THE IMPACTS OF PUBLIC-PRIVATE SCHOOL CHOICE ON PUBLIC SCHOOLS IN THE ST. LOUIS AREA

By

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THE IMPACTS OF PUBLIC-PRIVATE SCHOOL

CHOICE ON PUBLIC SCHOOLS IN THE

ST. LOUIS AREA

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Abstract: St. Louis Public Schools was once a thriving school district, leading the way for cities west of the Mississippi, but since 1967 the district has been declining in enrollment and is less than 1/4th of its peak size (Feldmann and Watson 2012). This thesis has two main research questions: the first is how policy changes have affected enrollment and segregation of St. Louis area schools from 1991 to 2017. The second is how segregation and enrollment have impacted school district achievement. The primary study area includes St. Louis City Public Schools, which is located in St. Louis City County, and the more than twenty suburban public school districts surrounding the city. For the first research question, I used temporal GIS to see if segregation has increased in St. Louis area school districts from 1991 to 2017, and to see when inner-city school districts started losing enrollment to private, charter, or surrounding suburban schools. Then, using historical and political context, I explored how desegregation and school-choice efforts have affected enrollment and segregation. I found that the amount of segregated school districts increased from 63% of school districts in 1991 to 91% in 2017. Furthermore, non-segregated school districts lost enrollment from 1991 to 2017. For the second research question, I used geographically weighted regression of Missouri school districts to analyze the impact of district indicators—including enrollment and racial demographics—on student achievement. I found that enrollment had a positive correlation with school district achievement, and segregation had a negative correlation with school district achievement for school districts with a greater percentage of minorities. This thesis provides a comprehensive display of the changes in enrollment over time alongside the historical context, in order to provide a better understanding of the impacts of policy changes and school choice on St. Louis schools.

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CHAPTER I

INTRODUCTION

A. GENERAL FOCUS AND SIGNIFICANCE

St. Louis, Missouri, was once known for its thriving public school system; however, since its peak enrollment of 110,000 in 1967, enrollment within St. Louis Public Schools (SLPS) has declined by approximately 80% (Feldmann and Watson 2012). Figure 1 shows that this decline in enrollment was still an issue for St. Louis City School District from 1991 to 2017.

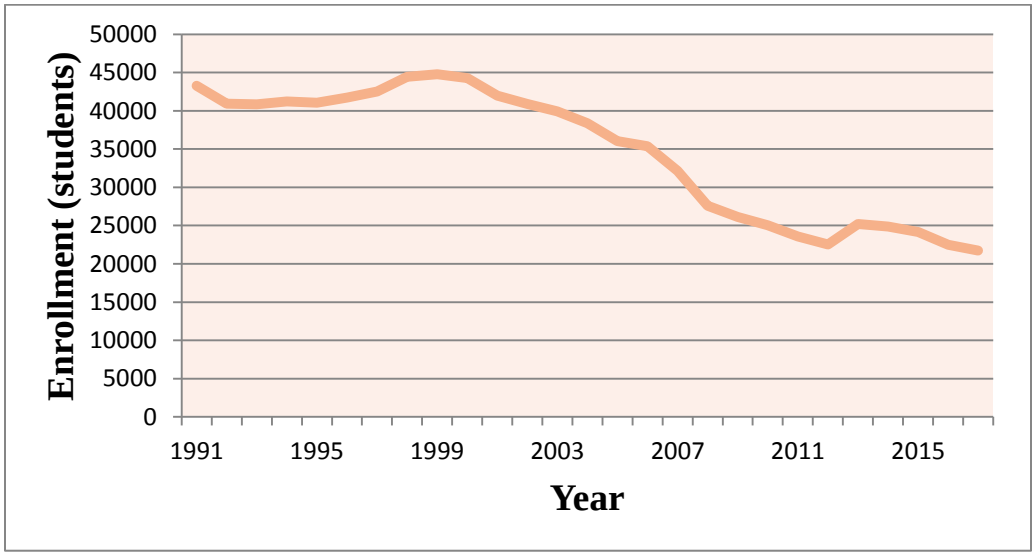

Figure 1: Enrollment in St. Louis City School District from 1991 – 2017

Along with declining enrollment, student performance on standardized tests has declined and the district's debt has increased. I became personally interested in exploring why public school enrollment in St. Louis has declined after working for a tutoring company in the city. I noticed that my students either attended private schools or public schools located in the suburbs of St. Louis—none attended SLPS. Furthermore, many people that I knew outside of my tutoring job sent their students to private schools or moved to suburbs—whether or not they could afford to do so. I also became interested in exploring how segregation may have changed alongside enrollment after noticing the racial segregation of neighborhoods in St. Louis.

I plan on living in St. Louis after earning my master's degree, but, like others who I knew from tutoring, I am unhappy with the education options there. With this thesis, I hope to better understand why so many people who cannot afford to, end up sending their children to private schools or moving to the suburbs, and how this impacts children who stay in SLPS. The purpose of this thesis is to investigate the impacts of historical and political changes on public schools, and to visualize these changes with maps. The school options in the St. Louis area seem inadequate compared to the educational opportunities that I received in a smaller metropolitan area; thus, I would like to understand spatial variations in education achievement. As more education data becomes available, I believe that geographical visualization of data, as well as geographically weighted regression, can assist policymakers. And, with the rise of critical geographies of education, I think that research about SLPS and similar school districts in large, metropolitan areas will grow.

Like Marlow (2010), I use quantitative analyses to look at the influence of private, charter, and suburban schools on public school performance and enrollment. Similar to Le et al. (2016) and Schultz (2014), I analyze data about public school enrollment and public high school standardized test scores. In my analysis, I use critical analyses to investigate the response of the media to

education policy changes in St. Louis (Grooms 2016; Jones 2008). Furthermore, I will use ArcGIS Pro to create all of the maps included.

B. RESEARCH QUESTIONS

My two main research questions and their sub-questions are:

1. How has policy change impacted enrollment and segregation of St. Louis area schools from 1991 to 2017?
    a. Has segregation increased in St. Louis City and County school districts from 1991 to 2017?
    b. When did inner-city school districts start losing enrollment numbers to private, charter, or surrounding suburban schools?
    c. How have desegregation and school-choice efforts affected enrollment and segregation?
2. How do segregation and enrollment affect school district achievement?
    a. How well does a regression equation predict student achievement based on indicators like racial demographics and enrollment?
    b. Does geographically weighted regression do a better job predicting achievement?

In order to gain insight into why SLPS began losing enrollment numbers to the surrounding suburbs and private schools, I will be placing the enrollment and achievement of SLPS in the context of significant historical and political changes to the country, state, and city since the beginning of desegregation. Some of the federal policy changes that I will discuss include the 1954 Brown v. Board of Education case, the Federal-Aid Highway Act of 1956, and the Elementary and Secondary Education Act of 1965, as well as more recent changes such as the 2001 No Child Left Behind Act, and its 2015 replacement: Every Student Succeeds Act

(Clotfelter 2004; Feldmann and Watson 2012). Some of the Missouri policy changes that I will account for include: the 1968 Spainhower Commission, the 1987 Liddell v. Board of Education case, and the resulting Voluntary Transfer Program (Gardner and Rury 2013, Goodwin 2013; Grooms 2016; Tate et al. 2014). Lastly, the school district policy changes that I will include are the various state takeovers, and the Alvarez and Marsal takeover (Jones 2005, Feldmann and Watson 2012, Rogers 2012).

C. STUDY BOUNDARIES

Figure 2 shows24 total school districts in the study area including St. Louis City School District and the 23 surrounding school districts within St. Louis County. It is important to note that one of the school districts in St. Louis County, Wellston School District, closed and merged with Normandy Schools Collaborative in 2010; therefore, after 2010, there were 22 school districts within St. Louis County—and 23 total, including St. Louis City School District. For the second research question, I will focus on the same study area; however, in order to create regression equations, I will use data from school districts throughout the state of Missouri.

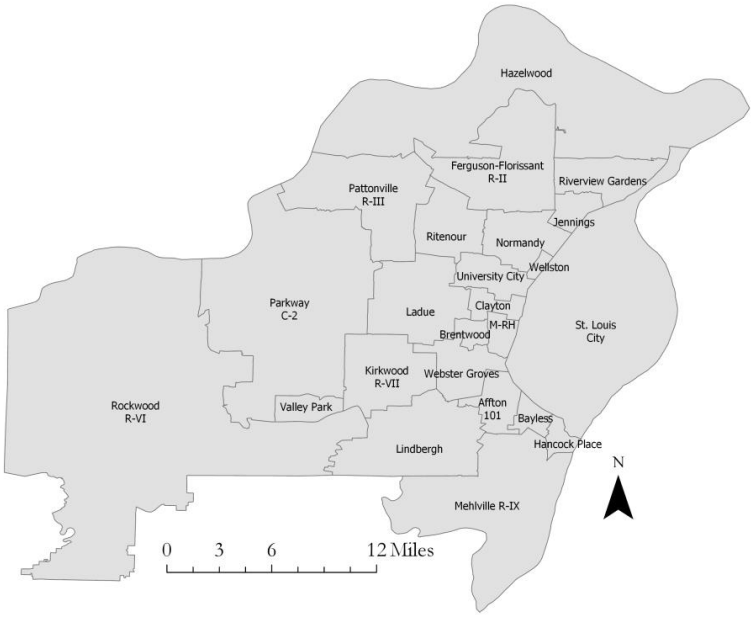

Figure 2: School Districts in St. Louis County and St. Louis City County

D. TERMS

The legal definition of **segregation** changes by court. In Liddell v. City of St. Louis, the Court of Appeals found that "a school with a black enrollment between 30 and 50 percent shall be considered to be integrated" (Liddell v. City of St. Louis 1980). In this thesis, I will consider a school district is segregated if it has a black enrollment lower than 25 or higher than 50 percent. I chose to expand the range of black enrollment percent in order to account for the current racial demographics of the population in St. Louis City and County: approximately 25 percent of St. Louis County residents are black, while 47 percent of St. Louis City County residents are black.

Re-segregation refers to the increasing segregation of school districts after desegregation efforts and policies have been implemented.

School takeovers vary by state, but usually occur when a school district loses accreditation for a variety of reasons—such as low test scores, graduation rates, and attendance—and a state appoints a board to take over the school district. Sometimes preventative takeovers occur before school districts lose accreditation, and sometimes school districts remain under a takeover after regaining accreditation.

Charter schools are public schools that have created a contract—called a charter—that allows them to receive public funds; furthermore, charters are known for having fewer regulations than traditional public schools (Bratberg et al. 2007; Foreman 2017; Henderson 2015).

Magnet schools are also public schools that provide students with a specific type of curriculum or specialty; students may be allowed to attend magnet schools in other districts based on the school district and state government (Grooms and Williams 2015).

I will refer to **suburban schools** throughout this study. What I mean by suburban school is any school in the St. Louis Metropolitan area that does not fall inside of the SLPS district—or the St. Louis City County (Johnson 2006).

E. EXPECTED RESULTS

For the first research question, I expect to see that St. Louis area school districts will show a decline in enrollment for school districts with higher percentage of black enrollment, and that have experienced an increase in segregation since 1991. I expect to see that segregation increases with school choice efforts.

For the second research question, I suspect that segregation is negatively correlated with school district achievement, and that geographically weighted regression (GWR) will be a better fit for

predicting achievement, as it will account for the spatial variations that would be unaccounted for in an ordinary least squares (OLS) regression.

CHAPTER II

REVIEW OF LITERATURE

Similar to many large metropolitan cities in the United States, there is a notable discrepancy between the racial demographics of public, inner-city high schools in St. Louis and the private or public suburban schools in the surrounding area. This phenomenon appears to be a re-segregation of schools. In this literature review, I discuss the study of public-private school choice alongside the history of school segregation. This is important in order to piece together the potential causes of re-segregation.

A. PUBLIC-PRIVATE SCHOOL CHOICE

School choice is a politicized issue in today's world. I worked in the Arkansas Lieutenant Governor's office in the spring semester of 2015, at which time some constituents were growing tired of federally standardized education, and calling for more school choice. This section will briefly explain the inspiration for school choice, the types of choice, and common arguments for and against choice.

The first widespread call for school choice is often cited as the 1955 chapter "the role of government in education" by Milton Friedman. Friedman cited the need for more competition

among types of educational entities and believed that school choice was unable to take place if the government only offers free, federally-regulated schools (Friedman 1955, 14). He claimed that the government should provide subsidies for families to choose from any type of school—including private, for-profit schools (Friedman 1955, 14).

It is important to explore some of the school choice options. Charter schools are free, public schools that any students within a school district can choose to attend (Bratberg et al. 2007, 2). Similar to traditional public schools, busing is usually provided to students. The difference between charter schools and regular, public schools is that charter schools have a charter with the government that allows them access to public funds as long as there are "terms under which the school can be held accountable for improving student performance and achieving goals" (Bratberg et al. 2007, 1-2). This sounds similar to federally-regulated public schools; however, charters have fewer regulations than public schools due to the nature of the charter (Bratberg et al. 2007, 2). Charter schools have only had a presence in St. Louis Public Schools in recent years. In 1998, Missouri passed legislation that allowed an unlimited number of charter schools to be built in cities with populations larger than 350,000 people (Bratberg et al. 2007, 2). This significantly increased the number of charter schools in Kansas City and in St. Louis. Lastly, it is important to note that the Missouri Department of Elementary and Secondary Education does not supervise charter schools as it does regular, public schools; each charter school is supervised by its sponsor (Bratberg et al. 2007, 2). In general, charter schools have no statistically significant impact on student achievement relative to traditional public schools (Bratberg et al. 2007, 8; Clark et al. 2015, 429).

Compared to charter schools, magnet schools are not talked about as much in recent news; however, they are more common and have been around longer than charter schools (Grooms and Williams 2015, 455). Magnet schools were created in the 1970s, in an effort to integrate public schools and reduce the need for forced busing; furthermore, magnet schools have academic

specialties designed to appeal to both urban black students and suburban white students (Grooms and Williams 2015, 455). In St. Louis, Grooms and Williams found that magnet schools are becoming more racially segregated—black student enrollment is over 50% and increasing—and are having little to no impact on student achievement relative to traditional public schools (Grooms and Williams 2015, 468-469).

Voucher transfer programs are generally city-wide programs that allow inner-city black students to attend surrounding suburban schools; likewise, they may be a "dual transfer program," in which case white suburban students are eligible to attend inner-city public schools (Grooms 2016, 1). In St. Louis, for example, inner-city black students are bused in to suburban schools like Kirkwood or Ladue, which are known for having higher academic achievement and significantly higher percentages of white students (Johnson 2006, 49, 56).

Another school choice option is private schools. Private schools have been around for a long time, but private enrollment in metropolitan areas, like St. Louis, is disproportionately higher than average. I saw, first hand, that many parents in St. Louis work multiple jobs just to pay for their students' private education. Private schools, unlike public choice schools, have tuition and, thus, usually have lower enrollment and more homogenous enrollment (Clotfelter 2004, 101). There have been studies done in California—due to publicly-available data on private school enrollment—that have shown that "public school test scores are inversely related to private enrollments thus supporting the view that private enrollments partly reflect exiting from public schools due to poor academic performance" (Marlow 2010, 20).

One issue often discussed with school choice is the availability of qualified teachers. Schools increasingly have to rely on teachers with emergency certifications, or they turn to alternatives such as Teach for America (TFA), when they do not have enough properly certified teachers. This occurs among all types of schools—traditional public, charter, magnet, and private schools.

While I did not teach with an emergency certification, I worked alongside emergency certified teachers at a traditional public school in an AmeriCorps program called City Year, and I know several people who taught with emergency certifications at charter schools through TFA. While TFA is highly regarded as an enriching program for corps members, many traditionally certified teachers see TFA "as an instrument…to displace local, traditionally trained teachers" (Henderson 2015, 76). However, many studies have shown that teacher certification is not related to student achievement (Hanushek 2011, 468). Furthermore, Schultz found that the distribution of highly qualified teachers, traditionally certified teachers, and teachers with advanced degrees is particularly low in schools that have higher percentages of black students and poverty-stricken students (Schultz 2014, 17). Thus parents may choose to remove their students from schools with lower quality teachers, which could lead to higher rates of segregation.

While most of the literature that I could find spoke of the negative effects of school choice on public schools, some proponents of school choice challenge this notion. Hoxby notes that the term "cream skimming"—which refers to the notion that school choice skims the best students from public schools—does not apply to recently-created school choice schools (Hoxby 2001, 141). Furthermore, Hoxby goes on to suggest that public schools improve achievement in the face of competition that would not be there without school choice (Hoxby 2001, 177). Foreman suggests that there are statistics that portray school choice in the best light—as opposed to test scores or standardized methods of assessment—including high school completion, college enrollment, and college persistence (Foreman 2017, 642). It is important to note that many studies (Marlow 2010, Bratberg et al. 2007, Clark et al. 2015) contain information contradictory to Hoxby and Foreman.

B. HISTORY OF SCHOOL SEGREGATION

St. Louis has an important role in the US history of school segregation, alongside other metropolitan areas. This section will look at the history of SLPS, then discuss segregation laws, mass migration, re-segregation of schools, and, lastly, the privatization of public education.

St. Louis was once a place lauded for its education. St. Louis opened "the first public school for secondary education west of the Mississippi river" in 1853, and the first publicly-funded kindergarten in the US in 1873 (Feldmann and Watson 2012, 556). Furthermore, the first high school for black students west of the Mississippi river—Sumner High School—was opened in St. Louis in 1875 (Feldmann and Watson, 556). For the next century, St. Louis Public Schools continued to grow, reaching the peak enrollment of 110,000 students in 1967 (Feldmann and Watson 2012, 556). However, since 1967, SLPS enrollment dropped to 43,000 in 1991, and to 22,000 as of 2017 (Feldmann and Watson 2012, 556).

1. SEGREGATION LAWS

In the 1896 case Plessy v. Ferguson, the Supreme Court of the United States found that segregation that is "separate but equal" is constitutional (Canup 2015, 1). This case justified the use of separate public restrooms and water fountains, restaurants and entertainment, and public schools (Canup 2015, 1). Plessy v. Ferguson was overturned in 1954 with the Supreme Court case of Brown v. Board of Education of Topeka (Canup 2015, 1). Brown v. Board made state-sanctioned segregation of public schools unconstitutional (Canup 2015, 1). Brown did not mandate how or when schools needed to desegregate; also, it did not address if it was unconstitutional for schools to be racially segregated by "de facto segregation"—which is when school segregation is caused by residential segregation instead of state laws (Clotfelter 2004, 3). Thus, many states and local governments interpreted Brown v. Board individually.

In Brown II—following the original Brown v. Board decision—the Supreme Court mandated that lower federal courts must order integration; thus, from 1955 to 1960, lower federal courts held hundreds of school desegregation hearings (Southern Poverty Law Center 2004). This court-ordered integration was met by opposition from many southern legislators, who called for school closures in response to integration orders; furthermore, many states did not comply with the court-ordered integration due to fear of "social unrest or violence" (Southern Poverty Law Center 2004). However, in Cooper v. Aaron, the Supreme Court ruled that that states must comply with Brown v. Board even in the face of violent opposition (Southern Poverty Law Center 2004). Federal courts had authority to order desegregation plans until 1995, when the Supreme Court ruled in Missouri v. Jenkins that desegregation plans should return to local control (Southern Poverty Law Center 2004). Lastly, in 2007, the Supreme Court ruled that voluntary school integration plans were unconstitutional, so many voluntary integration plans ended (Southern Poverty Law Center 2004).

2. MIGRATIONS

A few documented mass migrations have changed the racial makeup of St. Louis and other cities across the US. The Second Great Migration, from World War II to the 1970s, featured rural black families in the South moving to urban areas outside of the South (Canup 2015, 12). This directly changed the racial composition of southern towns, and increased the black population in cities like St. Louis (Canup 2015, 12). It is important to note that this happened around the same time that Brown v. Board was decided and solutions were implemented at the state level. If black populations increased in cities such as St. Louis, enrollment numbers in public schools should have increased around this time. This may explain why 1967 was the year that public school enrollment peaked in SLPS (Feldmann and Watson 2012, 556).

White flight is a commonly referenced migration pattern that changed urban demographics, including school enrollment. "Declining white enrollment was common to many large desegregating school districts during the period of large-scale desegregation orders;" many wonder if white flight was a direct reaction to desegregation, or if it was attributable to other factors associated with "urban decline" (Clotfelter 2004, 75). In general, people moved outside of the central city at increasing rates between 1950 and 1970; furthermore, it was around the same time that the 1956 Interstate Highway Act, and the improvement of highways, led to suburban growth (Clotfelter 2004, 77). The effects of the Second Great Migration and white flight were seen in urban school enrollment: the black student population increased as the white student population decreased. Furthermore, it is noted that suburban school enrollment increased in areas where there were more school districts, but in areas with less public school choice, it was more common for families to choose private schools (Clotfelter 2004, 108). While the timeframe of this thesis is considerably later than the timeframe commonly associated with white flight, some of the same migration patterns may be at work.

3. RE-SEGREGATION

Missouri schools encountered significant policy changes after Brown v. Board. In 1968, the Spainhower Commission was formed with the goal of increasing the size of school districts throughout the state (Gardner and Rury 2013, 125). Theoretically, an increase in the size of school districts reduces inequality due to segregation; furthermore, there is more centralized concentration of power for the state (Gardner and Rury 2013, 125). Thus, it is arguable that school district size is a partisan issue. Suburban and rural communities strongly opposed this commission, and their opposition "was [often] expressed in racial terms" (Gardner and Rury 2013, 125). St. Louis area school districts met to work together after formation of the

commission, and ended up having to deal with court-ordered desegregation cases (Gardner and Rury 2013, 141). The commission likely started important conversations that helped the St. Louis school administrators find solutions to segregation problems (Gardner and Rury 2013, 141).This was necessary, because in 1979, St. Louis City School District and Missouri were held responsible for the sustained segregation that happened in inner-city schools; both the school district and the state were ordered to desegregate schools (Goodwin 2013, 11).

There have been court cases dealing with the methods that St. Louis and Missouri chose for desegregation—namely the student transfer program. In Turner v. Clayton, Clayton School District—a wealthy, suburban school district just outside of the inner-city—did not want to accept any transfer students from SLPS and did not want to pay for their tuition (Gardner and Rury 2013, 126). Clayton School District is a public school district; however, since transfer students do not live within the school district, Clayton School District does not receive funding to cover the students' tuition. Previously, Clayton School District would have been required to accept the student and pay for their tuition. In 2012, St. Louis Circuit Court decided that Clayton did not have to accept any students and that the unaccredited district—in this case, SLPS—must pay for the tuition of transfer students (Gardner and Rury 2013, 126). This case is very similar to a ruling that exempted certain suburban schools near Kansas City from the inter-district transfer program (Gardner and Rury 2013, 125-6). It is important to note that the cases were appealed to the Supreme Court of Missouri and the state disagreed with both of the circuit courts' rulings (Gardner and Rury 2013, 126). However, after remanding Turner v. Clayton, the lower court ruled that Clayton School District had a right to decline admittance to these students and that SLPS must pay for tuition fees for any transfer students (Turner v. Clayton 2010). This ruling placed unaccredited schools in a financially dangerous position; after losing accreditation, an increase in student transfers could happen, leading to an increase in funds spent on the transportation of those transfer students out of the district.

4. PRIVATIZATION OF PUBLIC EDUCATION

St. Louis Public Schools made history when it became the first school district taken over by a corporate takeover firm in April of 2003 (Jones 2005, 7; Jones 2007, 191). The corporate takeover firm Alvarez and Marsal was given $5 million and responsibility to name a superintendent who was to have total academic, political, and financial control of the school district (Jones 2005, 7; Jones 2007, 191). Alvarez and Marsal are known for working with companies like Arthur Andersen, the accounting firm for Enron Corporation, and the Lehman Brothers during their demises. Unlike a state-appointed board takeover, this corporate takeover was not handled by education policymakers. Instead, this placed St. Louis City School District in the hands of a corporate takeover firm. This event is an example of the privatization of public education.

