston's Charter High Schools on College Preparation, Entry, and Choice." *Journal of Labor Economics*, 34(2): 275–318.
- Arce-Trigatti, Paula.** 2018. "The impact of state-mandated Advanced Placement programs on student outcomes." *Economics of Education Review*, 63(C): 180–193.
- Avery, Christopher, Oded Gurantz, Michael Hurwitz, and Jonathan Smith.** 2018. "Shifting College Majors in Response to Advanced Placement Exam Scores." *Journal of Human Resources*, 53(4): 918–956.
- Banks, Joanne, and Emer Smyth.** 2015. "Full article: 'Your whole life depends on it': academic stress and high-stakes testing in Ireland." *Journal of Youth Studies*, 18(5): 598–616.
- Berggren, Andrea, and Louise Jeppsson.** 2021. "The Impact of Upper Secondary School Flexibility on Sorting and Educational Outcomes." *Economics of Education Review*, 81: 102080.
- Bernhardt, Elizabeth B., and Cici M. Leffell.** 2020. "Oral proficiency levels of first-year entering college students with and without Advanced Placement scores." *Foreign Language Annals*, 53(3): 401–415.
- Bettinger, Eric P.** 2005. "The effect of charter schools on charter students and public schools." *Economics of Education Review*, 24(2): 133–147.
- Bettinger, Eric P., and Bridget Terry Long.** 2009. "Addressing the Needs of Underprepared Students in Higher Education." *Journal of Human Resources*, 44(3): 736–771.

- Bifulco, Robert, and Helen F. Ladd.** 2006. "The Impacts of Charter Schools on Student Achievement: Evidence from North Carolina." *Education Finance and Policy*, 1(1): 50–90.
- Borland, Melvin V., and Roy M Howsen.** 1992. "Student academic achievement and the degree of market concentration in education." *Economics of Education Review*, 11(1): 31–39.
- Bound, John, Brad Hershbein, and Bridget Terry Long.** 2009. "Playing the Admissions Game: Student Reactions to Increasing College Competition." *Journal of Economic Perspectives*, 23(4): 119–146.
- Burdman, Pamela.** 2000. "Extra Credit, Extra Criticism." *Black Issues in Higher Education*, 17(18): 28–33.
- Cisneros, Jesus, Holloway-Libell Jessica, and Laura Gomez.** 2014. "The advanced placement opportunity gap in Arizona: access, participation, and success." *AASA journal of scholarship and practice*, 11(2): 20–33. Publisher: American Association of School Administrators.
- Coleman, J, T Hoffer, and S Kilgore.** 1982. *High school achievement: Public, Catholic, and private schools compared*. New York: Basic Books.
- Dougherty, Chrys, and Lynn Mellor.** 2010. "Preparation Matters." National Center for Educational Achievement.
- Duffy, R.** 2010. "Persistence and performance at a four-year university." In *AP: A critical examination of the Advanced Placement program*. 139–163. Harvard Education Press.
- Dutkowsky, Donald H., Jerry M. Evensky, and Gerald S. Edmonds.** 2009. "Should a High School Adopt Advanced Placement or a Concurrent Enrollment Program? An Expected Benefit Approach." *Education Finance and Policy*, 4(3): 263–277.
- Eberts, Randall W., and Kevin Hollenbeck.** 2002. "Impact of Charter School Attendance on Student Achievement in Michigan." *SSRN Electronic Journal*.
- Evans, Brent J.** 2018. "How College Students Use Advanced Placement Credit." *American Educational Research Journal*, 56(3): 925–954.
- Evans, W. N., and R. M. Schwab.** 1995. "Finishing High School and Starting College: Do Catholic Schools Make a Difference?" *The Quarterly Journal of Economics*, 110(4): 941–974.
- Fazlul, Ishtiaque, Todd Jones, and Jonathan Smith.** 2021. "College Credit on the Table? Advanced Placement Course and Exam Taking." *Economics of Education Review*, 84: 102155.

- Geiser, Saul, and Veronica Santelices.** 2004. "The Role of Advanced Placement and Honors Courses in College Admissions."
- Gollub, Jerry P, Meryl W Bertenthal, Jay B Labov, and Phillip C Curtis.** 2002. "Learning and Understanding: Improving Advanced Study of Mathematics and Science in U.S. High Schools, NRC Report."
- Goodman, Joshua, Julia Melkers, and Amanda Pallais.** 2012. "Can Online Delivery Increase Access to Education? | Journal of Labor Economics: Vol 37, No 1."
- Goodman, Joshua, Michael Hurwitz, and Jonathan Smith.** 2017. "Access to 4-Year Public Colleges and Degree Completion." *Journal of Labor Economics*, 35(3): 829–867.
- Hallett, Ronald E., and Kristan M. Venegas.** 2011. "Is Increased Access Enough? Advanced Placement Courses, Quality, and Success in Low-Income Urban Schools." *Journal for the Education of the Gifted*, 34(3): 468–487.
- Hemelt, Steven W., Nathaniel L. Schwartz, and Susan M. Dynarski.** 2020. "Dual-Credit Courses and the Road to College: Experimental Evidence from Tennessee." *Journal of Policy Analysis and Management*, 39(3): 686–719.
- Hoxby, Caroline, and Christopher Avery.** 2013. "The Missing "One-Offs": The Hidden Supply of High-Achieving, Low-Income Students." *Brookings Papers on Economic Activity*, 44(1 (Spring)): 1–65.
- Hoxby, Caroline M.** 2000. "Does Competition Among Public Schools Benefit Students and Taxpayers?" *American Economic Review*, 90(5): 1209–1238.
- Hoxby, Caroline. M.** 2003. "The Economics of School Choice." In *The Economics of School Choice*. University of Chicago Press.
- Hoxby, Caroline M.** 2009. "The Changing Selectivity of American Colleges." *Journal of Economic Perspectives*, 23(4): 95–118.
- Hurwitz, Michael, Jonathan Smith, and Jessica S. Howell.** 2014. "Student Age and the Collegiate Pathway." *Journal of Policy Analysis and Management*, 34(1): 59–84.
- Iatarola, Patrice, Dylan Conger, and Mark C Long.** 2011. "Determinants of High Schools' Advanced Course Offerings." *Educational Evaluation and Policy Analysis*, 33(3): 340–359. Publisher: American Educational Research Association.
- Jackson, C. Kirabo.** 2010. "A Little Now for a Lot Later: A Look at a Texas Advanced Placement Incentive Program." *Journal of Human Resources*, 45(3).
- Jeong, Dong Wook.** 2009. "Student Participation and Performance on Advanced Placement Exams: Do State-Sponsored Incentives Make a Difference?" *Educational Evaluation and Policy Analysis*, 31(4): 346–366.

- Kirkeboen, Lars J., Edwin Leuven, and Magne Mogstad.** 2016. "Field of Study, Earnings, and Self-Selection*." *The Quarterly Journal of Economics*, 131(3): 1057–1111.
- Klopfenstein, Kristin.** 2004. "Advanced Placement: do minorities have equal opportunity?" *Economics of Education Review*, 23(2): 115–131.
- Klopfenstein, Kristin, and M. Kathleen Thomas.** 2009. "The Link between Advanced Placement Experience and Early College Success." *Southern Economic Journal*, 75(3): 873–891.
- Kolluri, Suneal.** 2018. "Advanced Placement: The Dual Challenge of Equal Access and Effectiveness." *Review of Educational Research*, 88(5): 671–711.
- Lichten, William.** 2000. "Whither Advanced Placement?" *education policy analysis archives*, 8: 29.
- Lin, Ching-Hui, Victor M. H. Borden, and Jyun-Hong Chen.** 2018. "A Study on Effects of Financial Aid on Student Persistence in Dual Enrollment and Advanced Placement Participation." *Journal of College Student Retention: Research, Theory & Practice*, 152102511775373.
- Mane, Ferran.** 1999. "Trends in the payoff to academic and occupation-specific skills: the short and medium run returns to academic and vocational high school courses for non-college-bound students." *Economics of Education Review*, 18(4): 417–437.
- Moore, George W., and John R. Slate.** 2008. "Who's Taking the Advanced Placement Courses and How Are They Doing: A Statewide Two-Year Study." *The High School Journal*, 92(1): 56–67.
- Neal, Derek.** 1997. "The Effects of Catholic Secondary Schooling on Educational Achievement | Journal of Labor Economics: Vol 15, No 1, Part 1."
- Page, Lindsay C., and Judith Scott-Clayton.** 2016. "Improving college access in the United States: Barriers and policy responses." *Economics of Education Review*, 51: 4–22.
- Pallais, Amanda.** 2015. "Small Differences That Matter: Mistakes in Applying to College." *Journal of Labor Economics*, 33(2): 493–520.
- Sadler, Philip, and Gerhard Sonnert.** 2010. "High School Advanced Placement and Success in College Coursework in the Sciences." In *AP: A Critical Examination of the Advanced Placement Program*. 119–137. Harvard Education Press.
- Sadler, Philip, and Gerhard Sonnert.** 2018. "The Path to College Calculus: The Impact of High School Mathematics Coursework." *Journal for Research in Mathematics Education*, 49(3): 292.

- Sadler, P. M., and R. H. Tai.** 2007. "TRANSITIONS: The Two High-School Pillars Supporting College Science." *Science*, 317(5837): 457–458.
- Smith, Jonathan, Michael Hurwitz, and Christopher Avery.** 2017. "Giving College Credit Where It Is Due: Advanced Placement Exam Scores and College Outcomes." *Journal of Labor Economics*, 35(1): 67–147.
- Smith, Jonathan, Michael Hurwitz, and Jessica Howell.** 2015. "Screening mechanisms and student responses in the college market." *Economics of Education Review*, 44: 17–28.
- Warne, Russell T., Ross Larsen, Braydon Anderson, and Alyce J. Odasso.** 2015. "The Impact of Participation in the Advanced Placement Program on Students' College Admissions Test Scores." *The Journal of Educational Research*, 108(5): 400–416.
- Winston, Gordon C.** 1999. "Subsidies, Hierarchy and Peers: The Awkward Economics of Higher Education." *Journal of Economic Perspectives*, 13(1): 13–36.

