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Hurricane Katrina's Impact on Louisiana's Educational Systems

Emily Alice Larson

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Emily Alice Larson
Candidate for B.S. Economics Degree
and Renée Crown University Honors

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Honors Capstone Project in ________ Economics ________

Capstone Project Advisor: ______________________
(Professor Christopher Rohlfs)

Honors Reader: ______________________
(Professor Jeffrey Weinstein)

Honors Director: ______________________
James Spencer, Interim Director

Date: ______________________

ABSTRACT

This study examines how Hurricane Katrina affected educational statistics within Louisiana by comparing standardized test scores and school performance scores over time. To measure these educational factors, I focus on two levels of observation: district and individual. In particular, I focus on New Orleans schools before and after the hurricane and find that these educational factors increased, signaling a positive impact from Hurricane Katrina. However, on the district level there is a gap in available data due to the severity of damage to particular school systems, which led me to examine individual-level observations for more comparisons. At the individual level of observation, I focus on individuals' test scores by categorizing the scores at particular schools and districts by the extent of damage that they received. Individuals are categorized as living in the Damage 1, Damage 2, or Damage 3 regions, where the Damage 3 region experienced the most physical damage from the natural disaster. I classified these regions based off the Federal Emergency Management Agency's (FEMA) data on disaster declaration. As with the district-level analysis, I find that sample means for individuals' test scores across all three damage regions increased, indicating either a time trend or a possible positive influence Hurricane Katrina had on the entire state of Louisiana. Using regression analysis with the individual-level data, I tested for possible selection biases that may have altered the scores across the damage regions. These possible selection biases include time trends, control variable effects (race, gender, limited English proficiency (LEP) status, lunch status, and education classification), group fixed effects constructed from student characteristics, and student displacement. Since these potential selection biases exist among my observations, I aimed to disentangle the true effects of the hurricane that corresponded with the initial findings of positive trends in the educational attainment measures. Without any corrections, 4^{th} and 8^{th} graders both saw large increased test scores after exposure to Hurricane Katrina and the natural disaster's damages. However, after correcting for the above-mentioned biases, results show that the overall effect across all damage regions was negative, but the Damage 3 region experienced the least harm. Further regressions suggest that this is due to student evacuees' departure from the worst damaged regions and moving elsewhere, which in turn lowers the surrounding regions' standardized test scores. These findings show that the initial trends of largely increasing scores for New Orleans are not due to Hurricane Katrina directly, but instead, the changing composition of students is highly responsible for these trends.

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I. Acknowledgements

I would like to thank my advisor, Professor Chris Rohlfs, for helping me create my Capstone Project. He taught a yearlong course for Economics students writing a thesis and pursuing the Distinction in Economics, along with providing valuable one-on-one assistance on a weekly basis. Without his guidance and suggestions, my thesis would not be nearly as thorough or complete. Additionally, I would like to thank Professor Jeffrey Weinstein for taking the time to be my Capstone Reader. I greatly appreciate his advice and helpful insights towards the construction of my paper throughout the past year as well.

In regards to the data used in my research, I want to thank Louisiana's Department of Education Office of Standards, Assessments, and Accountability, particularly Dr. Fen Chou, for accepting my request to use its confidential micro-level data files that provided me with the individual-level of observation used in my research. Without access to this information, my thesis would not have the necessary points of view to examine the true effects of Hurricane Katrina on two different levels of observation.

II. Advice to Future Honors Students

My primary advice is to start thinking about your projects early. While some of you may wait until senior year to begin exploring your topics, I suggest starting sooner so that you can utilize summer months when you do not have other schoolwork to interfere with the process. Additionally, if you are an Economics student, I highly recommend contacting the Economics Department early in your spring semester junior year about the Program of Distinction in Economics. Currently, this program is split into two courses, one in the fall and one in the spring, where Professor Rohlfs leads weekly classes that guide us through the thesis process. I did not thoroughly examine any topics during the summer months before my senior year, but Professor Rohlfs quickly gave us ideas for approaching topics within the first week of classes in August, and by early September, my topic was taking shape into a project.

If you are not an Economics student, then I suggest finding an advisor that cares as much about your research as you do. Even if you are unfamiliar with a professor, you will be surprised by how many match your research interests. I did not know Professor Weinstein before asking him to be my Honors Reader, but after looking into his research interests and past papers, I realized he was a great fit for my project. In summary, start early and look into people that can assist you along the way.

III. Introduction

Hurricane Katrina hit the Gulf Coast in late August 2005, uprooting and changing the course of hundreds of thousands of lives. While some of the destruction became permanent, the economy rebuilt much of the infrastructure along the Gulf Coast, including homes, businesses, and even schools. This hurricane was one of the deadliest and most destructive natural disasters in United States history, and much of the attention has focused around these negative effects. This paper explores the effect on education within the areas of destruction.

As a result of Hurricane Katrina's damages, many residents along the Gulf Coast evacuated and moved further inland, whether still in Louisiana or in a completely different state. A city at the focal point of the hurricane destruction was New Orleans, Louisiana. While thousands of residents moved away, many remained in the city to try to continue life there. A huge struggle for continuing life within this damaged region has to do with previous living situations. Like most urban communities, New Orleans has many low-income sectors, and these sectors experienced much neglect even before the hurricane. Numerous studies find that low-income community students statistically struggle the most with education (Carey 2002). This struggle includes lower test scores, lower graduation rates, and even lower college enrollment. Policies and outreach groups try to improve this achievement gap between low-income students and their higher-income peers by increasing school funding, creating smaller classes, and targeting learning needs, yet there remain unequal opportunities in every student's education. However, Hurricane Katrina destroyed schools and displaced students and teachers, ultimately affecting the educational systems within this urban area, as well as other highly damaged regions near the Gulf Coast. Is it possible for a natural disaster to improve the educational statistics of an affected urban community, such as New Orleans with Hurricane Katrina, or will the natural disaster dig the area further into educational disparity? By focusing on the natural disaster as a shock variable, I analyze the impact of Hurricane Katrina on the educational systems within Louisiana, particularly on New Orleans schools that make up Orleans School District, along with in other greatly damaged regions.

Post-Katrina educational statistics show that schools in New Orleans are currently performing better than they were before the hurricane. Orleans School District, which represents the city of New Orleans, has seen large improvements in student test scores (Perry and Schwam-Baird 2010). Some believe that this change is solely due to educational reforms and policies affecting Orleans School District, including Recovery School District (RSD), more charter schools, and collective bargaining for teachers to work for the school district (Perry and Schwam-Baird 2010). One of the primary policy impacts on New Orleans schools was the creation of RSD, which was designed to take over lower-performing schools. The Louisiana Department of Education (LDOE) created RSD in 2003, and RSD took over many New Orleans schools that were performing poorly. RSD also opened many charter schools that focus around students' learning needs, thus aiming to improve performances (RSD 2011).

Since this process involves individual schools switching districts, the composition of Orleans School District varies before and after the hurricane, which could greatly affect the educational statistics of both Orleans and surrounding school districts.

To avoid this school displacement bias, I group districts by levels of damage that they were exposed to during the hurricane; these rankings will be explained later. This way, even if New Orleans' schools changed districts, the physical school will remain in the same damage ranking, thus avoiding school displacement bias. However, many other potential biases exist that could try to explain why the educational statistics have improved, and my research examines potential explanations for these developments. One of those potential biases exists as a result of the academic quality of student evacuees displaced due to Hurricane Katrina.

Recent studies on Hurricane Katrina's impact on education focus around the characteristics of evacuees. Paxson and Rouse (2008) studied the likelihood of evacuees returning to damaged regions after the hurricane. They find a negative correlation between the extent of the damage in a family's region of residence and the probability that the family returns to that region after the hurricane. Therefore, the families evacuating New Orleans were the least likely to return to Louisiana. In conclusion, Paxson and Rouse (2008) suggest that some evacuees may not have known that better conditions were available to them previously, including both economic and social opportunities. While Paxson and Rouse (2008) acknowledge that they do not have any evidence to support this proposition, their findings suggest that displaced families might have chosen to stay at their relocation due to better opportunities there, including schools.

While the above results do not explain the implications of educational statistics within Louisiana's damaged regions, students leaving their school districts and not coming back ultimately changed the district averages of both their previous schools, as well as the newer, potentially better schools. In particular, Imberman, Kugler and Sacerdote (2009) found that some of the evacuees that moved to Texas ended up lowering average test scores in Houston. Their study suggests that the out-migration of Louisiana students into Texas contained primarily lower-performing students relative to students in Texas, and many of them came from New Orleans. This finding also suggests the possibility that the outward migration of lower-achieving students resulted in an improvement in those students' original schools. In other words, the high concentration of lower-performing students in New Orleans that moved to Houston suggests that either the majority of New Orleans students are lower performing, or the worst performing students were the ones that left. If the second scenario is true, then New Orleans schools could have thrived following the out-migration of the worst performing students. A common educational belief, referred to as peer effects, is the idea that improving one students' education improves his or her friends' education and vice versa. The study of Houston schools suggests that peer effects are causing the score changes, not necessarily the changes in other factors such as funding or class size (Imberman, Kugler, and Sacerdote 2009).