The corporation saved the school district $64 million; however, many questioned if its work ended up helping or hurting St. Louis Public Schools (Feldmann and Watson 2012, 557). "Within a four-week period, the interim superintendent shut down sixteen schools and laid off more than 2,000 school personnel, including teachers, maintenance, security, and food service staff" (Jones 2005, 7). The effects of the corporate takeover were detrimental (Strauss 2017). After the takeover, many of St. Louis City's historic public school buildings were listed for sale, like the historic Cleveland High School seen in Figure 3 (Strauss 2017). Furthermore, St. Louis School District "was two points away from regaining full accreditation…[but] the district fell 25 points down the accreditation ladder and was two points away from becoming fully unaccredited" (Jones 2008, 326). The corporate takeover was intended to improve conditions, but the school district was quickly taken over by a special administrative board (SAB) in 2007 (Rogers 2012, 911). While the corporate takeover was ultimately unsuccessfully, St. Louis schools have tried a variety of approaches to solving school district issues.

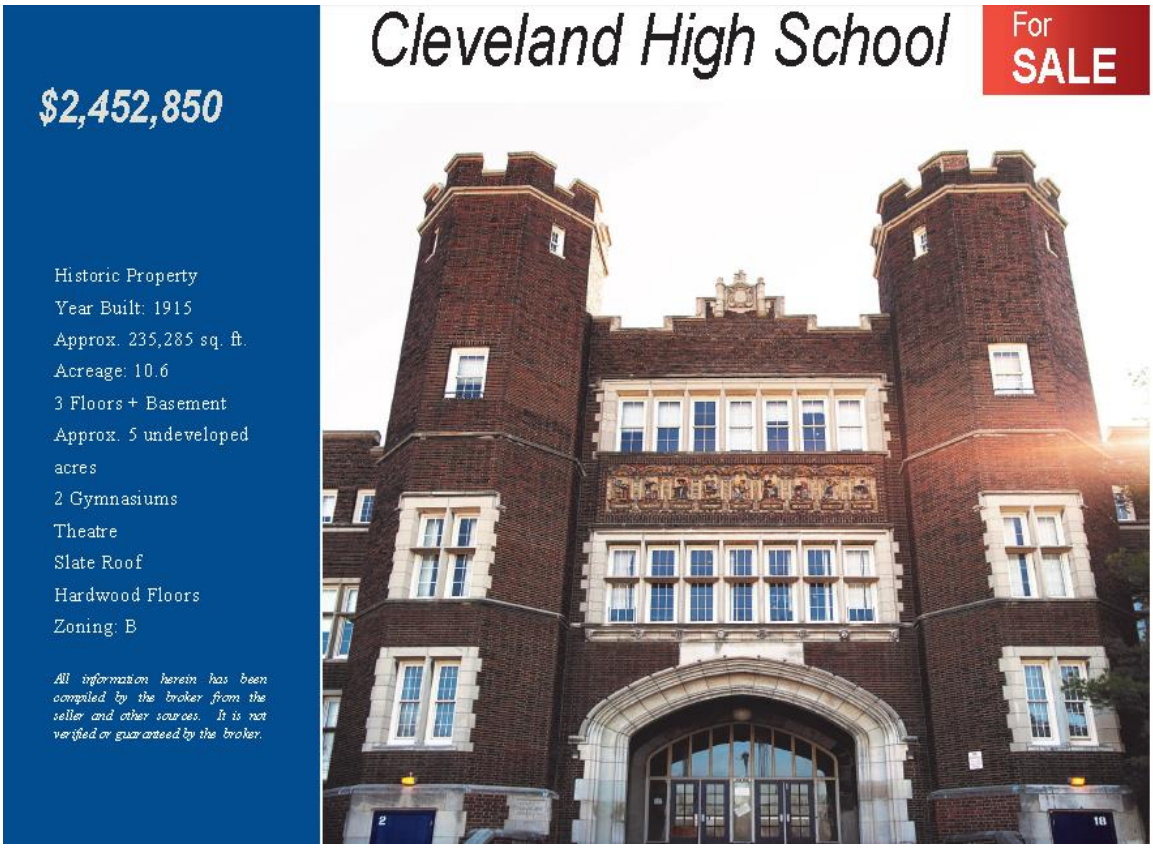

Figure 3: Cleveland High School Brochure (https://www.slps.org/Page/27265)

I will use the information from this chapter to analyze the changes in segregation and enrollment that I find from the dataset. The availability of school choice in the St. Louis area may have impacted student enrollment. Furthermore, desegregation policies may have caused further segregation. In my analysis, I will use the results from the dataset, alongside information from this chapter to uncover the potential impact of school choice and desegregation efforts on enrollment and segregation in St. Louis.

CHAPTER III

DATA AND METHODOLOGY

Since this thesis investigates the impacts of public-private school choice policies, I used data from 1991 to 2017 to compare enrollment and segregation changes following policy changes. To make these comparisons, I displayed the data year by year in a method called temporal GIS. I used regression of data from 2017 to investigate the impacts of enrollment and segregation changes on school district achievement. In this chapter, I discuss the data and methods for each of my research questions.

A. TEMPORAL GIS: DISTRICT ENROLLMENT AND SEGREGATION

1. DATA

This section describes the data and methods used to address research question one:

> How has policy change impacted enrollment and segregation of St. Louis area schools from 1991 to 2017?
>
> a. Has segregation increased in St. Louis City and County school districts from 1991 to 2017?
> b. When did inner-city school districts start losing enrollment numbers to private, charter, or surrounding suburban schools?

c. How have desegregation and school-choice efforts affected enrollment and segregation?

The data that I used to explore enrollment and segregation of St. Louis area public schools comes from the Missouri Department of Elementary and Secondary Education (MDESE) for the years 1991 through 2017 (MDESE 2018). This data was joined to TIGER shapefiles for Missouri unified school districts, available from the Missouri Spatial Data Information Service (MSDIS) Open Data Site (MSDIS Open Data Site 2018).

In order to assess if segregation has increased in St. Louis City and County school districts from 1991 to 2017, I used percent black within the student population. This variable measures the amount of students enrolled in the school district who identify as black and is created by dividing the black student population by the total number of enrolled students in the school district.

In order to approach the second sub-question about enrollment from 1991 to 2017, I used the enrollment of each school district—provided by MDESE—and normalized the data by the population of 5 to 18-year-olds residing in the school district. This variable measures the yearly percent of school-aged population enrolled in public schools. I found American Community Survey (ACS) yearly estimates for census population of 5 to 18-year-olds by school district for years 2009 through 2017. I then found 1990 and 2000 census population estimates by school district at https://census.missouri.edu/census2000/trends/. Since ACS yearly estimates did not exist during this time, I used the 1990 and 2000 estimates, and assumed a linear trend between the years to estimate the population of 5 to 18-year-olds from 1991 to 1999. I also used the 2000 and 2009 estimates, and assumed a linear trend between the years to estimate the population of 5 to 18-year-olds from 2001 to 2008.

Lastly, to approach the third sub-question about the impact of desegregation and school-choice efforts, I used a timeline of events created from the literature review of this study in order to

analyze the changes in enrollment and racial demographics in the context of desegregation and school-choice policies.

2. VISUALIZATION

In order to address the first research question, I created choropleth maps in ArcGIS Pro for each year from 1991 to 2017, to portray the percent of black students, and the percent of 5 to 18-year-olds enrolled in public schools. In order to show this temporal GIS data effectively, I created animations for each of the variables.

Based on the legal definition of segregation in the St. Louis area and on population demographics, I considered a school district as being segregated if it has a black enrollment lower than 25 or higher than 50 percent. I assumed that school district segregation has increased in the St. Louis area if the number of segregated school districts has increased.

B. GEOGRAPHICALLY WEIGHTED REGRESSION: SCHOOL DISTRICT ACHIEVEMENT

1. DATA

This section describes the data and methods used to address research question two:

How do segregation and enrollment affect school district achievement?

a. How well does a regression equation predict student achievement based on several indicators including racial demographics and enrollment?
b. Is geographically weighted regression a better fit for predicting the achievement indicator?

The dataset used for this question includes statistics about school districts from the entire state of Missouri in the 2016 – 2017 school year and comes from multiple reports published by the MDESE. This data was joined to a TIGER shapefile for Missouri unified school districts, available from the Missouri Spatial Data Information Service Open Data Site. It is important to note that I only used data from the 423 public school districts that reported all of the statistics featured in this study, as shown in Figure 4. It is also important to note that MDESE considers charter schools to be independent school districts outside of the public school district in which the charter is physically located; this makes sense due to the fact that charter schools operate independently of the school districts, and due to the lack of requirement for charter schools to report many of the statistics that traditional public schools—including magnet schools within each district—are required to provide. During the 2016 – 2017 school year, there were 562 total school districts in Missouri; however, many of these school districts were charter schools located within Kansas City or St. Louis City School Districts, and others were traditional public schools that did not report at least one of the variables that I chose to include in this study—specifically the ACT composite score, Total Adjusted Operating Tax Rate, and Local Tax Effort per Average Daily Attendance (ADA).

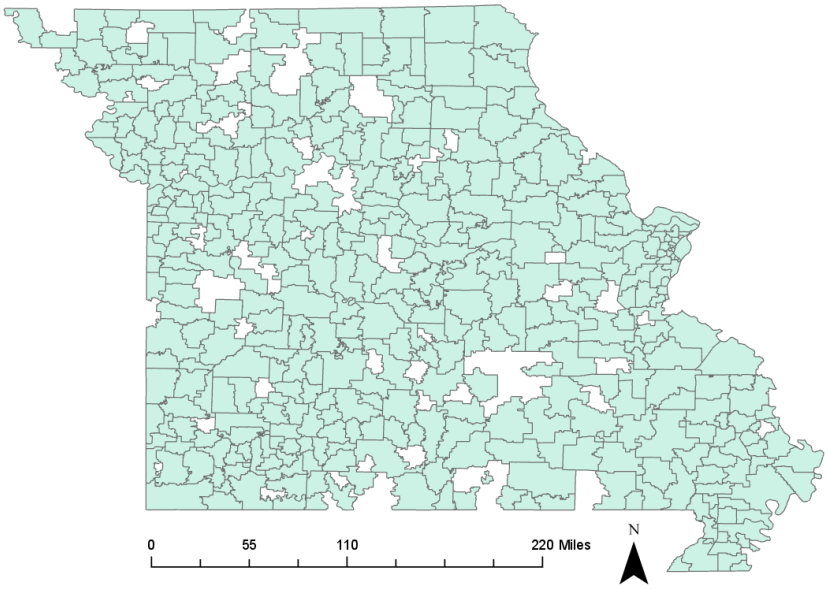

Figure 4: Missouri School Districts Included in this Study

I started this study with fourteen total variables in this dataset—which included two ID variables, one dependent variable, and eleven independent variables—but I omitted three of my original independent variables due to multicollinearity and insignificance in my regression models (Discipline Rate, Assessed Valuation (in $ million), and Percent Local (or the percent of funding that comes from local taxes)). My final dataset included eleven total variables: two ID variables, one dependent variable, and eight independent variables. The independent variables can be organized into three categories: student demographics (the first three independent variables), student behavior (the fourth independent variable), and district funding (the last four independent variables). Table 1 includes all of the variables (ID, independent (I), and dependent (D)):

Variable type:	Field:	Data:
ID	District_Code	Unique code for each school district
ID	District	School district name
D	ACT_Score	Average ACT composite score for each district
I	Enrollment	Total enrollment for grades K-12 in each district
I	White_Pct	Percent of students enrolled in district that identify as white
I	IEP_Rate	Percent of Students with Individualized Education Programs (special education)
I	Attend_Rate	Proportional attendance total percent
I	Pct_State	Percent of funding that come from state taxes
I	Adj_Op_Tax_Rate	Total adjusted operating tax rate
I	Local_Tax_Eff_per_ADA	Local tax effort per Average Daily Attendance
I	Unr_End_Bal_Pct	Unrestricted Ending Balance percent

Table 1: Variables for Student Achievement Regression

ID variables

My two ID variables are District_Code and District, which I used when joining the dataset with the shapefile in ArcGIS Pro. District is the district name. I changed the format of the district names in order to match the names in the shapefile.

Dependent variable

I selected ACT_Score as the dependent variable for this study. This data comes from the MDESE's report, which includes average ACT scores for each district by each section and by the composite score. Many school districts only reported composite scores, so I chose to only use the average composite score for the dependent variable. The ACT is one of the most dominant college-entrance exams in the United States, and is scored out of 36 points. It is important to note that both of the most dominant college-entrance exams—the SAT and the ACT—give an unfair advantage to white male test-takers from more affluent backgrounds; however, the creators of both exams have attempted to correct this bias, and the racial gap in test scores is smaller in recent years (FairTest 2007; Reeves and Halikias 2017). I am using ACT scores instead of Missouri's state-mandated standardized test scores, because the ACT is nationally known, and because I could not find information about potential biases in Missouri's state-mandated tests. In the figure below, there seems to be a trend of higher ACT scores around large towns or in suburban areas surrounding large cities.

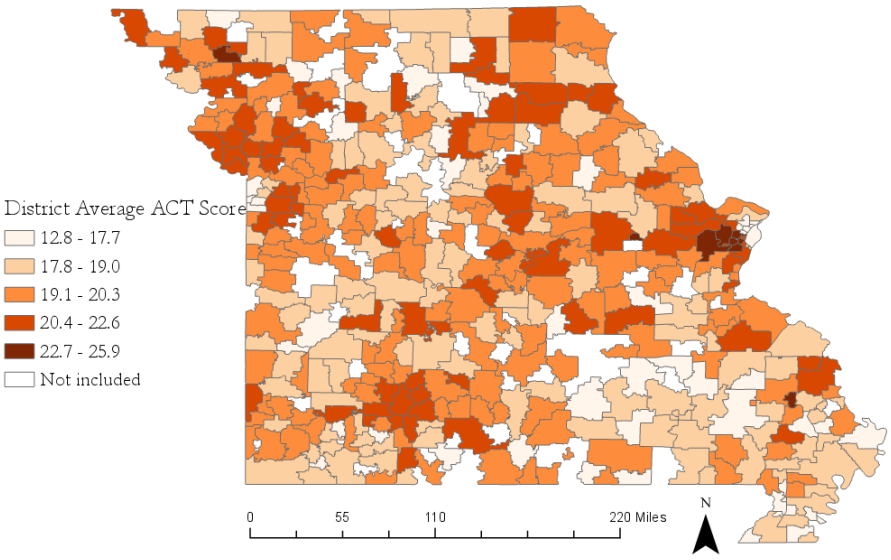

Figure 5: Average ACT Composite Score by school district.

Independent variables

Student demographics

I selected Enrollment as one independent variable in order to account for the size of the school district. This variable is the total enrollment for kindergarten through 12th grade in each school district. I chose not to normalize this variable in order to show the impact of district size on ACT scores.

I selected White_Pct as another independent variable in order to account for the racial makeup of the school district. This variable is the percent of students enrolled that identify as white, ranging from 0.44 to 100 percent.

Lastly, I selected IEP_Rate as an independent variable in order to account for the rate of special education in each school district. IEPs—or Individualized Education Programs—are created for students who are eligible to receive special education. This rate is the percent of total students that have an IEP, ranging from approximately 5 to 24 percent.

Student behavior

I selected Attend_Pct as an independent variable to account for student attendance in predicting average ACT score. This variable is the proportional attendance total percent, or the average percent of students attending school, ranging from approximately 73 to 99 percent.

District funding

I selected Pct_State to account for the amount of funding received from state taxes (as opposed to federal or local). This statistic is particularly interesting for Missouri schools, as they typically receive a smaller percent of their total funding from the state, compared to other states. This can be seen in Figure 6. Furthermore, Missouri legislators are currently attempting to raise state funding in order to increase their relatively low expenditure per ADA to meet rates that are more

common across the US (Taketa 2017). Since wealthier districts have higher property taxes per student, they likely have higher percentage of funding from local taxes; thus, these wealthier school districts will likely have lower percentage of funding that comes from state taxes. This variable is in percent format, ranging from approximately 2 to 60 percent.

I selected Adj_Op_Tax_Rate in order to account for the tax rate of the school district. This is the total adjusted operating tax rate. Some school districts have higher tax rates than others, depending on policy decisions.

Local_Tax_Eff_per_ADA is the local tax effort per ADA, and I selected this variable to account for the local funding per average daily attendance. It is notable that MDESE uses ADA in this calculation instead of enrollment; this might be caused by bias in order to increase the appearance of funding for inner-city schools, which tend to have lower attendance rates. This variable is in US dollars.

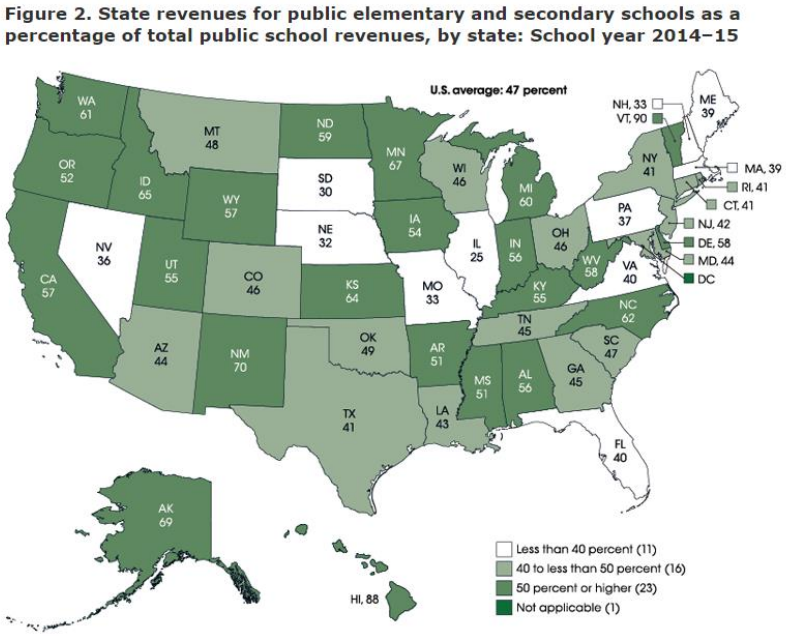

Figure 6: Percent of School District Funding by State (Institute of Education Sciences 2018)

Lastly, I chose to include Unr_End_Bal_PCT—the unrestricted ending balance percent—in order to account for the financial security of each school district. This variable is the unrestricted fund balance divided by the total expenditure of the school district; some school districts have a larger balance than expenditure, so values range from approximately 1 to 130 percent. A higher unrestricted ending balance percent indicates that a school district is spending a smaller amount of their fund balance each year; likewise, if school districts are spending a much larger amount of money per year than they have in their ending balance, they will have a lower unrestricted ending balance percent.

2. REGRESSION AND VISUALIZATION

In my first research question, I explored how enrollment and segregation have changed; in my second research question, I explored how these changes affect school achievement. Since I am using data from the MDESE, I selected variables from their datasets to best portray school achievement of school districts and other variables—in addition to the enrollment and segregation data—that may affect school achievement. I decided to use ACT scores for the school achievement indicator. In order to explore the effect that enrollment, segregation, and other variables have on ACT scores, I compared different regression models—including a GWR model. I decided to use GWR because it accounts for spatial variation, while conventional OLS regression does not (Sultana et al. 2018). A regular linear regression model finds "one parameter…for the relationship between each independent variable and the dependent variable and this relationship is assumed to be constant across the study region," (Fotheringham et al. 2001, 51). Fotheringham et al. (2001) depict an OLS model as

$$y_i = \alpha_0 + \sum_k a_k x_{ik} + \varepsilon_i.$$

A GWR model allows for the parameter *a* between each variable *k* and the dependent variable to change at each point *i*; thus, instead of a_k, a GWR model would have a_{ki} (Fotheringham et al. 2001, 52). In other words, an OLS model depicts the global influence of the independent variables on the dependent variable, while a GWR model depicts the local influence.

Before using GWR, I assessed the extent of spatial variation in my dataset by conducting a thorough Exploratory Spatial Data Analysis (ESDA) and analyzing spatial autocorrelation (SAC) statistics of the dataset. Similar to Sultana et al. (2018), once I finished the ESDA, I ran an OLS regression model and examined its residuals for SAC. Since there was SAC present, I ran GWR models and compared the results to determine which regression model best fits my dataset. In examining the residuals, I needed to make sure that residuals meet all of the residual assumptions. The first assumption is that the sum of all residuals must be 0. To meet the second residual assumption, the residuals must be normally distributed. To meet the third residual assumption, there must be constant variance of the residuals, or homoscedasticity. The fourth residual assumption is that the residuals must show spatial randomness. Moran's I statistic is used to test for "the validity of the assumption of spatial randomness among the residuals of spatial, and non-spatial diagnostic, models" (Fischer and Getis 2010, 5). Thus, a better model is one that has less spatial autocorrelation.

There is a function in the GWR4 software to test for the geographical variability of local coefficients; I used this in order to see if any of my variables do not vary spatially. This test helps the researcher to select which variables to assign as global and local. Global variables have a constant parameter defining the relationship between the variable and the dependent variable, while local variables have a spatially varying range of parameters. I constructed GWR models with all independent variables assigned as locally varying, as well as models that have both globally and locally varying variables. Variables assigned as locally varying have varying

estimates, while variables assigned as globally varying have constant estimates. It is important to examine if variables work best as globally varying or locally varying.

Comparing regression models

In order to determine the regression model that best fits this dataset, I compared the results of all of the models. To assess the results of a regression model, I compared the R^2 Adjusted R^2, Akaike information criterion (AIC), and the corrected AIC (AICc). R^2 is the measure of how well the independent variables predict the dependent variable; however, R^2 is flawed in that its value increases with an increase in independent variables (Rogerson 2015, 255). Adjusted R^2 removes this value inflation, so it is more accurate to use for models with many independent variables. AIC and AICc are used to compare the information loss of regression models. If a model has a lower AIC or AICc, then it is more likely to minimize information loss—and is, thus, a better model. AICc is the small sample size correction for the AIC. Once I found the best GWR model, I compared the spatial autocorrelation of the OLS and GWR residuals (the Moran's I, and its z statistic).

GWR analysis

I used the GWR4 software to run several GWR models. GWR4 allows the user to choose the type of kernel to use in the GWR model. In order to see which kernel fits my data best, I ran my models with an adaptive Gaussian kernel, an adaptive bi-square kernel, a fixed bi-square kernel, and a fixed Gaussian kernel. Iran all four models, and compared them in order to find which model reduced the SAC the most. The adaptive kernels use nearest neighbors (NN) weights, while the fixed kernels use distance-based weights. Gaussian kernels apply weights that are continuous and never reach 0, according to the Gaussian function. Bi-square kernels are determined by a piecewise function that applies weights that fall off until they reach the selected distance or NN, and are then 0.

GWR4 also has a feature called the golden bandwidth section that searches for the optimum bandwidth. In general, smaller bandwidths—whether NN or distance-based—allow for more localized variation than larger bandwidths. I selected the golden bandwidth section for each of my four kernels. After I found a kernel that performed best, I selected bandwidths above and below the golden section bandwidth that was selected for me, to see if there was a better performing bandwidth. I selected AICc as my criterion for optimal bandwidth for all of my GWR models. Thus, I reran all four kernels with mixed global and local models, to compare my results.

After comparing the results, I constructed maps in ArcGIS Pro of the results from my best model. I mapped the local R^2, the studentized residuals, the parameters of the variables, and the t statistics for each variable to see where the parameter was significant (Mennis 2006, 172). Moran's I and its z-values were found in GeoDa, a spatial analysis open source software package. This model can predict ACT scores for school districts using the independent variables, and accounting for spatial variation.

CHAPTER IV

RESULTS AND ANALYSIS

A. TEMPORAL GIS: DISTRICT ENROLLMENT AND SEGREGATION

The first research question asks the following:

How has policy change impacted enrollment and segregation of St. Louis area schools from 1991 to 2017?

a. Has segregation increased in St. Louis City and County school districts from 1991 to 2017?
b. When did inner-city school districts start losing enrollment numbers to private, charter, or surrounding suburban schools?
c. How have desegregation and school-choice efforts affected enrollment and segregation?