APPENDICES

APPENDIX A

MAIN TABLES

Table A.1: Table Of Policy Status by Year

AP Mandate	AP Funding	Both Policies
Arkansas (2005) District of Columbia (2011) Indiana (2007) Iowa (2009) Louisiana (2013) Mississippi (2008) South Carolina (1984) West Virginia (2012)	Tennessee (2013) Kentucky (2009) Idaho (2017) North Carolina (2014) South Carolina (2018) Florida (2002) Georgia (2018) Arkansas (2005) Indiana (2008) North Dakota (2017)	Arkansas (2005) Indiana (2008) South Carolina (2018)
$n = 8$	$n = 11$	$n = 3$

Table A.2: Table of Outcomes and Explanation

Outcome Variable	Description	Data Source
<i>Participation</i>		
Candidates	The number of students who take at least one AP exam.	College Board
Exams	The total number of exams taken.	College Board
<i>Performance</i>		
Count of Exams by Score	The number of exams receiving a certain score	College Board
<i>Post-Secondary</i>		
Score Send (Students)	The number of students who send at least one AP exam score to a university.	College Board
Score Send (Exams)	The number of AP exam scores sent to a university.	College Board
Applications	The number of first-year, first-time students who apply to a post-secondary institution for fall academic term.	IPEDS

Table A.3: Summary Statistics of Outcome Variables

At baseline (2000)				
	All States	Never Treated	Treated (Mandate)	Treated (Funding)
Total Candidates	14,665	17,601	4,078	13,178
Total Exams	24,359	26,782	6,259	21,780
Pass Rate	.597	.639	.576	.612
Exam Score - 1	3,355	3,984	1,047	3,609
Exam Score - 2	5,694	5,873	1,614	5,573
Exam Score - 3	6,816	7,520	1,726	5,897
Exam Score - 4	5,113	5,864	1,159	4,077
Exam Score - 5	3,553	4,012	711	2,622
	n = 51	n = 43	n = 10	n = 10

Note – The table reports averages of each outcome variable for states in the year 2000

Table A.4: Sample Summary Statistics of Control Variables, by eventual treatment status (mandate)

At baseline (2000)				
	Never Treated	Treated (Mandate)	Difference	T-Value
High School Enrollment	278,886	144,886	131,287**	(2.3)
Enrollment (Asian)	47,849	5,249	36,635**	(2.4)
Enrollment (Black)	137,936	133,343	27,731	(0.5)
Enrollment (Hispanic)	183,492	11,519	152,061**	(2.3)
Enrollment (White)	604,128	357,198	245,791*	(2.0)
Pupil Teacher Ratio	15.87	15.4	.47	(0.6)
Full Time Employees	65,350	32882	33,927**	(2.7)
# of Secondary Teacher	26,172	13,208	12,721**	(2.4)
Expenditure Per Pupil	13,674	12,457	611	(0.3)
Revenues Per Pupil	15,492	14,694	121	(0.0)
Average Teacher Salary	45,041	41,866	2,422	(0.8)
Median Household Income	45,572	37,122	7,310**	(3.2)
Count of Schools	1,791	1,165	590*	(1.8)
Percent Schools – Rural	.32	.34	.02	(-0.3)
At end of the period (2019)				
High School Enrollment	317,527	149,750	170,860**	(2.5)
Enrollment (Asian)	64,988	9,666	49,376***	(2.8)
Enrollment (Black)	126,942	124,534	29,810	(0.6)
Enrollment (Hispanic)	320,736	49,040	254,877**	(2.6)
Enrollment (White)	480,422	310,193	181,635*	(1.8)
Pupil Teacher Ratio	16.12	15.74	.38	(1.3)
Full Time Employees	59,579	32,186	27,019**	(2.4)
# of Secondary Teachers	21,261	11,987	9,127**	(2.2)
Expenditure Per Pupil	6,719	6,344	163	(0.2)
Revenues Per Pupil	7,651	7,164	266	(0.4)
Average Teacher Salary	39,551	35,961	2,794	(1.1)
Median Household Income	38,291	31,420	6,008***	(3.3)
Count of Schools	1,888	1,061	780**	(2.3)
Percent Schools – Rural	.32	.36	.04	(-0.6)
Observations	n = 41	n = 10	n = 51	

Note – The table reports averages of each variable for states that do and do not implement an AP mandate policy at some point between 2000 and 2019. T-test for difference in means between the two groups (never treated and eventually treated) is included – *, **, and ***, indicate statistical significance at the ten-, five-, and one-percent levels, respectively.

Table A.5: Sample Summary Statistics of Control Variables, by eventual treatment status (funding)

At baseline (2000)				
	Never Treated	Treated (Funding)	Difference	T-Value
High School Enrollment	259,364	149,750	6,175	(0.1)
Enrollment (Asian)	42,595	9,666	29,268*	(1.7)
Enrollment (Black)	138,522	124,534	-95,603	(-1.3)
Enrollment (Hispanic)	162,005	49,040	98,407	(1.2)
Enrollment (White)	563,174	310,193	-31,004	(-0.2)
Pupil Teacher Ratio	16.24	16.00	.24	(0.2)
Full Time Employees	60,633	32,186	-7,746	(-0.4)
# of Secondary Teachers	24,156	11,987	-142	(-0.0)
Expenditure Per Pupil	13,640	6,344	3,349***	(4.2)
Revenues Per Pupil	15521	7,164	3,687***	(3.9)
Average Teacher Salary	44,621	35,961	3,389**	(2.3)
Median Household Income	44,537	31,420	5,654***	(3.9)
Count of Schools	1,696	1,061	112	(0.3)
Percent Schools – Rural	.32	.30	.02	(-1.0)
At end of the period (2019)				
High School Enrollment	292,864	314,762	-2,1897	(-0.2)
Enrollment (Asian)	57,862	29,316	28,546	(1.4)
Enrollment (Black)	127,021	245,501	-11,8479	(-1.5)
Enrollment (Hispanic)	285,231	202,114	83,118	(0.6)
Enrollment (White)	450,159	535,528	-85,369	(-0.8)
Pupil Teacher Ratio	16.20	16.12	.08	(-0.4)
Full Time Employees	55,710	54,617	1,093	(0.1)
# of Secondary Teachers	19,780	20,191	-410	(-0.1)
Expenditure Per Pupil	6,697	5,619	1,078***	(3.9)
Revenues Per Pupil	7,603	6,533	1,070***	(3.2)
Average Teacher Salary	39,075	35,490	3,585**	(2.4)
Median Household Income	37,399	33,342	4,057***	(2.9)
Count of Schools	1,768	1,592	176	(0.4)
Percent Schools – Rural	.32	.28	.04	(-1.3)
Observations	n = 41	n = 10	n = 51	

The table reports averages of each variable for states that do and do not implement an AP funding policy at some point between 2000 and 2019. T-test for difference in means between the two groups (never treated and eventually treated) is included – *, **, and ***, indicate statistical significance at the ten-, five-, and one-percent levels, respectively.

Table A.6: Table of Covariates

Covariate	Description	Data Source
Enrollment - Grade 9	Total state enrollment in Grade 9 - also included by race.	CCD
Enrollment - Grade 10	Total state enrollment in Grade 10 - also included by race.	CCD
Enrollment - Grade 11	Total state enrollment in Grade 11 - also included by race.	CCD
Enrollment - Grade 12	Total state enrollment in Grade 12 - also included by race.	CCD
Pupil Teacher Ratio	The number of students per teacher.	CCD
Full Time Employees	The number of full-time employees employed across all schools.	CCD
Count of Secondary Teachers	The number of secondary teachers employed.	CCD
Count of Rural Schools	The total number of public schools.	CCD
Percent of Schools - Rural	The percent of total schools identified as rural.	CCD
Average Teacher Salary	The average salary a teacher receives.	NEA
Median Household Income	The median household income.	ACS
Yearly Population Estimates	The estimated population - included by race.	ACS
Unemployment Rate	The seasonally adjusted unemployment rate average for the year.	BLS

Table A.7: The Effect of Advanced Course Mandates on the Log Number of Candidates and Exams

	(1) Log Total Candidates	(2) Log Total Candidates	(3) Log Total Candidates	(4) Total Exams	(5) Log Total Exams	(6) Log Total Exams
AP Mandate	0.182* (0.101)	0.224** (0.096)	0.173* (0.090)	0.166* (0.096)	0.208** (0.093)	0.162* (0.088)
AP Funding	0.246*** (0.063)	0.198*** (0.070)	0.194*** (0.060)	0.241*** (0.066)	0.192** (0.074)	0.204*** (0.063)
R-squared	0.992	0.994	0.998	0.992	0.994	0.998
Observations	1,020	1,020	1,020	1,020	1,020	1,020
Years	20	20	20	20	20	20
States	51	51	51	51	51	51
Time-Varying Controls	No	Yes	Yes	No	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
State Time Trend	No	No	Yes	No	No	Yes

Note – The table reports regression estimates of the effect of state-level AP and dual enrollment mandates in regard to funding and access on the total number of students who take at least one AP exam. This sample includes students of all grade levels and ethnicities. Robust standard errors are in shown in parentheses. Standard errors are clustered on the state level. Regression includes state-level control variables when indicated - these are controls, in log, for school spending, number of schools, % rural schools, average teacher salary, total enrollment, enrollment by race and grade, median household income, unemployment rates, and population estimates by race. *, **, and ***, indicate statistical significance at the ten-, five-, and one-percent levels, respectively.

Table A.8: The Effect of Advanced Course Mandates on the Log Number of Candidates by Ethnicity Group

	(1) Log Candidates Ethnicity: White	(2) Log Candidates Ethnicity: Black	(3) Log Candidates Ethnicity: Asian	(4) Log Candidates Ethnicity: Hispanic
AP Mandate	0.137 (0.091)	0.214** (0.142)	0.138* (0.066)	0.147** (0.086)
AP Funding	0.243*** (0.064)	0.298** (0.120)	0.118** (0.052)	0.256*** (0.086)
Years	20	20	20	20
States	51	51	51	51
R-squared	0.896	0.976	0.970	0.985
Observations	1,020	1,020	1,020	1,020
Time-Varying Controls	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
State Time Trend	Yes	Yes	Yes	Yes

Note – The table reports regression estimates of the effect of state-level AP and dual enrollment mandates in regard to funding and access on the total number of students who take at least one AP exam. This sample includes students of all grade levels and ethnicities. Robust standard errors are in shown in parentheses. Standard errors are clustered on the state level. Regression includes state-level control variables when indicated - these are controls, in log, for school spending, number of schools, % rural schools, average teacher salary, total enrollment, enrollment by race and grade, median household income, unemployment rates, and population estimates by race. *, **, and ***, indicate statistical significance at the ten-, five-, and one-percent levels, respectively.

