

# Common Core State Standards' Effects on SAT Scores

Determining the effectiveness of education policy reform in  
America

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## **Abstract**

Quantifying the impact of Common Core on test scores has implications for education policy reform for public schools across the United States and California. This paper examines the effectiveness of Common Core State Standards (CCSS), which are internationally benchmarked K-12 public education standards for English Language Arts and Mathematics, implemented in 46 states in 2010. I employ a difference-in-differences approach to estimate the causal effect of Common Core on Scholastic Aptitude Test (SAT) Math and Verbal scores. I use state-level longitudinal data from 1995 to 2014 and California public high school longitudinal data from 1999 to 2015 in order to measure changes in SAT scores. The preliminary results suggest that Common Core had no significant effect on test scores during the period I examine.

## Education Standards in America

Education standards in the United States are affected by regulatory changes on a federal, state, and local level. The Department of Education was established in the 1980s to provide federal support for effective school systems<sup>1</sup> and has since undertaken efforts to provide guidelines for state standards. In 1965, President Lyndon B. Johnson signed into law the *Elementary and Secondary Education Act* (ESEA), which was the first landmark federal education standards law.

Over the past decade, the United States has seen some major changes in education standards, and updates to ESEA, which is reauthorized every 5 years by the president. In 2002, President George W. Bush significantly increased the role of the federal government in education through the *No Child Left Behind Act* (NCLB), which put a higher emphasis on K-12 standardized testing and accountability. In December 2015, President Obama, with bipartisan support, signed the *Every Student Succeeds Act* (ESSA), to replace NCLB<sup>2</sup>. This bill maintains the same goals for achievement as previous education reform legislature, but massively scales back the federal government's influence on state standards. Additionally, it revokes the formulaic approach that came with the rollout of NCLB, and no longer uses student scores to evaluate teachers' performance and merit<sup>3</sup>.

The overhaul process of NCLB overlaps with state-led efforts to establish their own measures for academic success. The Council of Chief State School Officers (CCSSO) and the National Governors Association Center for Best Practices (NGA center) came together in 2009 to develop the Common Core State Standards (CCSS) to provide a better framework for college and workforce training program readiness in K-12 classrooms in states that implement this curriculum.

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<sup>1</sup> "Federal Role in Education." Home. US Department of Education (ED), 27 July 2016. Web. 13 Mar. 2017.

<sup>2</sup> Turner, Cory. "President Obama Signs Education Law, Leaving 'No Child' Behind." NPR. NPR, 10 Dec. 2015. Web. 13 Mar. 2017.

<sup>3</sup> Turner

## **Common Core State Standards**

Common Core State Standards (CCSS) are K-12 standards that aim to prepare each student for college-level academic rigor. Its developers state that the primary goal is that “the standards as a whole must be essential, rigorous, clear and specific, coherent, and internationally benchmarked”<sup>4</sup>. These internationally benchmarked standards attempt to call for similar levels of conceptual understanding, mathematical reasoning, and problem solving as countries that regularly are heralded as global leaders in education.<sup>5</sup> They provide clearly detailed expectations for students’ achievement levels in English language arts (ELA) and math for year of schooling. Common Core equips teachers to develop consistent goals and aims to increase professional development<sup>6</sup>.

## **Common Core Implementation Considerations**

Since Common Core is an entirely state-led effort and has not been developed via the use of federal funds and is not federally mandated, the timeline and implementation levels vary across states, districts, and schools, which is an obstacle in the analysis of the effectiveness of Common Core. Additionally, state-level implementation of Common Core is not static, as more states continue to repeal or make changes to the standards. Per the Common Core website, CCSS has been implemented in 42 states. States that have not completely implemented CCSS are Alaska,

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<sup>4</sup> "Common Core State Standards Initiative." The SAGE Encyclopedia of Economics and Society (n.d.): n. pag. Web.

