



University of Kentucky
UKnowledge

MPA/MPP/MPFM Capstone Projects

Student Scholarship

2023

An Analysis of Test Scores in the Central and Eastern Time Zones

Riley Reed

University of Kentucky, rileyer66@gmail.com

Follow this and additional works at: https://uknowledge.uky.edu/mpampp_etds



Part of the [Public Affairs, Public Policy and Public Administration Commons](#)

[Right click to open a feedback form in a new tab to let us know how this document benefits you.](#)

Recommended Citation

Reed, Riley, "An Analysis of Test Scores in the Central and Eastern Time Zones" (2023). *MPA/MPP/MPFM Capstone Projects*. 415.

https://uknowledge.uky.edu/mpampp_etds/415

This Graduate Capstone Project is brought to you for free and open access by the Student Scholarship at UKnowledge. It has been accepted for inclusion in MPA/MPP/MPFM Capstone Projects by an authorized administrator of UKnowledge. For more information, please contact UKnowledge@lsv.uky.edu.

An Analysis of Test Scores in the Central and Eastern Time Zones

Riley Reed

University of Kentucky

Martin School of Public Policy and Administration

Faculty Advisor: Dr. Ron Zimmer

Spring 2023 Capstone Project

Table of Contents

Abstract.....	3
Background.....	4
Problem Statement & Introduction.....	5
Literature Review.....	6
Data.....	7
Research Design.....	9
Results.....	10
Reading Regression.....	11
Math Regression.....	11
Limitations.....	13
Implications.....	14
Conclusion.....	14
References.....	15

Abstract

During daylight savings in Kentucky, elementary students in the Eastern Time Zone receive around an hour less of sunlight than students in the Central Time Zone when attending school in the morning. With recent discussion of making daylight savings permanent, it's important to discuss the effects that going to school in the dark has on students' test scores. Research has been done to study the effects that operating on less amounts of sunlight has on school aged children. This study seeks to do the same, by comparing test scores of 3rd grade students on the Central and Eastern Time Zones in Kentucky, to see if students on the Eastern Time Zone test scores varied from students in the Central. Findings indicated that there is no adverse relationship between less sunlight and the test scores of 3rd grade students. In fact, I found that there is a marginal statistical positive relationship between darker mornings and academic performance in math, which is not consistent with expectations.

Background

In the past year, there has been talk in Congress about making daylight savings permanent. Making daylight savings permanent means an extra hour of daylight in the afternoon during the winter months with the Sunshine Protection Act. The logic behind making daylight savings permanent stems from an interest in benefiting the economy and public health.

“Spending more standard work hours in sunlight would reduce rates of seasonal depression.

Americans exercise more frequently during Daylight Saving Time, reducing the risk of stroke and heart problems. Research also suggests that the extra hour of afternoon sun leads to fewer car accidents and evening robberies.” (McCabe, 2022)

As many as 75% of Americans agree that it's time to put an end to this practice (Melillo, 2022). Implementation of the Sunlight Protection Act means darker mornings and sunnier evenings and although many Americans are in favor of removing the inconvenience of changing their clocks twice a year, what are the consequences? Sleep experts explain that there are health benefits when operating on more sunlight in the morning compared to the evening. When it's dark out, our bodies naturally produce melatonin, a hormone that promotes sleep and is suppressed by light (Melillo, 2022), and too much sunlight in the evening can throw off a person's natural circadian rhythm.

Waking up to sunlight in the morning is the most ideal way to start a person's day, whereas waking up while it's still dark outside poses a threat to one's health. Not getting enough sleep can lead to risks of developing heart disease, diabetes, weight gain, and even cancer (Melillo, 2022). Teenagers and young adults are most at risk when thinking about making daylight savings permanent. This group of people is already susceptible to sleep deprivation which would not be helped by waking up when it's still dark out to go to work or school. Sleep

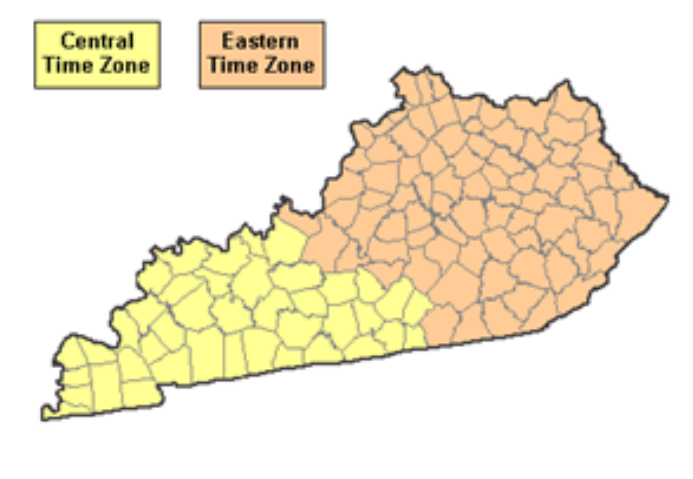
expert Beth Malow describes making daylight savings permanent as, “mandatory jet lag for 8 months out of the year” (Melillo, 2022).