Table A.9: The Effect of Advanced Course Mandates on the Log Number of Exams by Ethnicity Group

	(1) Log Exams Ethnicity: White	(2) Log Exams Ethnicity: Black	(3) Log Exams Ethnicity: Asian	(4) Log Exams Ethnicity: Hispanic
AP Mandate	0.195** (0.086)	0.315** (0.156)	0.103 (0.079)	0.213** (0.095)
AP Funding	0.207*** (0.067)	0.227 (0.156)	0.107* (0.063)	0.366*** (0.108)
Years	20	20	20	20
States	51	51	51	51
R-squared	0.994	0.987	0.994	0.990
Observations	1,020	1,020	1,020	1,020
Time-Varying Controls	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
State Time Trend	Yes	Yes	Yes	Yes

Note – The table reports regression estimates of the effect of state-level AP and dual enrollment mandates in regard to funding and access on the total number of students who take at least one AP exam. This sample includes students of all grade levels and ethnicities. Robust standard errors are in shown in parentheses. Standard errors are clustered on the state level. Regression includes state-level control variables when indicated - these are controls, in log, for school spending, number of schools, % rural schools, average teacher salary, total enrollment, enrollment by race and grade, median household income, unemployment rates, and population estimates by race. *, **, and ***, indicate statistical significance at the ten-, five-, and one-percent levels, respectively.

Table A.10: The Effect of Advanced Course Mandates on the Log Number of Exams By Exam Type

	(1) Log English Exams	(2) Log Social Studies Exams	(3) Log Math Exams	(4) Log Science Exams
AP Mandate	0.095 (0.078)	0.153 (0.095)	0.068 (0.054)	0.171** (0.080)
AP Funding	0.165* (0.096)	0.222*** (0.075)	0.194** (0.086)	0.278*** (0.103)
Years	19	19	19	19
States	51	51	51	51
R-squared	0.995	0.997	0.997	0.996
Observations	969	969	969	969
Time-Varying Controls	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
State Time Trend	Yes	Yes	Yes	Yes

Note – The table reports regression estimates of the effect of state-level AP and dual enrollment mandates in regard to funding and access on the total number of AP exams broken up by the subject type. This sample includes students of all grade levels and ethnicities. Robust standard errors are in shown in parentheses. Standard errors are clustered on the state level. Regression includes state-level control variables when indicated - these are controls, in log, for school spending, number of schools, % rural schools, average teacher salary, total enrollment, enrollment by race and grade, median household income, unemployment rates, and population estimates by race. *, **, and ***, indicate statistical significance at the ten-, five-, and one-percent levels, respectively.

Table A.11: The Effect of Advanced Course Mandates on the Pass Rate

	(1) Pass Rate	(2) Pass Rate
AP Mandate	-0.051*** (0.018)	-0.034* (0.018)
AP Funding	-0.016 (0.015)	-0.050*** (0.016)
Years	20	20
States	51	51
R-squared	0.905	0.963
Observations	1,020	1,020
Time-Varying Controls	No	Yes
State FE	Yes	Yes
Year FE	Yes	Yes
State Time Trend	No	Yes

Note – The table reports regression estimates of the effect of state-level AP and dual enrollment mandates in regard to funding and access on the AP pass rate. Robust standard errors are in shown in parentheses. Standard errors are clustered on the state level. Regression includes state-level control variables when indicated - these are controls, in logs, for school spending, number of schools, % rural schools, average teacher salary, total enrollment, enrollment by race and grade, median household income, unemployment rates, and population estimates by race. *, **, and ***, indicate statistical significance at the ten-, five-, and one-percent levels, respectively.

Table A.12: The Effect of Advanced Course Mandates on the Log Number of Candidates and Exams

	(1) Log Exams Score: 5	(2) Log Exams score: 4	(3) Log Exams Score: 3	(4) Log Exams Score: 2	(5) Log Exams Score: 1
AP Mandate	0.026 (0.049)	0.066 (0.052)	0.089 (0.056)	0.184** (0.087)	0.274** (0.150)
AP Funding	0.043 (0.042)	0.079* (0.042)	0.122** (0.051)	0.227** (0.078)	0.365** (0.109)
Years	20	20	20	20	20
States	51	51	51	51	51
R-squared	0.997	0.998	0.998	0.996	0.992
Observations	1,020	1,020	1,020	1,020	1,020
Time-Varying Controls	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
State Time Trend	Yes	Yes	Yes	Yes	Yes

Note – The table reports regression estimates of the effect of state-level AP and dual enrollment mandates in regard to funding and access on the total number of AP exams broken up by the score the exam received. This sample includes students of all grade levels and ethnicities. Robust standard errors are in shown in parentheses. Standard errors are clustered on the state level. Regression includes state-level control variables when indicated - these are controls, in log, for school spending, number of schools, % rural schools, average teacher salary, total enrollment, enrollment by race and grade, median household income, unemployment rates, and population estimates by race. *, **, and ***, indicate statistical significance at the ten-, five-, and one-percent levels, respectively.

Table A.13: The Effect of Advanced Course Mandates on the Log Number of Exams by Score - White Students

	(1) Log Exam Score: 5	(2) Log Exam Score: 4	(3) Log Exam Score: 3	(4) Log Exam Score: 2	(5) Log Exam Score: 1
AP Mandate	0.011 (0.045)	0.067 (0.051)	0.083 (0.052)	0.172* (0.080)	0.280* (0.097)
AP Funding	0.051 (0.039)	0.083* (0.047)	0.131** (0.060)	0.242*** (0.092)	0.382*** (0.137)
Years	20	20	20	20	20
States	51	51	51	51	51
R-squared	0.997	0.998	0.997	0.995	0.990
Observations	1,020	1,020	1,020	1,020	1,020
Time-Varying Controls	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
State Time Trend	Yes	Yes	Yes	Yes	Yes

Note – The table reports regression estimates of the effect of state-level AP and dual enrollment mandates in regard to funding and access on the log number of exams taken by students who indicate their race/ethnicity to be white that receive a certain score. Robust standard errors are in shown in parentheses. Standard errors are clustered on the state level. Regression includes state-level control variables when indicated - these are controls, in logs, for school spending, number of schools, % rural schools, average teacher salary, total enrollment, enrollment by race and grade, median household income, unemployment rates, and population estimates by race. *, **, and ***, indicate statistical significance at the ten-, five-, and one-percent levels, respectively.

Table A.14: The Effect of Advanced Course Mandates on the Log Number of Exams by Score - African American Students

	(1) Log Exam Score: 5	(2) Log Exam Score: 4	(3) Log Exam Score: 3	(4) Log Exam Score: 2	(5) Log Exam Score: 1
AP Mandate	0.165 (0.127)	0.039 (0.103)	0.152 (0.141)	0.243** (0.117)	0.293 (0.187)
AP Funding	0.280* (0.152)	0.142 (0.127)	0.172 (0.162)	0.235* (0.124)	0.463** (0.205)
Years	20	20	20	20	20
States	51	51	51	51	51
R-squared	0.975	0.984	0.987	0.990	0.986
Observations	1,020	1,020	1,020	1,020	1,020
Time-Varying Controls	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
State Time Trend	Yes	Yes	Yes	Yes	Yes

Note – The table reports regression estimates of the effect of state-level AP and dual enrollment mandates in regard to funding and access on the log number of exams taken by students who indicate their race/ethnicity to be African American that receive a certain score. This sample includes students of all grade levels and ethnicities. Robust standard errors are in shown in parentheses. Standard errors are clustered on the state level. Regression includes state-level control variables when indicated - these are controls, in logs, for school spending, number of schools, % rural schools, average teacher salary, total enrollment, enrollment by race and grade, median household income, unemployment rates, and population estimates by race. *, **, and ***, indicate statistical significance at the ten-, five-, and one-percent levels, respectively.

Table A.15: The Effect of Advanced Course Mandates on the Log Number of Exams by Score - Asian Students

	(1) Log Exam Score: 5	(2) Log Exam Score: 4	(3) Log Exam Score: 3	(4) Log Exam Score: 2	(5) Log Exam Score: 1
AP Mandate	0.057 (0.074)	0.077 (0.060)	0.107 (0.068)	0.165 (0.074)	0.356*** (0.119)
AP Funding	0.001 (0.057)	0.049 (0.053)	0.028 (0.044)	0.090 (0.054)	0.274* (0.089)
Years	20	20	20	20	20
States	51	51	51	51	51
R-squared	0.992	0.995	0.994	0.994	0.988
Observations	1,020	1,020	1,020	1,020	1,020
Time-Varying Controls	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
State Time Trend	Yes	Yes	Yes	Yes	Yes

Note – The table reports regression estimates of the effect of state-level AP and dual enrollment mandates in regard to funding and access on the log number of exams taken by students who indicate their race/ethnicity to be Asian that receive a certain score. Robust standard errors are in shown in parentheses. Standard errors are clustered on the state level. Regression includes state-level control variables when indicated - these are controls, in logs, for school spending, number of schools, % rural schools, average teacher salary, total enrollment, enrollment by race and grade, median household income, unemployment rates, and population estimates by race. *, **, and ***, indicate statistical significance at the ten-, five-, and one-percent levels, respectively.

Table A.16: The Effect of Advanced Course Mandates on the Log Number of Exams by Score - Hispanic Students

	(1) Log Exam Score: 5	(2) Log Exam Score: 4	(3) Log Exam Score: 3	(4) Log Exam Score: 2	(5) Log Exam Score: 1
AP Mandate	-0.049 (0.169)	-0.024 (0.084)	0.118 (0.097)	0.184* (0.097)	0.193 (0.175)
AP Funding	0.155* (0.085)	0.191** (0.092)	0.141* (0.078)	0.280*** (0.105)	0.391** (0.147)
Years	20	20	20	20	20
States	51	51	51	51	51
R-squared	0.988	0.991	0.993	0.992	0.989
Observations	1,020	1,020	1,020	1,020	1,020
Time-Varying Controls	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
State Time Trend	Yes	Yes	Yes	Yes	Yes

Note – The table reports regression estimates of the effect of state-level AP and dual enrollment mandates in regard to funding and access on the log number of exams taken by students who indicate their race/ethnicity to be African American that receive a certain score. This sample includes students of all grade levels and ethnicities. Robust standard errors are in shown in parentheses. Standard errors are clustered on the state level. Regression includes state-level control variables when indicated - these are controls, in logs, for school spending, number of schools, % rural schools, average teacher salary, total enrollment, enrollment by race and grade, median household income, unemployment rates, and population estimates by race. *, **, and ***, indicate statistical significance at the ten-, five-, and one-percent levels, respectively.