Sacerdote (2008) also examined the effects of Hurricanes Katrina and Rita on the academic performances of evacuees. Sacerdote (2008) looked at the effect on test scores over time, finding that test scores initially dropped slightly for evacuees. In the following years, however, the author finds that evacuees started experiencing academic gains, as compared to their pre-hurricane scores. The relocation of these students from poorer-performing districts resulted in a beneficial transition for them. While he acknowledges that some studies find that student evacuees bring local averages down, Sacerdote (2008) found that some of the district's average scores end up rising over time. In conclusion, these findings suggest that the evacuees' initial lower scores are offset by long-term gains within their new districts (Sacerdote 2008).

These studies can lead to potentially misleading perceptions of academics within New Orleans and other highly damaged regions. Some assumptions that need to be questioned are whether primarily lower-performing students are located in New Orleans and surrounding heavily damaged regions, whether the majority of evacuees' are mainly lower-performing, and possible reasons as to why academic performance changed within those regions.

My study aims to disentangle the true effects of Hurricane Katrina, while taking into account potential selection biases. It has been noted that academic growth has not been statistically related to reforms within New Orleans (Perry and Schwam-Baird 2010). Therefore, some other explanation must be influencing educational statistics, and Hurricane Katrina may be that driving force. While the primary interest of this paper is on the hurricane's educational implications in

New Orleans, my research also explores the effects of the hurricane on different damaged-ranked regions in Louisiana. My strategy focuses on two levels of observation: district-level and individual-level. Using data from Louisiana's Department of Education Office of Assessment and Accountability, I analyzed particular education factors that will signal a positive or negative impact on education. These educational factors include School Performance Scores (SPS) averaged at the district level, which are based on dropout rates, attendance, and standardized test scores. I also examine standardized test score means along with using the test scores as dependent variables in regression analysis. Increases in these statistics over time will signal a positive impact on education.

The estimation strategy focuses on each educational statistic separately as a dependent variable. This strategy compares before and after Hurricane Katrina values for the variables, meaning whether the values were before August 29, 2005, the date when Hurricane Katrina struck Louisiana, or after this date. The Federal Emergency Management Agency (FEMA) created disaster rankings based on wind and water damages. Using these damage-ranked categories, I also compare educational statistics across locations with different levels of damage caused by the hurricane. Means for these variables will initially estimate a positive or negative effect of the hurricane, and then linear regression models will measure the size of that effect.

Focusing on the academic years from 1998-1999 through 2009-2010, my initial findings using district-level data show that Louisiana experienced rising school performance scores, but New Orleans schools had much higher gains.

Additionally, the more damaged regions in Louisiana also experienced larger positive increases in average test scores compared to the rest of the state following the shock of the hurricane, suggesting that some of the educational improvements were not due to factors specific to New Orleans. Next, by regressing individual-level test scores on the extent of the damage and the occurrence of Hurricane Katrina, my findings show a positive correlation between the extent of the hurricane's damage and educational measures, where the most damaged regions have the largest positive effect of the hurricane. Since the initial regressions do not correct for the previously mentioned biases, I then perform regressions on manipulated data to correct for the changing composition of students, using fixed effects for a group of controls that describe personal characteristics of the students. This regression analysis aims to correct for specific group effects on test scores, since test scores could be affected by changing student characteristics across different regions.

Next, by focusing only on students that did not evacuate, I aim to correct for student displacement across the different damage regions. I compare regression estimates using a sample that does not allow movement of students into new regions to the original regression estimates that include student's moving to different regions in Louisiana. For some tests, the former regression shows very similar results across all damaged regions, suggesting that the lowest-achieving students were not the only students leaving the most damaged regions. However, for other test scores, the regions with the highest damage rating experienced the largest negative effects from the hurricane, suggesting that if the students had not moved, we would not have seen such large gains in student performance in the Damage 3 region, specifically in New Orleans schools. These findings suggest that some test scores improved primarily because of student displacement across the regions, but other test scores improved with and without this displacement.

The remainder of this paper provides more detailed data descriptions and explorations of the potential biases. Section IV describes the data for both levels of observation, providing summary statistics for before and after Hurricane Katrina. Section V includes the estimation strategy and the statistical models used in my analysis. The estimation strategy includes multiple regression equations to measure the size of the effect, and statistical models analyze those equations. Section VI summarizes empirical results from the estimation strategy and models. Section VII concludes my research findings. Finally, figures and tables can be found in the Appendices in Section IX, following the references in Section VIII.

IV. Data and Descriptive Results

a. Data Description

To explore Hurricane Katrina's effect on education within Louisiana, I focus on two levels of observation: district-level and individual-level. Starting at the district-level, Louisiana contains 64 parishes (equivalent to counties in other states), and each parish is a school district. Orleans Parish is the entire city of New Orleans. Besides the 64 parishes, a new school district in Louisiana was created in 2003, consisting of the worst performing schools that were taken over by the state. This district, the Recovery School District (RSD), contains varying amounts of schools each year, many of which are New Orleans schools. Before the hurricane, only five schools from Orleans School District were part of RSD. Immediately after the hurricane, over 100 Orleans schools were placed in this district, which is over 75% of the total Orleans schools (RSD 2011). Because this large school displacement occurred directly after the hurricane, post-Hurricane Katrina estimates for Orleans include only a small fraction of the schools from pre-Hurricane Katrina. Therefore, I examine averages for both Orleans and RSD following the shock of the hurricane.

To measure the effects at the district-level, I focus on school performance scores (SPS) averaged for Orleans and RSD. LDOE's (2011) online record of SPS has values from August 2008 through March 2010, where SPS are based on students' standardized test scores, attendance, and dropout rates. According to the National Center for Educational Statistics (2011), dropout rates for each district are the percentage of students who are not enrolled in school between the ages of 16 and 24 and have not earned a high school diploma or GED certificate. A high dropout percentage represents a large amount of students fitting this classification, and higher dropout rates lead to a lower SPS. Higher attendance and standardized test scores both cause a school to have a higher SPS.

By requesting micro-data from the LDOE's Office of Standards, Assessments, and Accountability, I gained access to an individual-level dataset. Within this individual-level dataset, there are roughly 150 school districts, where

64 of them are individual parishes. The remaining school districts are primarily RSD schools; additional school districts are charter schools that may not be assigned to particular parish school districts for a particular year, thus being classified as their own districts within the dataset (LDOE 2010b). Approximately 6.3 million observations are within this dataset. Individual ID numbers assigned by LDOE organize the data. Other variables within this dataset are birthdate, grade level, type of test, test subject, and other personal characteristics, including race, gender, lunch status, Limited English Proficiency (LEP) status, and education class. Lunch status is free/reduced, paid, or unknown for an individual, where free/reduced represents a student that receives either a free or a reduced price daily lunch; paid represents a student that pays for the lunch at his or her school's price, and unknown is when a student's lunch status is not recorded or blank. LEP categorizes a student by whether he or she has limited English ability. Education class classifies a student by whether he or she is in a regular education program or in a special education program.

Test dates include both the month and the year of the exam. For multiple entries with the same ID and test date, my analysis will include the average of those two entries. Test types include Norm-Referenced Tests (NRT) and Criterion-Referenced Tests (CRT); these tests are administered throughout the academic year. NRT ranks a student's score against his or her peers' scores, which can be converted into percentiles. CRT focuses on criteria learned within a particular curriculum (Brualdi 1998). Test subjects include Mathematics, English and Language Arts, Social Studies, Science, and Reading. Later regressions will use subject test scores from CRT as dependent variables.

CRT in Louisiana includes the Louisiana Educational Assessment Program (LEAP), the Integrated Louisiana Educational Assessment Program (iLEAP), and the Graduate Exit Examination (GEE). LEAP is administered during 4^{th} and 8^{th} grades; iLEAP is administered during 3^{rd}, 5^{th}, 6^{th}, and 7^{th} grades; and GEE is administered during 10^{th} grade. Students taking 4^{th} and 8^{th} grade LEAP tests must pass to continue on to the next grade. A passing score on the GEE is a requirement for graduation. While the GEE is initially administered in 10^{th} grade, high school students can retake the GEE until they pass the test.

CRT scores range from 100-500. Subjects include Mathematics, English and Language Arts, Social Studies, Science, and Reading. While Reading is a CRT subject, it began in 2007 post-Hurricane Katrina, so I do not use it in this study because it started after Hurricane Katrina. Additionally, I chose to focus on the scientific fields, so my regressions use Mathematics, Science, and Social Studies as dependent variables. Even though the dataset contains observations for multiple statewide tests, the standardized test I focus on is LEAP, which is a CRT taken by both 4^{th} and 8^{th} graders.

Individual-level estimates include descriptive data gathered from the previous mentioned dataset, along with linear regression analysis. The regressions examine the effects of the hurricane and other components directly related to the hurricane, including the amount of damage. To determine the level of damage a student was exposed to, I use his or her physical location as opposed to the school or district since many schools were destroyed by the hurricane, and many others were moved in and out of RSD.

Records from FEMA have mapped out disaster declarations based on wind and flood damages across the state of Louisiana, and this map includes three categories of assistance (FEMA 2006). FEMA (2006) has defined Public Assistance (PA) as Federal disaster grants for publicly owned infrastructures, and there are seven subcategories of levels of assistance. All regions of Louisiana were granted some form of PA, but the most severe were allotted all levels of assistance, and less damaged areas were not. Individual Assistance (IA) consists of cash grants for households within severely damaged regions. These grants are designated for housing and other personal disaster-related needs. The amounts of PA and IA taken together determine FEMA's disaster declaration categories (FEMA 2006).

