

**\*\*Note:** This research paper was a group project. However, all sections from “Data” (sections Data, Strategy, Results, Conclusion) onwards were entirely written by me. All the R coding and data analysis was also conducted entirely by me.

What is the treatment effect of not adopting the Common Core State Standards curriculum on students' average GPA?

Marc Benjamin Kusno, Gisella Kontaria, Keren Ryant

ECON 474: Econometrics of Policy Evaluation

Fall 2022

Eun Yi Chung

## **Question**

What is the treatment effect of not adopting the Common Core State Standards curriculum on students' average GPA?

## **Motivation**

The importance of high school GPA reflects a student's academic ability as well as being a determining factor for pursuing higher education and joining the workforce. A 2008 study has shown that American students are falling behind as compared to their international counterparts in terms of academics (Barnum, 2019). As an effort to improve attaining academic knowledge for American students, the Common Core State Standards was introduced as one of the measures to be implemented in American education, with hopes to assess the readiness of K-12 students for a higher level education and their career.

The Common Core State Standards curriculum was implemented at a state-by-state level which aims to standardize education for K-12 students through mandatory standardized testing for measuring academic achievement. Common Core State Standards focused on improving and testing a student's proficiency in English and Mathematics courses learned in school. The curriculum also intends to prepare graduating students to meet a satisfactory level of knowledge as they transition to higher education. Furthermore, Common Core State Standards aims to standardize the education levels between states, but the final decision remains with the state whether or not to implement standardized testing through the Common Core State Standards curriculum.

The economic impact for the implementation of Common Core State Standards will require more state funding allocated to K-12 education in order to attain equipment, study materials and reform on education standards. These investments were crucial for successful implementation of

Common Core State Standards in order to prepare students to be college and career ready in terms of academics which will be reflected on the students GPA. Therefore, due to the importance of GPA in determining overall academic performance, this paper aims to evaluate the success of the implementation of this curriculum on improving a student's English and Math scores.

## **Relevant Literature**

According to the study "The Common Core Debacle: Results from 2019 NAEP and Other Sources" published by The Pioneer Institute, there has been a historical decline in the results of U.S. reading and math scores on the National Assessment of Educational Progress (NAEP) and other assessments in the states that have adopted the Common Core English and Mathematics curriculum. The results of this study are based on the following states: Massachusetts, California, Florida, Georgia, Illinois, Kentucky, and New York. The decline is evident in the gradual yearly half a point increase in 4th and 8th grade NAEP scores pre-Common Core (2003-2013) and a drop of nearly a full point each year after the policy was implemented (2013-present). This calls for a reevaluation of the success of the policy, especially when the biggest drops in score was seen in lower-performing students at the 25th and 10th percentiles. Furthermore, the policy is problematic because there is no clear evidence that raising standards (the idea behind Common Core curriculum) will result in increased student learning (Mathis, 2010). In all actuality, there is evidence that the Common Core standards have instead exacerbated graduation and dropout rates in states that have adopted the policy (Strauss, 2014).

The failure of the Common Core Standard may be attributed to the failure of standardized testing itself. In theory, standardized testing would provide students with a form of fair testing for all students. In reality, standardized testing assumes that students could progress equally. Studies from the Brookings Institute show that past implementations in standardized testing for math and

english show poor results (Loveless, 2021). Attempts to standardize algebra in the 1990s apparently resulted in students falling behind in learning algebra and subsequently failing in higher-level algebra courses. The lack of flexibility from standardized curriculums takes away teachers' ability to divert attention to more topics that students find more difficult. Kindergarten students diverted from proven teaching materials to standardized materials that hindered their performance in English classes. Common core may suffer from the same problems as general standardization have, where it works in theory but is not feasible in implementation.

Adding on, the study "Evaluating Common Core" by Kendall Deas points out that the implementation of the policy lacks a convincing research base to substantiate the efforts. There are a lot of factors that can contribute to the outcome of a policy and therefore policies should be designed and integrated in ways that are conducive to local level conditions. Deas argues that the Common Core should have included a more detailed approach in how to properly reform education under this curriculum that is tailored to the educational atmosphere surrounding each state. Considering that educational policies are costly to fully implement and will take time to enact progress, the success of the implementation would also most certainly be affected by each state's financial climate. This suggests that the failure of the Common Core might possibly be rooted in poor implementation and not because of the efforts in itself. In fact, the paper mentions that the initial implementations of the policy occurred at a time where local, state, and federal budgets were expected to decrease, further hinting that if given more funding and proper implementation it could have shown more progress.