<sup>5</sup> Garner, Brette Ashley. "Internationally Benchmarked : Comparing the Common Core State Standards to the Singapore Mathematics Framework." N.p., 01 May 2013. Web. 13 Mar. 2017.

<sup>6</sup> "Frequently Asked Questions." Frequently Asked Questions | Common Core State Standards Initiative. N.p., n.d. Web. 03 June 2017.

Nebraska, Minnesota, Oklahoma, South Carolina, and Texas. However, Common Core faces a great deal of backlash.

Because Common Core raises the bar for states that have historically underperformed, by setting the same expectations for them as states that have had well-established education accountability, it induces a lot of change. Critics of Common Core declare that it is too test-heavy and limits students' achievement<sup>7</sup>. From a logistical perspective, some worry that states are rushing into these standards without sufficiently preparing and training their teachers<sup>8</sup>. This backlash has caused many states to make changes to these standards—recently, for many states, this has just meant superficial changes, such as changing the name from “Common Core State Standards” to, in the case of Florida, “Next Generation Sunshine State Standards” to increase public support<sup>9</sup>.

The real-time changes of Common Core in the last few years makes it necessary to consider these implications when attempting to discern causation. It is likely that we will not have a clear resolution to Common Core for many states over the next few years since it is a dynamic process, but given the information we have, we can attempt to quantify its impact.

## **SAT Scores as a Measure of Learning**

I focus on obtaining tangible markers to quantify “learning outcomes,” and started by regressing state-level SAT averages on the implementation of CCSS. Although SAT scores do not adjust or account for school demographics, student extra-curricular activities, quality of teaching, or any other metrics such as GPA and other test scores, I use it as the dependent variable in my

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<sup>7</sup> Kirp, David L. "Opinion | Rage Against the Common Core." The New York Times. The New York Times, 27 Dec. 2014. Web. 04 June 2017.

<sup>8</sup> Layton, Lyndsey. "Turmoil Swirling around Common Core Education Standards." The Washington Post. WP Company, 29 Apr. 2013. Web. 04 June 2017.

<sup>9</sup> Layton, Lyndsey. "What's in a Name? Trouble, If It's Common Core." The Washington Post. WP Company, 30 Jan. 2014. Web. 04 June 2017.

model because it has the potential to examine if these standards have an *objective* impact. SAT scores serve as a good indicator for many reasons. State-level, district-level, and school-level data is widely available for multiple decades. The SAT sections that have remained constant through changes in the test are Math and Verbal, which run in parallel with the only two sections that Common Core influences: math and English Language Arts (ELA). Additionally, College Board, the organization that creates and administers the SAT, conducts regular validity studies<sup>10</sup> to confirm that there is an association between SAT scores and educational performance.

College Board publishes results on the test's predictive validity, claiming that "perhaps the most common and most critical form of validity evidence for large scale admissions tests such as the SAT is evidence of the test's predictive validity, that is, the extent to which the SAT is a good predictor of college performance."<sup>11</sup> College Board regularly calibrates the SAT, adding and changing various sections of the test to ensure that it serves as a valid assessment of academic success. In 2008, College Board published research that looked at a student's first year college GPA with respect to SAT scores and high school GPA.

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<sup>10</sup> "Validation is the process of accumulating evidence that supports the appropriateness of the inferences that are made of student responses for specified assessment uses. Validity refers to the degree to which the evidence supports that these interpretations are correct and that the manner in which the interpretations are used is appropriate" (American Educational Research Association, American Psychological Association & National Council on Measurement in Education, 1999).