Before mapping the segregation and enrollment data, I graphed the data for each school district, and found overall changes, as well as general trends. These graphs can be found in Appendix A. While the graphs are helpful to analyze each school district's yearly changes in segregation and enrollment, mapping all of the school districts' yearly data is helpful to see the context in which each school district changed. In order to assess how the relative enrollment changed from 1991 to

2017, I found and analyzed the percent of 5 to 18-year-olds enrolled in each school district. In order to assess if segregation increased in St. Louis City and County school districts from 1991 to 2017, I reviewed the percent black of students enrolled. Then, I analyzed the graphs in order to find common trends for each school district. Next, I created choropleth maps, for each year from 1991 to 2017, to portray the percent of 5 to 18-year-olds enrolled in public schools, and the percent of black students across all 23 or 24 school districts. In this analysis, I summarized the major findings from the graphs, and then discussed the results from the choropleth maps.

Throughout this analysis, I took into consideration the historical and political context of the St. Louis area school districts. Figure 7 is a timeline of relevant policy changes and school choice efforts that I used to assess the impact of policy changes on St. Louis enrollment and segregation.

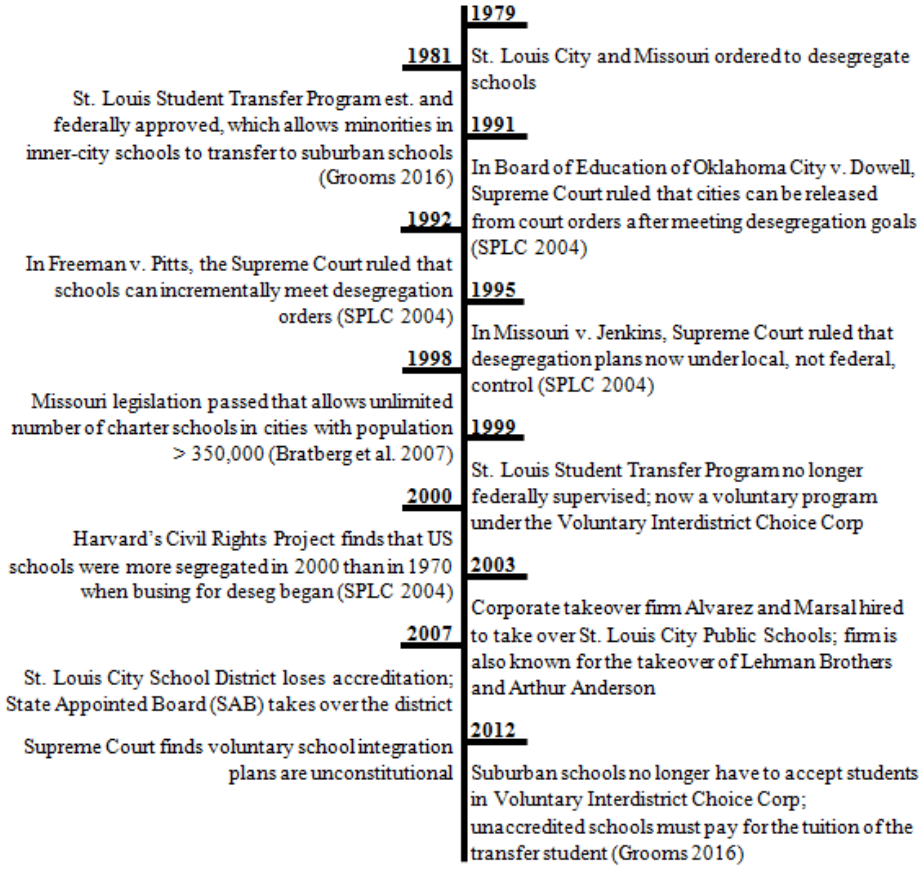

Figure 7: Timeline of Policy Changes and School Choice Efforts

1. SCHOOL DISTRICT GRAPHS

In order to summarize the findings from the school district graphs, I created Tables 2 and 3, which rank the 24 school districts' overall changes in enrollment and in segregation from 1991 to 2017. I also created tables which organize the 24 school districts into 4 categories: those that increased in enrollment, and decreased in percent black (Table 4); those that decreased in enrollment, and increased in percent black (Table 5); those that increased in both (Table 6); and those that decreased in both (Table 7). It is important to note that in all of the tables, I listed the overall changes in enrollment and percent black; thus, the tables do not show the varying increases and decreases in enrollment or percent black that some school districts reported.

The five greatest declines in percent enrollment were St. Louis City, Normandy, Wellston, University City, and Parkway. Of the five highest declines in the percent of 5 to 18-year-olds enrolled in the school district, four were from school districts further north and east in the St. Louis area. The five highest increases in percent enrollment were Ladue, Rockwood, Lindbergh, Bayless, and Clayton. All five of these school districts were in the southern or eastern halves of the St. Louis area. Similarly, the five highest declines in percent black were Lindbergh, Kirkwood, Maplewood-Richmond Heights, Webster Groves, and Ladue. Again, all five of these school districts were in the southern or western halves of the St. Louis area. Lastly, the five highest increases in percent black were Hazelwood, Ferguson-Florissant, Riverview Gardens, Jennings, and Ritenour. All five of these school districts were further north and east in the St. Louis area.

Tables 2 through 7 use the following key:

▲ At least a 45% increase from 1991 to 2017

▲ 30% to 45% increase from 1991 to 2017

▲ 15% to 30% increase from 1991 to 2017

▲ Less than 15% increase from 1991 to 2017

▼ Less than 15% decrease from 1991 to 2017

▼ 15% to 30% decrease from 1991 to 2017

▼ 30% to 45% decrease from 1991 to 2017

▼ At least a 45% decrease from 1991 to 2017

School District	**Δ Enrollment (%)**	
St. Louis City	-49.7	▼
Normandy Schools Collaborative	-47.9	▼
Wellston	-44.1	▼
University City	-40.4	▼
Parkway C-2	-22.4	▼
Ritenour	-11.5	▼
Pattonville R-III	-9.5	▼
Mehlville R-IX	-8.5	▼
Hancock Place	-7.2	▼
Ferguson-Florissant R-II	-4.6	▼
Jennings	-2.1	▼
Brentwood	-1.2	▼
Maplewood-Richmond Heights	2.0	▲
Hazelwood	3.7	▲
Webster Groves	8.0	▲
Affton 101	8.2	▲
Kirkwood R-VII	10.1	▲
Riverview Gardens	10.3	▲
Valley Park	19.3	▲
Clayton	21.9	▲
Bayless	27.0	▲
Lindbergh	32.4	▲
Rockwood R-VI	34.2	▲
Ladue	37.0	▲

Table 2: Change in Percent Enrollment per School District from 1991 to 2017

School District	Δ % Black	
Lindbergh	-16.0	▼
Kirkwood R-VII	-13.6	▼
Maplewood-Richmond Heights	-11.3	▼
Webster Groves	-10.9	▼
Ladue	-9.2	▼
Affton 101	-8.2	▼
Rockwood R-VI	-5.6	▼
Mehlville R-IX	-5.3	▼
Brentwood	-4.6	▼
Parkway C-2	-3.9	▼
Clayton	-3.8	▼
Bayless	-1.9	▼
Valley Park	-1.3	▼
Wellston	0	–
Hancock Place	1.1	▲
University City	1.8	▲
Normandy Schools Collaborative	1.9	▲
St. Louis City	3.0	▲
Pattonville R-III	10.0	▲
Ritenour	15.5	▲
Jennings	25.3	▲
Riverview Gardens	36.2	▲
Ferguson-Florissant R-II	37.2	▲
Hazelwood	48.6	▲

Table 3: Change in Percent Black per School District from 1991 to 2017

The largest category was school districts that increased in enrollment, while they decreased in percent black (Table 4). Ten of the 24 school districts fall into this category, and all are located within the southern half of St. Louis County. Seven of the school districts are involved in the Voluntary Interdistrict Choice Corporation—or the Student Transfer Program (not involved are Ladue, Lindbergh, and Maplewood-Richmond Heights). The transfer program was created in 1981 in order to reduce the segregation of St. Louis Public Schools and the involved suburban school districts (Grooms 2016); however, Figure 7 shows that the state of the transfer program changed within this time period. In 2012, the suburban school districts were no longer required to accept students from the transfer program; furthermore, St. Louis Public Schools, the unaccredited school district, was now responsible for paying the tuition of transfer students

(Grooms 2016). These changes to the transfer program likely caused some of the decrease in the percent black of the suburban school districts. Lastly, all five of the ten school districts in this category that were not segregated in 1991 (had between 25% and 50% black) became segregated (below 25% black) within the time period: Valley Park, Kirkwood, Webster Groves, Ladue, and Maplewood-Richmond Heights.

School District	Δ Enrollment (%)		Δ % Black	
Ladue	37.0	▲	-9.2	▼
Rockwood R-VI	34.2	▲	-5.6	▼
Lindbergh	32.4	▲	-16.0	▼
Bayless	27.0	▲	-1.9	▼
Clayton	21.9	▲	-3.8	▼
Valley Park	19.3	▲	-1.3	▼
Kirkwood R-VII	10.1	▲	-13.6	▼
Affton 101	8.2	▲	-8.2	▼
Webster Groves	8.0	▲	-10.9	▼
Maplewood-Richmond Heights	2.0	▲	-11.3	▼

Table 4: Increased in Enrollment; Decreased in Percent Black

Table 5 shows the second largest category of schools districts that I organized: school districts that decreased in enrollment, while they increased in percent black. I included Wellston School District in this category because of similarities to other school districts, although there was no change in percent black as it was always 100%. Nine of the 24 school districts fall into this category, and eight of the nine are located in the northern half of the St. Louis area. The exception, Hancock Place, is located south of St. Louis City, and is part of the Voluntary Interdistrict Choice Corporation. Lastly, two of the nine school districts in this category were not segregated in 1991 (had between 25% and 50% black), Ritenour, and Ferguson-Florissant. Ritenour remained within 25 to 50% black, but Ferguson-Florissant became segregated (above 50% black) within the time period. Furthermore, Pattonville was segregated (below 25% black), but has stayed between 25 and 50% black since 2006. Of the six remaining school districts, five have maintained a segregation level above 50% black, and one (Hancock Place) has maintained a segregation level below 25% white—with the exception of 2007 through 2009. The only two

school districts that were not segregated in 2017 fell into this category of school districts; thus, school districts that are not re-segregating are losing enrollment.

School District	Δ Enrollment (%)		Δ % Black	
St. Louis City	-49.7	▼	3.0	▲
Normandy Schools Collaborative	-47.9	▼	1.9	▲
Wellston	-44.1	▼	0	–
University City	-40.4	▼	1.8	▲
Ritenour	-11.5	▼	15.5	▲
Pattonville R-III	-9.5	▼	10.0	▲
Hancock Place	-7.2	▼	1.1	▲
Ferguson-Florissant R-II	-4.6	▼	37.2	▲
Jennings	-2.1	▼	25.3	▲

Table 5: Decreased in Enrollment; Increased in Percent Black

Table 6 lists the smallest category of schools districts that I organized: school districts that increased in enrollment and percent black. Riverview Gardens and Hazelwood school districts are located in far northern St. Louis County. Hazelwood had the largest increase in percent black of any school district, while Riverview Gardens had the third largest increase. Both school districts experienced a shift in their enrollment trends in 2006; before 2006, they were experiencing an increase in enrollment, but after 2006, they experienced a decrease. The enrollment graphs of other school districts—Jennings, and Ferguson-Florissant—also showed a similar trend around the mid-2000s. Riverview Gardens remained segregated and increased in segregation throughout the time period; however, Hazelwood was between 25 and 50% black in 1991, and became segregated after 2001.

School District	Δ Enrollment (%)		Δ % Black	
Riverview Gardens	10.3	▲	36.2	▲
Hazelwood	3.7	▲	48.6	▲

Table 6: Increase in Enrollment and Percent Black

The last category of school districts is shown in Table 7: school districts that decreased in enrollment and in percent black. All three of these school districts are located in the southern half St. Louis County. Parkway and Mehlville had a segregation level below 25% black, and became

more segregated throughout the time period. Brentwood had above 25% black in 1991, but became segregated from 2007 through 2013, and after 2015.

School District	Δ Enrollment (%)		Δ % Black	
Parkway C-2	-22.4	▼	-3.9	▼
Mehlville	-8.5	▼	-5.3	▼
Brentwood	-1.2	▼	-4.6	▼

Table 7: Decrease in Enrollment and Percent Black

I found that most of the school districts that increased enrollment from 1991 to 2017 were in the southern half of the St. Louis area, and decreased in the percentage of black students enrolled. I also found that school districts with decreased enrollment were in the northern half of the St. Louis area, and increased the percent of black students enrolled. This could imply that white students moved out of school districts in the northern half of St. Louis area in order to move into school districts in the southern half of St. Louis area. This also implies that districts that became increasingly white were more successful at increasing enrollment, while schools that became increasingly black were not. Overall, I found that the two school districts that remained between 25 and 50% black by 2017 lost enrollment across the time period. This means that the only non-segregated districts lost enrollment. This is not ideal, since the goal of legislation enacted in St. Louis and many other urban areas is to reduce segregation.

2. MAPS

While the graphs that I analyzed in the previous section describe the changes in enrollment and segregation for each school district, I created choropleth maps to see how school districts' changes occurred relative to each other. The following figures and paragraphs summarize the changes in enrollment and segregation for three-year intervals from 1991 to 2017. I uploaded animations of the 1991 through 2017 enrollment and segregation maps, respectively: https://youtu.be/iQPLe__mb4c, and https://youtu.be/FNqh0ttYBYI.

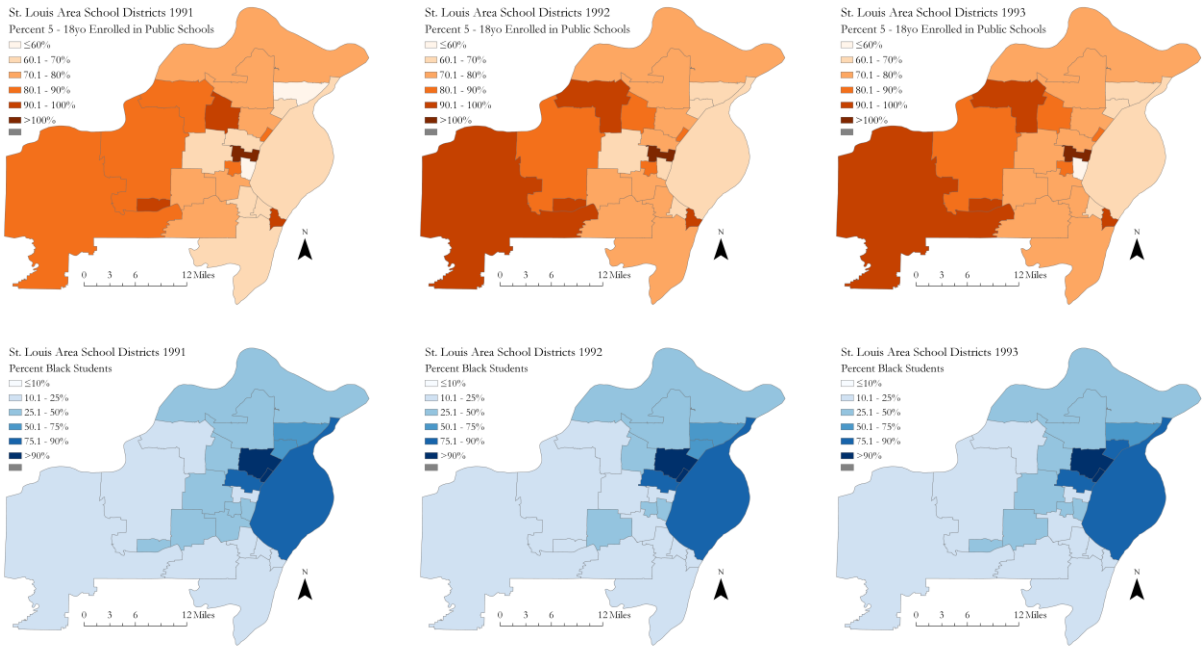

Figure 8: % Enrollment and % Black for St. Louis area school districts from 1991 to 1993

From 1991 to 1993 (Figure 8), Clayton School District had more than 100 percent of school-aged children enrolled in its school. This is likely because the Student Transfer Program that was created in response to Liddell v. City of St. Louis caused an increase in the number of transfer students attending Clayton School District from St. Louis City Public Schools. Five other schools had above 90 percent enrollment: Ritenour, Valley Park, Hancock Place, Rockwood, and Pattonville. Only two school districts fell below 60 percent enrollment: Riverview Gardens and Maplewood-Richmond Heights. Using the definition of segregation, 15 to 18 of the 24 school districts experienced segregation from 1991 to 1993. Wellston and Normandy had greater than 90 percent black students, while St. Louis, Jennings, and University City had greater than 75 percent. No schools had below 10 percent, but most of the southern and western school districts, as well as Clayton, were below 25 percent black.

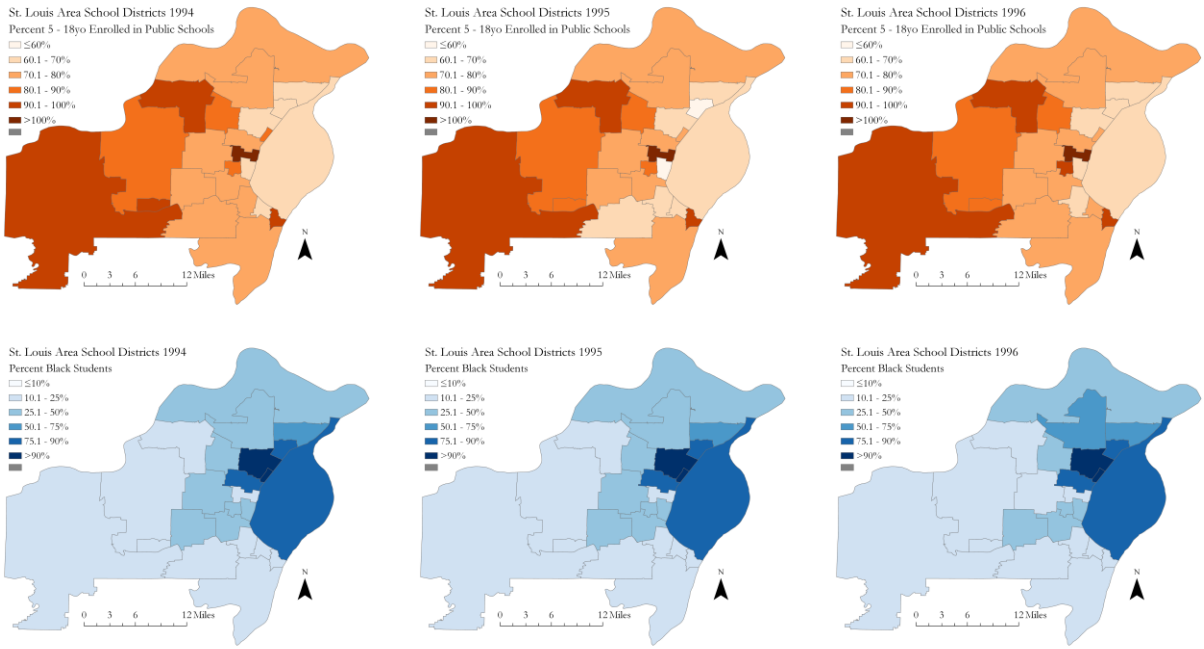

Figure 9: % Enrollment and % Black for St. Louis area school districts from 1994 to 1996

From 1994 to 1996 (Figure 9), Clayton School District's enrollment remained above 100 percent. Five other schools had greater than 90 percent enrollment: Valley Park, Hancock Place, Rockwood, Pattonville, and Brentwood. Only two school districts fell below 60 percent enrollment: Jennings and Maplewood-Richmond Heights. In 1995, the Supreme Court ruled that desegregation plans were under local, not federal, control (SPLC 2004); this might have impacted desegregation efforts within and after this time period. 16 to 18 of the 24 total school districts experienced segregation from 1994 to 1996. Wellston and Normandy had greater than 90 percent black students, while St. Louis, Jennings, and University City had greater than 75 percent. No schools had below 10 percent, but most of the southern and western school districts, as well as Clayton, were below 25 percent black.

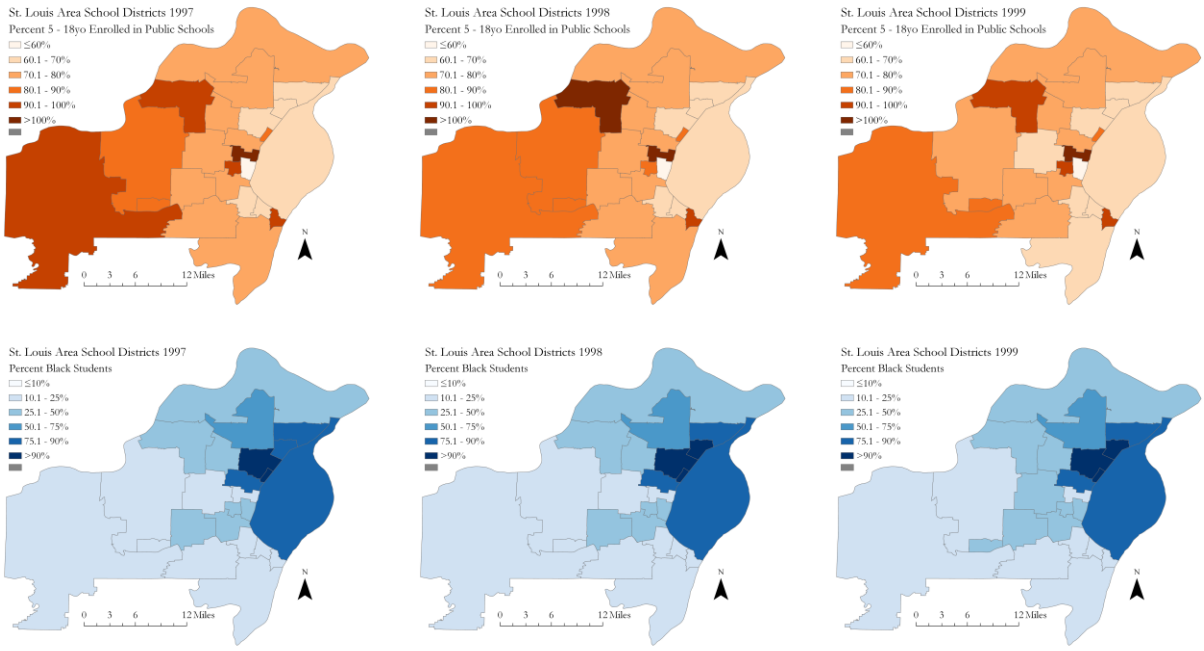

Figure 10: % Enrollment and % Black for St. Louis area school districts from 1997 to 1999

From 1997 to 1999 (Figure 10), Missouri passed legislation that allowed for an unlimited number of charter schools in St. Louis and Kansas City, and the federally-supervised Student Transfer Program became a voluntary program under the Voluntary Interdistrict Choice Corp (Bratberg et al. 2007). The maps continue to show that Clayton had greater than 100 percent of school-aged children enrolled in its schools. Pattonville's enrollment increased above 100 percent within this time period. Three other schools had greater than 90 percent enrollment: Hancock Place, Rockwood, and Brentwood. Only Maplewood-Richmond Heights stayed below 60 percent enrollment. 15 to 17 of the 24 school districts experienced segregation from 1997 to 1999. Wellston, Normandy, and Jennings had greater than 90 percent black students, while St. Louis, University City, and Riverview Gardens had greater than 75 percent. Most of the percent black statistics of southern and western school districts remained below 25 percent.