Based off this system, my damage rankings have three categories: Damage 3, Damage 2, and Damage 1. These damage regions coincide with parish boundaries within Louisiana, and a map of this assignment will be in the upcoming section. A region in the Damage 3 category experienced the most damage, having received the largest amount of assistance; all seven levels of public assistance along with individual assistance were allotted to these parishes. A region in the Damage 2 category also received both public assistance and individual assistance, but the amount of public assistance in these parishes is limited to only two of the seven subcategories. A region in the Damage 1 category received limited public assistance with only one of the seven categories, and this category included emergency protective measures (FEMA 2006). Orleans Parish experienced category four winds with extensive flood damage, causing Orleans Parish to receive a classification of Damage 3 (Hafale et al. 2011). Northwest Louisiana experienced the least amount of wind and flooding, so those parishes are part of the Damage 1 category. I will later provide tables of descriptive statistics organized by the damage-ranking level, showing before and after trends of average individuals' characteristics and test scores by this level of damage.

b. Graphs and Sample Means

Figure 1 represents the average SPS for Louisiana, Orleans School District, and RSD from the academic years of 1998-9999 through 2009-2010 (LDOE 2011). Many years have data for both fall and spring, so the academic year SPS in this figure is an average of the two scores. Some academic years have available data for only one semester, spring or fall, so this value will be the average for the entire academic year. This figure indicates an increasing trend of average SPS for Louisiana, Orleans, and RSD, where pre-hurricane Orleans averages were below the state averages, and the averages immediately following the hurricane were above the state averages. Figure 2 is the before-mentioned classification of the damage regions designated by FEMA (2006). This figure categorizes individuals as living in a Damage 1, 2, or 3 region depending on where the individuals' school district is located.

Table 1 contains CRT averages for all grades in Louisiana before and after Hurricane Katrina, as constructed from the individual-level dataset (LDOE 2010a). Table 1 disaggregates the district-level analysis into an individual-level analysis of standardized scores, examining damage-ranked category averages of student performance. The table contains two panels, one for each damage ranking, using 4th and 8th grade test scores. Each panel shows before and after Hurricane Katrina averages. For each damage ranking, I find increasing subject test scores over time for both grades. Also, Table 2 classifies students into damage regions, and this table demonstrates the changing composition of students for before and after Hurricane Katrina. The increasing sample means and changing composition of students across regions will be analyzed in more detail later in Section VI.

V. Estimation Strategy/Model

For individual *i*'s test scores, the first regression equation takes the form:

(1) $y_{it} = \pi_o + \pi_1 Damage_i + \boldsymbol{\delta}'\mathbf{X}_{\mathbf{it}} + u_{it}$

This equation measures the effect of damage on individual test scores over time, where y_{it}, the dependent variable, is the test score in a specific subject for individual i in time t. $Damage_i$ takes the values of 1-3 for each individual in classified districts, where "1" is the smallest level of damage and "3" is the highest. The term u_{it} is an individual-level mean zero unobservable within the regression, which assumes that the model is correctly specified to examine the effect of level of damage on subject test scores. $\mathbf{X_{it}}$ is a vector of controls that varies across specifications, including a time trend and controls for gender, ethnicity, LEP status, lunch status, and education class. This equation assumes a linear relationship between the dependent and the independent variables, using the Ordinary Least Squares (OLS) assumptions to estimate the parameters. A negative coefficient estimate for $Damage_i$ reflects larger decreases in the test scores for regions that experience higher levels of damage.

After considering the individual effect of damage on test scores both with and without controls, I examine other combinations of effects that could potentially explain the rise in test scores. Combining Hurricane Katrina and damage rankings takes the form:

$$(2) \quad y_{it} = \pi_o + \pi_1 DamageR_i{*}Katrina_t + \pi_2 DamageR_i + \pi_3 Katrina_t + \ldots + \boldsymbol{\delta}'\mathbf{X_{it}} + u_{it}$$

$DamageR_i$ measures the effect of individuals living in different damage ranked districts before Hurricane Katrina with R being the damage rankings of 1-3. This variable is now a series of dummy variables where "1" represents being in the particular damage region, and "0" represents otherwise. $Katrina_t$ is a dummy variable that measures before or after Hurricane Katrina, which takes the value of "0" for a time period before August 2005, and "1" for after. $DamageR_i{*}Katrina_t$ is the interaction term that measures the effect on different damage-ranked districts after the hurricane. The dependent variable, y_{it}, is the test score in a specific subject for individual i in time t. To understand the effects of Hurricane Katrina across the damage regions, I examine the coefficient on each damage category post-Katrina. If the coefficient for a specific damage region post-Katrina is negative, then this reflects a negative effect of living in that type of region on the test score in a specific subject. As before, $\mathbf{X_{it}}$ is a vector of controls that varies across specifications.

One control specification includes a linear time trend to make the coefficient estimates more precise, adding a variable that describes the month and year of test administration. After including the time trend, another specification includes the set of control variables for gender, ethnicity, lunch status, educational class, and LEP status.

After these control specifications, I examine this group of controls with a fixed effects model. Assuming these controls are time-invariant for each individual taking the standardized tests, I group the control variables into categories of dummy variables since each group of these controls may have special characteristics affecting the test scores.[1] The grouping of controls is what I refer to as group fixed effects, which aims to capture any correlation between the control variable characteristics and the individuals that they describe.

To examine group fixed effects, I group together the previously listed five control variables as fixed effects, and use the following equation:

$$(3) \qquad y_{it} = \pi_o + \pi_1 DamageR_i * Katrina_t + \pi_2 DamageR_i + \pi_3 Katrina_t + \ldots$$

$$\ldots + \alpha_i + \boldsymbol{\delta}'\mathbf{X_{it}} + u_{it}$$

[1] This assumption of time-invariance is necessary to use the fixed effects estimations with the group of controls to remove omitted variable bias; however, some individuals' lunch status, LEP status, and educational class could change across time if they were near the dividing line of classifications to begin with. Since these variables may change, there still remains some omitted variable bias within this fixed effects regression (Gujarati and Porter 2009).

The variables represent the previous descriptions as in equation (2), but now α_i captures unobserved group effects of the control variables that may be correlated with the regressors of interest.

The next regression focuses on regrouping test takers back into the initial school district that they appear in the dataset, which corrects for student displacement. This assigns a student to his or her initial school district with an assigned damage ranking. Instead of allowing the individual to move over time, he or she keeps the same damage ranking across the years of observation. While some students may move for other reasons throughout this period, I am not allowing any movement across damage rankings for all observations. Additionally, some students relocated into Texas and other states, so the effects from Hurricane Katrina on those scores are unable to be examined. The regression equation used to correct for student displacement within Louisiana is as follows:

$$(4) \qquad y_{it} = \pi_o + \pi_1 MinDamageR_i * Katrina_t + \pi_2 MinDamageR_i + \ldots$$

$$\ldots + \pi_3 Katrina_t + \alpha_i + \boldsymbol{\delta}'\mathbf{X_{it}} + u_{it}$$

This regression includes the same variable descriptions as (3) with the group fixed effects as well as the vector of control specifications, but now $MinDamageR_i$ represents an individuals' damage ranking, and $MinDamageR_i*Katrina_t$ is the interaction term for the effect post-Hurricane Katrina, where "*Min*" refers to that initial damage ranking. Since this regression does not allow the heavy out-migration from the largely damaged regions into the less damaged regions, equation (4) aims to capture a more precise effect of Hurricane Katrina within

Louisiana on the students that would not have moved without the shock of the natural disaster. The changing quality of students could potentially affect the test scores across the different damage-ranked regions, so by not allowing the students to move, this regression equation should show a more accurate impact on the individuals' scores within the initial districts.

To estimate the effects of Hurricane Katrina further, I examine student fixed effects within the panel data. This model is similar to the group fixed effects model, but instead of focusing on the groups of personal characteristics, I restrict the sample to include only students that took both the 4^{th} and 8^{th} grade LEAP tests. Using individual fixed effects within this restricted sample absorbs individuals' characteristics over time that might be correlated with the test scores. This regression equation is identical to (3) with the same variable descriptions, but now instead of using group fixed effects, α_i captures the unobserved individuals' effects based on the student ID and all identifying characteristics that may be correlated with the subject test scores.

VI. Empirical Results

Figure 1 illustrates average SPS for Louisiana, Orleans School District, and RSD for each academic year between 1998-1999 and 2009-2010. This graph demonstrates an increasing trend of improved SPS across all three geographies. Note that directly after Hurricane Katrina hit in August 2005, there is a gap in the available data to use for comparison for Orleans School District. Orleans shows a large leap in SPS directly following this gap of missing data, suggesting that the students within this district were improving test scores, attendance, and/or decreasing dropout rates to increase average SPS. Since RSD took over many Orleans schools, I have also included the RSD averages to show that the Orleans School District scores appear artificially higher than they would without the school displacement.

Before Hurricane Katrina, Orleans educational statistics were significantly below the state average. In the 1998-1999 academic year, Orleans SPS was approximately 38, which is 46% lower than Louisiana's SPS average of about 70. While I did not examine the individual factors for why the score is 46% lower, SPS rankings are based on standardized test scores, attendance, and dropout rates, so the combination of these factors is what made Orleans far below the average. However, the values of Orleans were catching up to Louisiana; the 2004-2005 SPS in Orleans was at about 55, and Louisiana's average was around 84. Orleans was only 35% lower during this academic year. While pre-Hurricane Katrina policies include the formation of RSD in 2003, only five schools were from Orleans School District before the hurricane. The data for RSD is not available until Spring 2008, but since such few schools in Orleans were moved into this district before the hurricane, the percentage gains of Orleans were catching up to the state averages even without the RSD policies.