<sup>11</sup> CollegeBoard Research Study: Validity of the SAT for Predicting First-Year College Grade Point Average

**Table 1**

**Raw and Adjusted Correlations of SAT and HSGPA with FYGPA by Institution Control, Selectivity, and Size**

		<b>n</b>	<b>SAT</b>	<b>HSGPA</b>	<b>SAT + HSGPA</b>
Control	Private	45,786	0.39 (0.57)	0.37 (0.55)	0.48 (0.65)
	Public	105,530	0.34 (0.52)	0.36 (0.53)	0.45 (0.61)
Selectivity	Under 50%	27,272	0.39 (0.58)	0.36 (0.55)	0.47 (0.65)
	50–75%	84,433	0.34 (0.53)	0.35 (0.54)	0.44 (0.62)
	Over 75%	39,611	0.36 (0.51)	0.40 (0.54)	0.47 (0.60)
Size	Small	6,471	0.42 (0.60)	0.41 (0.57)	0.52 (0.67)
	Medium to Large	30,333	0.36 (0.55)	0.38 (0.55)	0.47 (0.63)
	Large	40,861	0.34 (0.53)	0.37 (0.55)	0.45 (0.62)
	Very Large	73,651	0.36 (0.53)	0.35 (0.53)	0.45 (0.61)

Note: Pooled within-institution correlations are presented. The adjusted correlations (in parentheses) are corrected for restriction of range. With regard to institution size, small = 750 to 1,999 undergraduates; medium to large = 2,000 to 7,499 undergraduates; large = 7,500 to 14,999 undergraduates; and very large = 15,000 or more undergraduates. SAT is the multiple correlation for all three sections.

**Source:** CollegeBoard Research Study: Validity of the SAT for Predicting First-Year College Grade Point Average

As demonstrated in the above table, these results vary by group, containing adjusted correlation coefficients that range from 0.52 to 0.67, which indicates that SAT scores play a part in college first year GPA. Although SAT scores will never be perfectly correlated with future academic success, College Board’s model strives to maximize the validity of the test, which makes it an appropriate response variable for a preliminary data analysis.

## Description of the Data

For my preliminary analysis, I examined trends in SAT scores through a national lens, using average math and verbal scores for every state. This data<sup>12</sup> was sourced from the United States Department of Education’s National Center for Education Statistics (NCES)<sup>13</sup> and is observed every few years from 1995 to 2015. There are observations for 6 academic years in total.

After analyzing the aggregate trends in SAT scores in America, I looked at high schools strictly within California. There are over 700 public high schools in California, all of which are supposed to have implemented Common Core at some point within 2010, with a full rollout in the 2014-2015 school year. The California Department of Education, from which I downloaded SAT information for all these high schools from 1999 to 2015, also issued a voluntary survey to gain more details about each school’s implementation status<sup>14</sup>. This survey was taken by 127 public high schools in 2014. This survey contains information about schools’ status of transition (“awareness”, “transition”, or “implementation”), status of plan (“in development”, “completed”, or “completed, approved”), and mapped implement value (an integer ranging from 1 to 7). Additionally, the survey asks about CCSS-specific materials, recording information on if CCSS materials are being used in class (“no”, “few”, “most”, or “every”), and the percentage of students using CCSS-related practice tests.

The following graphs display the difference between math and verbal SAT scores with states that have implemented Common Core at some point in 2010, and states that have not (the