The covariates that we introduce in our model are: state education expenditure, gender and family income. Lang and Rudd (2006) have discovered that students with lower family income have shown to be a pivoting indicator that affects a student's GPA. Furthermore, Rouse and

Barrow (2006) inquired about the relationship between family background, specifically their socioeconomic status, affecting GPA of students. With lower family income, students are more likely to struggle in school and adopt new concepts which leads to a lower GPA.

Additionally, we assume that there may be discrepancies between academic performance of male and female students. Buddin (2014) had shown that female students outperformed their male counterparts in terms of high school GPA, especially in Math and English. However, in standardized testing, though female students show a similar trend in Mathematics performance, they also showed a more inconsistent result, where male students outperforms female students in the English category (Buddin, 2014). Buddin (2014) inferred that standardized testing is a better measure of academic achievement rather than a high school GPA as it could be affected by other factors such as academic disciplinary issues.

The other covariate is government expenditure on education and previous literature have shown a correlation towards student's high school performance. As GPA is the measure of student's performance, Jackson et al. (2018) took data from the great recession and showed that a cut in government spending on education had declined student's performance. Similarly, Miller (2018) has shown that an increase in government expenditure has shown an increase in student's performance. Hence, we will use the proposed covariates as supplemental factors to estimate a model that can help predict the effect of using standardized testing, such as the Common core curriculum, on a student's average GPA.

## **Data**

The dataset in CORGIS comes from the National Center for Education Statistics that recorded a thorough database on the primary and secondary school statistics of publicly enrolled students in the United States. The dataset contains the year, state, average GPA by state, SAT

score, family income, average study time. Average GPA and average study time are also broken down into several subjects, namely: mathematics, english, social sciences, natural sciences, art and music, and foreign languages. Since the Common Core curriculum pertains to only two subject areas (English and Math), this paper will only use the data for those two subjects to evaluate the average GPA of students.

The proposed dataset covers data from all 50 states from 2005 to 2015, and we can compare the average GPA between states before and after the implementation of Common Core curriculum in 2010, which will be reflected in the average GPA of students in the table shown below. From the 50 states, we will treat 36 states (OR, CA, NV, UT, AZ, CO, NM, KS, SD, IA, MO, AR, LA, MS, AL, GA, FL, TN, IL, WI, MI, OH, WV, NC, NY, PA, VT, NH, MA, RI, CT, NJ, DE, MD, KY) that implemented the curriculum since its establishment in 2010 as control and VA which has never implemented the curriculum as the treatment group. VA is selected amongst other states which never implemented the curriculum after observing that it has the closest trend between synthetic control and observed values after plotting using R. Additionally, Virginia is chosen as the treatment group as it has a long history of education reforms and consistently placed high in the education rankings (Virginia History, n.d.). However, as a state, it has chose not to implement the Common Core standards in its school education.

Furthermore, we will utilize external datasets with the following covariates: government expenditure on education (state per pupil spending), gender and family income. As previous literature has shown that these covariates may have potential significance in the process of making our model to predict the significance of the Common Core curriculum as a testing standard and its effect on a student's average GPA. Median family income per state is obtained from the St Louis

FRED. State per pupil spending would be used to determine state expenditure on education, the data is gathered from the Annual Survey of School System Finances by the US Census.

### **Strategy**

A difference-in-difference was considered but the difference between states was too systematic to be valid, thus synthetic control was chosen to test the hypothesis. A synthetic control group would be created using the control states pool and the results will be compared with best fitting treatment states, with GPA as the outcome. Using gender, median income, government spending on education (Per Pupil Spending) and past GPA scores from 2007 to 2010 as covariates. Post-treatment results will be observed to determine the effect of not implementing the common core state initiative. Ideally a divergence between pre and post implementation would occur to show the effect of common core on GPA.

Using weights determined by R, an appropriate synthetic control group would be created with the weights applied to the control states donor pool and the covariates. Finding the best fitting plot pre-intervention (2007-2010) would determine the validity of the synthetic control group. Observing the result post-treatment would show the effect of the treatment.

After plotting the time series result, it is shown that Virginia has the best fit with the synthetic control group. The match between math GPA and english GPA is the best amongst the 4 possible treatment states. The following table 1 and 2 showcase the weights of each variable that is used in synthetic control for Mathematics and English, respectively.