Starting back up in 2007-2008, Orleans SPS averages were actually above Louisiana's, where Orleans' average SPS was approximately 93 and Louisiana's 87. While Orleans is now scoring 7% higher than Louisiana's averages, RSD is

40% below the state average with a score of about 54. These findings suggest that Orleans School District's improvement could merely be due to the worst schools' entering RSD. However, Orleans' averages continue to rise higher than the state average, with a 2009-2010 Orleans average SPS 16% above the state average; RSD also gets closer to the state average by being only 31% below it in that academic year.

Since it is not clear whether RSD is the primary reason for improvement, and the continuous SPS gains for Orleans suggest otherwise, the upcoming analysis investigates other explanations for this empirical anomaly. Additionally, all scores are increasing, which shows a potential time trend of scores improving before RSD. The size of the increase in scores is much higher in Orleans though, also indicating that some other factors besides the RSD implementation were creating higher scores for the districts.

While these findings using district averages of SPS data agree with results from previous literature that claim New Orleans' schools improved following Hurricane Katrina, many biases remain that cannot be observed on this level of observation. To examine these biases, I use the individual-level descriptive analysis, along linear regressions described in Section V, to compare effects of the hurricane on both Orleans and highly damaged regions.

LEAP averages for test subjects of Math, Science, and Social Studies for 4^{th} and 8^{th} are found in Table 1. This table has two panels for 4^{th} and 8^{th} grade averages, respectively, and each panel is broken into pre-Hurricane Katrina (Spring 1999 through Summer 2005) and post-Hurricane Katrina (Fall 2005 through Spring 2010). Additionally, these two panels are divided into the three damage rankings, and I present means, standard deviations, and average numbers of students per academic year for each damage ranking.

The LEAP averages for 4th graders in Panel A show that Damage 3 region has the largest number of students per year, and post-Katrina this region contains the largest decrease in the percentage of students across the three subject categories. For the 4th grade sample, Damage 3 CRT subjects experienced an approximately 12.6% decrease in number of students taking tests, whereas Damage 2 experienced a 1.3% decrease, and Damage 3 had a 2.2%. Across all subjects for 8th graders in Panel B, Damage 3 also experienced the largest decrease in annual number of students with a roughly 9.2% decrease, Damage 2 has about a 0.4% decrease, and the number of students actually increased on average post-Katrina for Damage 1 with about a 0.7% increase. One can assume that Damage 3 had lower levels of students after this hurricane because it had the largest out-migration of students; this may or may not help explain the changing test scores over time. The increase for 8th graders in Damage 1 regions and the very small decrease in Damage 2 regions also suggest that residents of Damage 3 regions were moving into the other two regions.

However, these findings show that every subject category across both panels had increasing test scores after the shock of the hurricane. The only difference is the magnitude of the increase in test scores. For 4th graders, Damage 2 received the smallest increase in test score averages across the three subjects, with an approximate 2.7% increase. Damage 1 had an average 3.1% increase, and

Damage 3 had the largest increase with an approximately 4.3% rise in subject test scores. Similar results are observed for 8th graders, with slightly different increase values of about 2.1%, 1.5%, and 4.2% rise in subject scores for Damage 1, 2, and 3 regions, respectively.

From these two panels, all scores are increasing and numbers of students are changing, but a few possible explanations can explain the increased test scores. For example, the students may all be performing better due to teachers preparing their students better for tests, a common occurrence among standardized testing. Kane and Staiger (2008) find that teachers have a short-term impact on student performance, including test scores, so changing administration post-Hurricane Katrina could have been responsible for the rise in test scores for some regions. Alternatively, Damage 2 scores might have increased less due to in-migration of poorer-performing students in Damage 3 regions, similar to the decrease in test scores in Houston schools due to the evacuees' relocating there (Imberman, Kugler, and Sacerdote 2009). Table 1 is unable to examine either of these hypotheses; however, Table 2 provides descriptive demographic characteristics of the students before and after the hurricane, since variation in student characteristics may also lead to variation in test scores.

Table 2 represents the changing composition of students recorded as having taken standardized tests in each of the damage regions. Again, this table is split into before and after Hurricane Katrina averages, with Spring 1999 through Summer 2005 in the pre-Hurricane Katrina columns, and Fall 2005 through Spring 2010 in the post-Hurricane Katrina columns. Table 2 summarizes the selected controls used in the linear regressions as percentages, which include gender, ethnicity, LEP, lunch status, and education class. Although the changes in compositions appear quite small across all characteristics, there are some consistent changes for one or more regions, which may affect the interpretation of the main empirical results.

Percent male decreased in all damage categories post-Katrina. The percentage of white students decreased in the Damage 1 and 2 regions but increased in the Damage 3 region. Percent black in the Damage 2 region increased, yet the percentage of black students decreased in both the Damage 1 and 3 regions. LEP status increased across all categories post-Katrina, signaling that more students had limited English speaking and reading abilities in all regions of Louisiana after the hurricane. The fraction of free or reduced lunch recipients increased in all categories after the hurricane, also indicating that more students needed higher levels of financial assistance for lunches. Specifically, all damage regions have a majority of free/reduced lunch status students after the hurricane. Before the hurricane, only Damage 1 and 3 had primarily free or reduced lunch status students, and Damage 2 had paid as the main lunch status. After the hurricane, higher fractions of students were enrolled in regular education classes, while a smaller fraction were in special education programs.

In summary, while some of these category changes seem intuitive, such as the fact that the hurricane shock led to increased student financial assistance with school lunches, other category changes, such as the increase in the fraction of students enrolled in regular education classes, are less obvious as to how the hurricane affected them. Although the percentages of these composition changes are small, the changes could greatly affect test score outcomes, which is why I correct for these changes in the regression analysis.

The first regression table is Table 3. Assuming that LEAP subject scores are linear functions of damage rankings, I use equation (1) to estimate the sole effects of damages on Math, Social Studies, and Science testing. Table 3 illustrates these findings of damages for 4th and 8th graders across six different panels. Panels A, B, and C examine effects of damages on 4th grade scores, and C, D, and E show effects on 8th grade scores.

Across all panels, we see negative coefficients on damage for all subject tests. This corresponds to a relationship between higher levels of damage and lower test scores. Panels A and C show the effects of damage levels without any controls for 4th and 8th graders, respectively. Panels B and D show the effects of damages with a time trend, and Panels C and F include the full set of controls and the time trend for 4th and 8th graders. Moving across the levels of specification for both 4th and 8th graders, the values of the coefficients become less negative, but the effects do remain negative.

The two panels that show the most precise estimates of the effects of the level of damages are C and F. In Panel C (4th graders), higher levels of damage have the largest negative effect on Science test scores. In Panel F (8th graders), higher levels of damage have the largest negative effect on Social Studies test scores. These six panels disagree with previous LEAP subject test means, which showed that the highest damaged regions experienced the largest positive gains.

This indicates that some other explanatory variable has been left out, leading to bias in these regressions. The next tables explore the combined effects of both Hurricane Katrina and levels of damage, with and without controls, to find a more precise estimate of the effect.

Examining the combined effects of Hurricane Katrina and damages on individuals' test scores, Tables 4, 5, and 6 give the Math, Science, and Social Studies results, respectively. Each table has two panels for 4^{th} and 8^{th} grade, and every panel has three exogenous interaction terms, Damage1*Katrina, Damage2*Katrina, and Damage3*Katrina, each of which represents the effect of living in a specific damage region post-Hurricane Katrina. There are five regressions in each panel, where the first regression corresponds to equation (2) without any controls, the second regression also corresponds to equation (2) but only with a time trend, and the third regression corresponds to equation (2) with both a time trend and the five control variables. The fourth regression uses equation (3) which examines group fixed effects, and the fifth regression uses equation (4) with both student displacement and group fixed effects.

Looking at Panel A in Table 4, the initial OLS findings without any controls or specifications show a largely positive effect of Hurricane Katrina and the amount of damage on each damage-ranked district. These initial findings can be interpreted for an individual living in a particular district, where Hurricane Katrina increased the Math scores by the value of the coefficient. For an individual living in the Damage 3 region, Hurricane Katrina increased scores by 17.5 units. Agreeing with previous means found in Table 1, the highest damaged region, Damage 3, experiences the largest positive effect on Math LEAP scores. The second regression in this panel includes a time trend. This time trend largely decreases the initial positive effect on Math scores, and for the Damage 2 region, the hurricane now has a negative effect on test scores for the individuals living there, and for the Damage 3 region, the hurricane now only has a 4.2 unit increase on Math scores for 4th graders. The third regression includes the group of controls along with the time trend, and all damage categories now show negative effects on Math scores, where the Damage 3 region now exhibits a 4.5 unit decrease on Math standardized tests for 4th graders. As in the second regression, the Damage 2 region experiences the most negative effect. Further, adding group fixed effects for the control variables, along with a time trend and the controls, lessens the negative effect of damages and Hurricane Katrina, so now the 4th graders living in the Damage 3 region experience a 3.8 unit decline in Math test scores. However, the effects remain negative, and the largest effect is still in the Damage 2 region. Finally, the fifth regression contains each control variable, the time trend, group fixed effects, and student displacement. Without controlling for student displacement, the 4th grade Math results show that the Damage 3 region experiences the least harm. Conversely, with student displacement controls, the Damage 3 region students have the largest negative effect from Hurricane Katrina, with a 7.7 unit decrease, while the Damage 1 region had a 6.0 unit decrease and the Damage 2 region had a 1.4 unit increase in test scores. Although we can assume that these results did not occur by chance in the fourth regression because all coefficients are statistically significant, only the coefficient for the

Damage 3 region in the fifth regression is statistically significant, so there are imprecise estimates for the Damage 1 and 2 regions.