Problem Statement

Is there a significant difference in the educational achievements of students who begin their day with different amounts of sunlight?

Introduction

When looking at Kentucky, it seems to be split in half, with one half being in the Eastern Time Zone and the other half being in the Central Time Zone. Therefore, for students in the Central Time Zone, the sun rises an hour earlier than in the Eastern Time Zone. For many elementary students in the Eastern Time Zone, this means that they are starting their day at school in the dark for nearly 240 days out of the year.



In 2016, Jennifer Heissle and Samuel Norris analyzed the effects of school start times on academic performance from childhood through puberty in Florida. They examined the performance of students near the time zone split for Eastern and Central Time to see if students who had more exposure to morning daylight before school did better than students who had less exposure. Their research stated that adolescents struggle more with early start times compared to

older students. They found that students having more exposure to sunlight before the start of the school day increased adolescent scores by 13% in math and 12% in reading (Heissl, et al., 2016).

For my capstone, I compare the proficient reading and math rates of 3rd graders among schools in the Central Time Zone to schools in the Eastern Time Zone. Using collected data from a little over 100 schools from 29 different counties, I analyze the differences in proficiency rates by OLS regression.

This project seeks to examine if students in the Eastern Time Zone will test lower than students in the Central Time Zone due to the hour of daylight lost. If those findings are true, it will show the negative effects that less daylight has on students. Alongside the health risks, car accidents, and just going against your body's natural rhythm, daylight savings could also have a negative effect on the way elementary students are learning.

Literature Review

There has been plenty of research done on the effects that daylight savings has on students' health and learning abilities. In 2022, Jaime K Devine, Jake Choynowski, and Steven R Hursh conducted research on the effects of daylight savings and what that would look like if daylight savings was made permanent. They state that making daylight savings permanent could be harmful to school aged children specifically. Their research found that delaying school start times is beneficial to students' sleep and daytime function (Devine, et al., 2022), something that daylight savings does not contribute to. The authors use a biomathematical model of fatigue to see the effects of daylight savings and found, "that under ideal hypothetical circumstances, abandoning the twice-yearly clock change may be nominally beneficial for Effectiveness.

Permanent DST conditions resulted in less light at waketime, during morning rush hour, and less light exposure across the day” (Devine, et al., 2022).

Similarly in 2015, Diana Medina, Matthew Ebben, Sara Milrad, Brianna Atkinson, and Ana C. Krieger conducted a study about the effects of daylight savings on adolescent sleep and vigilance. They found that post-daylight savings, students lost about 27 minutes of sleep each night while daytime sleepiness increased. They saw a decline in reaction times from students and got worse as time went on. They concluded that daylight savings time can lead to less sleep, leading to a decline in cognitive function. They all agree that it needs to be studied more before it is implemented anywhere, and these previous studies did not look at outcomes specifically.

Astill et al. conducted a meta-analysis on sleep deprivation and how it contributes to behavioral problems in school-aged children. They were able to find a significant association between the two. “In particular, shorter sleep is associated with worse executive and multiple-domain cognitive functioning and worse school performance” (Astill, et al., 2022). Although this study in particular does not include the effect of daylight savings, sleep deprivation can be caused by daylight savings, leading to worse behavioral issues and school performance.