**Table 1a: Weights for Virginia in Math GPA**

<b>Variable</b>	<b>Weight</b>
2007 GPA	0.265
2009 GPA	0.199
Median Income	0.138
Male test taker	0.132
PPS	0.131
Female test taker	0.124
2010 GPA	0.0104
2008 GPA	0.0000655

**Table 1b: Weights of significant Control States in Math GPA**

<b>State</b>	<b>Weight</b>
FL	0.480
RI	0.155
NH	0.154
MA	0.116
MI	0.0619

\*Only top 5 weights showed, almost all states receive very small (<0.007) weights; other weights by state are attached in the appendix



**Table 2a: Weights for Virginia in English GPA**

<b>Variable</b>	<b>Weight</b>
Male test taker	0.246
2007 GPA	0.149
2009 GPA	0.125
2010 GPA	0.123
2008 GPA	0.101
PPS	0.0999
Female test taker	0.0798
Median Income	0.0759

**Table 2b: Weights of significant Control States in English GPA**

<b>State</b>	<b>Weight</b>
FL	0.491
CT	0.241
HI	0.192
KY	0.0736
MI	0.0022

\*Only top 5 weights showed, almost all states receive very small ( $<0.007$ ) weights; other weights by state are attached in the appendix.

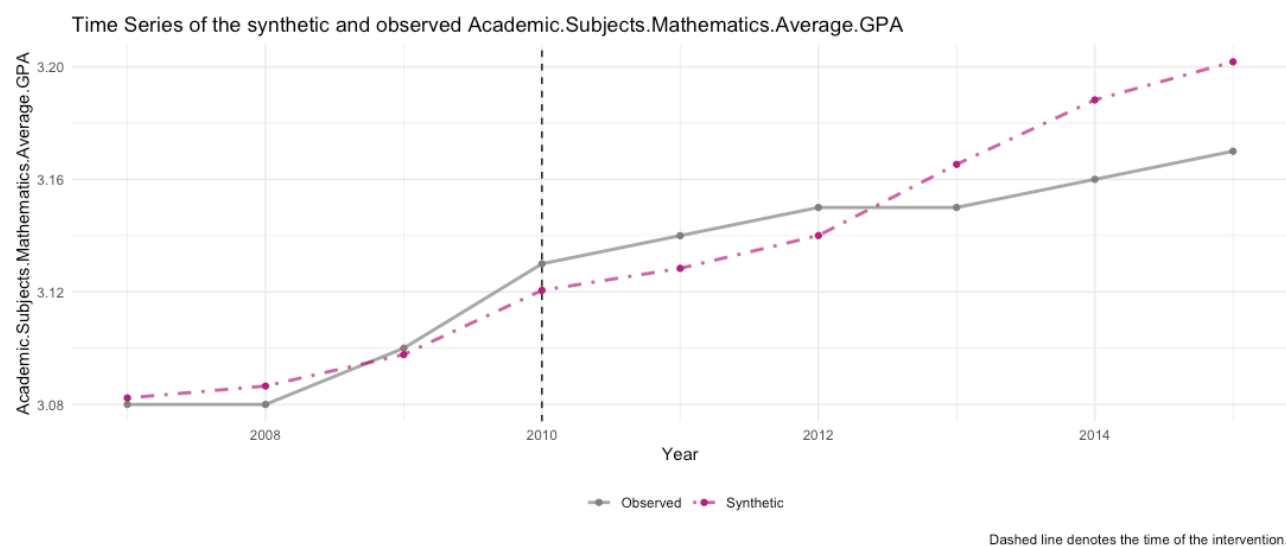
## **Results**

Using weights determined by R, a synthetic control group was created to replicate a synthetic ‘Virginia’. Plotting the outcomes for both GPA for actual and synthetic Virginia would

show the effect of common core post-treatment. Figures 1 and 2 show the time-series plot of math and english GPA, respectively.