For the 8th grade Math results, we see similar trends across the first three specifications, but the fourth and fifth column are much different. These results show that the Damage 3 region individuals without student displacement controls experience positive gains for Math testing, where the Damage 3 region showed a 2.5 unit increase in scores, but none of the coefficients in the fourth column are statistically significant. Additionally, with student displacement controls, all of the regions experienced positive effects, signaling a positive impact of Hurricane Katrina if none of the families moved across regions or out of state. For this regression, the only region that has statistical significance is Damage 2. This suggests that Hurricane Katrina positively affected the Damage 2 region if there was no migration of students over the time period considered. Thus, the migration of students after the hurricane negatively affected the 8th grade Math scores in the Damage 2 region.

In table 5, the 8th grade Science results again are slightly different from the 4th grade results for the fourth and fifth regression specifications. One notable consistency is that the Damage 2 region with student displacement controls has a positive coefficient, but without those controls, it is negative. This is the only statistically significant coefficient across both specifications, and it again agrees with the region's having much more negative Science test scores due to the migration of students going into and out of the region.

Social Studies results for both 4th and 8th graders are very similar to the Math results from earlier. Specifically, for 8th graders, we see that the Damage 2 region is the only one with statistical significance in both the fourth and fifth columns, and this region experienced much more positive effects from the hurricane when migration of students is not allowed. Even though the coefficient is significant only on the 10% confidence interval for 4th graders, the Damage 3 region shows a 4.5 unit decrease after student displacement controls, yet again agreeing with the out-migration of lower-performing students potentially raising the scores post-Hurricane Katrina within the Damage 3 region.

While these three subjects have varying results across 4th and 8th graders, a common trend is that regressions controlling for student displacement show a positive effect on 8th grade scores in the Damage 2 region because they have positive coefficients. The students in this region, had there been no movement after the hurricane, would have experienced gains, but in reality there was in-migration into the Damage 2 region, so the region experienced the negative effects as seen in the fourth column of these regression tables. This again suggests that the large out-migration of Damage 3 region individuals into the other regions may have been highly correlated with the lower average LEAP scores in the Damage 1 and 2 regions after Hurricane Katrina.

Due to the varied findings with the 4th and 8th grade results, the next set of regressions correct for student fixed effects to control for both observed and unobserved time-invariant determinants of subject test scores that may have been correlated with residence in a particular damage region. Table 7 adjusts for changes in the composition of students by only focusing on students who took the test in both 4th and 8th grades. Students who took the test in only one grade are effectively dropped from a regression that includes the student fixed effects. The student fixed effects regressions measure the effect of Hurricane Katrina on the 8th grade subject scores by controlling for any characteristics of the students that can be inferred from their 4th grade scores. In other words, all characteristics that an individual had in 4th grade are controlled for in student fixed effects, and these characteristics should have the same effect in 8th grade as well.

This table has separate panels for Math, Science, and Social Studies, and each panel displays three specifications. The first column has controls for student fixed effects only, the second column adds in a linear time trend, and the third column replaces the linear time trend with year fixed effects. While the number of observations in Table 7 is much lower than that of previous tables, this is likely a result of out-migration due to Hurricane Katrina, along with general mobility. For example, in between 2002 and 2003, approximately 2.7% of people moved out of state (Schachter 2004). Across the ten years of observation within my dataset, this may have played a large role in the decrease in the number of observations.

Panel A shows the Math results for the student fixed effects regression. When including only the student fixed effects, there is an overall negative effect on performance, with a decrease in Math score units by 4.6, 1.7, and 0.2 for the Damage 1, 2, and 3 regions, respectively. The negative effect remains when a linear time trend is added, and the Math scores decrease even more, with a 6.4, 3.5, and 2.0 unit decrease in test scores for the Damage 1, 2, and 3 regions, respectively. However, with both student and year fixed effects, there is an increase in Math scores, with the Damage 1, 2, and 3 region having a 5.0, 7.8, and 9.4 unit increase in Math test scores, thus the largest Math score gains are in the Damage 3 region. This agrees with the results from Table 4, where 8th graders, without student displacement controls, saw the largest positive gains, even though the 4th graders experienced negative effects.

Additionally, the Science results in Panel B agree with the previous results from Table 5. Science results reflect negative effects on test scores on all damage regions with every control specification, and in particular, there is a very large negative effect on Science test scores when including both student and year fixed effects, with a 24.0, 22.7, and 19.1 decrease in units for the regions Damage 1, 2, and 3, respectively. From the group fixed effects regression for both 4th and 8th graders in Table 5, we saw negative effects from Hurricane Katrina on all damage regions, with the least negative effects in the Damage 3 region. This agrees with the Table 7 Science test score findings, even though the results are now much more negative than seen in previous tables.

Social Studies test scores follow a very similar pattern as Science test scores. While the student and year fixed effects results for the Damage 3 region exhibit the least negative effect from the hurricane compared to the other two regions, each damage region experienced large negative effects, with statistically significant values that have similar magnitudes to the Science student and year fixed effects results. This indicates that Hurricane Katrina negatively affected all individuals' Social Studies test scores.

While the student fixed effects results for Math show positive coefficients, reflecting a positive effect from Hurricane Katrina on the students present in both 4^{th} and 8^{th} grades, the Science and Social Studies test score results exhibit largely negative effects across all regions, agreeing with the group fixed effects results from previous tables.

VII. Conclusion

Initial district-level findings showed increasing SPS for Louisiana, Orleans, and RSD. Additionally, initial individual-level findings showed increasing LEAP scores post-Hurricane Katrina, particularly for the Damage 3 region. Both of these sample means agree with publications that New Orleans schools and highly damaged regions experienced large educational gains after Hurricane Katrina. The interpretation of the hurricane's effect on Louisiana's educational systems is not as easily understood.

After correcting the linear regressions for time trends, control variables, and group fixed effects, Hurricane Katrina negatively affected 4^{th} and 8^{th} grade Science and Social Studies LEAP test scores for all regions. While sample means indicate increasing scores in those subject areas, the hurricane is not responsible for those gains; rather, the slightly changing composition of students across the regions might be. None of the control variable characteristics from Table 2 showed large changes in student characteristics, but the regression tables suggest that these small changes in composition, along with time trends, do have larger implications on the overall test results. These findings also suggest that, while the initial findings show highly positive correlations between test scores and Hurricane Katrina (Tables 4, 5, and 6), the high gains can be attributed to the student-level controls, time trends, and group fixed effects, whereas the hurricane itself had negative impacts on the scores in all regions. This is intuitive; a natural disaster that uproots many individuals is likely to have large negative effects on performances, and in our example, the standardized test scores.

On the other hand, 8^{th} grade Math results reflected overall positive increases, specifically from the student fixed effects regression, in all damage regions following the hurricane. One argument for this difference could be that Louisiana schools focused heavily on Math testing following the hurricane, which led to their neglecting the other subjects. This would agree with the Science and Social Studies results, but other arguments could try to explain this irregularity within the regression results. For example, Math LEAP tests could be easier compared to other tests, so the test scores do not see a large decrease because of the hurricane. In both grades before and after the hurricane, the sample means of Math scores are higher than the other subjects across the damage regions, so it is possible that these scores remained positive even with a negative shock of the hurricane. Or, the possibility that Math teachers received better incentives, such as pay, for students performing better, thus the teachers focused on their students scoring better in this class. These reasons are highly subjective, but all could try to counter the deviation of Math compared to the other subject results.

A consistency across all tables with student displacement controls indicated that the Damage 3 region saw the largest decreases in test scores across the Math, Science, and Social Studies testing for 4th and 8th graders. Even though 8th grade Math had positive coefficients and the Damage 3 region's coefficient was not statistically significant, the value still showed the smallest positive effect. These findings yet again agree with the Houston schools study by Imberman, Kugler, and Sacerdote (2009) that the out-migration of students from Louisiana's highly damaged regions contained primarily poorer-performing students with respect to the region that they were migrating. In Louisiana, this led to lower educational gains for the Damage 1 and Damage 2 regions, which would explain the lower percentage increases of LEAP average scores from Table 1. If this is the case, then the out-migration and the RSD are both responsible for making the Orleans School District appear to have such high district-level gains.

In conclusion, New Orleans schools and other highly damaged regions experienced educational increases after the hurricane, but the out-migration of these students into the other regions explains why the surrounding areas did not exhibit the same gains. Hurricane Katrina was the driving force of the changing composition of students, but the hurricane itself negatively affected standardized test scores for the 4th and 8th graders.