Data

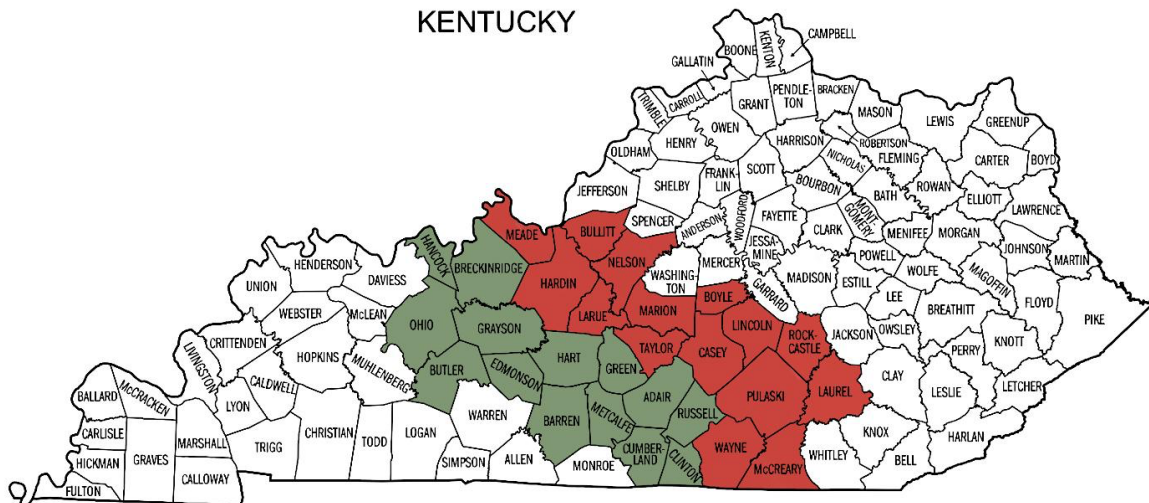
For my capstone, I compare the test scores of 3rd grade students that scored at least Proficient in reading and math. Half of the elementary schools are from counties in Kentucky in the Central Time Zone, and the other half are from schools in the Eastern Time Zone. As part of the analysis, I control for the percent of white students, and black students, and the percent of students on free and reduced lunch at each elementary school.

The sources of the data that I used are as follows:

Kentucky Department of Education: School and Community Nutrition Qualifying Data

Kentucky Department of Education: School Report Card

By going to the Kentucky Department of Education's School Report Card, and looking at the assessment results data set, I can access test scores for grades 3-11 for all schools in all counties in Kentucky for the 2021-2022 school year. In my analysis, I examine the counties that are closest to the time zone change in the state, as well as the counties that touch those counties, seeing if test scores differ from one zone to the other. These counties can be seen in the map below. The Central Time Zone counties are represented in green, and the Eastern Time Zone counties are represented in red.



Seeing that elementary school students in the Eastern Time Zone go to school for an extra hour in the dark, looking at test scores will be able to show if this has any effect on their academic performance.

On the Kentucky Department of Education's School Report Card, I am also able to see the percentage of white and black students at each elementary school for the 2021-2022 school year. Being able to compare the student demographic at each school across county lines will show how similar the counties I am comparing are. Through the Kentucky Department of Education: School and Community Nutrition Qualifying Data, I can compare the percentage of

students receiving free and reduced lunch in each school. I am again able to compare these results to see the differences between the counties.

Research Design

For my research design I use an OLS regression, which allows me to compare the average proficiency rates across schools across the time zones to see if going to school in the dark longer has any effect on academic performance. There is no pre and post treatment group, just a simple comparison of schools in the eastern and central time zone.

This method will help address whether there are differences in learning associated with the difference in the amount of light students experience before the start of the school day in the two time zones. The hypothesis I am testing is as follows: *3rd grade students in the Eastern Time Zone will have lower test scores due to less sunlight in the morning.* Looking at these test scores and seeing a negative effect on students when they are going to school in the dark can help provide an argument that if they went to school in the dark longer it would not be beneficial to them.

For the Free and Reduced Lunch (FRL) data, I pulled data from the 2011-2012 school year. This is because in 2022, changes in federal law allowed entire school populations to be classified as FRL students if schools had a sufficient percentage of FRL students. Therefore, I use data prior to this policy to serve as a control for poverty within the schools. Getting data from when individual students themselves could qualify for FRL will give a more accurate representation of the students at the school, rather than comparing data of schools themselves that can qualify.

Results

I compared the Proficient rates in reading and math in the 3rd grade at 126 elementary schools from 29 different counties. Each county that I took scores from touches the line where the time changes, as well as the counties that touch those counties. Counties in the Eastern Time Zone consisted of, Bullitt, Boyle, Casey, Hardin, Larue, Laurel, Lincoln, Marion, McCreary, Meade, Nelson, Pulaski, Rockcastle, Taylor, and Wayne. Counties in the Central Time Zone included Adair, Barren, Breckenridge, Butler, Clinton, Cumberland, Edmonson, Grayson, Green, Hancock, Hart, Metcalf, Ohio, and Russell. I also considered the percentage of white and black students and students on free and reduced lunch in each school.