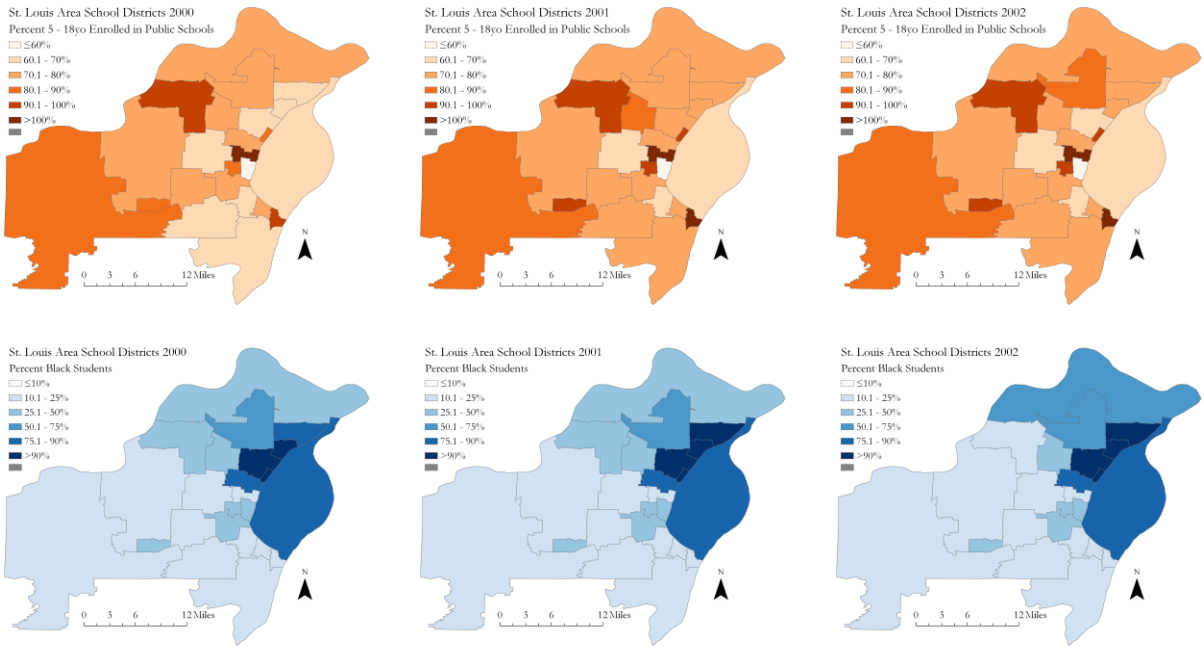

Figure 11: % Enrollment and % Black for St. Louis area school districts from 2000 to 2002

From 2000 to 2002 (Figure 11), Clayton and Hancock Place had greater than 100 percent enrollment. Four other schools had above 90 percent enrollment: Pattonville, Valley Park, Wellston, and Brentwood. Maplewood-Richmond Heights remained below 60 percent enrollment. The number of school districts that experienced segregation increased to 17 to 19 of the 24 total districts. Wellston, Normandy, Jennings, and Riverview Gardens had greater than 90 percent black students, while St. Louis and University City had greater than 75 percent. Within these three years, all of the northern school districts were above 50 percent.

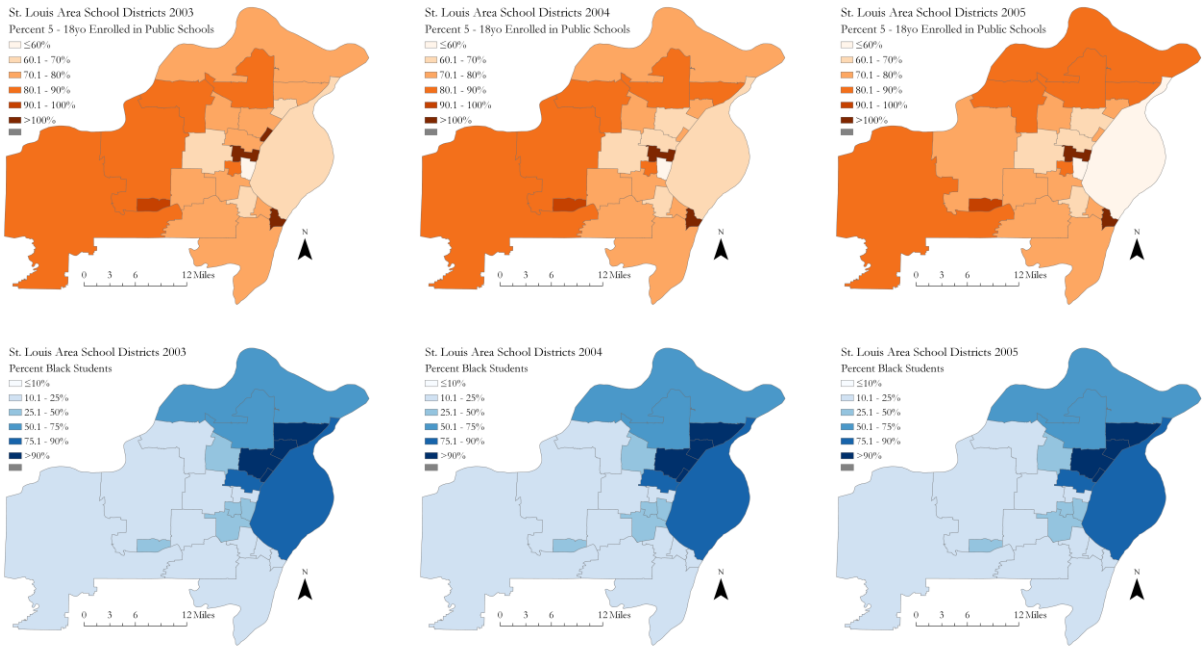

Figure 12: % Enrollment and % Black for St. Louis area school districts from 2003 to 2005

From 2003 to 2005 (Figure 12), Clayton and Hancock Place continued to have above 100 percent enrollment. Wellston, a school district with 100 percent black students enrolled, briefly reported greater than 100 percent enrollment. One other school had above 90 percent enrollment: Valley Park. Maplewood-Richmond Heights remained below 60 percent enrollment, and St. Louis City Public Schools fell below 60 percent enrollment. This is possibly due to the corporate takeover firm closing SLPS schools in the 2003-2004 school year, or the formation of charter schools from the 1998 legislation. 19 of the 24 school districts experienced segregation from 2003 to 2005. Wellston, Normandy, Jennings, and Riverview Gardens had greater than 90 percent black students, while St. Louis and University City had greater than 75 percent. No schools had below 10 percent, but most of the southern and western school districts, as well as Clayton, were below 25 percent black, while northern school districts were above 50 percent.

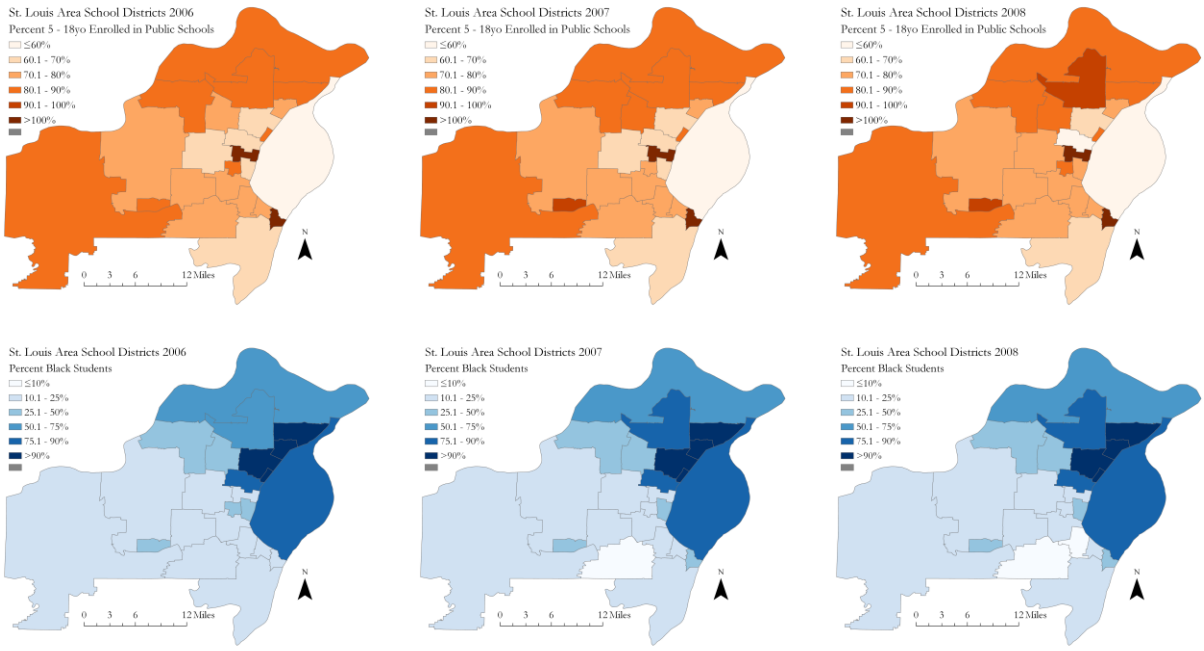

Figure 13: % Enrollment and % Black for St. Louis area school districts from 2006 to 2008

From 2006 to 2008 (Figure 13), Clayton and Hancock Place continued to have more than 100 percent of school-aged children enrolled. Two other schools had above 90 percent enrollment: Valley Park and Ferguson-Florissant. Maplewood-Richmond Heights was no longer below 60 percent enrollment, but St. Louis City Public Schools and University City fell below 60 percent enrollment. In 2007, SLPS lost accreditation, which may have decreased the percent enrollment. Using the definition of segregation, 19 of the 24 school districts experienced segregation from 2006 to 2008. Wellston, Normandy, Jennings, and Riverview Gardens had greater than 90 percent black students, while St. Louis, University City, and Ferguson-Florissant had greater than 75 percent. For the first time, some schools fell below 10 percent black: Lindbergh and Affton 101. More school districts were experiencing segregation, and some of those were experiencing more extreme segregation.

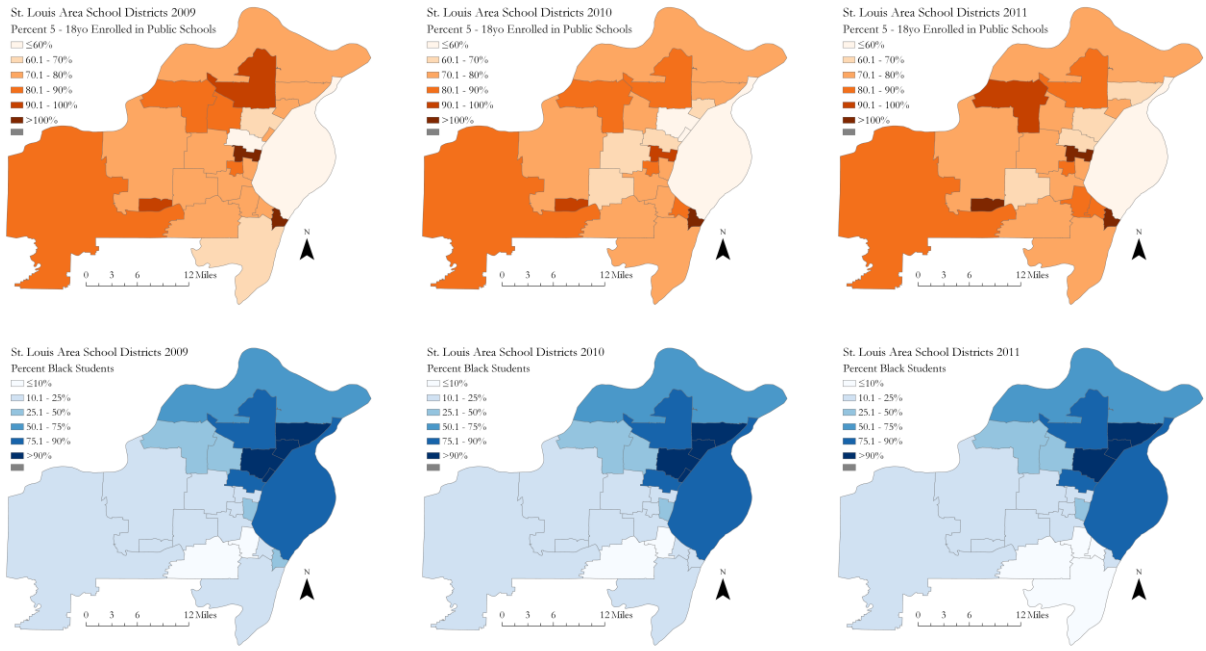

Figure 14: % Enrollment and % Black for St. Louis area school districts from 2009 to 2011

From 2009 to 2011 (Figure 14), the percent enrollment of Clayton, Hancock Place, and Valley Park remained above 100 percent. Pattonville had greater than 90 percent enrollment. St. Louis City remained below 60 percent enrollment, and Normandy and Wellston dipped below 60 percent—although not in 2011, because Wellston closed and students were forced to go to Normandy. The number of school districts that experienced segregation increased to 20 to 21 of the 24 school districts. Wellston (until its closure in 2010), Normandy, Jennings, and Riverview Gardens had greater than 90 percent black students, while St. Louis, University City, and Ferguson-Florissant remained greater than 75 percent black. Lindbergh and Affton 101 remained below 10 percent black, but more schools fell below 10 percent: Bayless and Mehlville. Again, more school districts were experiencing segregation, and some of those were experiencing more extreme segregation.

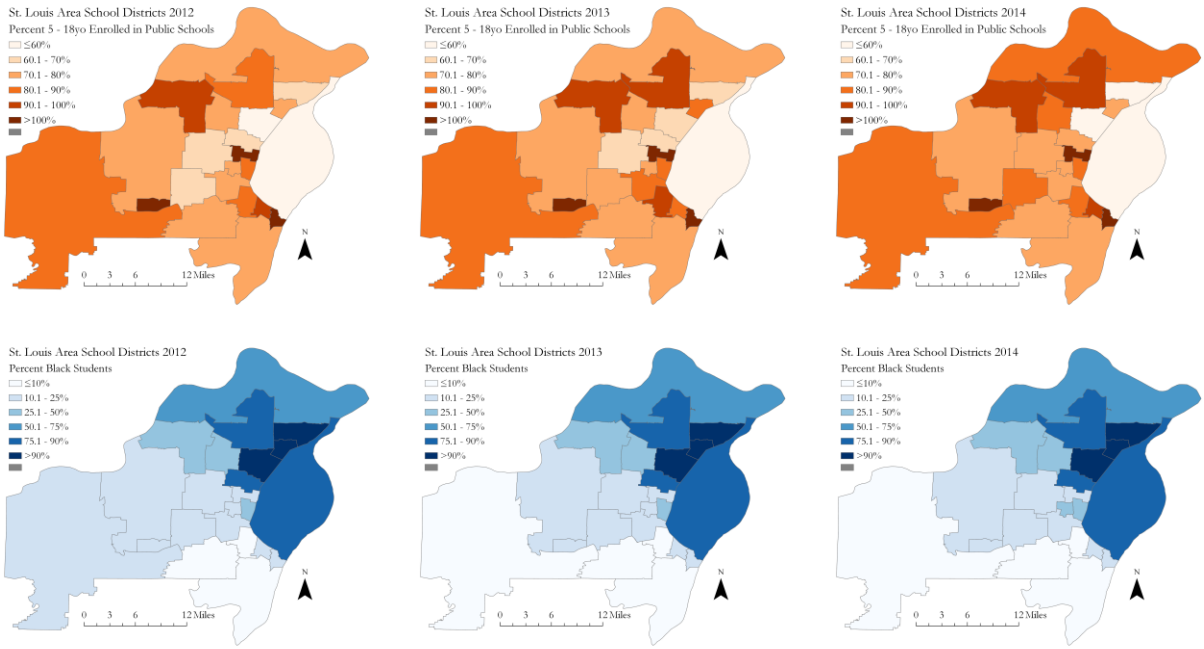

Figure 15: % Enrollment and % Black for St. Louis area school districts from 2012 to 2014

From 2012 to 2014 (Figure 15), Clayton, Hancock Place, and Valley Park continued to have above 100 percent of school-aged children enrolled. Pattonville, Ferguson-Florissant, and Bayless had more than 90 percent enrollment. St. Louis City remained below 60 percent enrollment, while Normandy and Riverview Gardens fell below 60 percent. 19 to 20 of the 23 school districts experienced segregation from 2012 to 2014. Normandy, Jennings, and Riverview Gardens continued to have greater than 90 percent black students, while St. Louis, University City, and Ferguson-Florissant remained greater than 75 percent black. Lindbergh, Affton 101, and Mehlville remained below 10 percent black, and Rockwood fell below 10 percent.

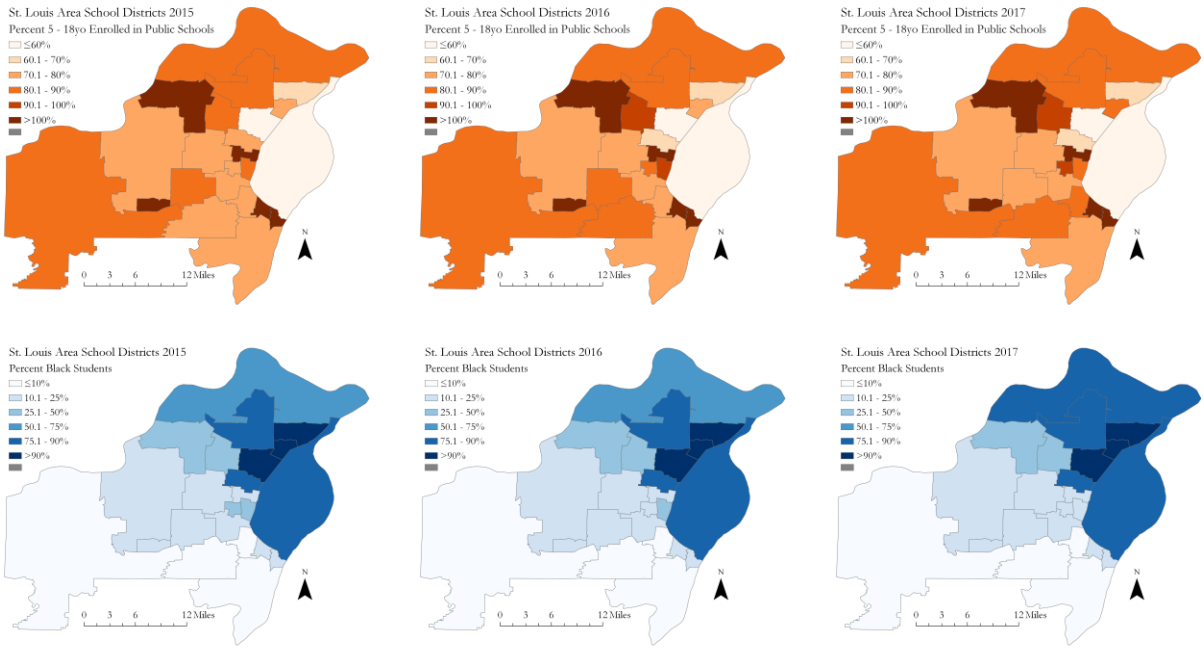

Figure 16: % Enrollment and % Black for St. Louis area school districts from 2015 to 2017

From 2015 to 2017 (Figure 16), the percent enrollment of Clayton, Hancock Place, and Valley Park remained above 100 percent. The percent enrollment of Pattonville and Bayless rose above 100 percent. Ritenour and Brentwood, and, briefly, Maplewood-Richmond Heights had greater than 90 percent enrollment. St. Louis City and Normandy remained below 60 percent enrollment. The largest number of school districts within this time period experienced segregation from 2015 to 2017: 19 to 21 of the 23 districts. Normandy, Jennings, and Riverview Gardens continued to have greater than 90 percent black students, while St. Louis, University City, and Ferguson-Florissant remained greater than 75 percent black; Hazelwood rose above 75 percent black. Lindbergh, Affton 101, Mehlville, and Rockwood remained below 10 percent black. Almost all school districts were experiencing segregation, and many of those were experiencing more extreme segregation.

The maps for percent enrollment and percent black depicted some patterns from 1991 to 2017. The gap between school districts with higher percent enrollment and lower percent enrollment increased from 1991 to 2017. Many school districts that had greater than 90 percent enrollment of

the school-aged population continued to have a higher percent enrollment throughout the years. Furthermore, the maps for percent black suggest that the St. Louis area became more segregated. There is a clear pattern in the 2017 map showing the further north and east in the St. Louis area, the higher the percent black of the student population. The number of school districts with less than 25 percent or higher than 50 percent black enrollment increased from 15 to 21 school districts. In other words, from 1991 to 1993, 9 school districts were not considered segregated; however, in 2017, only two school districts were not considered segregated.

B. GEOGRAPHICALLY WEIGHTED REGRESSION: SCHOOL DISTRICT ACHIEVEMENT

This section discusses the results from research question two:

> How do segregation and enrollment affect school district achievement?
>
> a. How well does a regression equation predict student achievement based on several indicators including racial demographics and enrollment?
> b. Is geographically weighted regression a better fit for predicting the achievement indicator?

First, I will examine the exploratory spatial data analysis, and then I will discuss the results from the regression models.

1. EXPLORATORY SPATIAL DATA ANALYSIS

Univariate Choropleth Maps

In the following paragraphs, I analyze the graduated color—or choropleth—maps of my dependent variable and eight independent variables. I can see trends in almost all of the nine maps, with the exception of IEP rates among school districts. Some of the variables' trends

follow other variables that I already account for (primarily showing population hot spots), so I checked for multicollinearity; however, I noticed that some variables have spatial trends that I do not think is accounted for by other variables. For example, there is a trend in the funding variables that splits southern and northern Missouri, but I am unaware of an underlying demographic that would explain this trend.

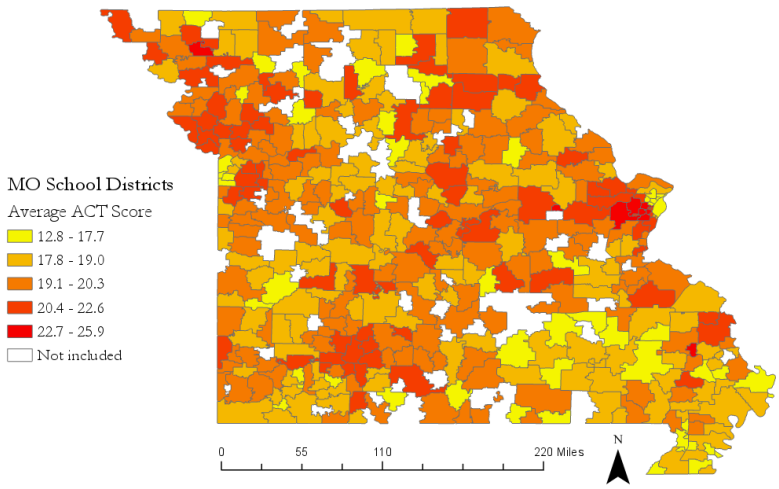

Figure 17: Average ACT Score

There appears to be a trend in the univariate choropleth map of the average ACT composite scores, in Figure 17. Higher ACT scores seem to overlap with wealthier, suburban school districts. I do not think that the regression for ACT scores is that simple; thus, I will be using this variable as my dependent variable to see if I can predict ACT scores using a variety of variables.

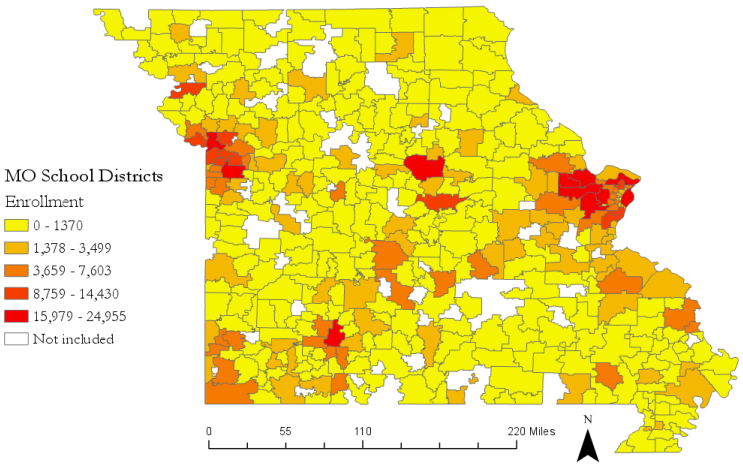

Figure 18: Number of Students Enrolled per School District

There is an obvious trend in Figure 18, the univariate choropleth map of enrollment. There seems to be higher enrollment around urban and suburban schools. St. Joseph, Kansas City, Springfield, Columbia, Jefferson City, and St. Louis are all surrounded by higher enrollment.