The shock of the hurricane may have had a negative impact on the LEAP scores, but the disruption of the community outweighed these negative effects enough that there were still increases in the test scores and SPS for all damage regions. The less damaged regions saw larger declines in statistics because of the movement of lower-performing individuals into the region. Again, this could be a result of peer effects, where students tend to score lower if their peers are scoring lower. On the other hand, the lower-performing students that moved into the higher-performing regions could also exhibit peer effects by scoring better because their peers are scoring higher than their previous schools. The peer effects could work in either way, but for the lower-performing students, the out-migration into higher-performing school districts leads to a potentially brighter future for them. Hurricane Katrina may have negatively affected overall test scores, but indirectly, the educational systems still saw increased test scores and SPS due to the disruption and changing composition of students. On the other hand, there may have been very different results if the focal point of hurricane destruction was within a higher-performing population as opposed to an urban area.

These findings have a large impact on policy implications within educational systems. While the scope of my research was on district-averaged SPS and individual-level standardized test scores, other educational attainment measures should be considered for an even more accurate picture of Hurricane Katrina's effect on Louisiana's educational systems. These include graduation rates, college attendance, and even future earnings. The long-term effects on all of these educational variables should be analyzed to help prepare other educational systems for a natural disaster. For students living in an urban area, the results suggested that a natural disaster could provide an opportunity to thrive elsewhere. For the surrounding less-damaged regions, the potential to thrive becomes less likely. Although these surrounding regions still showed positive scores on average, the long-term effects of Hurricane Katrina can give us a more accurate picture of how the out-migration changed the dynamic of those initially higher-performing schools. Is Hurricane Katrina responsible for indirectly reducing the achievement gap between the students in the urban, highly damaged regions and their higher-performing peers? If so, then policies should focus around ways to alter the composition of students to benefit both lower-performing and higher-performing children across school districts without the destruction of a hurricane. Future work on more educational attainment measures will be able to provide a much clearer impact on these educational systems.

VIII. References

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IX. Appendix

i. Figures

Figure 1:

School Performance Scores for 1998-1999 to 2009-2010 Academic Years

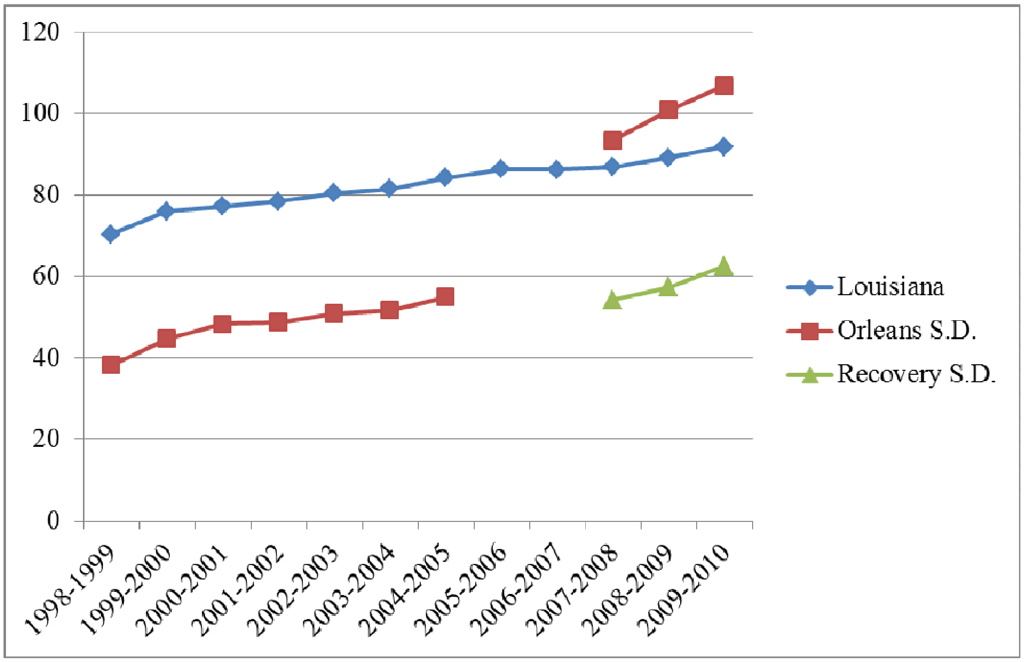
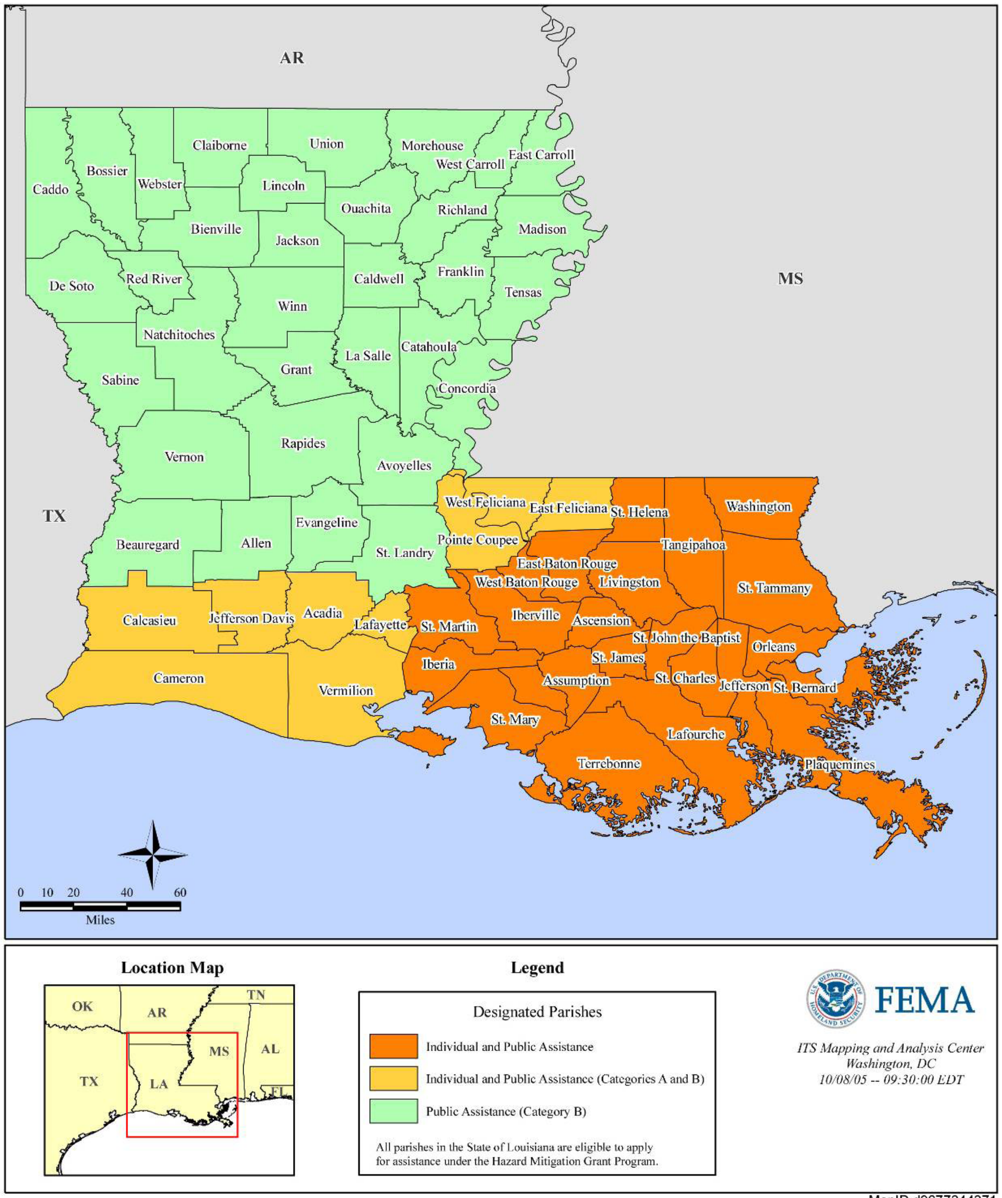


Figure 2:

FEMA-1603-DR, Louisiana
Disaster Declaration as of 10/07/2005



Source: FEMA (2006, 6).

ii. Tables

Table 1: *Average LEAP Scores across Different Damage-Ranked Regions Pre- and Post- Hurricane Katrina*

Panel A: 4th Grade Results

		Pre-Hurricane Katrina (Spring 1999 – Summer 2005)			Post-Hurricane Katrina (Fall 2005 – Spring 2010)		
		Math	Science	Social Studies	Math	Science	Social Studies
Damage 1	Mean	312.102	313.445	306.520	328.160	320.330	312.711
	Std. Dev.	(52.471)	(49.470)	(43.763)	(63.589)	(62.348)	(46.074)
	Avg. Observations per year	23248	19855	19851	22630	19503	19404
Damage 2	Mean	317.793	318.275	310.748	331.094	324.623	315.982
	Std. Dev.	(52.205)	(48.904)	(43.456)	(62.456)	(59.726)	(44.632)
	Avg. Observations per year	8932	7812	7808	8779	7749	7714
Damage 3	Mean	304.405	303.433	299.893	321.962	315.021	308.578
	Std. Dev.	(56.262)	(54.262)	(48.549)	(65.338)	(63.863)	(48.691)
	Avg. Observations per year	38780	32056	32036	33603	28191	28056

*Scores range from 100 – 500

Table 1 (continued):