Table A.17: The Effect of Advanced Course Mandates on the Log Number of Students Sending AP Exam Scores to Universities

	(1) # Students Sending To All Universities	(2) # Exams Sent To All Universities
AP Mandate	0.153 (0.137)	0.149 (0.133)
AP Funding	0.261*** (0.081)	0.264*** (0.082)
States	51	51
Years	19	19
R-squared	0.985	0.987
Observations	969	969
Time-Varying Controls	No	No
State FE	Yes	Yes
Year FE	Yes	Yes
State Time Trend	No	No

Note – The table reports regression estimates of the effect of state-level AP policies in regard to funding and access on the log number of students who apply to a university. Robust standard errors are in shown in parentheses. Standard errors are clustered on the state level. Regression includes state-level control variables when indicated - these are controls, in logs, for school spending, number of schools, % rural schools, average teacher salary, total enrollment, enrollment by race and grade, median household income, unemployment rates, and population estimates by race. *, **, and ***, indicate statistical significance at the ten-, five-, and one-percent levels, respectively.

Table A.18: The Effect of Advanced Course Mandates on the Log Number of Students Sending AP Exam Scores to Universities

	(1) # Students Sending To In State Universities	(2) # Students Sending To Out of State Universities	(3) # Students Sending To All Universities
AP Mandate	0.188 (0.132)	0.066 (0.107)	0.148 (0.134)
AP Funding	0.233*** (0.085)	0.258*** (0.065)	0.262*** (0.081)
States	51	51	51
Years	19	19	19
R-squared	0.989	0.979	0.985
Observations	969	969	969
Time-Varying Controls	No	No	No
State FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
State Time Trend	No	No	No

Note – The table reports regression estimates of the effect of state-level AP policies in regard to funding and access on the log number of students who send at least one AP exam to a university. Robust standard errors are in shown in parentheses. Standard errors are clustered on the state level. Regression includes state-level control variables when indicated - these are controls, in logs, for school spending, number of schools, % rural schools, average teacher salary, total enrollment, enrollment by race and grade, median household income, unemployment rates, and population estimates by race. *, **, and ***, indicate statistical significance at the ten-, five-, and one-percent levels, respectively.

Table A.19: The Effect of Advanced Course Mandates on the Log Number of Students Applying to Universities

	(1) Log Applications	(2) Log Applications	(3) Log Enrollment	(4) Log Enrollment
AP Mandate	0.110** (0.044)	0.024 (0.028)	0.086** (0.036)	0.002 (0.025)
AP Funding	0.114*** (0.036)	0.126*** (0.039)	0.010 (0.033)	0.024 (0.028)
Universities	430	430	430	430
Years	19	19	19	19
R-squared	0.947	0.950	0.954	0.957
Observations	8,170	8,170	8,170	8,170
Time-Varying Controls	No	Yes	No	Yes
University FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
State Time Trend	No	Yes	No	Yes

Note – The table reports regression estimates of the effect of state-level AP and dual enrollment mandates in regard to funding and access on the number of students who apply to a university. Robust standard errors are in shown in parentheses. Standard errors are clustered on the state level. Regression includes state-level control variables when indicated - these are controls, in logs, for school spending, number of schools, % rural schools, average teacher salary, total enrollment, enrollment by race and grade, median household income, unemployment rates, and population estimates by race. *, **, and ***, indicate statistical significance at the ten-, five-, and one-percent levels, respectively.

Table A.20: The Effect of Advanced Course Mandates on the Log Number of Candidates

	(1) Log Total Candidates	(2) Log Total Candidates	(3) Log Total Candidates	(4) Log Total Candidates	(5) Log Total Candidates
Advanced Course Mandate	0.083 (0.071)	-0.047 (0.042)	-0.048 (0.042)	0.049 (0.051)	-0.057*** (0.018)
AP Mandate		0.269** (0.122)	0.274** (0.123)		0.228** (0.092)
AP Funding				0.217*** (0.075)	0.196*** (0.061)
Dual Enrollment Access			-0.023 (0.042)	0.005 (0.037)	-0.014 (0.039)
States	51	51	51	51	51
Years	20	20	20	20	20
R-squared	0.998	0.998	0.998	0.998	0.998
Observations	1,020	1,020	1,020	1,020	1,020
Time-Varying Controls	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
State Time Trend	Yes	Yes	Yes	Yes	Yes

Note – The table reports regression estimates of the effect of state-level AP and dual enrollment mandates in regard to funding and access on the total number of students who take at least one AP exam. An advanced course mandate is defined as any state level policy that requires schools or school districts to offer advanced courses. An AP mandate is defined as any state level policy that requires schools or school districts to specifically offer courses from the Advanced Placement program. This sample includes students of all grade levels and ethnicities. Robust standard errors are in shown in parentheses. Standard errors are clustered on the state level. Regression includes state-level control variables when indicated - these are controls, in log, for school spending, number of schools, % rural schools, average teacher salary, total enrollment, enrollment by race and grade, median household income, unemployment rates, and population estimates by race. *, **, and ***, indicate statistical significance at the ten-, five-, and one-percent levels, respectively.

Table A.21: The Effect of Advanced Course Mandates on the Log Total Candidates

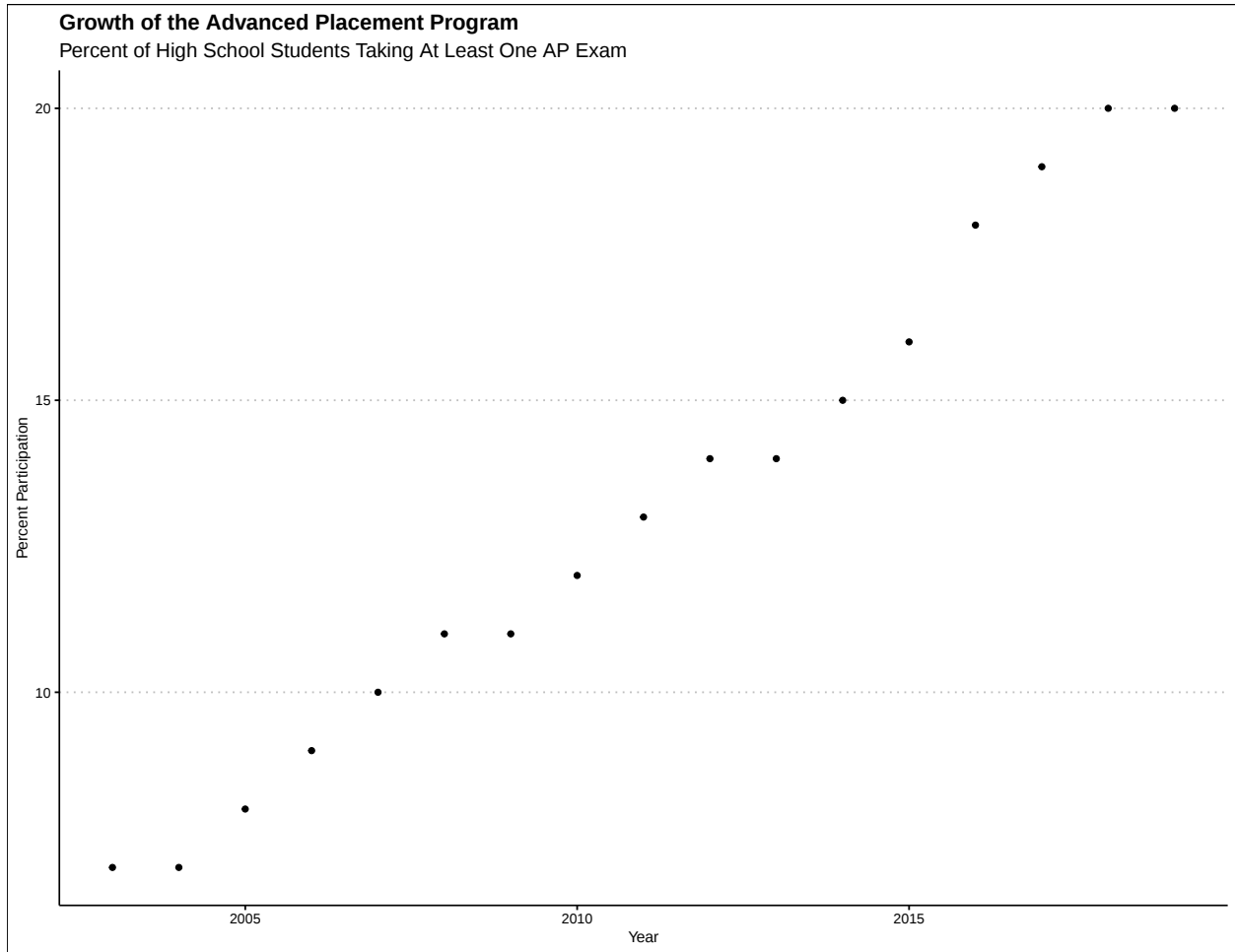
	(1) Log Total Candidates	(2) Log Total Candidates
AP Mandate	0.178* (0.091)	0.180* (0.098)
AP Funding	0.230*** (0.073)	0.232*** (0.079)
Years	20	20
States	51	51
Comparison Group	Not Yet Treated	Never Treated
R-squared	0.905	0.963
Observations	1,020	1,020
Time-Varying Controls	No	Yes
State FE	Yes	Yes
Year FE	Yes	Yes
State Time Trend	No	Yes

Note – The table reports regression estimates of the effect of state-level AP and dual enrollment mandates in regard to funding and access on the AP pass rate. Robust standard errors are in shown in parentheses. Standard errors are clustered on the state level. Regression includes state-level control variables when indicated - these are controls, in logs, for school spending, number of schools, % rural schools, average teacher salary, total enrollment, enrollment by race and grade, median household income, unemployment rates, and population estimates by race. *, **, and ***, indicate statistical significance at the ten-, five-, and one-percent levels, respectively.