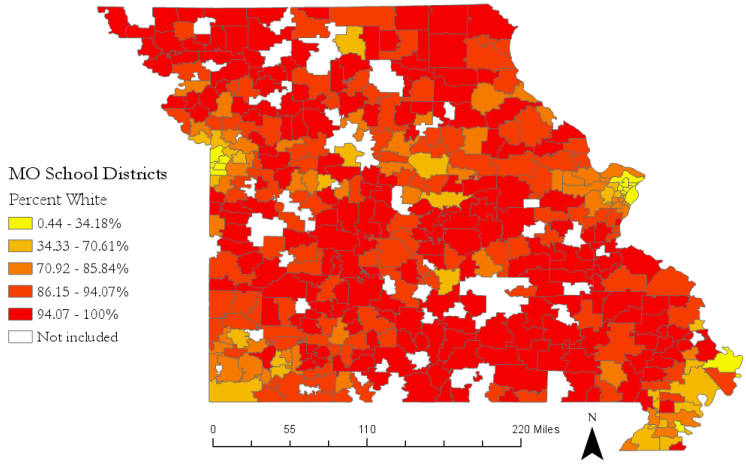

Figure 19: Percent White of Student Population

Again, there seems to be an obvious spatial trend in the univariate choropleth map of percent white enrollment, in Figure 19. There seems to be lower percent white around urban areas, and toward the southeast corner of the state.

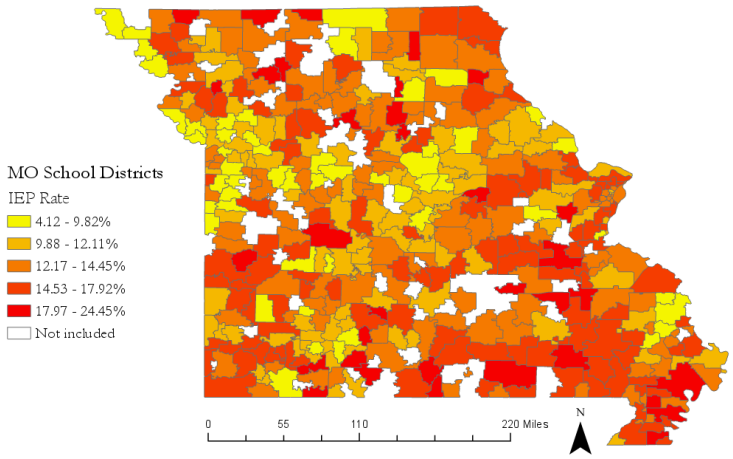

Figure 20: Rate of Individualized Education Programs

In Figure 20, there seems to be no trend in the IEP rates among school districts. It is hard to tell with the naked eye, but it seems like there might be some negative Spatial Autocorrelation (SAC) present. Positive and negative SAC are spatial patterns; positive SAC appears as clustering on a map, while negative SAC appears more evenly spaced.

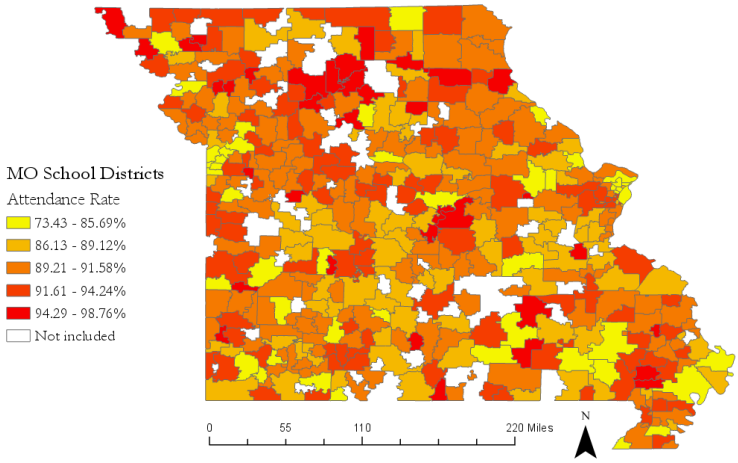

Figure 21: School District Attendance Rate

I chose this variable because I learned how important attendance is for students' graduation rates. I would have guessed that low attendance is a problem in urban areas—which we can see that it is, from Figure 21. However, I am curious as to how attendance became an issue in the other school districts that are sprinkled throughout the state.

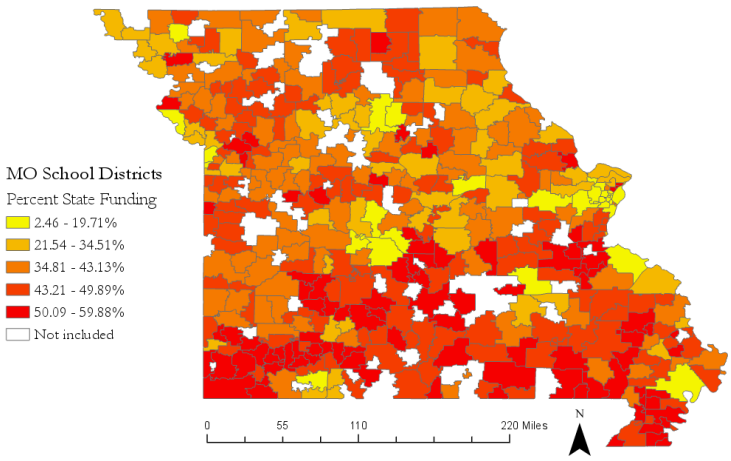

Figure 22: Percent of School District Funding from State

Percent state funding is a unique variable that appears to have a strong pattern in Figure 22: the further south, the higher the percent state. I will note that the St. Louis area has lower state funding except for the areas with provisional or no accreditation. Likely this is because those districts have been given state funding in order to improve.

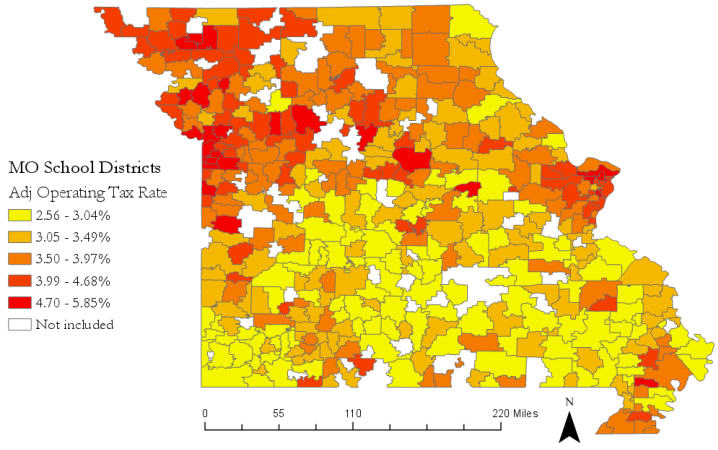

Figure 23: Adjusted Operating Tax Rate

The influence of the Adjusted Operating Tax Rate variable will likely be similar to percent of funding that is from state taxes, except that this variable is the local tax rate. There does seem to be a geographic trend in Figure 23: the further south, the lower the local tax rate. Furthermore, around wealthier suburban areas, they have lower tax rates because they have higher valued property; in other words, they get a reasonable amount of funding from lower taxes since the area

is so wealthy. Lastly, it seems that in larger cities or more northwestern cities, there are higher taxes. Perhaps this is due to sales tax in larger cities or other policies.

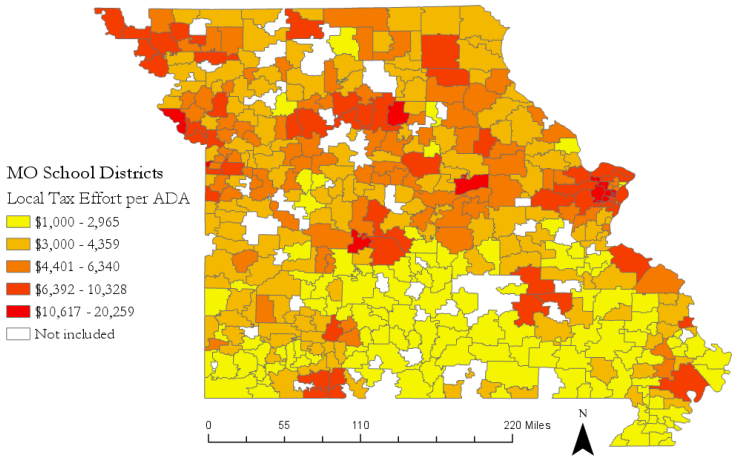

Figure 24: Local Tax Effort per Average Daily Attendance

Local tax effort per ADA might be a slightly biased variable, so I am interested to see how it interacts with other variables. In Figure 24, it appears that in urban areas, there is a higher local tax effort per ADA. Perhaps this is because there are higher taxes, or perhaps this is because there are lower attendance rates. Again, there is an obvious line separating southern and northern Missouri.

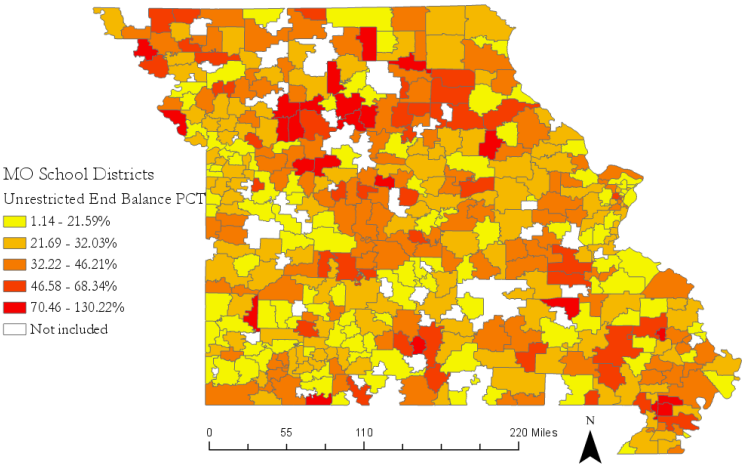

Figure 25: Unrestricted Ending Balance Percent

Lastly, it is difficult to see a trend with the naked eye in Figure 25, which depicts the unrestricted ending balance percent. When looking at the St. Louis region, it seems that poorer areas have a lower percent balance to expenditure, which does make sense. I know that many urban school districts have struggled to support themselves in the past.

Spatial Autocorrelation Statistics

In order to check each variable for Spatial Autocorrelation (SAC), I computed the Moran's I statistic for each variable, and then I performed a Monte Carlo simulation with 999 permutations to determine critical values that allow me to determine if Moran's I is random. Table 8 shows the Moran's I and z-value after running 999 permutations on each of my variables. I chose to use 30 nearest neighbors because I know that the St. Louis region has 23 school districts within St. Louis City County and St. Louis County; thus, about 30 districts total including the suburbs outside of the County.

Variable	Moran's I	z-value
ACT_Score	0.110	9.757
Enrollment	0.241	20.579
White_Pct	0.328	30.129
IEP_Rate	0.122	10.617
Attend_Rate	0.0383	3.578
Pct_State	0.235	21.382
Adj_Op_Tax_Rate	0.457	40.776
Local_Tax_Eff_per_ADA	0.341	30.950
Unr_End_Bal_Pct	0.0877	7.940

Table 8: Spatial Autocorrelation Statistics

For all of my variables, I have a significant level of SAC present with pseudo p-values below 0.05. However, there are some variables that have a much higher presence of SAC than others. It is notable that the z-value and pseudo p-value for the Moran's I for the Attendance Rate came closest to being unable to reject the null hypothesis. The Adjusted Operating Tax Rate variable had the highest z-value for its Moran's I; thus, we are most certain about rejecting the null hypothesis for this variable. From the results of running a global Moran's I on each variable, I believe it was useful to look into regression equations that can account for SAC.

2. RESULTS

First, I used an OLS regression model to predict ACT scores using my eight independent variables. The comparison of each model is shown in Table 9. The OLS model had an R^2 of approximately 0.42, and an adjusted $R^2$of approximately 0.41. This was the lowest R^2value I found for any of my models, which means that the OLS model does not predict ACT scores as well as the GWR models. Furthermore, the AIC and AICc values were the highest at 1353.5, and 1354, which means that the OLS model was more likely to have information loss than any of the other models.

In order to test which kernel worked best for my model, I ran each of the four kernels available in GWR4 with all of my variables set as local, and then I re-ran the kernels with mixed global and local variables. The test of geographic variability for the adaptive Gaussian model suggested I make these variables global: Percent White, IEP_Rate, Adj_Op_Tax_Rate, and Local_Tax_Eff_per_ADA. This means that the test found these models to work best with a constant regression coefficient. I found that the adaptive Gaussian model had an optimum bandwidth of 58 nearest neighbors (NN). The R^2value of the model with all local variables was higher; however, the mixed global and local model had a higher adjusted R^2 value. Furthermore,

the AIC and AICc values were lower for the mixed global and local models. Thus, I think that the mixed global and local adaptive Gaussian model is a better fit than the totally local model.

The test of geographic variability for the adaptive bi-square model suggested I make these variables global: White_Pct, IEP_Rate, Pct_State, Adj_Op_Tax_Rate, Local_Tax_Eff_Per_ADA. I found that the adaptive bi-square model had an optimum bandwidth of approximately 165 NN, but the mixed global and local model had a much higher optimum bandwidth of 423 NN, which is concerning because that is the entire sample of school districts. In this model, the totally local model was a better fit than the mixed global and local model. The R^2 and adjusted R^2 values of the totally local model were much higher; furthermore, the AIC and AICc values were lower for the totally local model.

The test of geographic variability for the fixed bi-square model suggested I make these variables global: White_Pct IEP_Rate, and Adj_Op_Tax_Rate. I found that the fixed bi-square local model had an optimum bandwidth of 2.653 degrees, while the mixed global and local model was a smaller bandwidth at 1.97 degrees. The R^2 and adjusted R^2 values of the mixed global and local model were higher; furthermore, the AIC and AICc values were lower for the mixed global and local models. Thus, I think that the mixed global and local fixed bi-square model is a better fit than the totally local model.

I found that the fixed Gaussian mixed local and global model was the best fit out of all of the models. The test of geographic variability for the fixed Gaussian model suggested I make these variables global: Percent White, IEP_Rate, Adj_Op_Tax_Rate, and Local_Tax_Eff_per_ADA. The totally local model had an optimum bandwidth of 0.912 degrees, while the mixed global and local model was a smaller bandwidth at 0.691 degrees. These optimum bandwidths are noticeably smaller than the other models, which means that they account for more local variation. The R^2 and adjusted R^2 values of the mixed global and local model were higher at 0.57 and 0.51, respectively; furthermore, the AIC and AICc values were lower for the mixed global and local

models at approximately 1296 and 1305, respectively. Thus, I think that the mixed global and local fixed bi-square model is a better fit than the totally local model.

Since my best fit model was the fixed Gaussian mixed local and global model, I wanted to make sure that the optimum bandwidth selection was correct, so I re-ran the fixed Gaussian mixed local and global model using a bandwidth of 0.60 degrees and 0.78 degrees—slightly smaller and slightly larger bandwidths. I found that optimum bandwidth was still 0.691 degrees.

Models	**Bandwidth**	R^2	**Adj R^2**	**AIC**	**AICc**
OLS	N/A	0.42167	0.40906	1353.50	1354.04
Adaptive Gaussian	N=58	0.53712	0.47682	1314.20	1321.69
Mixed global local	N=59.834	0.51380	0.48371	1311.29	1314.73
Adaptive bi-square	N=164.506	0.57115	0.49246	1311.34	1326.34
Mixed global local	N=423	0.42302	0.40630	1358.28	1359.16
Fixed bi-square	H=2.653	0.52400	0.46879	1322.27	1329.00
Mixed global local	H=1.97	0.54687	0.49107	1309.41	1317.79
Fixed Gaussian	H=0.912	0.55209	0.48008	1314.62	1325.41
Mixed global local	H=0.60	0.53988	0.45893	1338.62	1352.87
	H=0.691	0.56694	0.50724	1295.51	1305.10
	H=0.78	0.54711	0.49596	1302.43	1309.41

Table 9: Comparisons of OLS and GWR models

I checked for SAC in the OLS model, and found a Moran's I value of 0.089, with a z-value of 3.2; this z-value has a pseudo p-value of 0.001, indicating there is statistically significant spatial autocorrelation in the OLS model. Next, I selected the fixed Gaussian mixed model as my best fit model, and checked for SAC in the model to compare the OLS and GWR models' SAC. I used GeoDa to compute the Moran's I value and z-value of the GWR model's residuals.

The Moran's I value of the residuals from the fixed Gaussian mixed GWR model was 0.021, with a z-value of 0.84. This z-value had a pseudo p-value of 0.193, indicating the GWR model does not have a statistically significant level of spatial autocorrelation present. This model passes the regression assumption that residuals are not autocorrelated. There are three other residual regression assumptions that the model must meet. First, I confirmed that the sum of all the residuals is 0. Second, I looked at the histogram of the residuals to confirm that they are normally distributed. Third, I looked at the scatterplot of the predicted values and the residuals in order to confirm that there was constant variance of the residuals, or homoscedasticity.

Regression equations

The following equations are the OLS regression model and the fixed Gaussian mixed GWR model (with a distance bandwidth of 0.691 degrees). The OLS model has constant coefficients for each variable, while the GWR model assigns a varying coefficient for each variable that is spatially varying.

OLS model

$$ACT\ Score = 5.91 + 1.61 \times 10^{-4} * (Enrollment) + 0.122 * (Attend_{Pct}) + 0.0123 * (Percent_{State}) - 0.0115 * (Pct_{EndBal}) + 0.0295 * (White_{Pct}) - 0.0667 * (IEP_{Rate}) - 0.285 * (AdjTax_{Rate}) + 3.05 \times 10^{-4} * (LocalTaxEff) + \varepsilon$$

In the OLS model, Enrollment has a positive coefficient. This means that an increase in the enrollment size would increase the average ACT score of a school district. This variable has a p-value of <0.001; thus, it is significant. Although this variable has the coefficient with the smallest magnitude, the enrollment numbers are in the hundreds or thousands compared to other variables.

Percent Attendance also has a positive coefficient. This means that an increase in the average percent of a school district's daily attendance would increase the average ACT score. This

variable has a p-value of <0.001; thus, it is also significant. This is one of the largest magnitude coefficients, so attendance is an important factor in district achievement.

Percent state funding has a positive coefficient. This means that the larger the percent of funding that comes from the state, the higher the district's ACT score. This estimate has a p-value of 0.12, thus, this variable is not significant at a 90 or 95% confidence level. This is the only variable that is not significant in the OLS model. If I was just running an OLS regression model, I might chose to omit this variable; however, by running GWR models, I can find if the variable is significant in local areas instead of across the entire study area of Missouri.

The unrestricted ending balance percent variable has a negative estimate. This means that the higher the percent of unrestricted ending balance—or when school districts are more financially unstable—there is a negative impact on ACT scores. This estimate has a p-value of <0.001; thus, it is significant.

Percent white has a positive estimate. This means that higher ACT scores are associated with higher percent white in a school district. Furthermore, since I found that only two school districts in the St. Louis area remained desegregated in 2017, school districts that have a higher percentage of white enrollment are likely districts that have lower than 25% black enrollment. Districts that have a lower percentage of white enrollment likely have a higher percentage of minority enrollment. Thus, districts with higher minority enrollment are associated with lower ACT scores. The behavior of this variable suggests that districts with higher minority populations are negatively impacted by segregation, while districts with higher white populations are positively impacted by segregation. This estimate has a p-value of <0.001; thus, it is significant.

IEP Rate has a negative coefficient, which means that as a school district has more special education needs, the average ACT score is lower. This variable suggests that districts with lower

special education needs correlate with higher ACT scores. This estimate has a p-value of <0.001, which means that it is significant.

Adjusted Operating Tax Rate has a negative coefficient, which means that as the tax rate increases, the average ACT score lowers. Again, it is important to note that wealthier districts may have a lower tax rate, but a higher percentage of their funding from local taxes than districts with higher tax rates. This is due to the higher property values. Thus, wealthier neighborhoods will likely benefit from a reduced need to increase local tax rates. This estimate has a p-value of 0.002, which means that it is significant.

Lastly, Local Tax Effort per Average Daily Attendance has a small, positive coefficient. This means that an increase in the local tax effort has a small increase on average ACT scores. Like the last variable, this variable is likely influenced by the higher property values of wealthier neighborhoods. This variable has a p-value of <0.001, which means that it is significant.

GWR fixed Gaussian mixed model (bandwidth distance = 0.691 degrees)

$$ACT\ Score = (0.472\ to\ 17.3) + (9.8 \times 10^{-5} to\ 4.5 \times 10^{-4}) * (Enrollment) + (-0.011\ to\ 0.19) * (Attend_{Pct}) + (-0.04\ to\ 0.035) * (Percent_{State}) + (-0.023\ to\ 0.034) * (Pct_{EndBal}) + 0.0286 * (White_{Pct}) - 0.055 * (IEP_{Rate}) - 0.30 * (AdjTax_{Rate}) + 1.94 \times 10^{-4} * (LocalTaxEff) + \varepsilon$$

The GWR fixed Gaussian mixed model has four spatially-varying coefficients and four constant coefficients. The coefficients for Enrollment range from $9.8 \times 10^{-5} to\ 4.5 \times 10^{-4}$, which means that enrollment has a positive impact on ACT scores across Missouri. Attendance Percent, Percent State Funding, and Percent Ending Balance all have varying coefficients that range from negative to positive. This means that in some areas in Missouri, these variables have negative impacts on ACT scores, while they have positive impacts in other areas.

Mapping GWR results

I produced maps for the GWR model with the best fit, the fixed Gaussian mixed model with a distance bandwidth of 0.691 degrees. I have mapped the local R^2 values, the coefficients for the local variables, the t-values for the local variables, and the residuals, all in ArcGISPro. Since this study has approximately 400 degrees of freedom, the estimates' t-values must have magnitudes equal to or greater than 1.965 for the estimate to be considered significant.

The local R^2 values in Figure 26 show that the model best predicts ACT scores for school districts surrounding St. Louis and Kansas City. The local R^2 values for the rest of the state are low. In the future, it might be interesting to do a GWR model for school districts around either Kansas City or St. Louis. As we can see, the St. Louis area has greater than 0.82 local R^2, which means this model does a good job predicting ACT scores for these school districts.

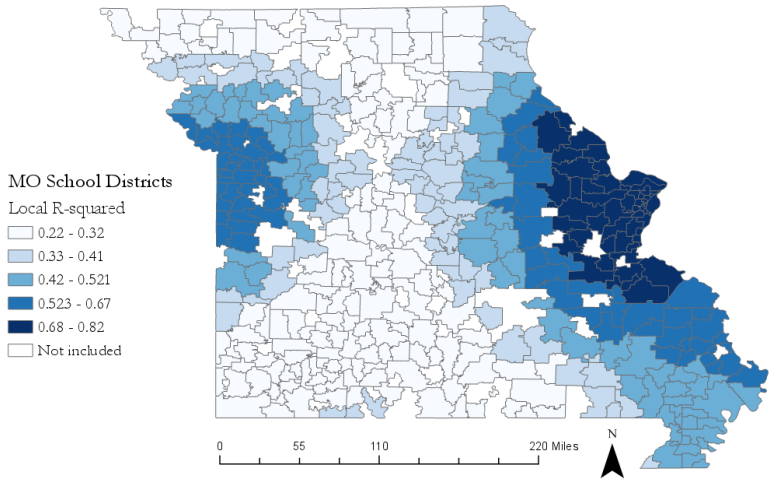

Figure 26: Local $\boldsymbol{R^2}$ *for fixed Gaussian mixed GWR model*

The local coefficients for the Enrollment variable, as well as the t-values associated with them, are shown in Figure 27. The t-values are all above the cutoff for significance at 95%, but have stronger significance in the less populated areas of Missouri. It looks like enrollment does not have a strong impact on ACT scores in the St. Louis metro area or the northwestern corner of the

state; however, it looks like the strongest impact from enrollment is in the southeastern corner of Missouri. This is interesting, because this area is less populated. Therefore, it seems as though low enrollment of school districts makes the largest impact within this area of the state.