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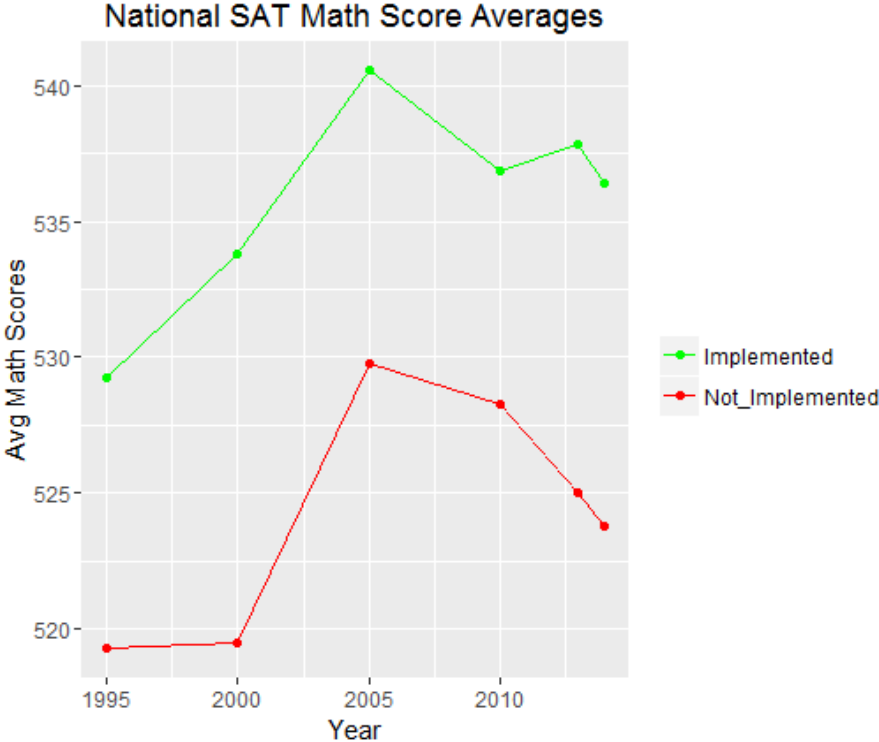
<sup>12</sup> Mean SAT scores of college-bound seniors and percentage of graduates taking SAT, by state: Selected years, 1995-96 through 2014-15

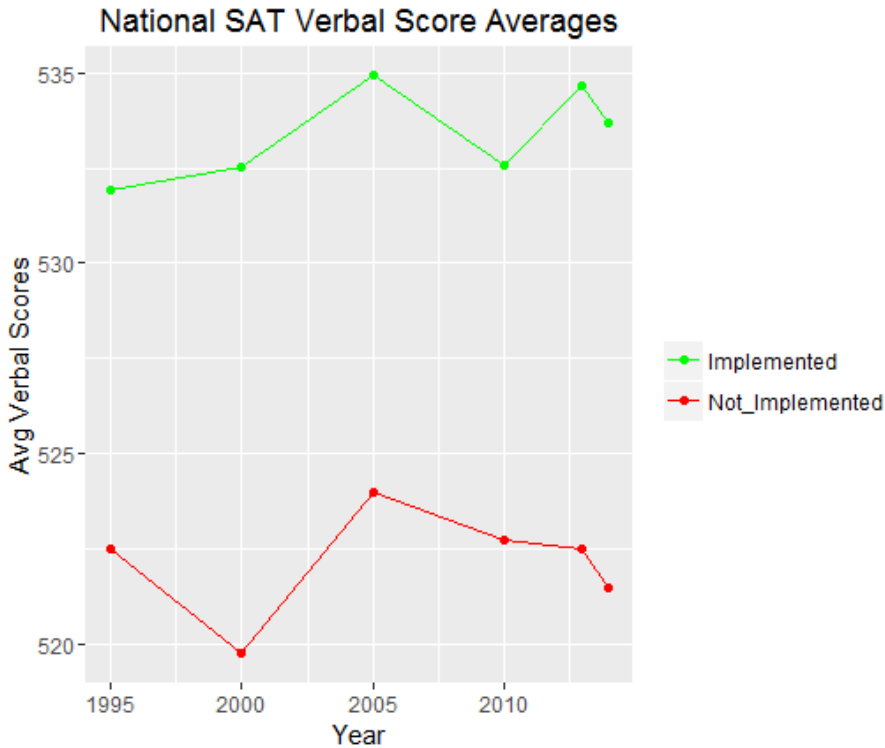
<sup>13</sup> National Center for Education Statistics (NCES)

<sup>14</sup> CA Department of Education – Schools with CCSS data



latter being Alaska, Nebraska, Oklahoma, and Texas). These averages were collected by the NCES for academic years beginning 1995, 2000, 2005, 2010, 2013, and 2014.