APPENDIX B

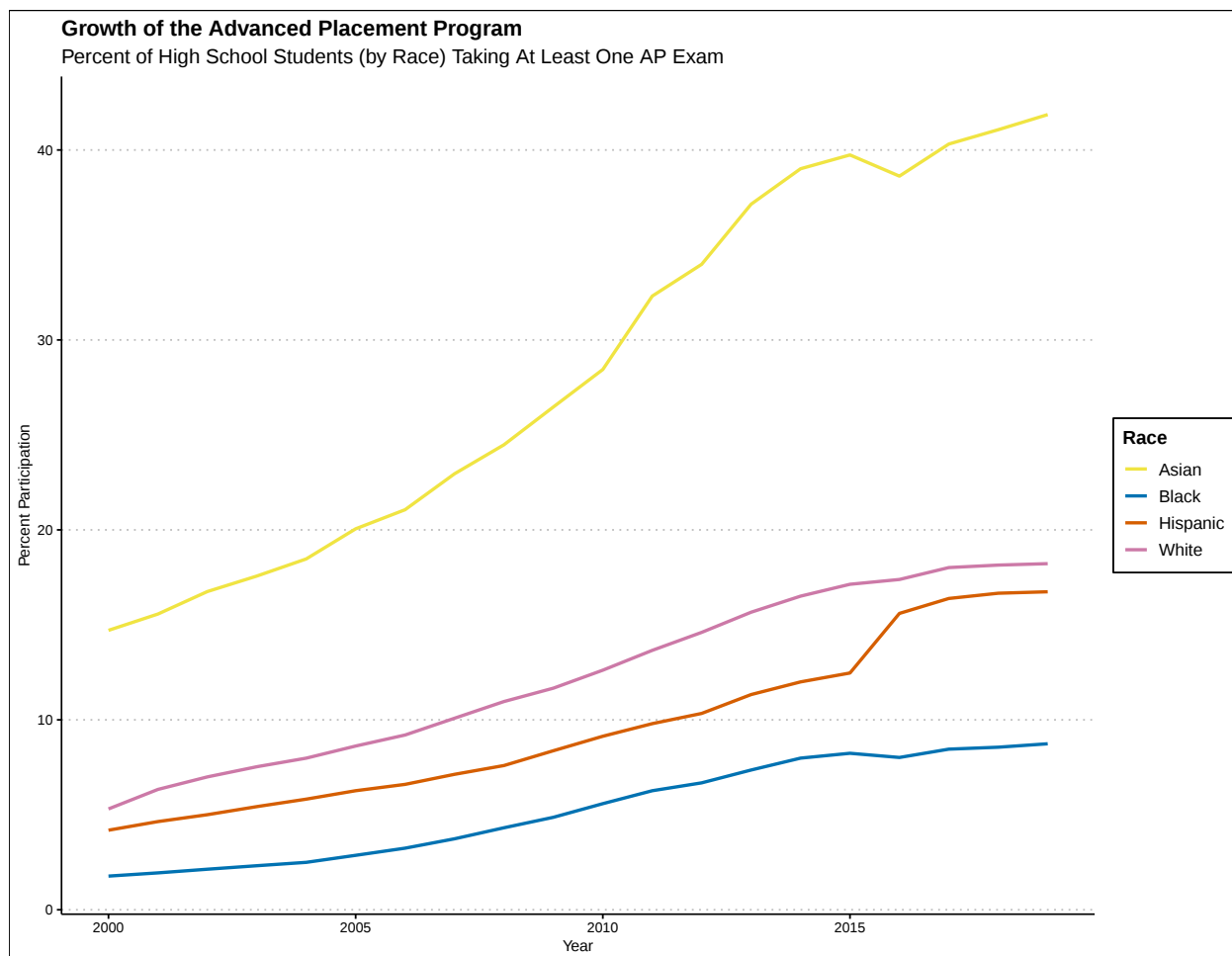
FIGURES

Figure B.1: Growth of the AP Program



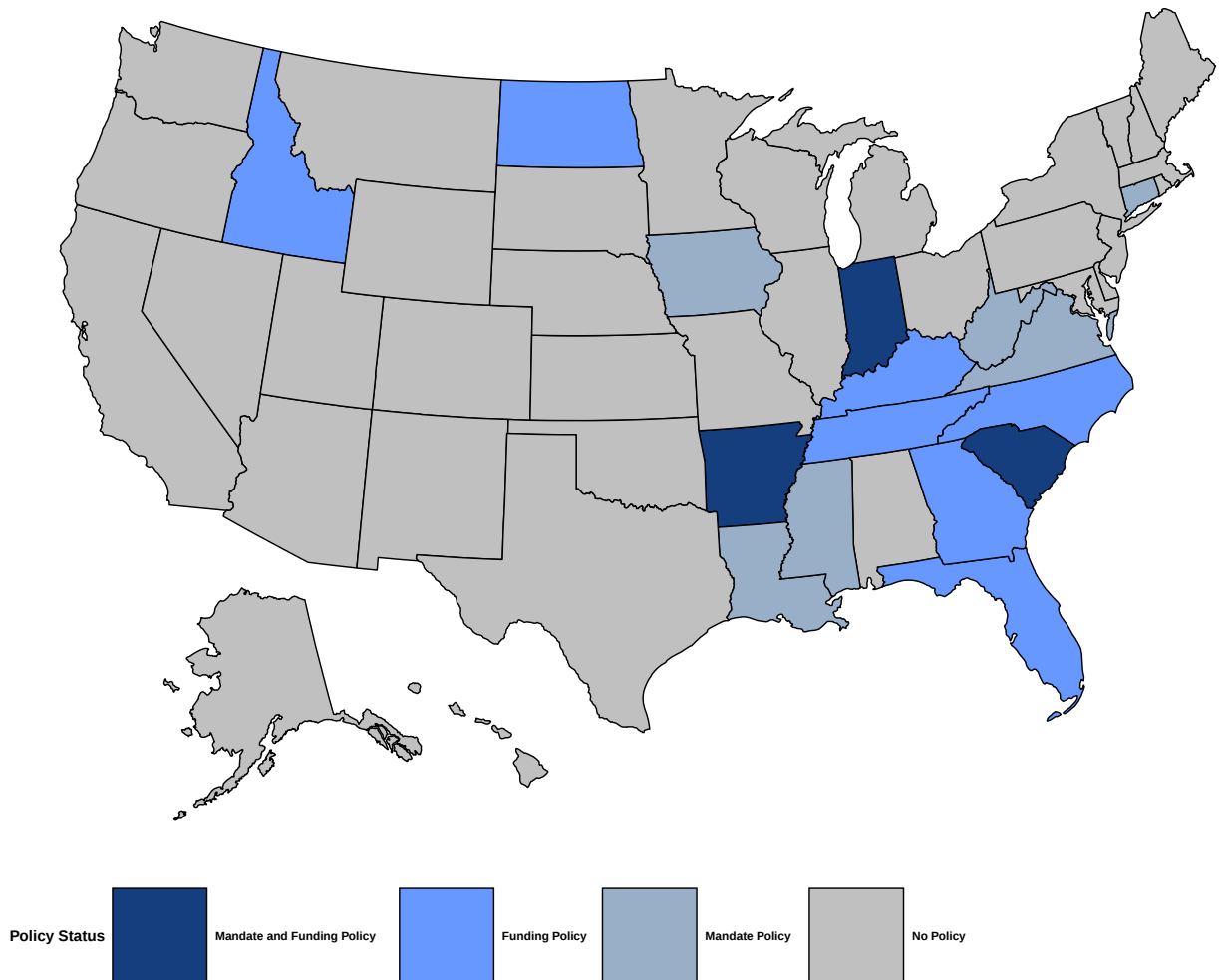
Note - This plots the percent of high school students who take at least one AP exam across the United States per year.

Figure B.2: Growth of the AP Program – By Race



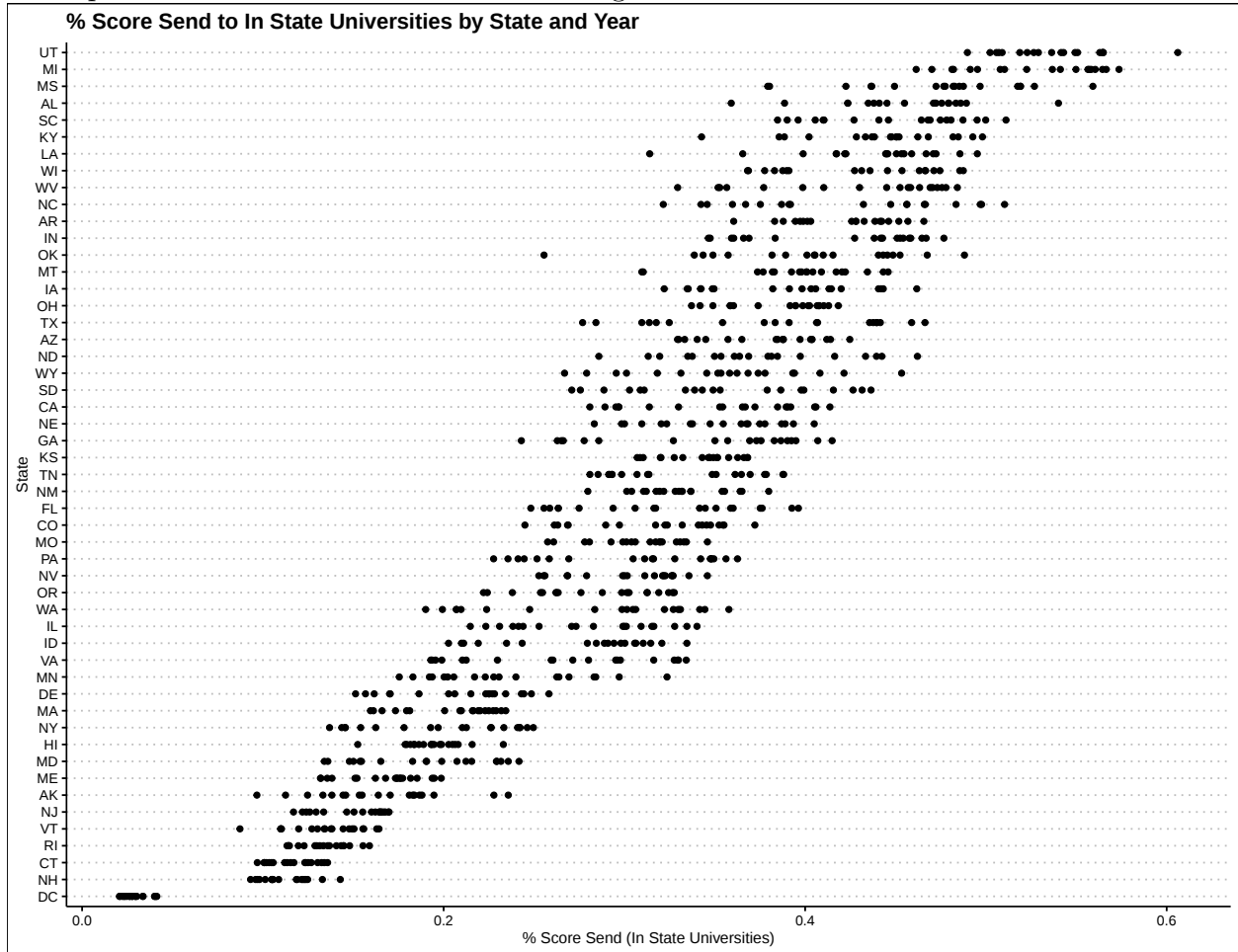
Note - This plots the percent of high school students, by race/ethnicity, who take at least one AP exam across the United States per year.