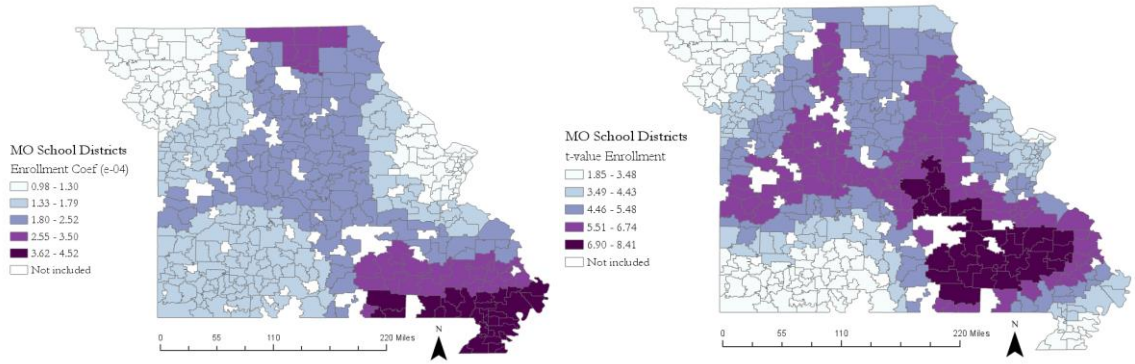

Figure 27: Enrollment Coefficients and t-values

The local coefficients for the Attendance Percent variable, as well as the t-values associated with them, are shown in Figure 28. The t-values are significant along the eastern border of the state—especially around St. Louis area—to Kansas City, but not in the north or southwestern corners. It seems as though Attendance has the strongest impact on ACT scores in the eastern part of Missouri—and, somewhat, within Kansas City.

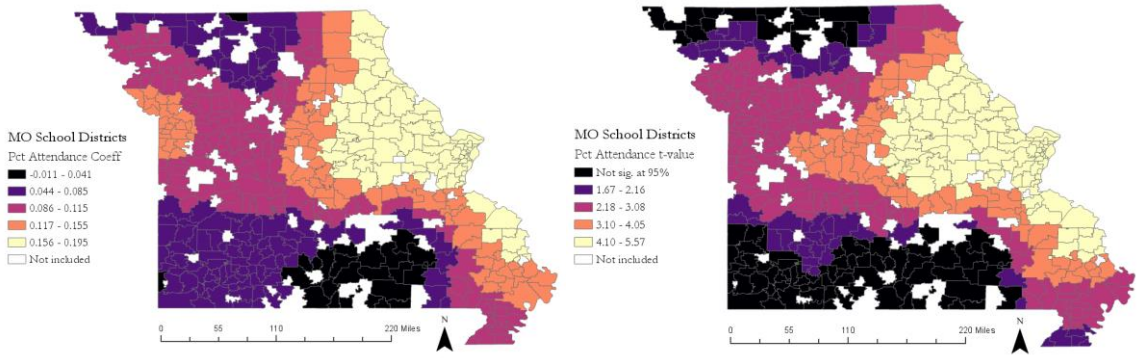

Figure 28: Attendance Rate Coefficients and t-values

The local coefficients for the Percent State funding variable, as well as the t-values associated with them, are shown in Figure 29. The t-values are negatively significant in the St. Louis area, and positively significant just north of the Springfield area, and three small school districts along the Arkansas border. It makes sense that the higher the percent of state funding, the lower the ACT scores in the St. Louis region. This is due to the extreme variation in property values that are associated with the percent of local school funding. In wealthier areas of St. Louis, they have a lower percent of school funding coming from the state, since those areas have higher property values, which help raise the contribution from local funding. Likewise, in more poverty-stricken areas of St. Louis, there are higher levels of state school funding due to the lower property values, which reduces the amount of local funding. It is unusual to see that the higher percent of state funding has a positive impact on ACT scores in the area north of Springfield. That area of Missouri has low population density, so it is not comparable to the St. Louis area. The three Arkansas border school districts with a positive impact on ACT scores also have low population density. While the strength and negative relationship between ACT scores and percent of state funding makes sense in the St. Louis area, the strength and positive relationship in those two less populated clusters needs to be further investigated.

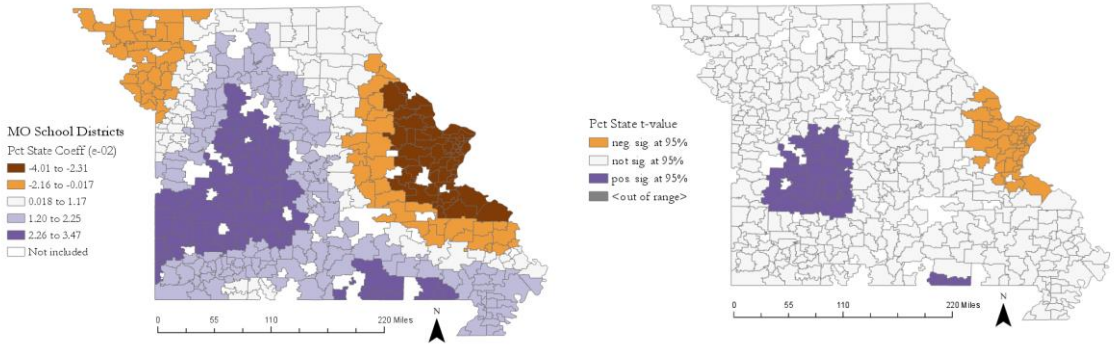

Figure 29: Percent State Funding Coefficients and t-values

The local coefficients for the Unrestricted Ending Balance Percent variable, as well as the t-values associated with them, are shown in Figure 30. The t-values are negatively significant in the north-central region of the state—including Kansas City area—and positively significant in the southeastern corner. The Unrestricted Ending Balance Percent variable is not statistically significant in any other area of the state, including the St. Louis region. It is interesting to see another split between negative and positive relationships. In this case, a higher Percent of the Unrestricted Ending Balance means that school districts are spending a smaller amount of their fund balance each year, while a lower Percent Unrestricted Ending Balance means that school districts are spending a much larger amount of money per year than they have in their ending balance. It makes sense that schools would have a negative relationship between this variable and ACT scores. If the school is more financially unstable, it will have a higher Percent Unrestricted Ending Balance, and that seems like it would be associated with a lower ACT score. Thus, the north-central region of the state makes sense. The southeastern corner has an unusual relationship between this variable and ACT scores. In this area of the state, more financially unstable school district tend to have higher ACT scores. This relationship needs to be further investigated.

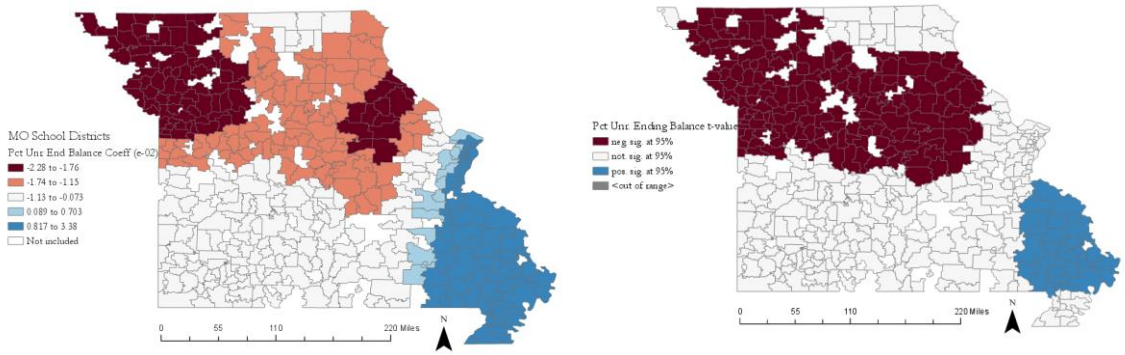

Figure 30: Percent Unrestricted Ending Balance Coefficients and t-values

The studentized residual map in Figure 31 helps identify outliers and uncovers unaccounted for spatial autocorrelation. In this map, residuals with a z-statistic magnitude greater than 2 are outliers. In this case, they do not seem to follow a geographic pattern. It is interesting to see in

Figure 32 that the St. Louis City is a negative outlier, while wealthier suburbs are positive outliers. Perhaps another variable could better predict ACT scores in the St. Louis area.

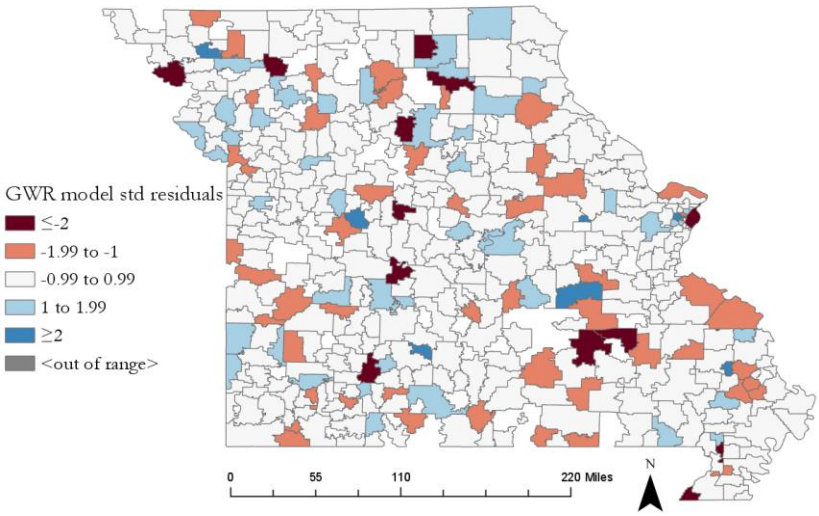

Figure 31: Studentized residuals of the GWR fixed Gaussian mixed model

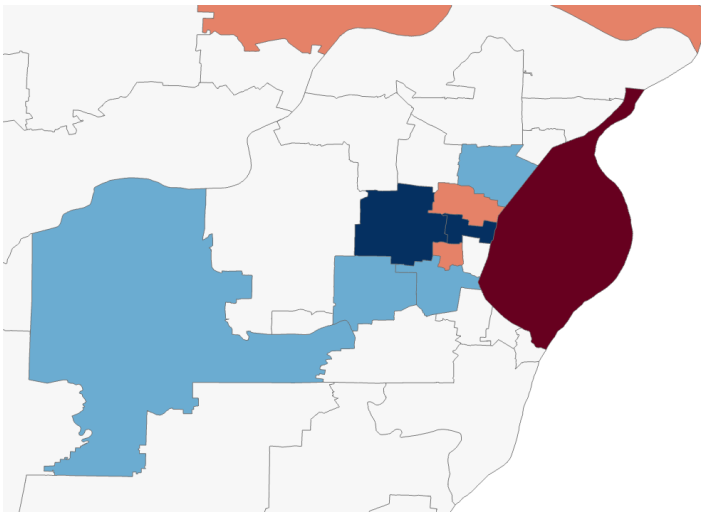

Figure 32: St. Louis area GWR model studentized residuals

CHAPTER V

CONCLUSION

A. TEMPORAL GIS: DISTRICT ENROLLMENT AND SEGREGATION

For the first research question, I looked at three sub-questions. First, I wanted to address:

a. Has segregation increased in St. Louis City and County school districts from 1991 to 2017?

In my research, I found that segregation increased in St. Louis City and County school districts from 1991 to 2017. I modified a definition of segregation used in legal proceedings in St. Louis in order to objectively measure segregation. My definition of a segregated school district was any district in St. Louis City or County that had below 25% or above 50% black students. Through graphs, I was able to determine that nine out of 24 school districts had between 25 and 50% black students in 1991, and only two out of 23 school districts fell between 25 and 50% black students in 2017. That means that approximately 63% of schools in the St. Louis area were segregated in 1991, but over 91% were segregated in 2017. Furthermore, through mapping segregation statistics, I was able to see how segregation changed over time. There was a clear spatial pattern in the percent black statistic across St. Louis area school districts: northern and eastern St. Louis

area school districts were more likely to have higher percent black, while southern and western districts were more likely to have higher percent white. Furthermore, I found that the school districts that have between 25 and 50% black students are losing enrollment.

The second sub-question asked the following:

b. When did inner-city school districts start losing enrollment numbers to private, charter, or surrounding suburban schools?

The inner-city district in this study, St. Louis Public Schools, began losing enrollment in 2001. The school districts to the north of St. Louis City, Ferguson-Florissant, Jennings, Riverview Gardens, and Hazelwood, all started losing enrollment in the mid-2000s.

Some school districts in the southern half of St. Louis County have increased enrollment since that time; however, I am unsure how many students moved out of the St. Louis area, or moved to private schools, charter schools, or surrounding suburban schools.

The third sub-question ties together the first two sub-questions with policy changes:

c. How have desegregation and school-choice efforts affected enrollment and segregation?

The St. Louis Transfer Program—later called the Voluntary Interdistrict Choice Corp—was created in 1981 in order to alleviate some of the pressures for St. Louis area school districts to desegregate (Grooms 2016). After looking through the graphs and maps, I noticed that the majority of the suburban schools that have accepted St. Louis Public Schools' students have actually become more segregated from 1991 to 2017. The suburban schools had below 25% black, and St. Louis Public Schools had over 50% black; however, after years of this program, the percent black of the suburban schools continued to drop, and the percent black of St. Louis Public

Schools continued to increase. Furthermore, now that the program is completely voluntary, the Voluntary Interdistrict Choice Corp is dropping the numbers of students involved each year.

I believe that the Supreme Court decisions since the early 1990s have supported more local efforts to desegregate, rather than federal regulations designed to desegregate. Since districts have lighter disincentives for remaining segregated, and since local government has control of the desegregation plans, I believe that segregation has continued to increase, while enrollment has decreased for minority school districts. The 1998 Missouri legislation that allows an unlimited number of charter schools in St. Louis and Kansas City has likely decreased the student enrollment in segregated public schools with higher than 50% black. Lastly, I think that the corporate takeover of St. Louis Public Schools did not succeed in regulating the district's balance. In fact, I think it may have led to even lower enrollment and higher segregation.

St. Louis is a unique setting for urban geographers to study the impacts of policy changes. This is because geographers can study the impacts of these desegregation efforts. Furthermore, the data available from the Missouri Department of Elementary and Secondary Education is very helpful for conducting spatial analyses and GWR.

B. GEOGRAPHICALLY WEIGHTED REGRESSION: SCHOOL DISTRICT ACHIEVEMENT

In order to answer my second research question, I will address both of the sub-questions:

a. How well does a regression equation predict student achievement based on indicators like racial demographics and enrollment?
b. Does geographically weighted regression do a better job predicting achievement?

I found that GWR does provide further explanation for the relationship between school district indicators and ACT scores beyond an OLS model. I found that a fixed Gaussian kernel mixed

global and local GWR model was the best fit model for this dataset. This model has an Adjusted R^2 of about 0.51, which means that about 51% of the variation in ACT scores in Missouri school districts is accounted for by this model. This is a reasonable Adjusted R^2 value for socioeconomic data, so I think the variables were appropriate for predicting ACT score. I did find that the St. Louis area has many outliers within the St. Louis City County and St. Louis County school districts; thus, I would like to narrow my study area in future research to include St. Louis City and County school districts, as well as districts located in counties that border St. Louis County.

I found that enrollment has a positive relationship with ACT scores. This makes sense to me, because smaller school districts likely do not have as many resources as larger school districts. I found that the attendance rate has a positive relationship with ACT scores. This also makes sense to me, because lower attendance is associated with lower-performing school districts that encounter other obstacles, like poverty. I found that the percent of funding from the state is negatively associated with ACT scores only in the St. Louis area, and positively associated with ACT scores in two low populated areas of the state. This variable's behavior needs to be further investigated. I found that the percent unrestricted ending balance is negatively associated with ACT scores in the north-central region of the state, but positively associated with ACT scores in a southeastern cluster. This variable's behavior also needs to be further investigated. I found that Percent White is positively associated with ACT score, and does not vary locally. This finding likely points to issues with standardized testing, as well as lower resources available for districts with higher minority enrollment. I found that the rate of IEPs is negatively associated with ACT score, and does not vary locally. I was not sure what to predict for this variable, but perhaps districts that have more special education needs have fewer resources available academically. I found that the adjusted operating tax rate is negatively associated with ACT scores. This makes sense as school districts in more poverty-stricken areas, like St. Louis City, have higher tax rates. Lastly, I found that local tax effort per average daily attendance is positively related to ACT

scores. This also makes sense, because higher local tax effort is associated with wealthier school districts.

School district achievement is important for education policymakers to understand. Studies like this could provide insight into ways to increase student achievement. This study suggests that school choice policies may have increased segregation and the gap between high and low percent enrollments in the St. Louis area. Other studies suggests that school choice policies have similar impacts in other US metropolitan areas, like Cincinnati and the Sumter-Lee-Clarendon tri-county area in South Carolina (Feldmann and Watson 2012; Canup 2015). This study also suggests that enrollment and segregation have an impact on student achievement; because segregation has increased from 1991 to 2017, more school districts experienced a disadvantage affecting student achievement in 2017 than in 1991.

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APPENDICES

APPENDIX A: SCHOOL DISTRICT GRAPHS

The graphs and paragraphs on the following pages describe the changes in enrollment and segregation of each school district from 1991 to 2017. I have arranged the school districts by geographic location; they are in order from the most southwestern school district to the most northeastern school district.

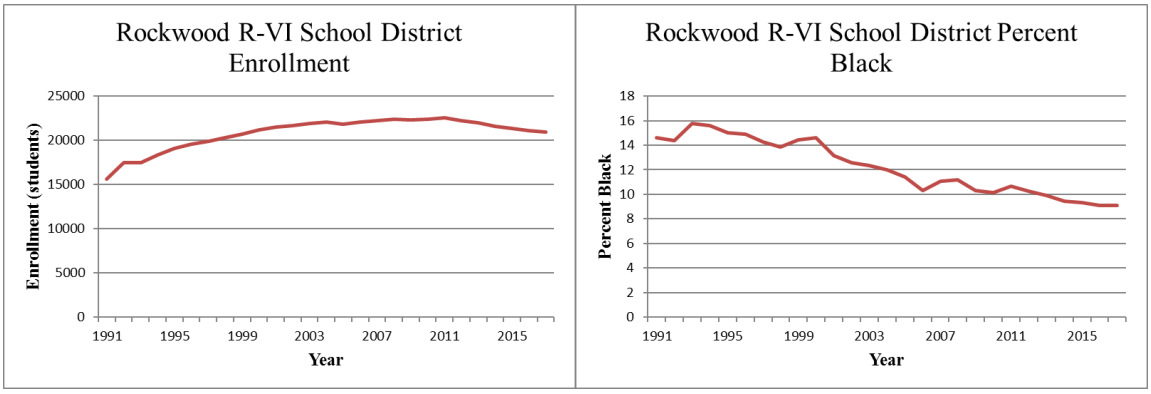

Figure 33: Rockwood R-VI School District graphs

Rockwood R-VI School District is located in the southwestern corner of St. Louis County. Figure 33 portrays that the school district enrollment increased as the percent black of the enrolled student population decreased. The enrollment increased by 34% from 15,608 students in 1991 to 20,952 students in 2017; this is the second highest percent increase in enrollment among St. Louis area school districts. The year with the highest enrollment was 2011, with an enrollment of 22,568 students; the year with the lowest enrollment was 1991, with an enrollment of 15,608 students. The percent black of the enrolled student population decreased from 14.63% in 1991 to 9.08% in 2017. The year with the highest percent black was 1993, with 15.76%; the year with the lowest percent black was 2017, with 9.08%. Based on my definition of segregated schools, Rockwood would have been segregated in 1991 and continued to be segregated in 2017 because the school district had lower than 25% black students.

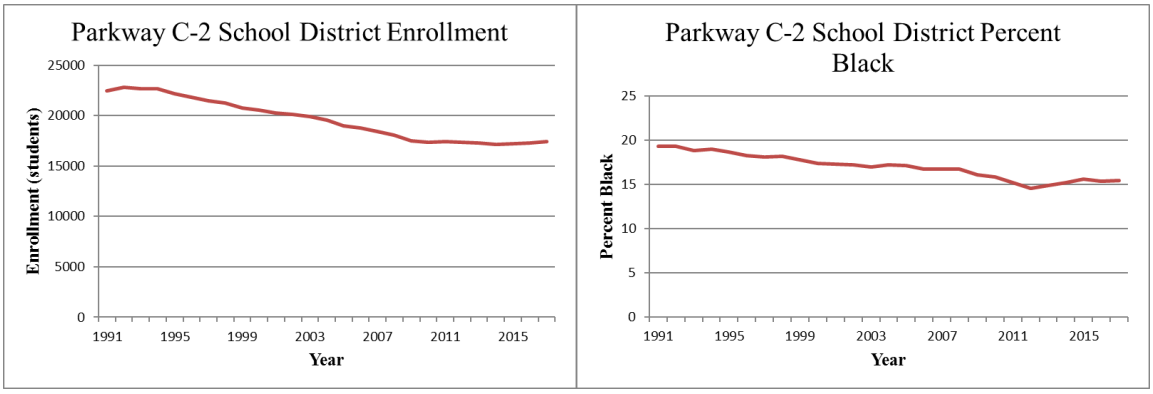

Figure 34: Parkway C-2 School District graphs

Parkway C-2 School District is located in southwestern St. Louis County. Figure 34 portrays that the school district enrollment decreased as the percent black of the enrolled student population also decreased. The enrollment decreased by 22% from 22,465 students in 1991 to 17,434 students in 2017; this is the fifth highest percent decrease in enrollment among St Louis area school districts. The year with the highest enrollment was 1992, with an enrollment of 22,581 students; the year with the lowest enrollment was 2014, with an enrollment of 17,147 students. The percent black of the enrolled student population decreased from 19.35% in 1991 to 15.49% in 2017. The year with the highest percent black was 1992, with 19.36%; the year with the lowest percent black was 2012, with 14.58%. Like Rockwood, I would classify Parkway as segregated, and increasing in segregation because it had below 25% black in 1991, and had lower percent black in 2017.

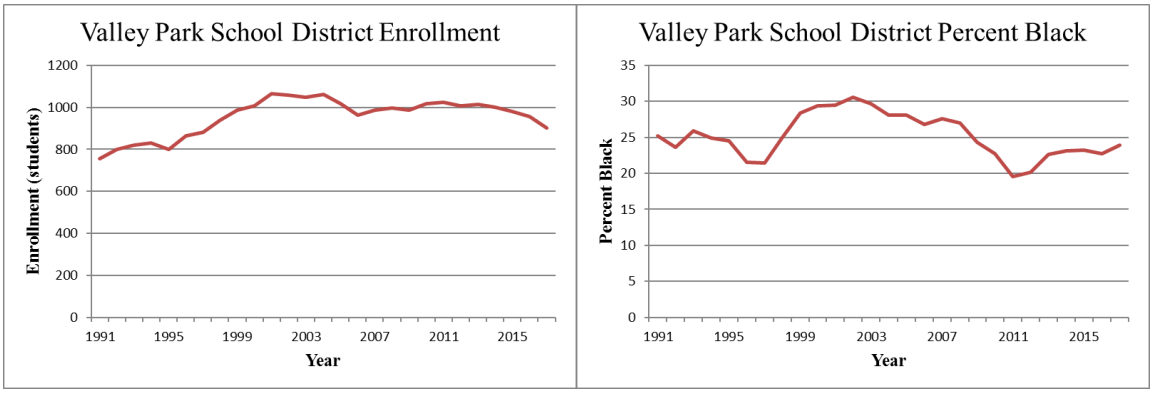

Figure 35: Valley Park School District graphs

Valley Park School District is located in southwestern St. Louis County. Figure 35 portrays that the school district enrollment increased as the percent black of the enrolled student population decreased. The enrollment increased by 19% from 757 students in 1991 to 903 students in 2017. The year with the highest enrollment was 2001, with an enrollment of 1,064 students; the year with the lowest enrollment was 1991, with an enrollment of 757 students. The percent black of the enrolled student population decreased from 25.23% in 1991 to 23.92% in 2017. The year with the highest percent black was 2002, with 30.53%; the year with the lowest percent black was 2011, with 19.53%. Unlike Figures 1 and 2 for the previous school districts, Valley Park's graphs do not have a uniform change in percent black or district enrollment. From 1997 to 2002, there was an increase in enrollment, and from 2003 to 2011, there was a decrease. Lastly, Valley Park became segregated when it dropped below 25% black between 1991 and 1997, and after 2009.