Panel B: 8th Grade Results

		Pre-Hurricane Katrina (Spring 1999 – Summer 2005)			Post-Hurricane Katrina (Fall 2005 – Spring 2010)		
		Math	Science	Social Studies	Math	Science	Social Studies
Damage 1	Mean	310.186	299.142	296.057	320.780	305.293	298.486
	Std. Dev.	(47.765)	(51.118)	(52.412)	(58.656)	(63.917)	(48.714)
	Avg. Observations per year	22312	17659	17638	22561	17812	17675
Damage 2	Mean	319.075	305.342	299.426	326.085	310.228	301.199
	Std. Dev.	(46.210)	(50.996)	(51.971)	(57.861)	(61.575)	(49.340)
	Avg. Observations per year	8610	7104	7095	8771	7013	6966
Damage 3	Mean	303.813	292.424	288.741	320.933	303.551	296.588
	Std. Dev.	(51.343)	(55.662)	(56.627)	(60.132)	(64.363)	(50.717)
	Avg. Observations per year	37841	28168	28119	33376	26035	25819

*Scores range from 100 – 500

Table 2: *Control Variable Percentages across Different Damage-Ranked Regions*

		Pre-Hurricane Katrina (Spring 1999 – Summer 2005)			Post-Hurricane Katrina (Fall 2005 – Spring 2010)		
		Damage 1 Region	Damage 2 Region	Damage 3 Region	Damage 1 Region	Damage 2 Region	Damage 3 Region
Gender	Male	50.66	51.49	50.82	50.30	51.20	50.58
	Female	49.13	48.36	48.89	49.56	48.71	49.22
	Invalid	0.21	0.15	0.29	0.14	0.09	0.19
Ethnicity	White	48.94	61.08	41.78	48.54	59.03	44.31
	Black	48.33	36.71	53.07	48.18	37.74	49.31
	Other	2.73	2.21	5.14	3.29	3.22	6.39
LEP Status	Not Limited	99.58	99.49	98.63	99.32	98.91	97.70
	Limited	0.42	0.51	1.37	0.68	1.09	2.30
Lunch Status	Free/Reduced Lunch	52.70	45.89	54.77	60.32	56.41	62.25
	Paid	47.30	54.11	45.23	39.68	43.59	37.75
Education Classification	Regular Education	88.16	87.06	87.50	89.44	88.52	89.30
	Special Education	11.84	12.94	12.50	10.56	11.48	10.70

Table 3: *Effect of Damages on 4th and 8th Grade CRT Scores*

Panel A: Effect on 4th Grade LEAP Results

	Math	Science	Social Studies
Damage	-4.052	-4.370	-3.076
	(0.072)**	(0.079)**	(0.065)**
R^2	0.0039	0.0048	0.0036
Observations	821853	635620	634113

Panel B: Effect on 4th Grade LEAP Results With Time Trend

	Math	Science	Social Studies
Damage	-3.903	-4.263	-3.007
	(0.071)**	(0.078)**	(0.064)**
R^2	0.0268	0.0158	0.0105
Observations	821853	635620	634113

Panel C: Effect on 4th Grade LEAP Results With Time Trend and Controls

	Math	Science	Social Studies
Damage	-2.383	-2.640	-1.732
	(0.060)**	(0.064)**	(0.057)**
R^2	0.2289	0.2438	0.2184
Observations	817245	632188	631841

** denotes statistical significance on the 5% confidence interval
* denotes statistical significance on the 10% confidence interval

Table 3 (continued):

Panel D: Effect on 8th Grade LEAP Results

	Math	Science	Social Studies
Damage	-2.391	-2.581	-2.674
	(0.066)**	(0.085)**	(0.077)**
R^2	0.0016	0.0016	0.0021
Observations	804911	571848	569386

Panel E: Effect on 8th Grade LEAP Results With Time Trend

	Math	Science	Social Studies
Damage	-2.233	-2.495	-2.620
	(0.066)**	(0.085)**	(0.077)**
R^2	0.0183	0.0095	0.0059
Observations	804911	571848	569386

Panel F: Effect on 8th Grade LEAP Results With Time Trend and Controls

	Math	Science	Social Studies
Damage	-0.934	-1.009	-1.344
	(0.053)**	(0.065)**	(0.068)**
R^2	0.2508	0.2595	0.2187
Observations	797672	566225	565293

** denotes statistical significance on the 5% confidence interval
* denotes statistical significance on the 10% confidence interval

Table 4: *Math LEAP Results*

Panel A: 4th Grade Math Results

	(1)	**(2)**	**(3)**	**(4)**	**(5)**
Damage1*Katrina	16.070	2.620	-5.517	-4.729	-5.986
	(0.227)**	(0.312)**	(0.265)**	(1.846)**	(4.252)
Damage2*Katrina	13.273	-0.286	-6.741	-5.923	1.412
	(0.365)**	(0.424)	(0.359)**	(2.322)**	(3.533)
Damage3*Katrina	17.548	4.185	-4.461	-3.855	-7.728
	(0.182)**	(0.280)**	(0.238)**	(1.652)**	(3.043)**
Time Trend?		Yes	Yes	Yes	Yes
Controls?			Yes	Yes	Yes
Group Fixed Effects?				Yes	Yes
Student Displacement Controls?					Yes
R^2	0.0247	0.0293	0.2299	0.2433	0.2411
Observations	821853	821853	817249	817289	817289

** denotes statistical significance on the 5% confidence interval
* denotes statistical significance on the 10% confidence interval

Table 4 (continued):

Panel B: 8th Grade Math Results

	(1)	**(2)**	**(3)**	**(4)**	**(5)**
Damage1*Katrina	10.603	2.253	-2.667	-2.101	2.323
	(0.210)**	(0.290)**	(0.233)**	(1.520)	(2.836)
Damage2*Katrina	6.965	-1.432	-4.247	-3.533	3.582
	(0.337)**	(0.392)**	(0.316)**	(1.965)*	(1.484)**
Damage3*Katrina	17.123	8.748	2.152	2.531	1.052
	(0.168)**	(0.261)**	(0.210)**	(1.707)	(2.673)
Time Trend?		Yes	Yes	Yes	Yes
Controls?			Yes	Yes	Yes
Group Fixed Effects?				Yes	Yes
Student Displacement Controls?					Yes
R^2	0.0213	0.0234	0.2528	0.2708	0.2698
Observations	804911	804911	797679	797717	797717

** denotes statistical significance on the 5% confidence interval

* denotes statistical significance on the 10% confidence interval

Table 5: *Science LEAP Results*

Panel A: 4th Grade Science Results

	(1)	**(2)**	**(3)**	**(4)**	**(5)**
Damage1*Katrina	6.899	-7.274	-11.016	-10.916	-7.447
	(0.246)**	(0.350)**	(0.285)**	(1.692)**	(3.455)**
Damage2*Katrina	6.339	-7.871	-9.681	-9.712	-3.696
	(0.391)**	(0.464)**	(0.377)**	(1.892)**	(3.291)
Damage3*Katrina	11.579	-2.594	-6.984	-6.984	-2.288
	(0.200)**	(0.320)	(0.260)**	(1.714)**	(2.290)
Time Trend?		Yes	Yes	Yes	Yes
Controls?			Yes	Yes	Yes
Group Fixed Effects?				Yes	Yes
Student Displacement Controls?					Yes
R^2	0.0143	0.0193	0.2461	0.2544	0.2501
Observations	635620	635620	632186	632231	632231

** denotes statistical significance on the 5% confidence interval
* denotes statistical significance on the 10% confidence interval

Table 5 (continued):

Panel B: 8th Grade Science Results

	(1)	**(2)**	**(3)**	**(4)**	**(5)**
Damage1*Katrina	6.144	-4.226	-6.885	-6.830	-0.589
	(0.265)**	(0.376)**	(0.288)**	(1.859)**	(3.011)
Damage2*Katrina	4.874	-5.493	-6.363	-6.282	4.404
	(0.421)**	(0.498)**	(0.381)**	(2.249)**	(1.784)**
Damage3*Katrina	11.128	0.643	-3.287	-3.270	0.221
	(0.215)**	(0.345)*	(0.264)**	(1.824)*	(2.558)
Time Trend?		Yes	Yes	Yes	Yes
Controls?			Yes	Yes	Yes
Group Fixed Effects?				Yes	Yes
Student Displacement Controls?					Yes
R^2	0.0095	0.0121	0.2613	0.2716	0.2706
Observations	571848	571848	566194	566218	566218

** denotes statistical significance on the 5% confidence interval
* denotes statistical significance on the 10% confidence interval

Table 6: *Social Studies LEAP Results*

Panel A: 4th Grade Social Studies Results

	(1)	**(2)**	**(3)**	**(4)**	**(5)**
Damage1*Katrina	6.199	1.053	-1.846	-1.728	-5.460
	(0.202)**	(0.288)**	(0.256)**	(1.606)	(2.689)**
Damage2*Katrina	5.227	0.067	-1.530	-1.501	0.130
	(0.321)**	(0.382)	(0.340)**	(1.809)	(2.083)
Damage3*Katrina	8.682	3.535	-0.070	-0.050	-4.513
	(0.164)**	(0.263)**	(0.234)	(1.570)	(2.281)*
Time Trend?		Yes	Yes	Yes	Yes
Controls?			Yes	Yes	Yes
Group Fixed Effects?				Yes	Yes
Student Displacement Controls?					Yes
R^2	0.0121	0.0131	0.2188	0.2268	0.2256
Observations	634113	634113	631842	631880	631880

