Assignment #3 - Comparative Interrupted Time Series

a) Research question quasi-experimental design:

The primary policy-related inquiry is whether the No Child Left Behind (NCLB) program has improved academic achievement nationwide. Specifically, this analysis seeks to address the following questions: How has the math achievement score for 8th graders changed in states with low and high proficiency standards before and after 2002? Furthermore, how has the difference between low and high proficiency states changed after 2002? A non-equivalent comparison time series design is employed to examine the impact of differences in proficiency standards across states.

b) Description of analytic method and model(s) estimated

The following two models were estimated. The first one uses state fixed effects (ϕ) and the second one both, state and year fixed effects (γ). β_1 and β_2 are interaction terms of the year and the performance of the states, *high* or *medium*. β_3 and β_4 show the differences in the mean change in 2002 for the high and medium proficiency standards group. β_5 andβ_6 test whether high and medium proficiency standards group differ in their post-NCLB slope changes. Finally, β_7 andβ_8 control for the percentage of students with free lunch and the pupil per teacher ration, respectively.

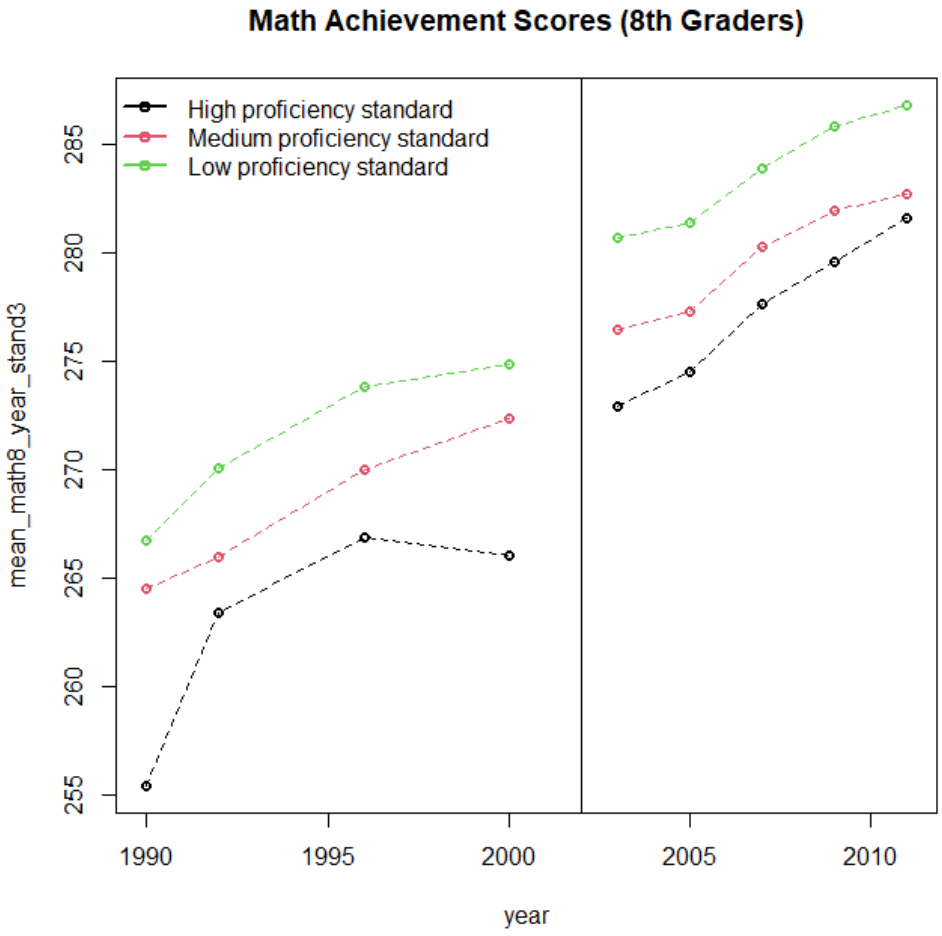
$$\begin{aligned} Y_{im} =& \beta_0 + \beta_1(year * high)_{it} + \beta_2(year * medium)_{it} + \beta_3(NCLB * high)_{it} + \beta_4(NCLB * medium)_{it} \\ &+ \beta_5(NCLB * high * year)_{it} + \beta_6(NCLB * medium * year)_{it} + \beta_7 lunch_{it} \\ &+ \beta_8 pupil_{it} + \phi + error \end{aligned}$$