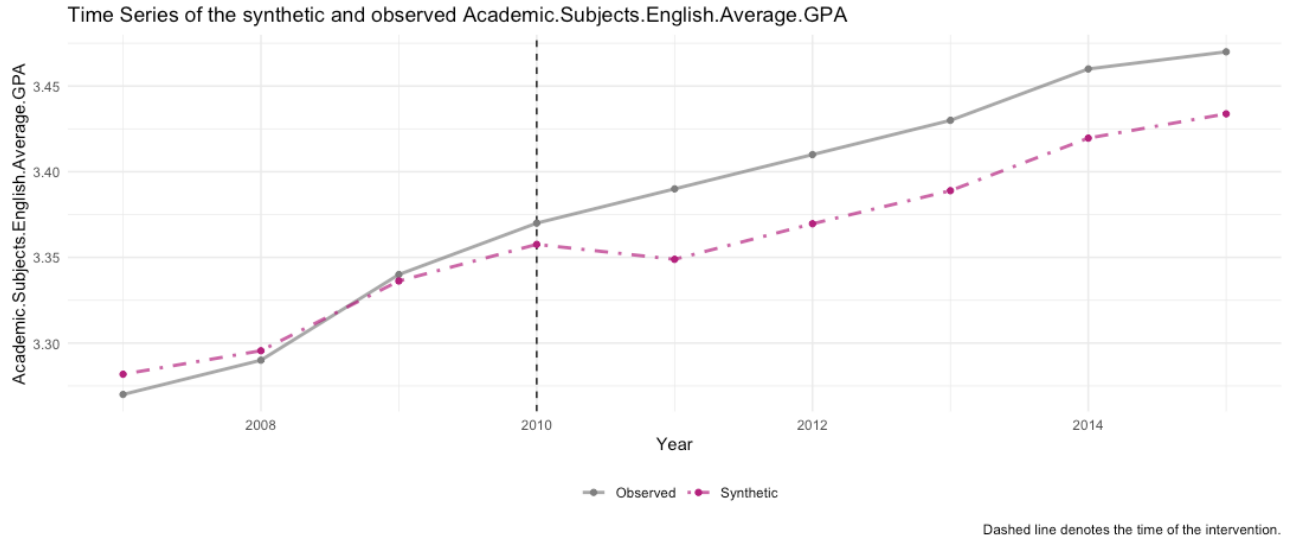
\*Dashed line indicates treatment implementation (2010)

\*Grey line = Virginia GPA, Purple = Synthetic Virginia GPA



**Figure 1 : Mathematics Synthetic control**

After creating a synthetic “Virginia” from the control states donor pool, there seems to be a positive impact on Math GPA if the policy was implemented. The trend for math GPA showed to have increased after 2012 for synthetic Virginia, while actual Virginia saw a smaller increase in math GPA, with math GPA dropping from 2012 to 2013. From the time-series plot, common core seems to have a long-term positive impact on math GPA. While not implementing common core would see a slower growth in math GPA.



**Figure 2 : English Synthetic control**

For English GPA, actual observations from Virginia saw a consistent increase in GPA, while synthetic GPA saw a slight decrease in GPA after treatment. The effect of common core on english had a negative impact on GPA, the opposite of the effect on math. Though, it needs to be mentioned that the fit for the result in 2010 is higher for actual GPA compared to synthetic GPA.

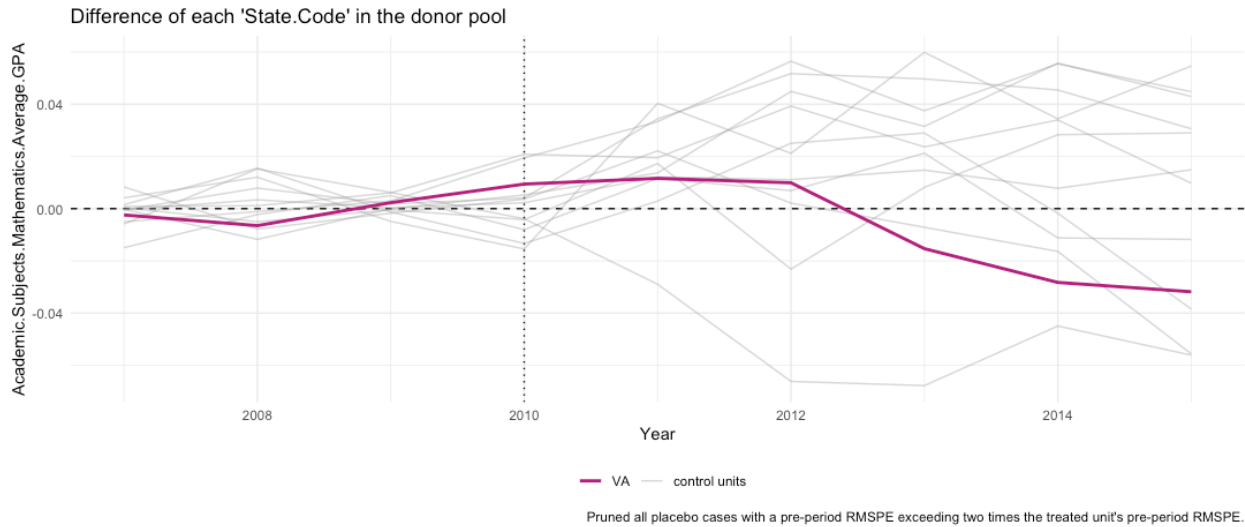
**Table 3: Aggregate comparison for GPA synthetic control results**