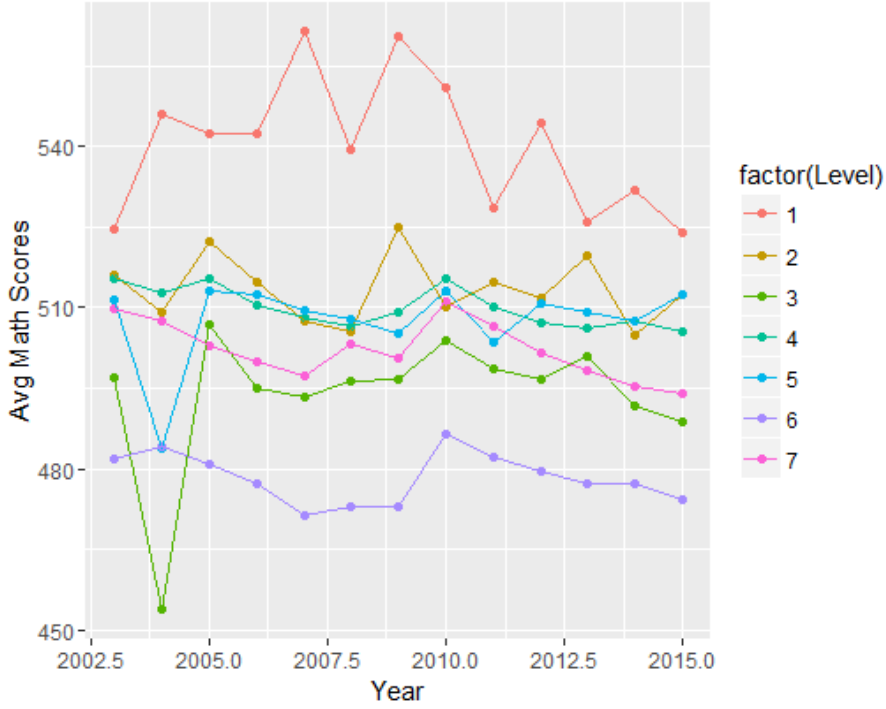




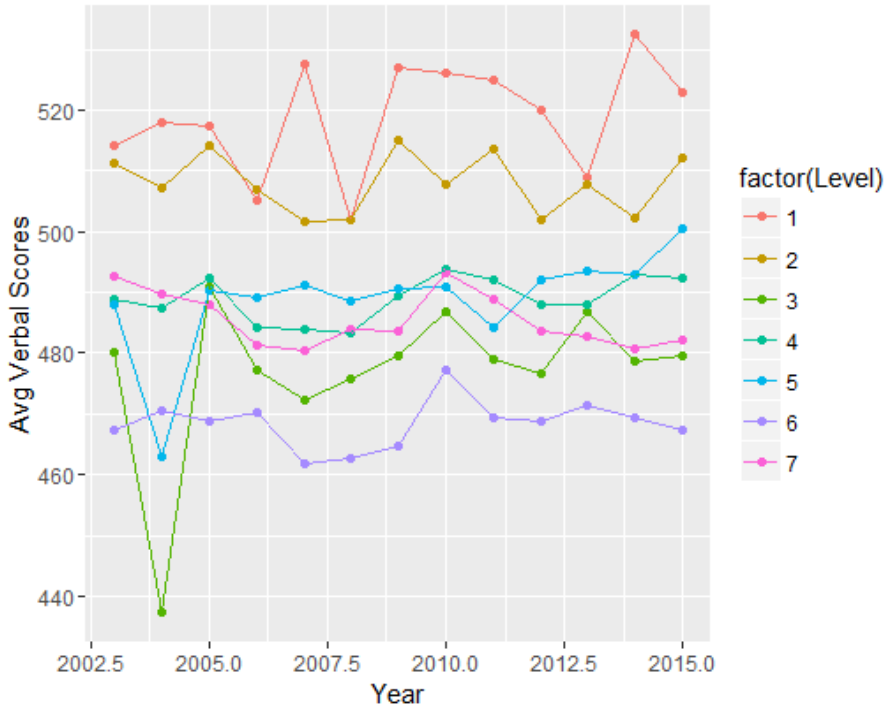
For both Math and Verbal scores, states' averages peak in 2005. Since the aggregate math scores for Common Core states seem to be different even before the curriculum change, this suggests there may be inherent differences in the states' education system that will later have to be accounted for by a fixed-effects model in the regression.