Figure B.3: US Map with AP Policy Status by 2019



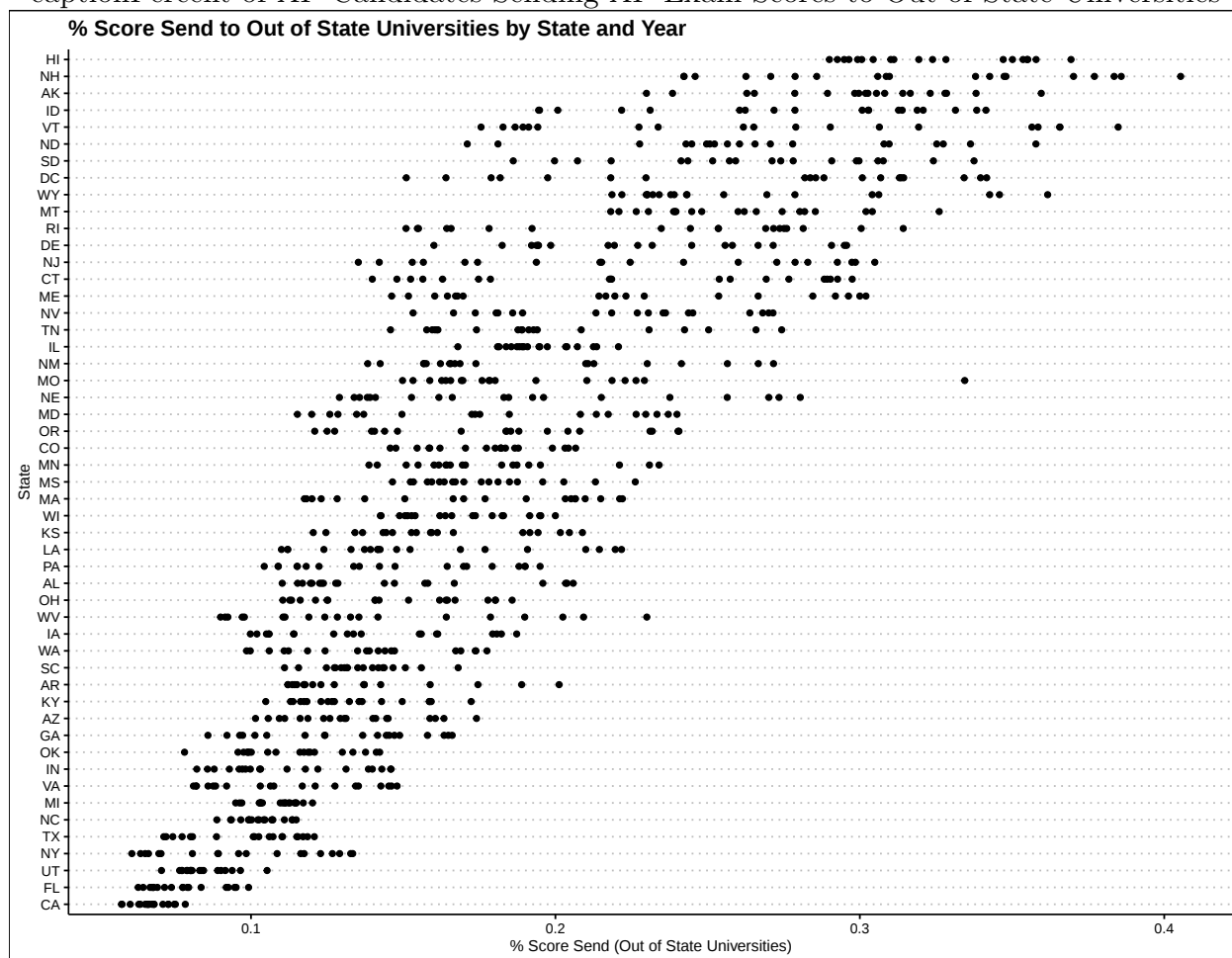
Note - This plots policy status for each state by the year 2019.

captionPercent of AP Candidates Sending AP Exam Scores to In State Universities



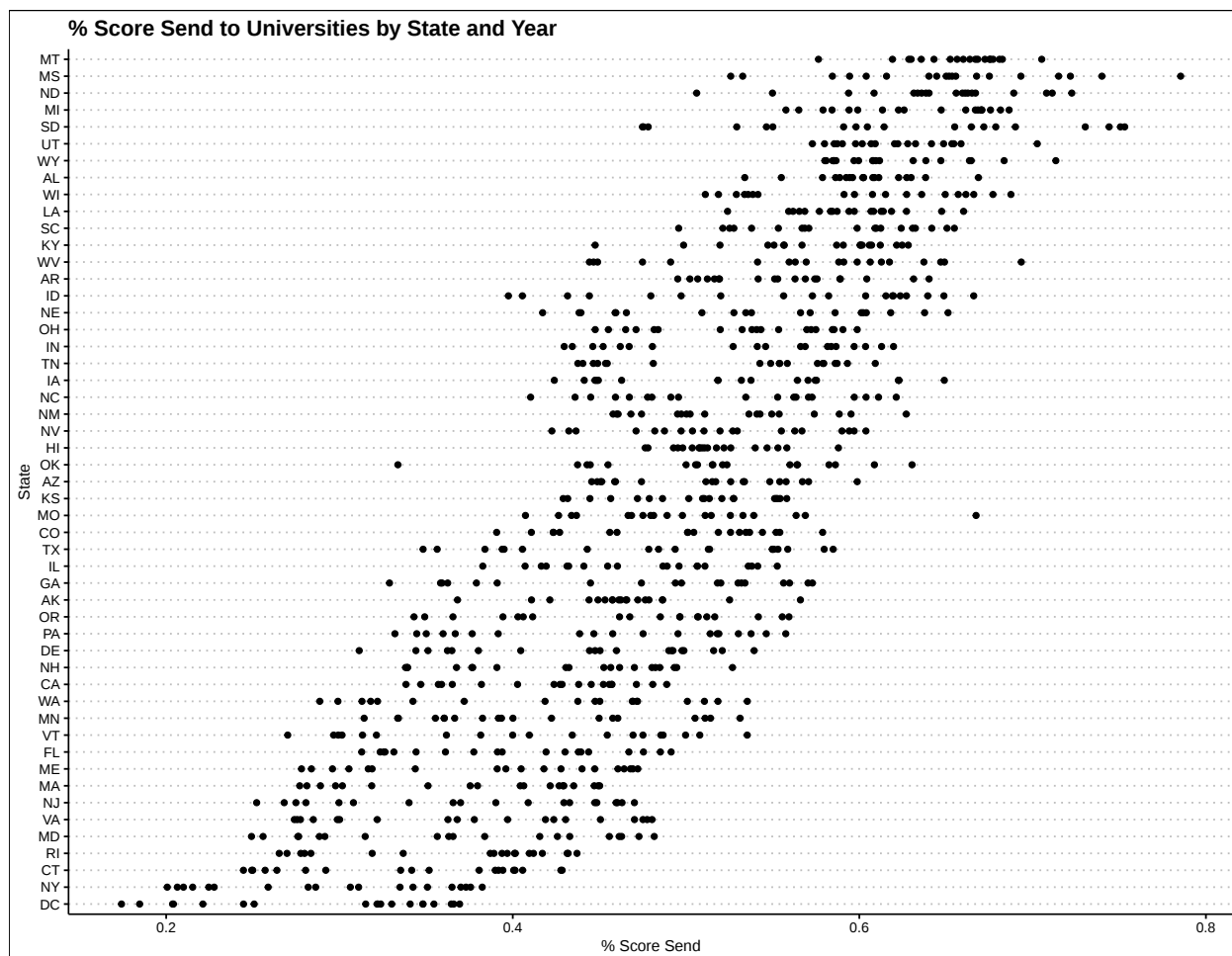
Note - This plots the percent of AP candidates who send at least one AP exam score to a university in the same state in which they took their AP exam.

captionPercent of AP Candidates Sending AP Exam Scores to Out of State Universities



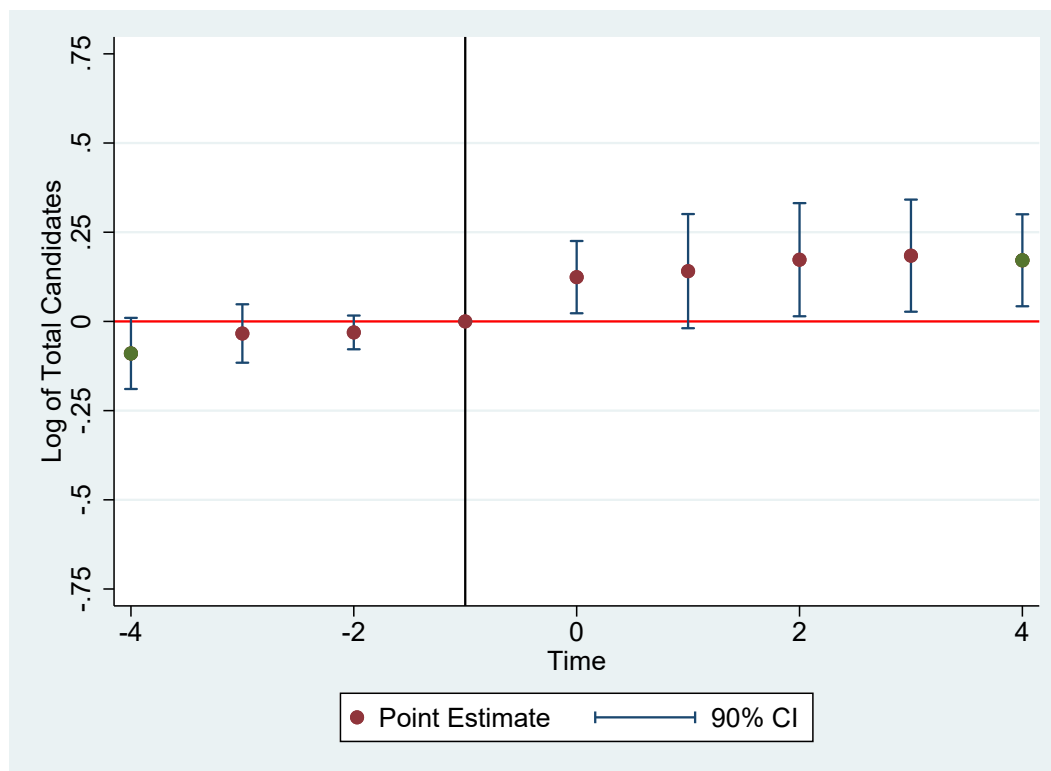
Note - This plots the percent of AP candidates who send at least one AP exam score to a university that is not in the same state in which they took their AP exam.