Based on this information, I found that the average number of 3rd grade students that scored Proficient in reading in the Central Time Zone was 30.25, compared to 30.57 in the Eastern Time Zone. In math, the average number of 3rd graders that scored Proficient in the Central Time Zone was 26.93 and 31.45 in the Eastern Time Zone. On average, students in the Central Time Zone were 88.71% white, 1.55% black, and 66.93% of them received FRL in the 2011 school year. In the Eastern Time Zone, the average number of students were 85.56% white, 3.21% black, and 62.13% of them received FRL in the 2011 school year. The differences between the counties can be seen in Figure 1.

Figure 1: Descriptive Average Characteristics of Schools in Central and Eastern Time Zones

Characteristics	Central	Eastern	Difference
% White	88.71	85.56	3.15
% Black	1.55	3.21	-1.66
% FRL 2011-12	66.93	62.13	4.8
% Proficient Reading	30.25	30.57	-0.32
% Proficient Math	26.93	31.45	-4.52

For my variables, I also created a correlation matrix of the variables used in my OLS model. A correlation matrix shows the correlation between two variables and helps to summarize the data. The correlation can be seen in Figure 2.

Figure 2: Correlation Matrix

	<i>Proficient Scores</i>	<i>% White</i>	<i>% Black</i>	<i>% FRL</i>
Proficient Scores	1			
% White	0.233833424	1		
% Black	-0.235907835	-0.9004353	1	
% FRL	-0.147530118	0.04384561	-0.041813	1

When the coefficient is 1, like when looking at the row and column of proficient scorers, it means there is a perfectly positive linear correlation. When the coefficient is 0.234, like when looking at the row proficient scorers and the column % white, it means that there is a correlation. When the coefficient is -0.042, like when looking at the row % black and the column % FRL, it means they are weakly negatively correlated.

Reading Regression

In my first regression analysis, my dependent variable is the proficient reading rates, and my independent variables are percent white, percent black, percent FRL, and the Eastern dummy variable. The main two areas of focus in the regression are the coefficient and the p-value associated with the Eastern variable in Figure 3. The coefficient describes the relationship between the independent variable and the dependent variable, and the p-value shows whether this relationship is statistically significant.

Figure 3: Regression Analysis of Reading Proficiency Rates

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95.0%</i>	<i>Upper 95.0%</i>
Intercept	29.139783	15.92657185	1.8296331	0.06976665	-2.39106679	60.6706328	-2.3910668	60.6706328
% White	0.09752859	0.167083763	0.58371073	0.56050147	-0.23325779	0.42831496	-0.2332578	0.42831496
% Black	-0.3056197	0.440744391	-0.6934171	0.48937678	-1.17818946	0.56695009	-1.1781895	0.56695009
% FRL 2011	-0.106555	0.061026215	-1.7460529	0.08333978	-0.22737249	0.01426249	-0.2273725	0.01426249
Eastern	0.2772189	1.724738085	0.16073101	0.8725733	-3.13735506	3.69179286	-3.1373551	3.69179286

The coefficient for the Eastern variable is 0.28 and the p-value is 0.87. The usual significance level for the p-value is 0.05. Seeing as the p-value in my regression is greater than the usual significance level, there is enough evidence to reject my hypothesis. The analysis suggests that there is no correlation between how much sunlight an elementary student is exposed to in the morning and their test scores.

The coefficient also does not point in the direction that is consistent with my hypothesis. For the coefficient to be consistent with my hypothesis, it would have to be negative. If the coefficient was negative, it would mean that students in the Eastern Time Zone tested worse than students in the Central Time Zone, which is not what we see here.

Math Regression

In the second regression, my dependent variable is the proficient math rates, and my independent variables are percent white, percent black, percent FRL, and the Eastern dummy variable. This regression can be seen in Figure 4.

Figure 4: Regression Analysis of Reading Proficiency Rates

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95.0%</i>	<i>Upper 95.0%</i>
Intercept	56.7813127	20.43675136	2.7783923	0.00634228	16.3179673	97.2446581	16.3179673	97.2446581
% White	-0.1419554	0.214409076	-0.6620776	0.50919098	-0.5664705	0.28255961	-0.5664705	0.28255961
% Black	-1.0726015	0.565450467	-1.8968973	0.06024516	-2.1921541	0.04695109	-2.1921541	0.04695109
% FRL 2011	-0.2351022	0.078292773	-3.0028599	0.00325536	-0.3901165	-0.080088	-0.3901165	-0.080088
Eastern	4.30538398	2.217782805	1.941301	0.05456619	-0.0856716	8.69643958	-0.0856716	8.69643958

The coefficient for the Eastern variable is 4.31 and the p-value is 0.05. Since the p-value is 0.05, it is statistically significant, and the analysis suggest that there is a correlation between amount of sunlight in the morning and student test scores. However, since the coefficient is 4.31, the direction is inconsistent with my hypothesis. Since the coefficient is positive, students in the Eastern Time Zone tested better than students in the Central Time Zone.