The following two graphs track the 127 public high schools surveyed in California, each recording a mapped implement value between 1 and 7. The survey was administered in 2014, and this information tracks average Math and Verbal scores from 2003 to 2015.

CA High School SAT Math Score Averages



CA High School SAT Verbal Score Averages



Each line tracks the aggregate means of SAT scores for a group of high schools at their recorded implementation levels. There appear to be some consistent differences between a few of the groups, but overall, they do not seem to be inherently different or trending the same way. To determine any statistical significance, I will run a series of statistical tests.

### **State-Level Longitudinal Data**

To determine if Common Core is significant with respect to state level Scholastic Aptitude Test (SAT) scores, I ran a linear regression using longitudinal data. Longitudinal data, also known as panel data, provides multiple observations on each cross-sectional unit in the sample over multiple time points<sup>15</sup>. I collected data on SAT statewide average scores over several years from 1995 to 2014. Using longitudinal data allows me to control for the effects of missing or unobserved variables because of its use of repeated observations. For my preliminary analysis, I ran two models: the first using SAT math scores as the dependent variable, and the second using SAT verbal (or critical reading) scores.

SAT Score is the response variable, depending on if states had implemented Common Core. The implementation map<sup>16</sup> pictured below displays all 50 states, plus the District of Columbia, and their levels of implementation. As mentioned earlier, 42 states currently implement Common Core. However, since this number of states (which was 46 in 2010), keeps changing due to repeals and legislative changes, this regression model simply compares states who have never touched Common Core to every other state.

In the model, “Implementation” is an indicator variable, taking on 0 if the state had never implemented CCSS, and 1 if it had. The map shows that there are only 4 states that had never

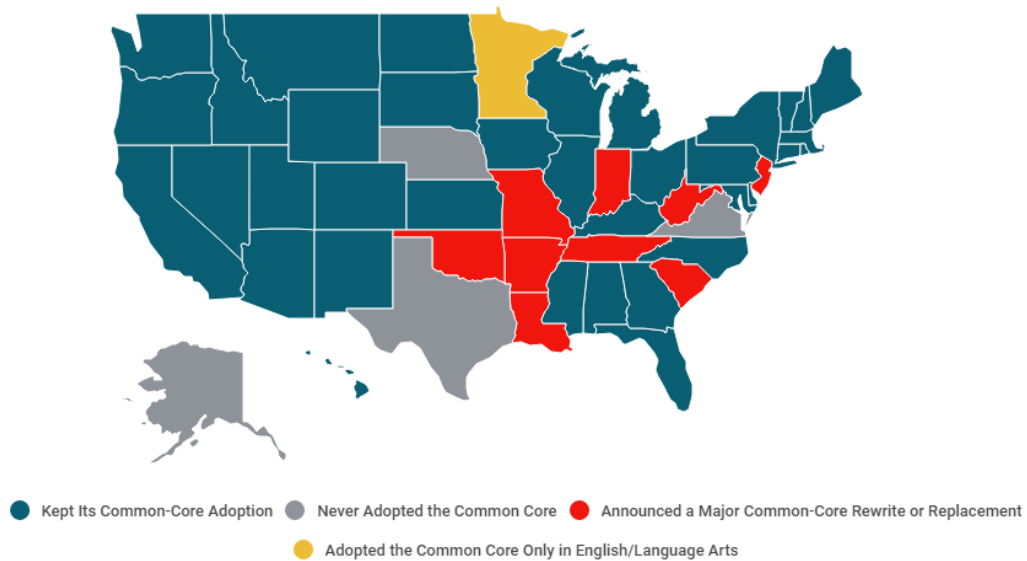
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<sup>15</sup> Hsiao, Cheng. *Analysis of Panel Data*. Cambridge: Cambridge UP, 2014. Print.