Variable	Actual Virginia	Synthetic Virginia	Actual control states average
Female test taker	31644	32247	16463
Male test taker	27586	27109	14079
Median Income	65479	65481	64037
PPS	10599	10605	10444
2007 Math GPA	3.08	3.08	3.28
2008 Math GPA	3.08	3.09	3.28
2009 Math GPA	3.1	3.1	3.3
2010 Math GPA	3.13	3.12	3.2

2007 English GPA	3.27	3.28	3.46
2008 English GPA	3.29	3.30	3.46
2009 English GPA	3.34	3.34	3.49
2010 English GPA	3.37	3.36	3.51

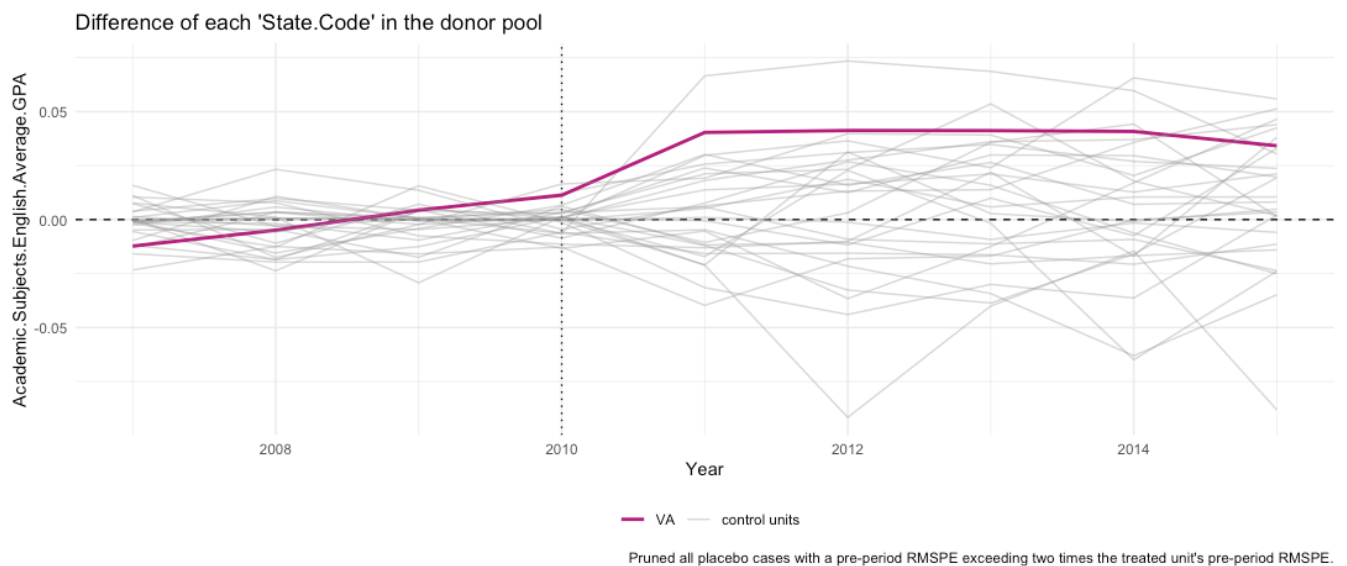
The aggregate covariate values for both actual and synthetic Virginia is shown in Table 3. From the values, all covariates, excluding previous GPA, were similar for both actual and synthetic GPA. The difference between actual or synthetic Virginia to the averages of the actual control states seems to be larger. This would be due to the fact that the values for these covariates would vary for each actual state, i.e. there would be more test-takers in larger states compared to smaller states.