Figure B.4: Percent of AP Candidates Sending AP Exam Scores to Any University



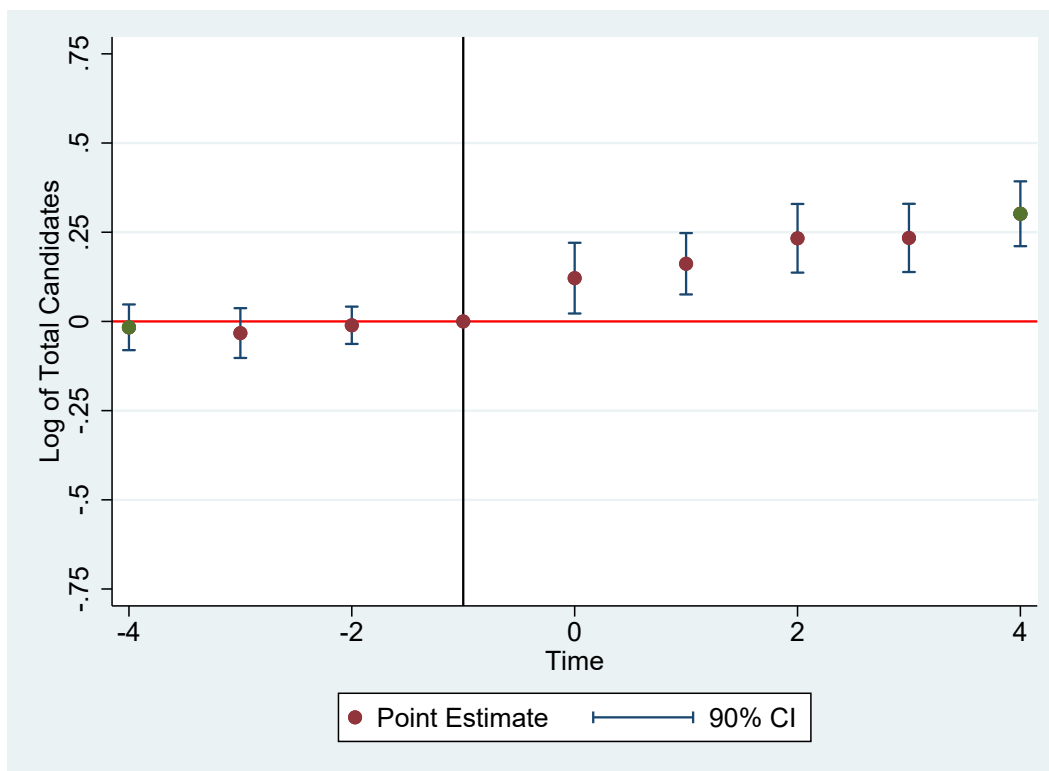
Note - This plots the percent of AP candidates who send at least one AP exam score to a university.

Figure B.5: Effect of AP Mandates on the Log of Total Candidates



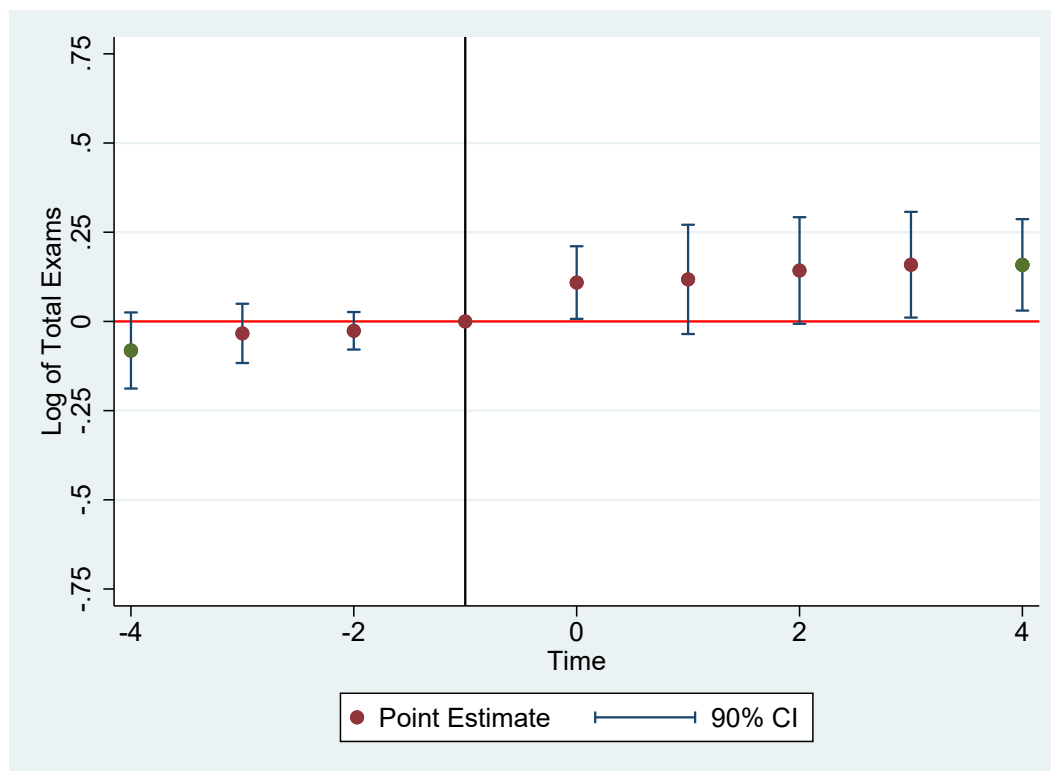
Note - This plots the event study estimation for the log of total students who take at least one AP exam in states that mandate AP courses compared to all other states using 2001 - 2019 data from the College Board. We define an AP mandate as a state-level policy that requires schools to offer AP courses specifically. This estimation includes state time trends and state-level control variables - these are controls, in log, for school spending, number of schools, % rural schools, average teacher salary, total enrollment, enrollment by race and grade, median household income, unemployment rates, and population estimates by race.

Figure B.6: Effect of AP Funding on the Log of Total Candidates



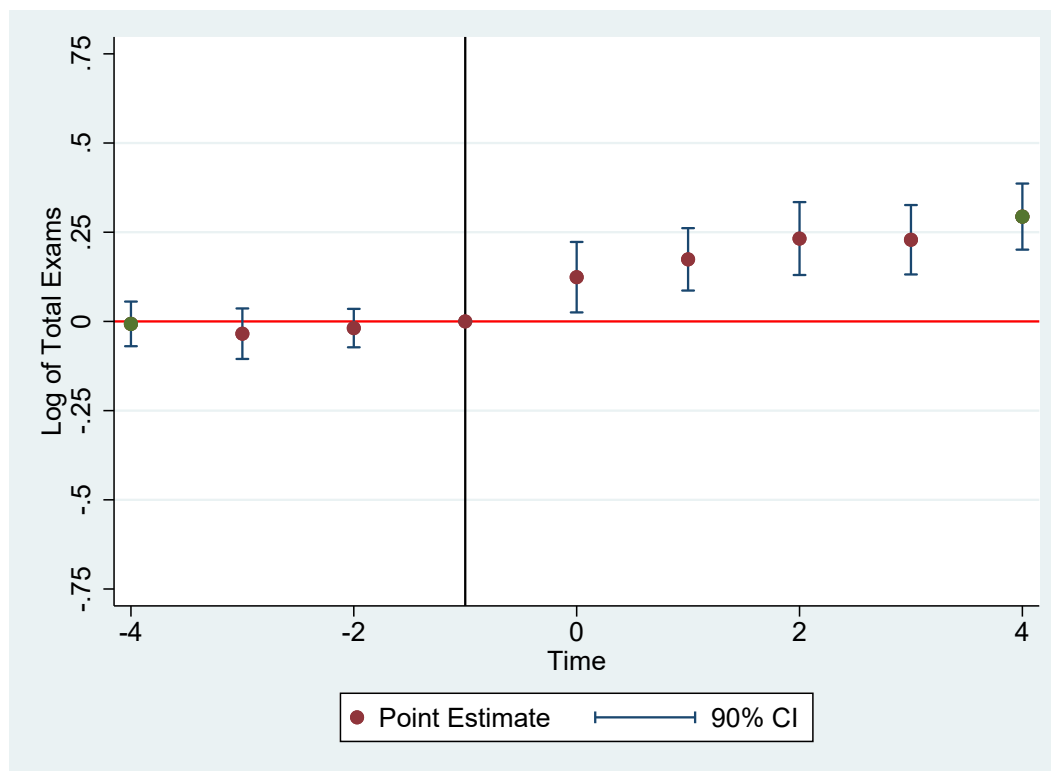
Note - This plots the event study estimation for the log of total students who take at least one AP exam in states that fund AP exams compared to all other states using 2001 - 2019 data from the College Board. We define AP funding as a state-level policy pays for students to take AP exams regardless of need. This estimation includes state time trends and state-level control variables - these are controls, in log, for school spending, number of schools, % rural schools, average teacher salary, total enrollment, enrollment by race and grade, median household income, unemployment rates, and population estimates by race.