<sup>16</sup> "Map: Tracking the Common Core State Standards." *Education Week*. N.p., 17 Apr. 2017. Web. 04 June 2017.

implemented any part of CCSS: Texas, Alaska, Nebraska, and Virginia. States that have implemented in part, or have later repealed it, still have an “Implementation” value of 1. The map below does not account for the degree of Common Core implementation and simply displays effects and differences in national average SAT scores.

**Figure 1**



**Source:** "Map: Tracking the Common Core State Standards." Education Week.

## Methodology

To measure the correlation between SAT scores and implementation for the state-level data, I used three models. The first one incorporates only state fixed effects, the second one uses both state and time fixed effects, and the third one adds a quadratic trend, since the graph shows us that the data seems non-linear. I did these for the Math average scores as well as the Verbal scores. These are the three types of regression models used.

$$(1) Y_{st} = \beta X_{st} + \alpha_s + \lambda_t + u_{st}$$

$$(2) Y_{st} = \beta X_{st} + \alpha_s + \gamma_s t + \lambda_t + u_{st}$$

$$(3) Y_{st} = \beta X_{st} + \alpha_s + \gamma_s t + \gamma_s t^2 + \lambda_t + u_{st}$$

Incorporating state and time fixed effects allows me to use a differences-in-differences model to isolate the impact of Common Core on test scores across time. State fixed effects account for the characteristics within each state that make it inherently different (such as demography, economy, etc.) and time fixed effects account for national trends. Allowing linear and quadratic state-level time trends is important, because the pre-2010 trends are different among implementation groups and I do not have other control variables.

The school-level analysis followed the same intuition, but explored more models. As mentioned earlier, I used survey information in conjunction with SAT data to best understand the state of Common Core implementation in each surveyed high school. I used the same differences-in-differences models listed above to run 6 regressions each for math and verbal. For the first four models, I started by using the “mapped implement value” column from the survey data, since this seemed to be the most comprehensive indicator of Common Core status. For two of these, I retained the information for all years from 2003-2015, and for the next two, I dropped 2010-2013

after demarcating those years as “transition years”, since Common Core was rolled out in 2010. The last model used a different response variable to see if it would better capture the effects of the policy. My response variable for this sixth regression was the survey column that recorded information that answered “Are CCSS materials being used in class?”. Respondents could choose between “every”, “most”, “few”, and “no”, and I transformed it into a binary variable (1 if “every”, 0 otherwise).

## Results

The results from my statistical analysis are tabulated below. There are three tables: the first displays state-level information, and the last two display California high school-level information, for math and verbal scores respectively.

For both state-level and school-level data, the implementation coefficients on all the regressions are not significant, which means that we cannot conclude that Common Core implementation affects SAT scores. Even from the graphs, displayed earlier, there is not a clear upward (or downward) trend associated with the post-2010 data points, which is consistent with these results.

There are a few other important factors to consider when analyzing the impact of Common Core on learning outcomes. First, although SAT scores may serve as a reliable and valid response variable, the SAT is by no means a comprehensive measure of learning. Student performance on the SAT is impacted by a myriad of factors, such as income, time, and test preparation materials. Second, the effects of major policy changes are not always immediately seen. Since changes in the education system will not always be instantly apparent, the conclusion that Common Core does not significantly affect SAT scores in 2017 may not hold in future years.