To check the significance of the result, placebo tests were conducted in other states and the plots of the time-series GPA gap are displayed below for Math and English. The purple line indicates the original synthetic control above. Ideally, the gap for the original would be larger compared to other placebo tests in the post-treatment period. This would indicate that the result shows significant evidence that common core had an impact on GPA and not due to selecting Virginia by chance. Comparing the RMSE ratio would also provide evidence if the results obtained would be statistically significant or not. Having a larger RMSE ratio compared to other states would also indicate that results obtained were statistically significant. If there are more states that have larger RMSE ratios, then the results were not significant enough to conclude the effect of common core.



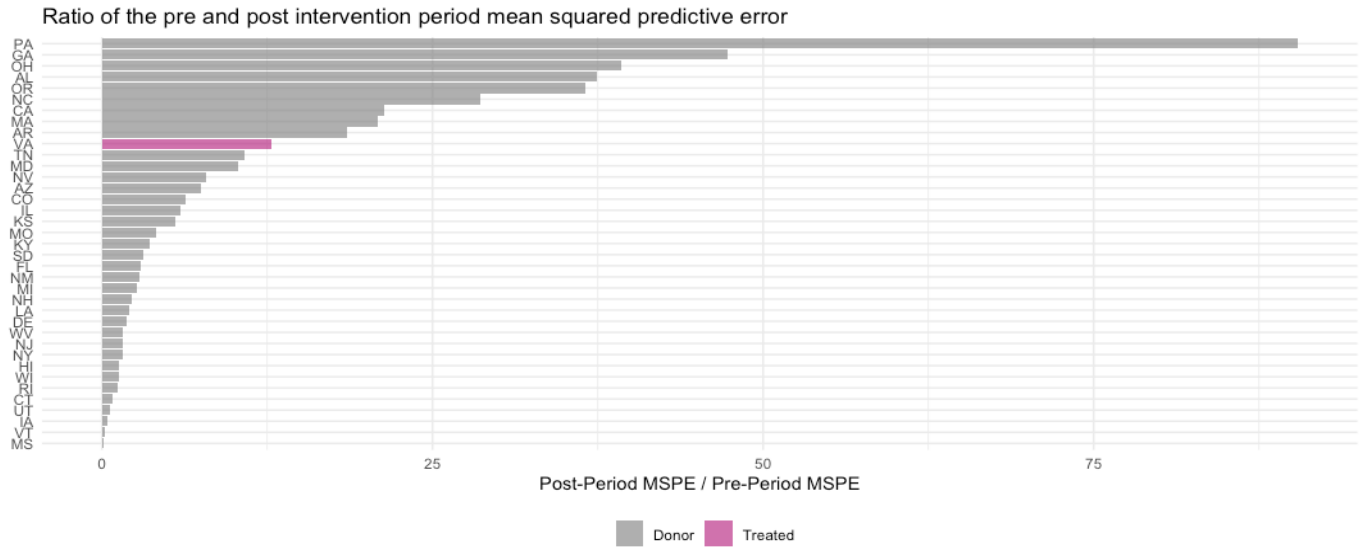
**Figure 3a: Placebo Test for Math**

From Figure 3A, the GPA gap in Virginia is smaller compared to other placebo states in the post-treatment period. This would mean that the results are not significant enough to conclude that common core had a significant impact on Math GPA.