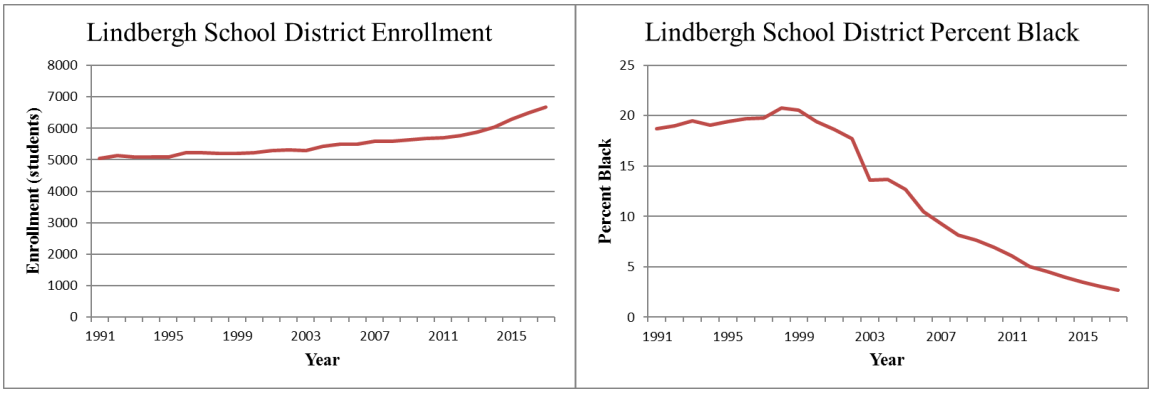

Figure 36: Lindbergh School District graphs

Lindbergh School District is located in southern St. Louis County. Figure 36 portrays that the school district enrollment increased as the percent black of the enrolled student population decreased. The enrollment increased by 32% from 5,051 students in 1991 to 6,687 students in 2017; this is the third highest percent increase in enrollment among St. Louis area school districts. The year with the highest enrollment was 2017; the year with the lowest enrollment was 1991. The percent black of the enrolled student population decreased from 18.73% in 1991 to 2.69% in 2017; this is the highest decrease in percent black among the school districts. Furthermore, the largest decrease in percent black happened in Lindbergh School District in 2003. The year with the highest percent black was 1998, with 20.73%; after 1998, there was an overall decrease in percent black. The year with the lowest percent black was 2017, with 2.69%. Lindbergh was segregated in 1991, and became more segregated from 1998 until 2017.

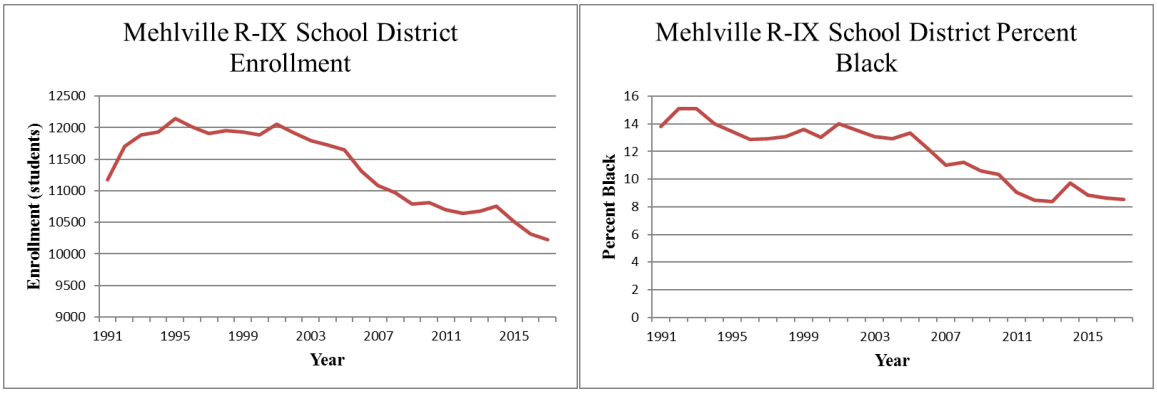

Figure 37: Mehlville R-IX School District graphs

Mehlville R-IX School District is located in southeastern St. Louis County. Figure 37 portrays that the school district enrollment decreased as the percent black of the enrolled student population also decreased. The enrollment decreased by 9% from 11,172 students in 1991 to 10,221 students in 2017. The year with the highest enrollment was 1995, with an enrollment of 12,146 students; the year with the lowest enrollment was 2017, with an enrollment of 10,221 students. The percent black of the enrolled student population decreased from 13.81% in 1991 to 8.56% in 2017. The years with the highest percent black were 1992 and 1993, with 15.1%; the year with the lowest percent black was 2017, with 8.56%. Mehlville was segregated in 1991, and became more segregated throughout this time period.

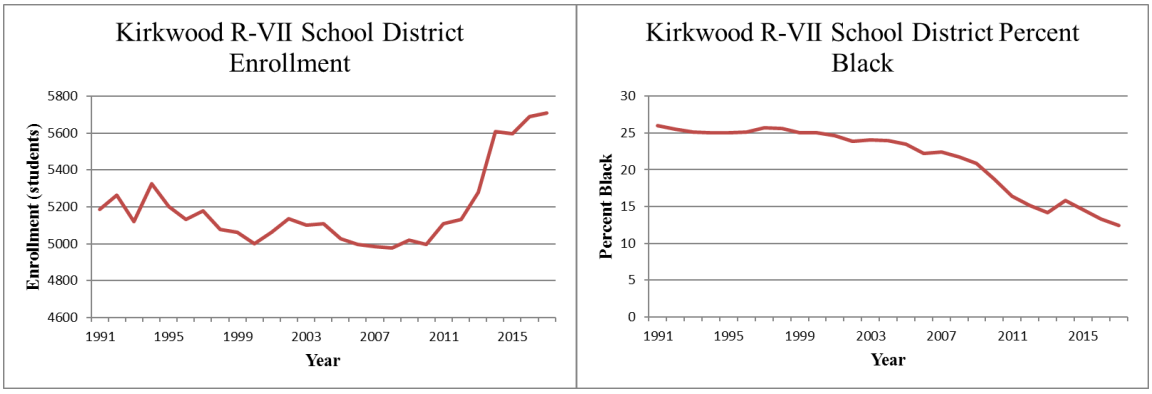

Figure 38: Kirkwood R-VII School District graphs

Kirkwood R-VII School District is located in southern St. Louis County. Figure 38 portrays that the school district enrollment increased as the percent black of the enrolled student population decreased. The enrollment increased by 10% from 5,186 students in 1991 to 5,708 students in 2017. The year with the highest enrollment was 2017; the year with the lowest enrollment was 2008, with 4,975 students. The enrollment of Kirkwood School District started increasing around 2008. The percent black of the enrolled student population decreased from 26.01% in 1991 to 12.4% in 2017; this is the second highest decrease in percent black. The year with the highest percent black was 1991; the year with the lowest percent black was 2017. Kirkwood classified as segregated after 1999.

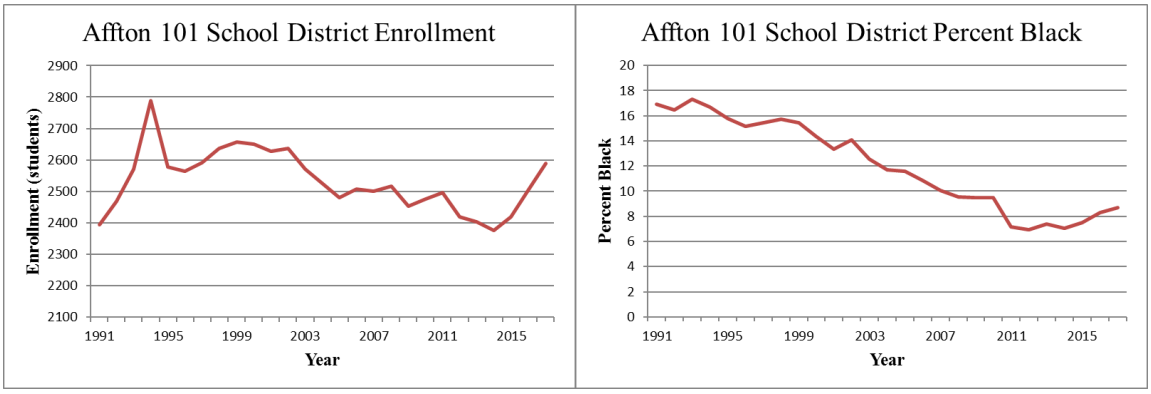

Figure 39: Affton 101 School District graphs

Affton 101 School District is located in southeastern St. Louis County and shares a border with St. Louis City School District. Figure 39 portrays that the school district enrollment increased as the percent black of the enrolled student population decreased. The enrollment had an overall increase by 8% from 2,393 students in 1991 to 2,589 students in 2017. However, there was a general decrease in enrollment from 2002 to 2014. The year with the highest enrollment was 1994, with 2,789 students; the year with the lowest enrollment was 2014, with 2,376 students. The percent black of the enrolled student population decreased from 16.92% in 1991 to 8.69% in 2017. The year with the highest percent black was 1993, with 17.32%; the year with the lowest percent black was 2012, with 6.95%. Similar to Valley Park's graphs, Affton 101's graphs do not have a uniform change in district enrollment. Affton 101 became increasingly more segregated over the time period.

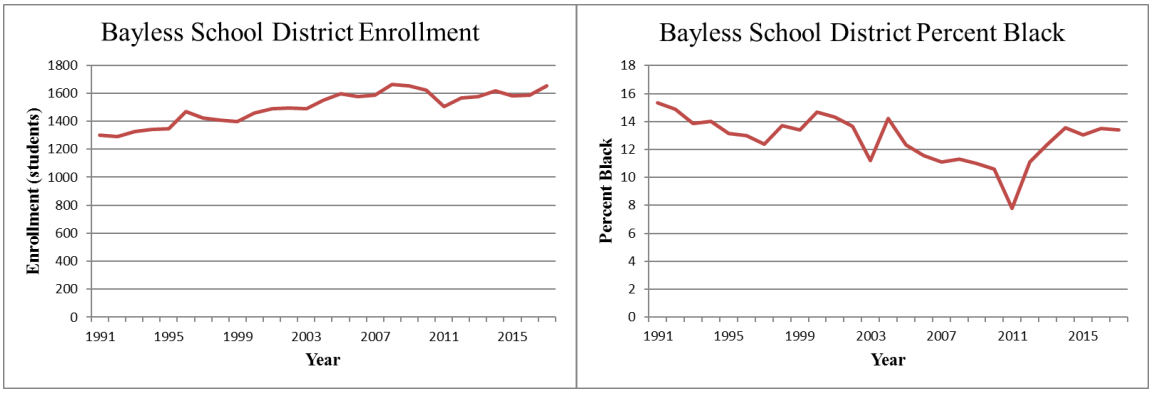

Figure 40: Bayless School District graphs

Bayless is a school district in southeastern St. Louis County and shares a border with St. Louis City School District. Figure 40 portrays that the school district enrollment increased as the percent black of the enrolled student population decreased. The enrollment increased by 27% from 1,303 students in 1991 to 1,655 students in 2017; this is the fourth highest percent increase in enrollment among St. Louis area school districts. The year with the highest enrollment was 2008, with 1,665 students; the year with the lowest enrollment was 1992, with 1,290 students. The percent black of the enrolled student population decreased from 15.35% in 1991 to 13.41% in 2017. The year with the highest percent black was 1991; there was a large decrease in percent black in 2011, with 7.78%. Bayless School District's graphs do not have a uniform change in percent black, but the school district remained segregated throughout the time period.

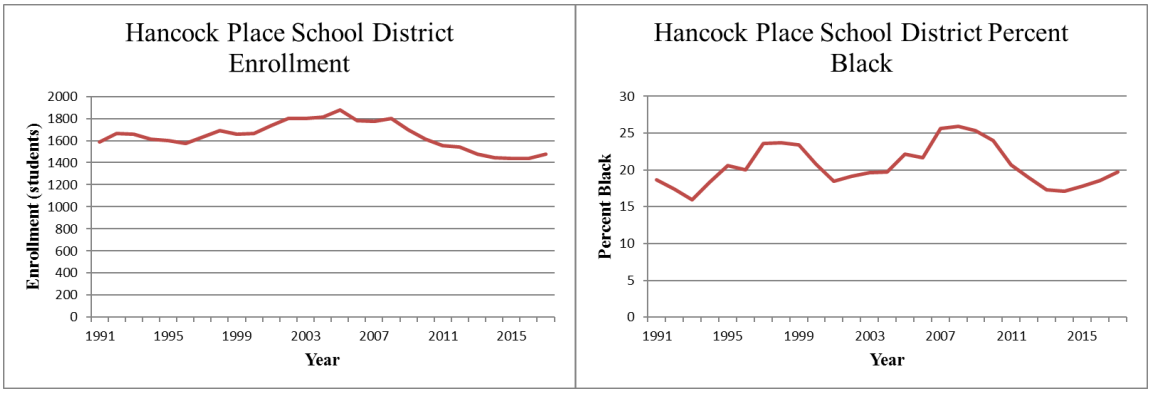

Figure 41: Hancock Place School District graphs

Hancock Place School District is located in southeastern St. Louis County and shares a border with St. Louis City School District. Figure 41 portrays that the school district enrollment decreased as the percent black of the enrolled student population increased. The enrollment decreased by 7% from 1,590 students in 1991 to 1,476 students in 2017. The year with the highest enrollment was 2005, with 1,878 students; the years with the lowest enrollment were 2015 and 2016, with 1,441 students. The percent black of the enrolled student population increased from 18.62% in 1991 to 19.72% in 2017. The year with the highest percent black was 2008, with 25.96%; the year with the lowest percent black was 1993, with 15.95%. Hancock Place School District's graphs do not have a uniform change in percent black or in enrollment. The enrollment seems to increase before 2005, and decrease after 2008. Hancock Place was segregated throughout the time period, except from 2007 through 2009.

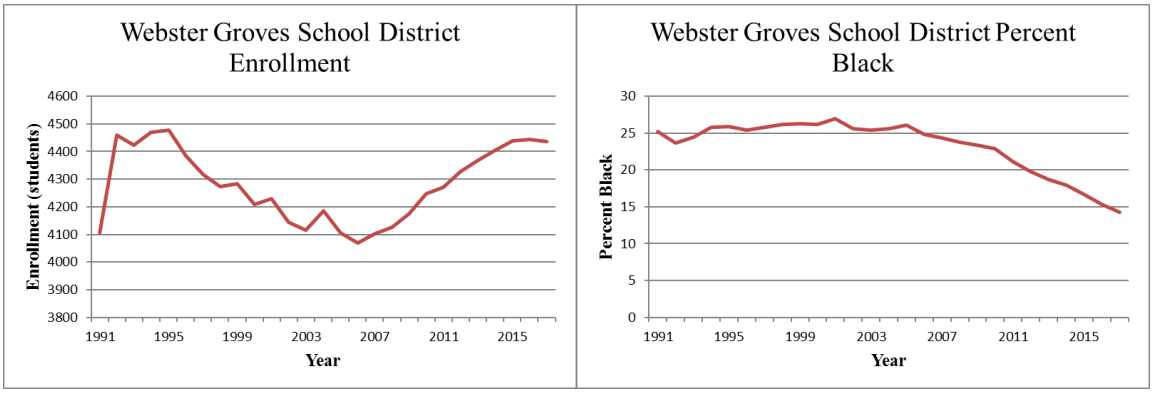

Figure 42: Webster Groves School District graphs

Webster Groves School District is located in southeastern St. Louis County and shares a border with St. Louis City School District. Figure 42 portrays that the school district enrollment increased as the percent black of the enrolled student population decreased. The enrollment increased by 8% from 4,106 students in 1991 to 4,435 students in 2017. The year with the highest enrollment was 1995, with 4,478 students; the year with the lowest enrollment was 2007, with 4,103 students. There seems to be opposite trends in enrollment before and after 2007; before 2007—but excluding 1991—there was a general decrease in enrollment, but after 2007, there was a general increase. The percent black of the enrolled student population decreased from 25.16% in 1991 to 14.25% in 2017; this is the fourth highest decrease in percent black. The year with the highest percent black was 2001, with 26.97%; the year with the lowest percent black was 2017. Similar to the enrollment, the graph for percent black shows a general increase in percent black until 2001, and a general decrease after 2005. Webster Groves was segregated in 1992 and 1993, as well as from 2006 to 2017.

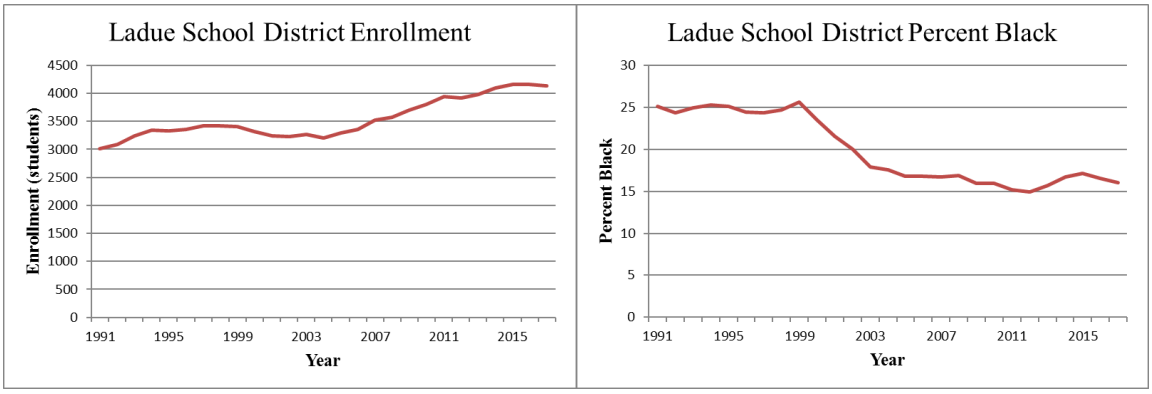

Figure 43: Ladue School District graphs

Ladue School District is located in central St. Louis County. Figure 43 portrays that the school district enrollment increased as the percent black of the enrolled student population decreased. The enrollment increased by 37% from 3,014 students in 1991 to 4,129 students in 2017; this is the highest percent increase in enrollment among St. Louis area school districts. Most of this increase in enrollment happened after 2004. The year with the highest enrollment was 2016, with 4,165 students; the year with the lowest enrollment was 1991. The percent black of the enrolled student population decreased from 25.18% in 1991 to 16.01% in 2017; this is the fifth highest decrease in percent black. Most of that decrease in percent black happened between 1999 and 2012. The year with the highest percent black was 1999, with 25.63%; the year with the lowest percent black was 2012, with 14.94%. Ladue became segregated in 1992, 1996 through 1998, and from 2000 through 2017.

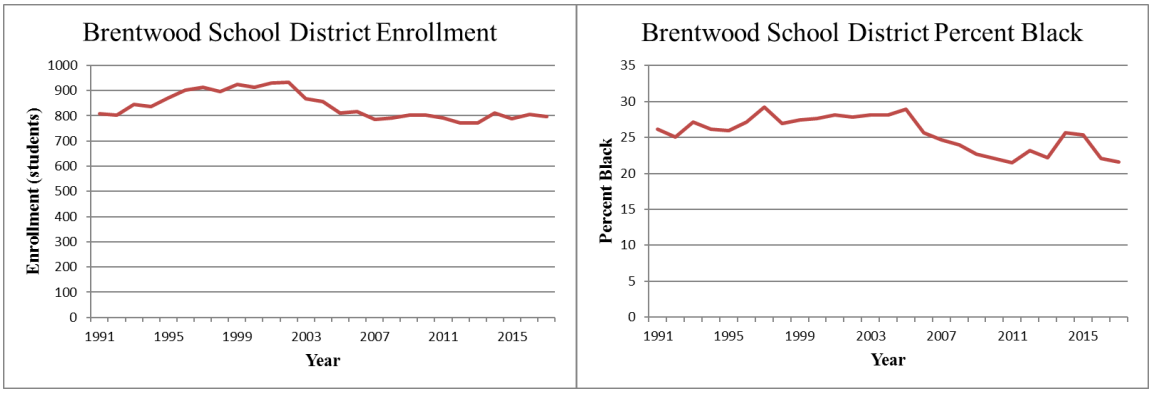

Figure 44: Brentwood School District graphs

Brentwood School District is located in eastern St. Louis County. Figure 44 portrays that the school district enrollment slightly decreases as the percent black of the enrolled student population decreased. The enrollment decreased by 1% from 807 students in 1991 to 797 students in 2017. The year with the highest enrollment was 2002, with 932 students; the years with the lowest enrollment were 2012 and 2013, with 772 students. The percent black of the enrolled student population decreased from 26.15% in 1991 to 21.58% in 2017. The year with the highest percent black was 1997, with 29.24%; the year with the lowest percent black was 2011, with 21.46%. Brentwood School District's graphs do not have a uniform change in percent black or in enrollment. Brentwood schools became segregated after 2006—with the exception of 2014 and 2015.

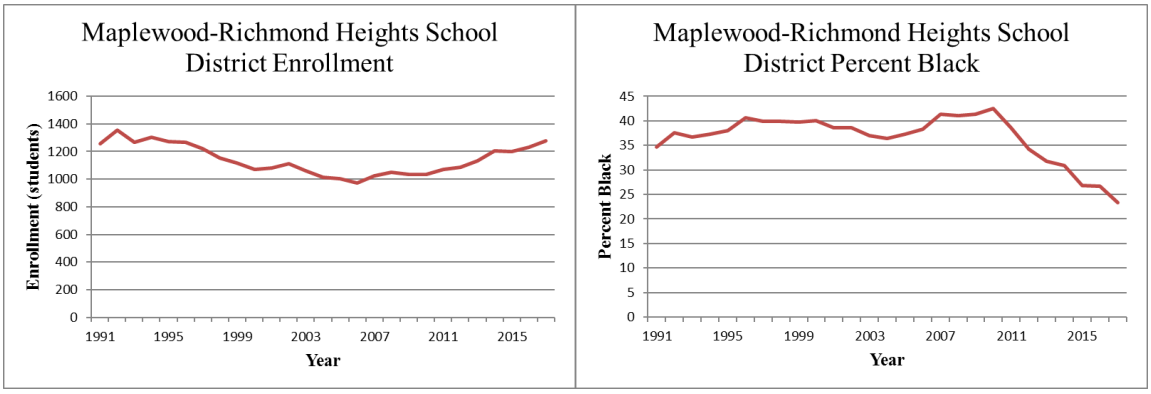

Figure 45: Maplewood-Richmond Heights School District graphs

Maplewood-Richmond Heights School District is located in eastern St. Louis County and shares a border with St. Louis City School District. Figure 45 portrays that the school district enrollment increased as the percent black of the enrolled student population decreased. The graphs do not have a uniform change; furthermore, before the mid-2000s, the enrollment decreased as the percent black increased. The enrollment increased by 2% from 1,254 students in 1991 to 1,279 students in 2017. The year with the highest enrollment was 1992, with 1,353 students; the year with the lowest enrollment was 2006, with 971 students. There is a decrease in enrollment before 2006, and an increase in enrollment after. The percent black of the enrolled student population decreased from 34.69% in 1991 to 23.38% in 2017; this is the third highest decrease in percent black. The year with the highest percent black was 2010, with 42.46%; the year with the lowest percent black was 2017. The decrease in percent black mostly happened from 2010 until 2017. Maplewood-Richmond Heights became segregated in 2017.

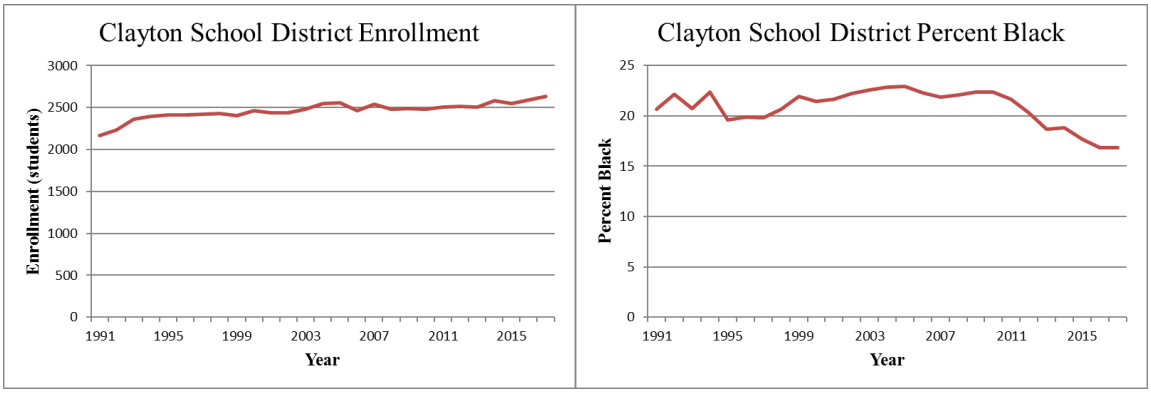

Figure 46: Clayton School District graphs

Clayton School District is located in eastern St. Louis County and shares a border with St. Louis City School District. Figure 46 portrays that the school district enrollment increased as the percent black of the enrolled student population decreased. The enrollment increased by 22% from 2,163 students in 1991 to 2,637 students in 2017; this is the fifth highest percent increase in enrollment among St. Louis area school districts. The year with the highest enrollment was 2017; the year with the lowest enrollment was 1991. The percent black of the enrolled student population decreased from 20.67% in 1991 to 16.84% in 2017. The year with the highest percent black was 2005, with 22.95%; the year with the lowest percent black was 2016, with 16.83%. Clayton School District's graphs do not have a uniform change in percent black. There is a larger decrease in percent black after 2010. Clayton School District became increasingly more segregated during this time period.