$$\begin{aligned} Y_{im} =& \beta_0 + \beta_1(year * high)_{it} + \beta_2(year * medium)_{it} + \beta_3(NCLB * high)_{it} + \beta_4(NCLB * medium)_{it} \\ &+ \beta_5(NCLB * high * year)_{it} + \beta_6(NCLB * medium * year)_{it} + \beta_7 lunch_{it} \\ &+ \beta_8 pupil_{it} + \phi + \gamma + error \end{aligned}$$

c) Results

As can be seen in Figure 1 and Table 1, NCLB has an effect on math achievement scores (for 8th grade students) and it differs across states with high, medium, and low proficiency standards. For example, Table 1 shows that the interaction between our policy (NCLB), a high performance of a State and post 2022 -$NCLB * High * Intervention$(2002)- is possitive and statistical significant with a 95 percent of confidence in both models. Therefore, there is a difference between proficiency standards groups and their post-NCLB slope changes too. In other words, math achievement score in the high proficiency standards group grows faster

Figure 1: Math scores (8th scores) among states with different proficiency standards



than in the low proficiency standards group.

d) Limitations

Based on Wong et al. (2015) and chapter #9 of Reichardt (2019)'s book, there might exist a few threats to the internal validity of interrupted time series. For instance, Reichardt (2019) points out that the effect might exist due to external events that occur while the treatment is introduced. It is possible that as the treatment was implemented, an external effect happened and produced an effect in the same or opposite direction. Wong et al. (2015) mention one contending theory that maybe states with low proficiency standards used the new math standards announced in 2000 by the National Council of Teachers of Mathematics in order to upgrade their standards. This event affected states with different proficiency standards differently. However, Wong et al. (2015) claim that they did not find any evidence that supports it.

Table 1: Linear Analysis of the Effect of NCLB

	Dependent variable:	
	Math Scores (8th grade)	
	(1)	(2)
NCLB*High	2.693** (1.217)	2.487 (1.806)
NCLB*Medium	−0.754 (0.959)	−0.886 (1.654)
NCLB*Low	−0.160 (1.405)	
High*Intervention(2002)	0.599*** (0.128)	−0.387** (0.175)
Medium*Intervention(2002)	0.937*** (0.097)	−0.095 (0.156)
Low*Intervention(2002)	1.056*** (0.136)	
NCLB*High*Intervention(2002)	0.528*** (0.179)	0.645** (0.258)
NCLB*Medium*Intervention(2002)	−0.068 (0.132)	0.101 (0.228)
NCLB*Low*Intervention(2002)	−0.201 (0.195)	
Free lunch (%)	−3.796* (2.151)	−3.821* (2.090)
Pupil-teacher (ratio)	−0.124 (0.200)	−0.313 (0.200)
Constant	265.977*** (3.058)	255.463*** (3.698)
State fixed effects	✓	✓
Year fixed effects		✓
Observations	400	400
R^2	0.942	0.946
Adjusted R^2	0.932	0.936
Residual Std. Error	2.979 (df = 340)	2.893 (df = 335)
F Statistic	93.127*** (df = 59; 340)	91.465*** (df = 64; 335)
Note:	*p<0.1; **p<0.05; ***p<0.01	

Likewise, another potential threat to internal validity is the manipulation of the results. In other words, school authorities manipulated test scores after the intervention in 2002. This happened more so in states with high proficiency standards than in states with low proficiency standards. For example, by modifying the number of students with disabilities or English language learners tested. However, Wong et al. (2015) argue that they found no differential exclusion pattern in the high score versus low scare state contrast where an NCLB effect is claimed. Finally, the two models did not take serial correlation into account. The results from the two approaches are hardly different, according to Wong et al. (2015).

e) Conclusion

The previous exploratory interrupted time series shows that the No Child Left Behind (NCLB) program improved academic achievement in the sample collected for 8th graders. Especially analysis suggests that the effect differs from states with low and high proficiency

standards before and after 2002. Even though the methodology has some internal limitations, Wong et al. (2015) claim that they did not find any evidence that supports the internal validity issues. Although this does not guarantee a causal claim, there are enough information to draw the conclusion that NCLB has different effects across states with different proficiency standards.

References

Reichardt, C. S. (2019). *Quasi-experimentation: A guide to design and analysis*. Guilford Publications.

Wong, M., Cook, T. D., and Steiner, P. M. (2015). Adding design elements to improve time series designs: No child left behind as an example of causal pattern-matching. *Journal of Research on Educational Effectiveness*, 8(2):245–279.