** denotes statistical significance on the 5% confidence interval

* denotes statistical significance on the 10% confidence interval

Table 6 (continued):

Panel B: 8th Grade Social Studies Results

	(1)	**(2)**	**(3)**	**(4)**	**(5)**
Damage1*Katrina	2.426	-4.500	-6.660	-6.577	2.307
	(0.240)**	(0.340)**	(0.301)**	(1.871)**	(2.378)
Damage2*Katrina	1.777	-5.149	-6.197	-6.072	4.738
	(0.380)**	(0.450)	(0.398)**	(2.106)**	(1.765)**
Damage3*Katrina	7.843	0.838	-2.678	-2.701	-1.259
	(0.195)**	(0.312)**	(0.276)	(1.840)	(2.195)
Time Trend?		Yes	Yes	Yes	Yes
Controls?			Yes	Yes	Yes
Group Fixed Effects?				Yes	Yes
Student Displacement Controls?					Yes
R^2	0.0065	0.0079	0.2197	0.2311	0.2301
Observations	569386	569386	565278	565293	565293

** denotes statistical significance on the 5% confidence interval
* denotes statistical significance on the 10% confidence interval

Table 7: *Restricted Sample using Student Fixed Effects*

Panel A: Math Student Fixed Effects Results

		(1)	**(2)**	**(3)**
Damage1*Katrina	Coef.	-4.591	-6.371	4.962
	Robust Std.Err.	(0.519)**	(1.132)**	(3.139)
Damage2*Katrina	Coef.	-1.688	-3.460	7.822
	Robust Std.Err.	(0.734)**	(1.256)**	(3.155)**
Damage3*Katrina	Coef.	-0.187	-1.968	9.388
	Robust Std.Err.	(0.659)	(1.211)	(3.124)**
R^2		0.7930	0.7933	0.8040
N		466748	466748	466748
Student Fixed Effects?		Yes	Yes	Yes
Time Trend?			Yes	
Year Fixed Effects?				Yes

** denotes statistical significance on the 5% confidence interval
* denotes statistical significance on the 10% confidence interval

Table 7 (continued):

Panel B: Science Student Fixed Effects Results

		(1)	(2)	(3)
Damage1*Katrina	Coef.	-16.478	-7.404	-24.024
	Robust Std.Err.	(0.556)**	(0.729)**	(1.738)**
Damage2*Katrina	Coef.	-14.987	-5.971	-22.685
	Robust Std.Err.	(1.580)**	(1.609)**	(2.113)**
Damage3*Katrina	Coef.	-11.510	-2.433	-19.103
	Robust Std.Err.	(0.677)**	(0.822)**	(1.829)**
R^2		0.8162	0.8203	0.8218
N		494322	494322	494322
Student Fixed Effects?		Yes	Yes	Yes
Time Trend?			Yes	
Year Fixed Effects?				Yes

** denotes statistical significance on the 5% confidence interval
* denotes statistical significance on the 10% confidence interval

Table 7 (continued):

Panel C: Social Studies Student Fixed Effects Results

		(1)	**(2)**	**(3)**
Damage1*Katrina	Coef.	-11.346	-2.512	-25.207
	Robust Std.Err.	(0.628)**	(0.803)**	(1.507)**
Damage2*Katrina	Coef.	-12.364	-3.586	-26.277
	Robust Std.Err.	(1.160)**	(1.269)**	(1.507)**
Damage3*Katrina	Coef.	-9.826	-0.987	-23.651
	Robust Std.Err.	(0.764)**	(0.904)	(1.588)**
R^2		0.8325	0.8370	0.8388
N		493756	493756	493756
Student Fixed Effects?		Yes	Yes	Yes
Time Trend?			Yes	
Year Fixed Effects?				Yes

** denotes statistical significance on the 5% confidence interval
* denotes statistical significance on the 10% confidence interval

X. Capstone Summary

Hurricane Katrina was one of the most destructive natural disasters to hit the United States, disrupting hundreds of thousands of lives along the Gulf Coast in late August 2005. Many of the evacuees left the region and relocated further north in Louisiana and into other states, including Texas and Alabama. However, those that stayed experienced much distress with the high costs of rebuilding businesses, homes, and even schools. Besides those negative effects, did Katrina bring any positive trends to this region? My Capstone's focus was on one of those potential positive trends that happened after the hurricane: improved educational statistics within New Orleans schools.

My research focused on a city at the focal point of the hurricane destruction, New Orleans, Louisiana. This paper analyzed the impact of Hurricane Katrina on this educational system along with schools with the closest proximity to the path of the hurricane. In particular, the educational statistics examined throughout the paper included standardized test scores across all grade levels and overall school performance scores averaged at the district-level. Within the past few years, positive educational trends have been recorded for New Orleans. While these statistics occur directly following the hurricane, one must wonder what the true correlation with Hurricane Katrina and this data is. Additionally, if New Orleans has experienced changing statistics, it is likely that surrounding districts also have similar results, which is why my project also focused on highly damaged regions and compares them with the districts located furthest away from Hurricane Katrina's path within Louisiana.

To examine these educational statistics, I focused on two levels of observation: district-level and individual-level. Orleans School District consists of all schools within New Orleans. On the district-level, my findings included district averages of School Performance Scores (SPS) across all districts. SPS are a standard system that Louisiana has designed to assess performance ratings for each school within the state, and this performance rating is based on dropout rates, attendance, and students' performance on standardized tests. This level of observation compared sample means before and after Hurricane Katrina. However, following the hurricane, many of Orleans School District's schools were taken over by the Recovery School District (RSD). RSD was created in 2003 for Louisiana to take over the poorest performing schools; RSD was not created because of the hurricane's destruction as the name might suggest. Approximately 75% of Orleans' schools entered RSD following Hurricane Katrina. Since many of the schools that make up RSD were originally from Orleans, I examined both districts' school averages over time to see the effects of Katrina on both school systems.

Most of my methods for estimating the effects of Hurricane Katrina were on the individual-level of observation. The individual-level of observation was used to compare students in the Louisiana educational systems over time, and to do so, I was granted access to a confidential, micro-level dataset that contained student test scores and personal characteristics from Spring 1999 through Spring

2010. Some of the other personal characteristics include gender, district, school, ethnicity, lunch status, and limited English proficiency status. With this dataset, I compared individuals living in different-damaged regions over time. Those damage comparisons were based off sample means for the individuals living within a specific damage region, where I had put the individuals into three different damage rankings of Damage 1-3. Damage 3 represents the highest levels of damage associated with the natural disaster. This damage ranking was organized by FEMA (2006), and it maps out the disaster declarations of people living in Louisiana, where the higher levels of financial assistance correspond to the largest amount of physical damage. The individual-level of comparison allowed me to look at averages across these damage-ranked regions.

Individuals' standardized test scores were also dependent variables in my linear regression models. In other words, I estimated the effects of Hurricane Katrina on standardized test scores by assuming a linear relationship between the two. From there, my estimation strategy used Ordinary Least Squares (OLS) assumptions, and I ran multiple regressions to see the size and direction of the effect. However, many biases appear in my dataset that could affect the true outcome of the effect, which include student displacement after Hurricane Katrina, time trends, and average personal characteristics of students changing across regions. Student displacement is the overall movement of students across regions, and the heavy out-migration of Orleans School District and other Damage 3 schools across other regions could be affecting the other school systems depending on the quality of student leaving. A time trend in this model is the overall increase of standardized test scores over time, which occurs because students tend to score better on standardized tests each year after knowing better ways to prepare for them. Personal characteristics changing refers to the composition of students' characteristics changing across districts, which is due to the out-migration of students. The percentage averages of some characteristics, such as gender, ethnicity, and lunch status, were all changing across the damage regions because of this hurricane. Because of these potential biases, I ran multiple regressions to correct for these effects to get a more accurate picture of the hurricane's effect on Louisiana's educational systems.

When looking at sample means of average standardized test scores and SPS, my research initially concluded the effects of the hurricane on all regions resulted in an overall positive effect of SPS after the hurricane. Also, the Damage 3 region had the largest gains. These findings might suggest that poorer performing students were leaving the most damaged regions and relocating to these less damaged areas, while the best performing students within the damaged districts did not evacuate to other schools.

After further corrections, my findings agreed with that hypothesis. When viewing the school districts' data and allowing the students to migrate as they did in real life, I found that the hurricane had an overall negative effect on test scores for all regions, but Damage 3 experienced the least harm. However, when controlling for student displacement, I found that Damage 3 students experienced the most harm with the largest decreases in scores, which signals that these students were lower-performing and bringing the test score averages down in other regions. This finding would explain the initial findings of Damage 3 having seemingly large gains compared to the other regions because the other regions were getting the in-migration of the lower-performing students.

However, even though my findings conclude that the hurricane had a negative effect on all performances, the observed data of test scores and SPS still has been increasing over time. Something has been making these scores rise over time, and my model suggests that the changing composition of students is largely behind this increase. The possibility of positive effects on education directly related to Hurricane Katrina in these poor performing schools is significant because it suggests that there could be a silver lining to even the worst natural disasters. Many outreach groups focus on policies such as increased federal spending or smaller class sizes that are geared towards improving education in the worst performing schools, yet this hurricane forced students and families to relocate, disrupting the previous school systems, and yet seeing increased trends in the educational attainment measures. In terms of policies, Hurricane Katrina was the driving force behind the changing composition, so future policies should be aimed at targeting this change, and how to incorporate it without a natural disaster.