<b>State-Level Average SAT Scores vs. Common Core Implementation</b>						
	<b>Math</b>			<b>Verbal</b>		
	(1)	(2)	(3)	(1)	(2)	(3)
<b>Implementation Coefficient</b>	-0.4007 (4.8764)	-3.512 (6.465)	-6.043 (5.914)	0.3723 (4.8745)	-2.623 (6.389)	-3.479 (6.175)
<b>State Fixed Effects</b>	Yes	Yes	Yes	Yes	Yes	Yes
<b>Time Fixed Effects</b>	Yes	Yes	Yes	Yes	Yes	Yes
<b>State-level time trends</b>	No	Linear	Quadratic	No	Linear	Quadratic

<b>School-Level Average SAT Math Scores vs. Common Core Implementation</b>					
<b>Dependent Variable</b>	(1)	(2)	(3)	(4)	(5)
<b>Implementation Coefficient</b>	-0.2322 (1.1123)	2.229 (2.080)	0.04884 (1.699)	7.339 (4.036)	13.85 (19.70)
<b>Indicator Variable</b>	Mapped Implement	Mapped Implement	Mapped Implement	Mapped Implement	CC Materials
<b>Years 2010-2013</b>	Present	Present	Dropped	Dropped	Dropped
<b>School Fixed Effects</b>	Yes	Yes	Yes	Yes	Yes
<b>Time Fixed Effects</b>	Yes	Yes	Yes	Yes	Yes
<b>School-level time trends</b>	No	Linear	No	Linear	Linear

<b>School-Level Average SAT Verbal Scores vs. Common Core Implementation</b>					
<b>Dependent Variable</b>	(1)	(2)	(3)	(4)	(5)
<b>Implementation Coefficient</b>	-0.8036 (0.9894)	1.025 (1.845)	-1.0821 (1.5209)	3.193 (3.601)	10.31 (17.56)
<b>Indicator Variable</b>	Mapped Implement	Mapped Implement	Mapped Implement	Mapped Implement	CC Materials
<b>Years 2010-2013</b>	Present	Present	Dropped	Dropped	Dropped
<b>School Fixed Effects</b>	Yes	Yes	Yes	Yes	Yes
<b>Time Fixed Effects</b>	Yes	Yes	Yes	Yes	Yes
<b>School-level time trends</b>	No	Linear	No	Linear	Linear

**Note:** For Indicator Variable, “Mapped Implement” refers to implement values of 1-7 (displayed in graphs on page 9); “CC Materials” reflects if Common Core materials are used in class (see page 13).

## Conclusion

The state-level and school-level analysis of Common Core's effect on SAT scores both yielded statistically insignificant results, indicating that Common Core implementation has no tangible impact on SAT scores. However, it is important to consider the limitations of the model I used. The only response variables used throughout my analysis were SAT math and verbal scores. Although these are reasonable outcomes to measure since Common Core is designed to impact primarily math and ELA curriculum, it is important to find other response variables. To build a more comprehensive model, it is possible to search for ones that are potentially less objective, and include things such as demographic information, college admissions rates, school profiles, socioeconomic status, and more. This framework could then be expanded to examine CCSS' effects on more general learning outcomes, without being limited to test scores.

Another issue with performing a strictly objective analysis of Common Core is that it ignores implications of teaching backgrounds, quality of administration, and other intangibles. It is also hard to measure the transition of states or schools into Common Core. For the school-level data, although a survey was administered, it does not seem to be well-calibrated to fully address what transition status should really be recorded as.

For future analyses, it would be important to prioritize finding other response variables and controlling for factors that are not currently included in this model. This analysis can also be supplemented by research that has a more international scope—part of Common Core's appeal is that it is internationally benchmarked, and it would be interesting to see how long it took the countries in which CCSS was benchmarked to actually reflect a change in their education outcomes.

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