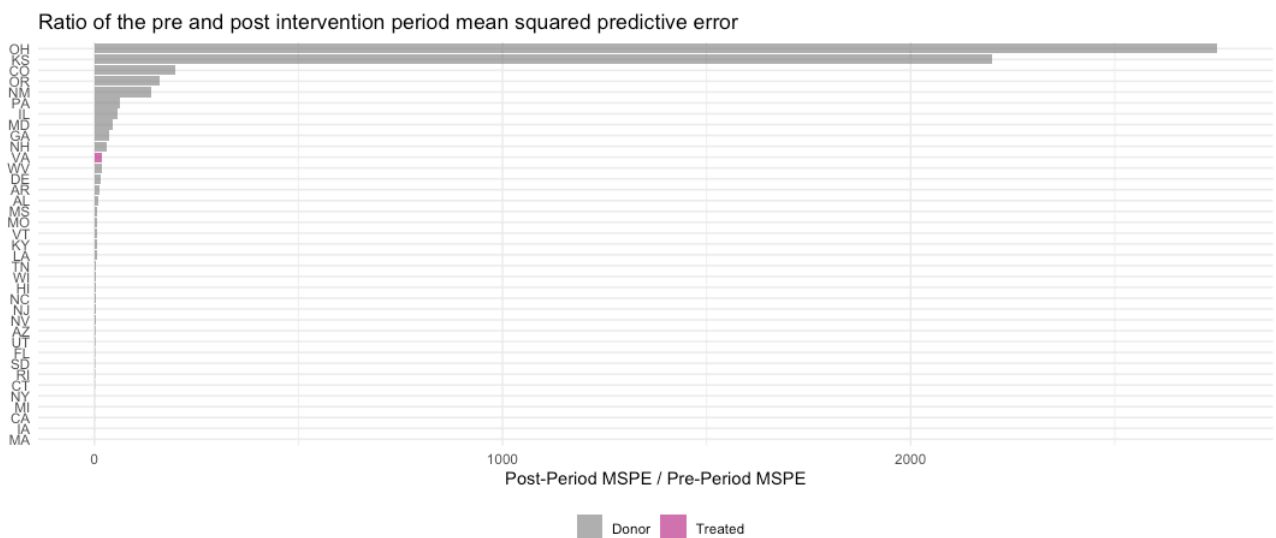
**Figure 3b: Placebo Test for English**

For English GPA, the gap in Virginia compared to other placebo tests' gap is larger, compared to the gap for math GPA. There are still some gaps that are larger in the post-treatment period but there are less instances compared to the GPA gaps for math GPA.



**Figure 4A: Ratio between pre and post-intervention MSPE, Math**

The plot above shows the MSPE ratio between pre and post intervention period, with the purple bar indicating treatment state. As seen in figure 4A, the MSPE ratio of Virginia is smaller than other states, meaning that the results are not as significant compared to other placebo MSPEs.



**Figure 4b: Ratio between pre and post-intervention MSPE, English**

The MSPE ratio for English GPA is significantly smaller than other placebo MSPE ratios. This would also indicate that the results obtained from synthetic control are not significant. Compared to Math MSPE ratios, Virginia's MSPE ratio is significantly smaller, while Math MSPE ratios are somewhat closer to the top placebo MSPE ratios.

## **Conclusion**

Based on the synthetic control results, we can observe that implementing common core curriculum in the state of Virginia resulted in a higher Mathematics GPA in the long-term and an overall decline in English GPA. The synthetic control model was created using supplemental information that is believed to have an influence on the outcome of interest (GPA). including the state education expenditure, students' gender, and their family income. The Math results which show a positive trend after some time supports the claim made in past literature about how the implementation will take time to enact progress. The English results which show an overall negative trend also supports the claim that this policy is ineffective, which might be due to lack of flexibility or poor implementation. The contrast in results between the two subjects also support the idea that policies have to be tailored to match local level conditions for them to create an impact. Evidently, the results show that the curriculum led to an improvement for Math but not English GPA in Virginia, and this might be due to the fact that the curriculum matches the local level conditions for the former but not the latter.

However, from placebo tests and comparing MSPE ratios with placebo states, the results obtained cannot be concluded to be significant. To show that the results are significant and not due to chance, a larger MSPE ratio compared to other states and an extreme gap compared to other placebo tests is desired. The time-series plots from placebo tests show that the GPA gaps from actual and synthetic Virginia are smaller compared to placebo tests. The gaps for Math GPA is

significantly smaller than other states, while the gaps in Virginia's English GPA is wider compared to the gaps in Math GPA. Comparing MSPE ratios, both Math and English GPA ratios for Virginia are significantly smaller compared to other placebo MSPE ratios. From placebo tests and MSPE ratios, it could not be concluded that the results obtained for actual and synthetic Virginia are significant. Thus, the effects on Math and English GPA from adopting common core could not be significantly inferred.

To improve the fit and overall significance of the result, some expansion to data could be implemented. Including more covariates could improve the fit of pre-intervention synthetic control results. More data with an expanded time period, could see the overall trend of both pre and post intervention results. More validity could be gained from getting a better fit in a longer pre-intervention period, while long term effects of the intervention could be observed with expanding data beyond the time period presented in this paper. Expanding the data, covariates and overall scope could improve the significance of the results, to conclude the effects of adopting common core on GPA.



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