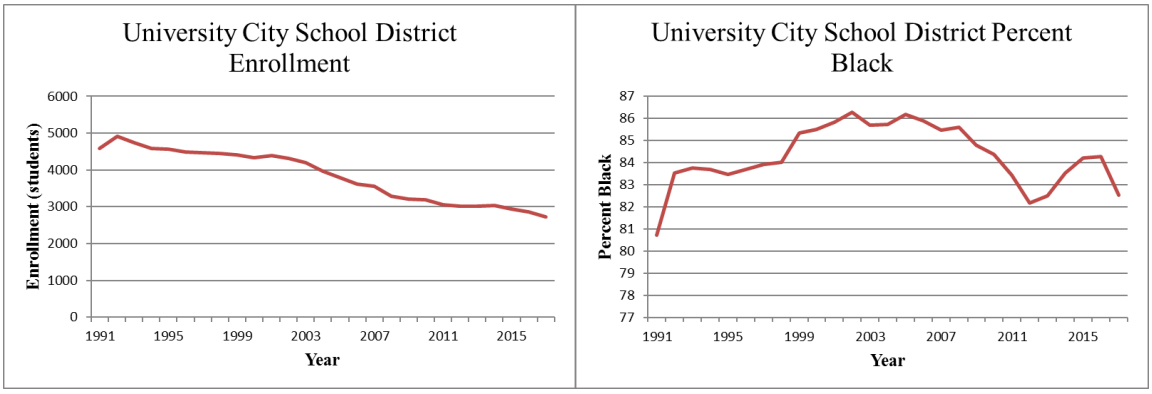

Figure 47: University City School District graphs

University City School District is located in northeastern St. Louis County and shares a border with St. Louis City School District. Figure 47 portrays that the school district enrollment decreased as the percent black of the enrolled student population increased. The change in percent black is not uniform—there is a decrease in percent black from 2005 to 2012, and in 2017—but there is an overall increase in percent black. The enrollment decreased by 40% from 4,587 students in 1991 to 2,732 students in 2017; this is the fourth highest percent decrease in enrollment among St. Louis area school districts. The year with the highest enrollment was 1992, with 4,912 students; the year with the lowest enrollment was 2017. The percent black of the enrolled student population increased from 80.73% in 1991 to 82.54% in 2017. The year with the highest percent black was 2002, with 86.28%; the year with the lowest percent black was 1991. University City was segregated during this time period; unlike the previous school districts—which had below 25% black—University City's percent black is considered segregated based on my definition because it has above 50% black.

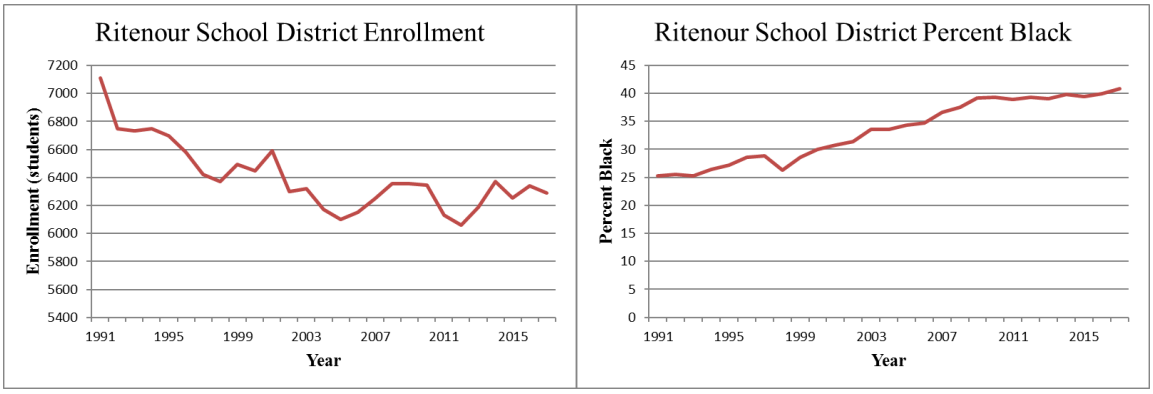

Figure 48: Ritenour School District graphs

Ritenour School District is located in northern St. Louis County. Figure 48 portrays that the school district enrollment decreased as the percent black of the enrolled student population increased. The change in enrollment was not uniform, but there is an overall decrease in the enrollment. The enrollment decreased by 12% from 7,110 students in 1991 to 6,289 students in 2017. The year with the highest enrollment was 1991; the year with the lowest enrollment was 2012, with 6,059 students. The percent black of the enrolled student population increased from 25.3% in 1991 to 40.83% in 2017; this is the fifth highest increase in percent black. The year with the highest percent black was 2017; the year with the lowest percent black was 1991. Ritenour School District was not segregated throughout this time period because the percent black of the student population was between 25% and 50%.

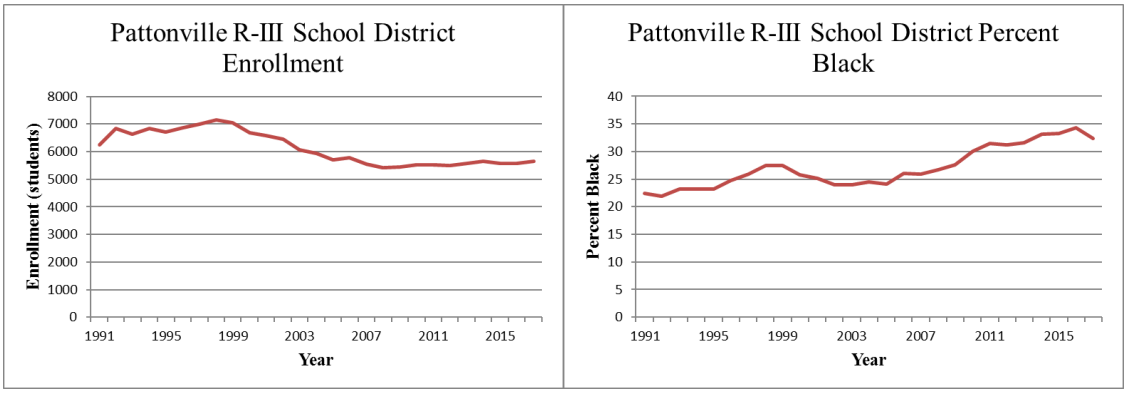

Figure 49: Pattonville R-III School District graphs

Pattonville R-III School District is located in northwestern St. Louis County. Figure 49 portrays that the school district enrollment decreased as the percent black of the enrolled student population increased. The enrollment decreased by 9% from 6,252 students in 1991 to 5,660 students in 2017. The year with the highest enrollment was 1998, with 7,145 students; the year with the lowest enrollment was 2008, with 5,430 students. The percent black of the enrolled student population increased from 22.39% in 1991 to 32.35% in 2017. The year with the highest percent black was 2016, with 34.26%; the year with the lowest percent black was 1992, with 21.91%. Pattonville was segregated in 1991 because it had below 25% black, but was not segregated from 1997 through 2001, or after 2006.

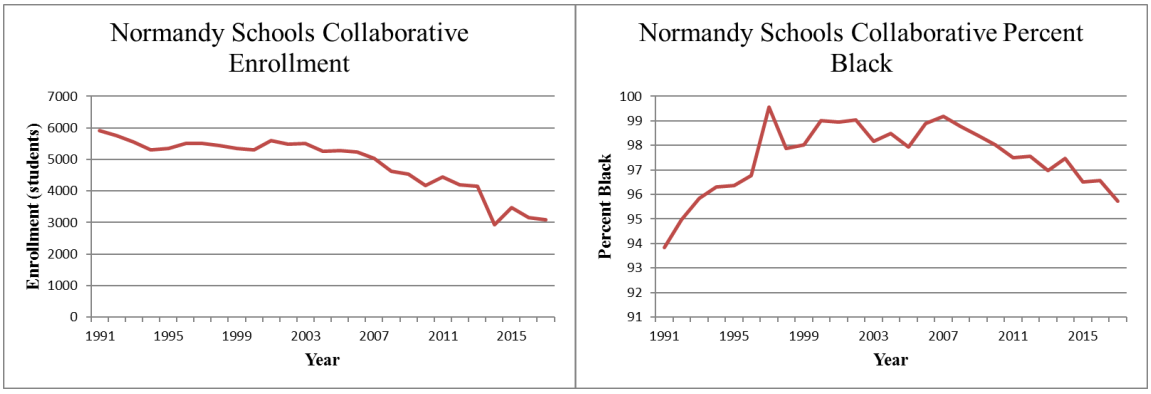

Figure 50: Normandy Schools Collaborative graphs

Normandy Schools Collaborative is located in northeastern St. Louis County and shares a border with St. Louis City School District. Figure 50 portrays that the school district enrollment decreased as the percent black of the enrolled student population increased. The change in the percent black is not uniform—there is a general decrease in percent black after 1997—but there is an overall increase in the percent black. The enrollment decreased by 48% from 5,914 students in 1991 to 3,083 students in 2017; this is the second highest percent decrease in enrollment among St. Louis area school districts. There was no enrollment spike in 2011 when Normandy and Wellston merged; this is likely due to Wellston's relatively low enrollment. The year with the highest enrollment was 1991; the year with the lowest enrollment was 2014, with 2,936 students. The percent black of the enrolled student population increased from 93.85% in 1991 to 95.72% in 2017. The year with the highest percent black was 1997, with 99.95%; the year with the lowest percent black was 1991. Normandy Schools remained segregated throughout the time period.

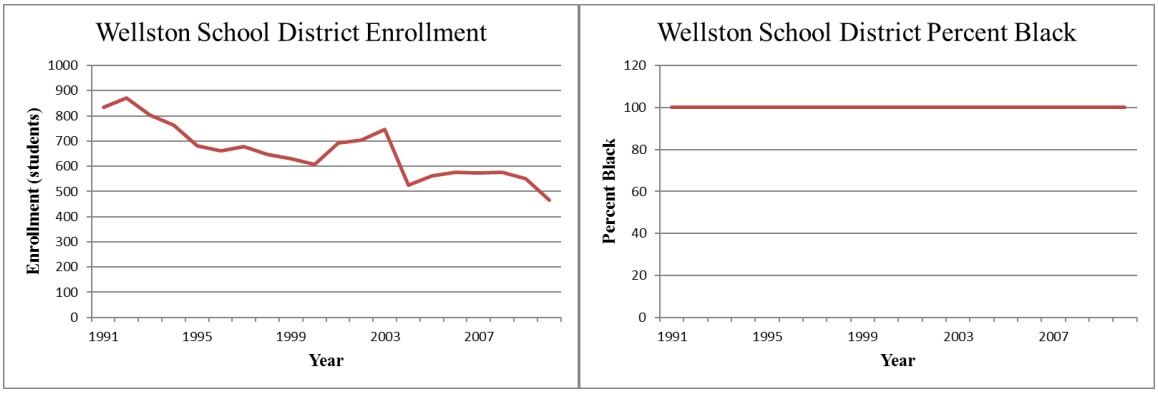

Figure 51: Wellston School District graphs

Wellston School District was located in northeastern St. Louis County and shared a border with St. Louis City School District until it was merged into the Normandy Schools Collaborative district. Figure 51 portrays that the school district enrollment decreased as the percent black of the enrolled student population stayed at 100%. The change in enrollment is not uniform, but there is an overall decrease in the enrollment. The enrollment decreased by 44% from 834 students in 1991 to 466 students in 2010; this is the third highest percent decrease in enrollment among St. Louis area school districts. The year with the highest enrollment was 1992, with 872 students; the year with the lowest enrollment was 2010. Missouri's Department of Elementary and Secondary Education reported that the percent black of the enrolled student population was 100% from 1991 to 2010.

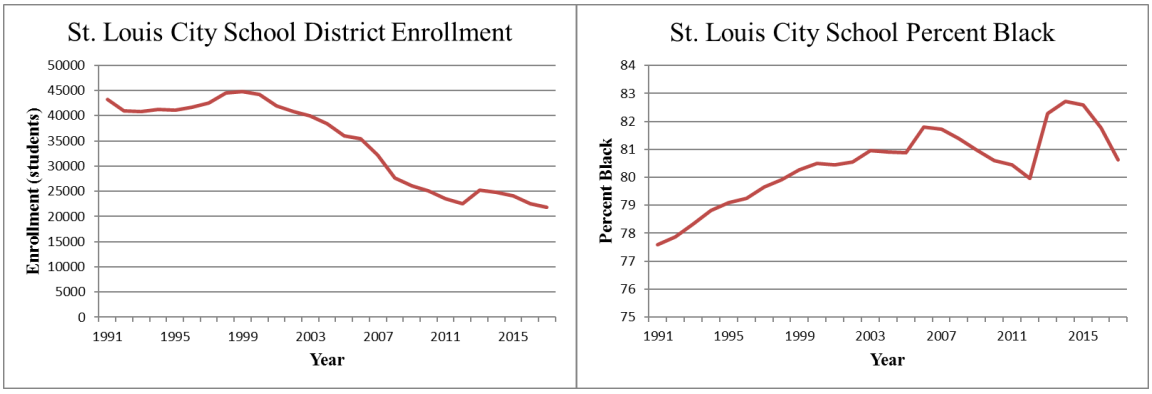

Figure 52: St. Louis City School District graphs

St. Louis City School District is located east of St. Louis County. Figure 52 portrays that the school district enrollment decreased as the percent black of the enrolled student population increased. The enrollment decreased by 50% from 43,284 students in 1991 to 21,754 students in 2017; this is the highest percent decrease in enrollment among St. Louis area school districts. The year with the highest enrollment was 1999, with 44,782 students; the year with the lowest enrollment was 2017. The percent black of the enrolled student population increased from 77.6% in 1991 to 80.63% in 2017. The year with the highest percent black was 2014, with 82.71%; the year with the lowest percent black was 1991. St. Louis City School District's change in percent black is not uniform, but there is an overall increase in the percent black. There was a spike in enrollment in 2013, and a dip in percent black. St. Louis became increasingly more segregated throughout this time period.

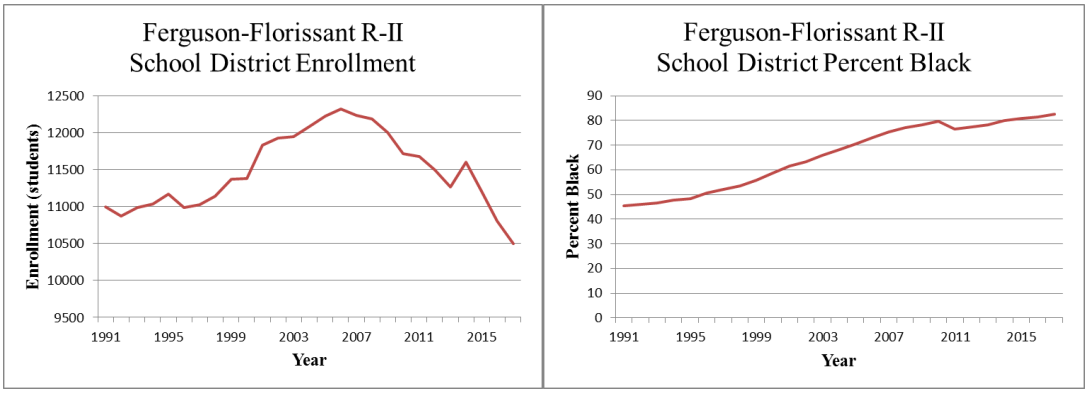

Figure 53: Ferguson-Florissant R-II School District graphs

Ferguson-Florissant R-II School District is located in northern St. Louis County. Figure 53 portrays that the school district enrollment decreased as the percent black of the enrolled student population increased. The change in the enrollment is not uniform—there is an increase in enrollment before 2006—but there is an overall decrease in the enrollment. The enrollment decreased by 5% from 11,000 students in 1991 to 10,495 students in 2017. The year with the highest enrollment was 2006, with 12,319 students; the year with the lowest enrollment was 2017. The percent black of the enrolled student population increased from 45.45% in 1991 to 82.63% in 2017; this is the second highest increase in percent black. The year with the highest percent black was 2017; the year with the lowest percent black was 1991. Ferguson-Florissant became segregated when the percent black increased above 50% in 1996.

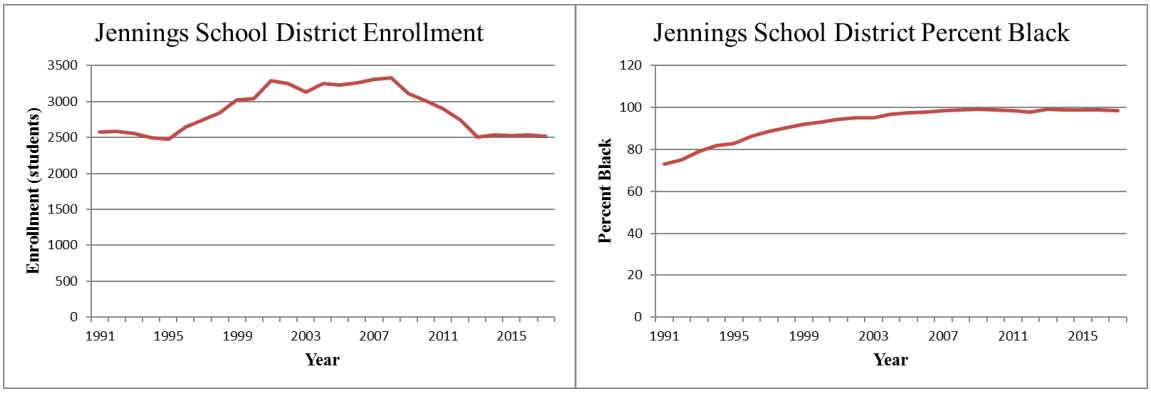

Figure 54: Jennings School District graphs

Jennings School District is located in northeastern St. Louis County and shares a border with St. Louis City School District. Figure 54 shows that the school district enrollment slightly decreased as the percent black of the enrolled student population increased. The change in enrollment is not uniform; the enrollment of Jennings School District increased overall from 1991 to 2001, but decreased overall from 2001 to 2017. The enrollment decreased by 2% from 2,574 students in 1991 to 2,521 students in 2017. The year with the highest enrollment was 2008, with 3,325 students; the year with the lowest enrollment was 1995, with 2,479 students. The percent black of the enrolled student population increased from 73.12% in 1991 to 98.45% in 2017; this is the fourth highest increase in percent black. The year with the highest percent black was 2009, with 99.2%; the year with the lowest percent black was 1991. Jennings became increasingly more segregated throughout the time period.

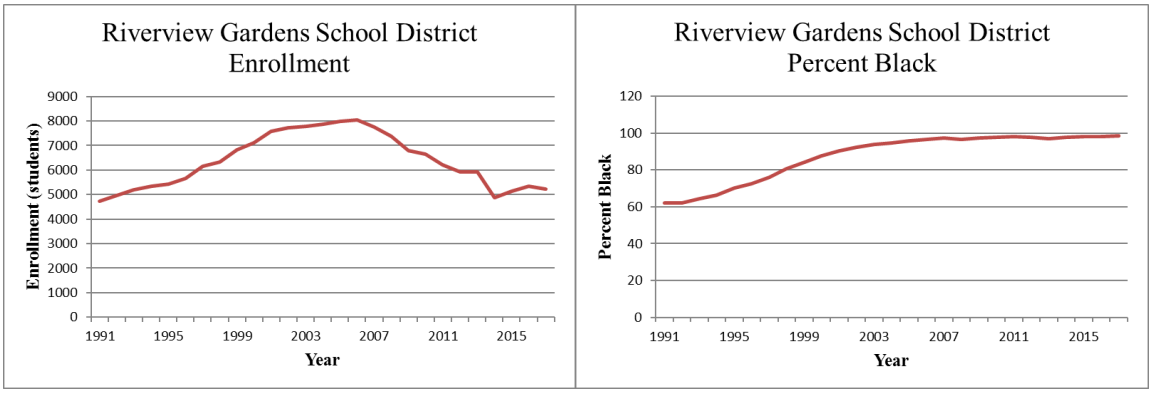

Figure 55: Riverview Gardens School District graphs

Riverview Gardens School District is located in northeastern St. Louis County and shares a border with St. Louis City School District. Figure 55 portrays that the school district enrollment increased as the percent black of the enrolled student population increased. The change in enrollment is not uniform; the enrollment of Jennings School District increased overall from 1991 to 2006, but decreased overall from 2006 to 2017. The enrollment increased by 10% from 4,727 students in 1991 to 5,213 students in 2017. The year with the highest enrollment was 2006, with 8,032 students; the year with the lowest enrollment was 1991. The percent black of the enrolled student population increased from 62.2% in 1991 to 98.41% in 2017; this is the third highest increase in percent black. The year with the highest percent black was 2017; the year with the lowest percent black was 1992, with 61.91%. Riverview Gardens became increasingly segregated from 1991 to 2017.

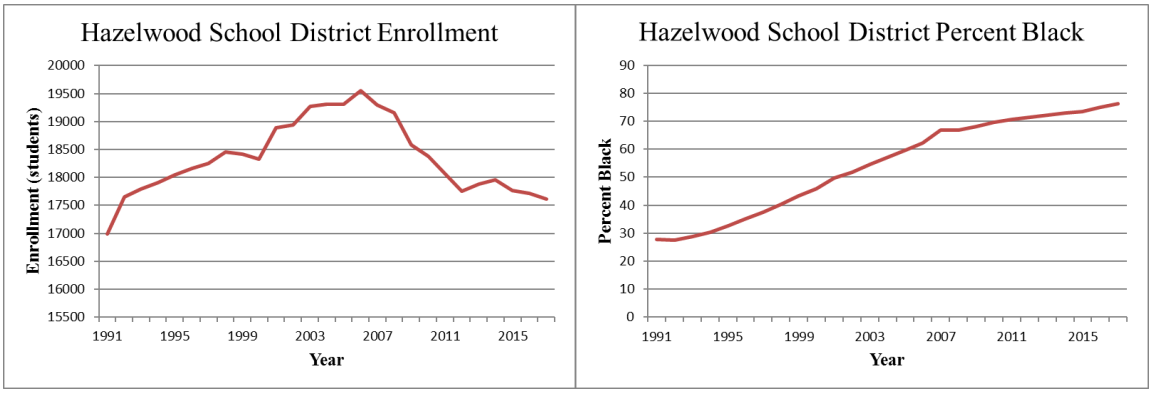

Figure 56: Hazelwood School District graphs

Hazelwood School District is located in northern St. Louis County and shares a border with St. Louis City School District. Figure 56 portrays that the school district enrollment increased as the percent black of the enrolled student population increased. The change in enrollment is not uniform; like the enrollment of Jennings School District, the enrollment of Hazelwood School District increased overall from 1991 to 2006, but decreased overall from 2006 to 2017—similar to Riverview Gardens, Jennings, Ferguson-Florissant, and Hancock Place. The enrollment increased by 4% from 16,985 students in 1991 to 17,610 students in 2017. The year with the highest enrollment was 2006, with 19,383 students; the year with the lowest enrollment was 1991. The percent black of the enrolled student population increased from 27.75% in 1991 to 76.34% in 2017; this is the highest increase in percent black. The year with the highest percent black was 2017; the year with the lowest percent black was 1992, with 27.43%. Hazelwood became segregated after 2002.

VITA

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