Limitations

There are a few limitations to consider when looking at my analysis. One of these limitations being the effect of COVID on students' learning. The effects that online learning had on students is still new and there is still a lot of research to be done about how it possibly could have negatively affected students. Online learning was a big change from being in a classroom every day and going back to that routine could be difficult for some and have no effect on others.

Another limitation is the differences between the students in the Eastern Time Zone and the Central Time Zone. Although the differences were low, 3.15% difference in percentage of white students, -1.66% difference in black students, and 4.8% difference in students on FRL, the students at these schools are still different. However, I do try to control for these differences in the regression analysis and still did not find a statistically significant difference.

Implications

Based on the research conducted in this capstone, there seems to be no adverse effect on the learning of elementary students in Kentucky with less light before school. In fact, the analysis suggests that students in the Eastern Time Zone are performing slightly better. This is not to say that there aren't other reasons as to why permanent daylight savings could be harmful. There have been other studies focusing on people's mental and physical health, sleep schedule, and many other things. Students' performance in school is not something that seems to be affected, at least with the current research out now.

Conclusion

Throughout this study, I looked to find if there was any relationship between elementary students going to school with less sunlight in the morning and their test scores. In my research, I found how damaging daylight savings time can be to a person and their health. Knowing this, I thought there would be an effect on students in the Eastern Time Zone that experienced an extra hour of darkness in their mornings compared to students in the Central Time Zone that did not. By using an OLS regression, I found that there was a marginally statistically significant relationship between my independent and dependent variables, leading to results that were not consistent with my theory.

References

As Americans prepare to spring ahead, Whitehouse renews call to make Daylight Saving Time Permanent: U.S. senator Sheldon Whitehouse of Rhode Island. The Official U.S. Senate website of Senator Sheldon Whitehouse of Rhode Island. (2022, March 12). Retrieved February 8, 2023, from <https://www.whitehouse.senate.gov/news/release/as-americans-prepare-to-spring-ahead-whitehouse-renews-call-to-make-daylight-saving-time-permanent#:~:text=There%20is%20considerable%20evidence%20that,lead%20to%20greater%20energy%20savings>.

Astill, R. G. , Van der Heijden, K. B. , Van IJzendoorn, M. H. & Van Someren, E. J. (2012). Sleep, Cognition, and Behavioral Problems in School-Age Children. *Psychological Bulletin*, 138 (6), 1109-1138. doi: 10.1037/a0028204.

Devine, Jaime and Choynowski, Jake and Hursh, Steven R, Predicting the Effects of Permanent Daylight Savings Time on Light Exposure and Risk Using a Biomathematical Model of Fatigue (June 16, 2022). Available at SSRN: <https://ssrn.com/abstract=4138534> or <http://dx.doi.org/10.2139/ssrn.4138534>

Kentucky School Report Card. (n.d.). Retrieved February 23, 2023, from <https://www.kyschoolreportcard.com/datasets?year=2022>

Kentucky School Report Card. (n.d.). Retrieved February 23, 2023, from <https://www.kyschoolreportcard.com/home?year=2022>

Medina D, Ebben M, Milrad S, Atkinson B, Krieger AC. Adverse effects of daylight saving time on adolescents' sleep and vigilance. *J Clin Sleep Med* 2015;11(8):879–884.

Melillo, G. (2022, November 4). *Why is there a push to end daylight saving time?* The Hill. Retrieved February 8, 2023, from <https://thehill.com/changing-america/well-being/longevity/3719890-why-is-there-a-push-to-end-daylight-saving-time/#:~:text=However%2C%20a%20law%20passed%20by,later%20and%20spend%20more%20money.>

Rise and shine: The effect of school start times on academic ... (n.d.). Retrieved February 9, 2023, from https://economics.nd.edu/assets/214954/heisselnorris_schoolstart_201610.pdf

Qualifying data. Qualifying Data - Kentucky Department of Education. (n.d.). Retrieved February 23, 2023, from <https://education.ky.gov/federal/SCN/pages/qualifying-data.aspx>