Figure B.7: Effect of AP Mandates on the Log of Total Exams



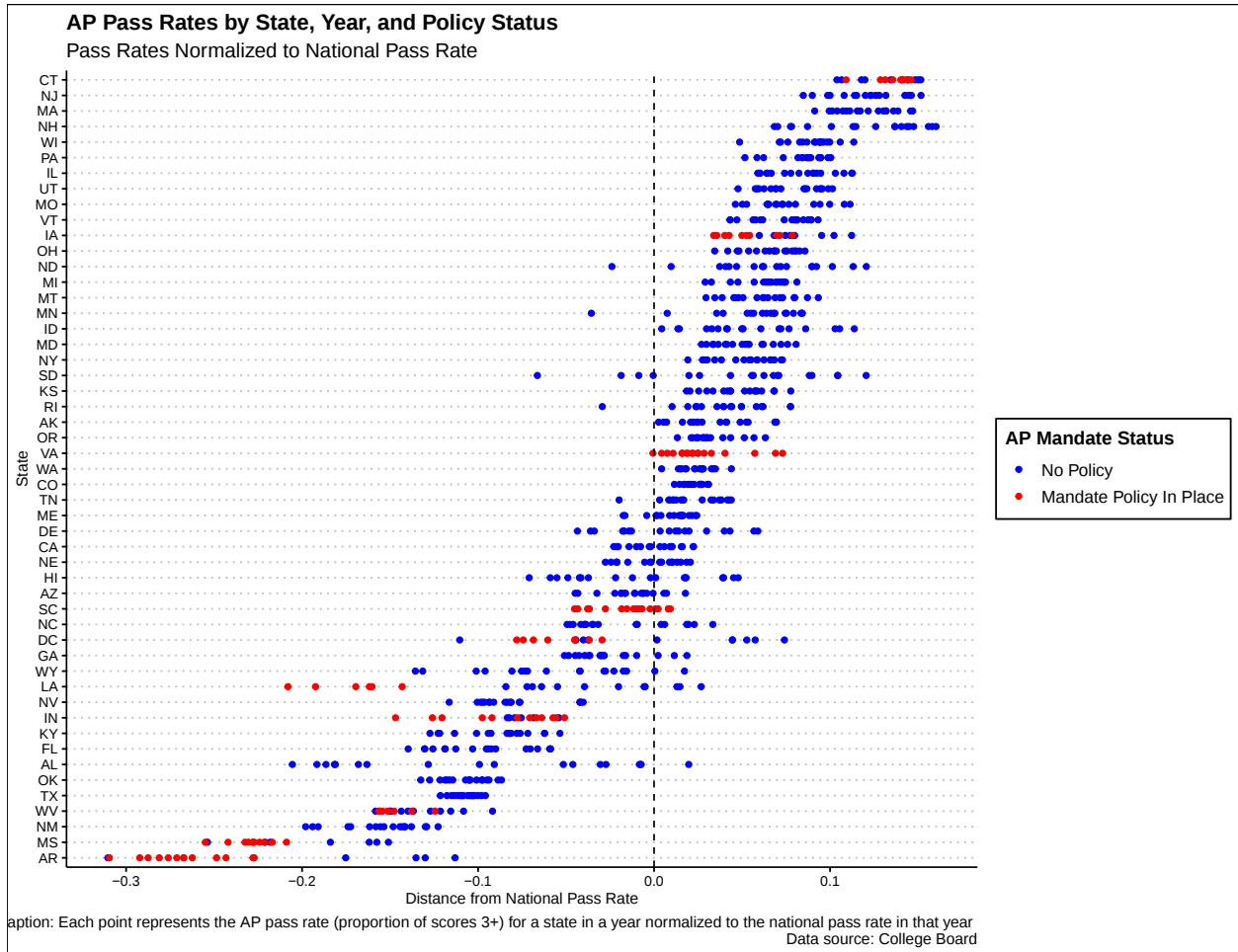
Note - This plots the event study estimation for the log of total exams in states that mandate AP courses compared to all other states using 2001 - 2019 data from the College Board. We define an AP mandate as a state-level policy that requires schools to offer AP courses specifically. This estimation includes state time trends and state-level control variables - these are controls, in log, for school spending, number of schools, % rural schools, average teacher salary, total enrollment, enrollment by race and grade, median household income, unemployment rates, and population estimates by race.

Figure B.8: Effect of AP Funding on the Log of Total Exams



Note - This plots the event study estimation for the log of total exams in states that fund AP exams compared to all other states using 2001 - 2019 data from the College Board. We define AP funding as a state-level policy pays for students to take AP exams regardless of need. This estimation includes state time trends and state-level control variables - these are controls, in log, for school spending, number of schools, % rural schools, average teacher salary, total enrollment, enrollment by race and grade, median household income, unemployment rates, and population estimates by race.

Figure B.9: Pass Rate on AP Exams by State, Year, and Mandate status



Note - This plots the pass rate for each state and year normalized to the national average pass rate across all AP exams. For years and states that have an AP mandate, the pass rate is indicated as such.

APPENDIX C

POLICY TABLES

Table A: Table of All State Policies Regarding Mandating Advanced Courses – Includes Policies Related to AP/IB/Dual Enrollment and Other Pathway Programs

State	Policy Year	Policy Summary	Specific AP Mandate	Magnitude of Mandate
Arkansas	2005-2006 school year.	All high schools must offer at least four AP courses.	Yes	Four AP courses in all high schools. One AP course in English, math, science and social studies in each district.
Connecticut	2011-2012 school year.	Local boards of education must provide advanced course programs.	No	No specification on the number of courses.
District of Columbia	2010	At least four AP courses offered at each traditional high school.	Yes	Four AP courses at each traditional high school.
Florida	2011-2012 school year.	Each high school must offer a combination of at least four courses in dual enrollment or AP.	No	Four courses that can be either AP or dual enrollment.
Idaho	2009-2010 school year.	All high schools must offer “advanced opportunities”.	No	No specification on the number of courses.
Indiana	2006-2007 school year.	Each high school must provide at least two AP and two dual credit courses.	Yes	Two AP courses and two dual enrollment courses. AP math and science sources must also be provided.
Iowa	2008-2009 school year.	AP courses must be available to resident students.	Yes	No specification on the number of courses.
Kentucky	2015	All high schools must offer AP, IB, dual enrollment or dual credit courses.	No	No specification on the number of courses.
Louisiana	2012-2013 school year.	Each high school must offer at least one AP course in each of the four content areas plus one additional AP course.	Yes	Four AP courses, one in each content area plus one additional AP courses – total of five AP courses must be offered.
Maine	2013	Secondary schools must offer opportunities for learning in multiple pathways.	No	No specification on the number of courses.
Mississippi	2007-2008 school year.	All districts must offer at least one AP course in the four content areas.	Yes	Four AP course, one in each content area.

Table A (continued): Table of All State Policies Regarding Mandating Advanced Courses – Includes Policies Related to AP/IB/Dual Enrollment and Other Pathway Programs					
	2010	Schools are required to demonstrate instructional programs that encourage students to participate in advanced courses.	No	No specification on the number of courses.	
New Hampshire		Local boards must establish a process to approve post-secondary learning opportunities.	No	No specification on the number of courses.	
New Jersey	2011	At least one of the units required for graduation must be earned as an AP, honors, dual credit or online course.	No	No specification on the number of courses. Students must take at least one courses but schools are not given a specific of courses to offer.	
New Mexico	2009-2010 school year.	Local boards must ensure all high school students have access to advanced courses in the four content areas.	No	No specification on the number of courses.	
North Carolina	Bill passed in July 2013.	All high schools must offer one unit of an AP or dual credit course.	No	At least one AP or dual credit course is required.	
North Dakota	2011	All schools/districts must offer students the opportunity to participate in a dual enrollment program.	No	No specification on the number of courses.	
Ohio	2007-2008 school year.	All school districts must offer accelerated college credit programs.	No	No specification on the number of courses. Bill does specify that access is particularly important in English, math and science.	
Oregon	2014-2015 school year.	Districts must establish pathways that represent a set of courses that allow students to achieve their academic and career goals.	No	No specification on the number of courses.	
Rhode Island	2013	State board policy requires all high schools must offer at least one AP course.	Yes	At least one AP course must be provided.	
South Carolina	1984	All districts are required to offer students the opportunity to earn at least 12 semester credit hours of college credit in high school.	No	No specific specification on the number of courses.	
Texas	2013				

Table A (continued): Table of All State Policies Regarding Mandating Advanced Courses – Includes Policies Related to AP/IB/Dual Enrollment and Other Pathway Programs				
Virginia	1992	All high schools must offer at least three college-level courses for degree credit.	No	At least three courses (either AP, IB or Cambridge).
West Virginia	2011-2012 school year.	All high schools must offer at least one AP course in each of the four core content areas.	Yes	Four AP course, one in each content area.

Table B: Table of All State Policies Regarding Funding Advanced Placement Exams			
State	Year	Citation	Description
Tennessee	2013	HB 705 (2013)	Public high school students enrolled in Advanced Placement courses shall not be required to pay any fee to take the AP examination.
Kentucky	2009	160.348 (2013)	Effective with the 2008-2009 school year and thereafter, students enrolled in AP or IB courses in the public schools shall have the cost of the examinations paid by the Kentucky Department of Education.
Idaho	2017	HB 458 (2016)	Students attending public schools in Idaho will be eligible for four thousand one hundred twenty-five dollars (\$4,125) to use toward overload courses, dual credits, college credit-bearing examinations and professional certificate examinations.
North Carolina	2014	SL2013-360 section 8.27 (2014)	"... appropriating funds to pay for all AP, IB, and AICE exams for public school or charter school students who are enrolled in the corresponding AP/IB/AICE courses. This funding continues in the recurring budget."
South Carolina	2018	Section 59-18-325 (2017)	"... This course selection might include remediation courses, dual-enrollment or dual-credit courses, advanced placement courses/International Baccalaureate, internships, career and technology courses that are aligned with appropriate industry credentials or certificates, or other options during the remaining semesters in high school..."
Florida	2002	S.B. 20E	"The State Department of Education shall reimburse districts for the administration of the college entrance and career readiness assessments." "... public secondary school students are exempt from payment of Advanced Placement exam fees, regardless of whether or not they obtain a passing score on the exam."
Georgia	2018*	https://www.covnews.com/news/education/georgia-redirects-support-ap-exams/	"This year Georgia will pay only for science, technology, engineering, or mathematics (STEM) related AP exams. It no longer will pay for AP exams in the arts, English, history, social science, or world languages and cultures. Lawmakers also opened up the opportunity to all students, that is, Georgia now will pay for one STEM-related AP exam for any public-school student regardless of the student's economic status."

Table B (continued): Table of All State Policies Regarding Funding Advanced Placement Exams			
Arkansas	2005	TBD	All AP Exam fees paid by the state. Student must take and complete corresponding AP course to qualify. Students may take unlimited exams as long as they meet the other requirements. In order to receive weighted credit for the course, students must take the AP exam.
Indiana	2008	P.L. 20-2007, SEC.4.	To pay the fees for each math or science advanced placement examination that is taken by a student who is: (a) enrolled in a public secondary school; and (b) a resident of Indiana. Priority shall be given to paying the fees for each math or science advanced placement examination that is taken by a student in grade 11 or 12.
North Dakota	2017	TBA	For economically disadvantaged students, the state will cover the entire exam fee for up to 4 exams in English, math, science or computer science over the student's high school career. For non-economically disadvantaged students taking AP exams in these subjects, the state will cover the exam fee for the student's first qualifying exam, and will cover 50% of the exam fee for the following 3 qualifying exams over the student's high school career. These exam fee waivers extend to private school, Bureau of Indian Education, and home school students.