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ATTRIBUTES OF PLACE ASSOCIATED WITH SCHOOL QUALITY:
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ATTRIBUTES OF PLACE ASSOCIATED WITH SCHOOL QUALITY: A MICHIGAN CASE STUDY

By

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ABSTRACT

ATTRIBUTES OF PLACE ASSOCIATED WITH SCHOOL QUALITY:
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School quality and the measurements of student, school, and district achievement have typically been estimated without considering physical attributes of place. Such studies have used variables for socioeconomic status, teacher salaries, time spent in the classroom, pupil-teacher ratio, and others to explain student achievement. This thesis introduces place attributes and their impact on student proficiency at the school district level in Michigan while controlling for common variables utilized throughout previous literature. The attributes of place introduced include natural amenities, such as the total area of lakes and publicly-owned open space, the total length of rivers, and adjacency to the Great Lakes, and built amenities, such as the presence of a university or museum and an amusement or recreational facility. Results indicate a positive relationship between combined math and reading proficiency and open space, rivers, and Great Lakes adjacency and a negative relationship with the presence of a university or museum and lake acreage at the seventh grade level. The presence of amusement or recreational opportunities was insignificant. No place attribute variables were significant in the fourth grade model. The results imply that attributes of place significantly contribute to combined math and reading proficiency at the seventh grade when introduced in a school quality function.

Dedicated to my wife Agustina, my Mom, and my sister Meg. Thank you for the unconditional support and inspiration you have given me throughout.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

I. INTRODUCTION

Public schools are rooted in communities and are heralded for being community anchors (Beaumont, 2003). Schools provide more than just a place to educate future adults. They provide identity both civilly, for the community, and personally, for all those who enter its doors, peruse its library, or socialize on its playground. To children, a school can seem a burden or an obligation. To adults, it is a place to remember, one that prompts reminiscence.

On the surface, a public school is a seemingly permanent structure, one constructed of bricks and mortar, one forever occupying the city block. Behind the surface, however, it represents a complex web of policies, politics, finances, economics, and geography that elicit the ultimate questions and concerns for public education. It includes the concerned parents, the devoted teacher, the compassionate guidance counselor, the stern principal, and the elected school board. At the center of this web are the children; all decisions, concerns, and efforts transmitted between education stakeholders must ultimately concern them.

Politics can be beneficial and can be a hindrance but will be omnipresent in the decisions made and policies implemented in the public schooling system (McClelland & Schneider, 2004; Norton, 2007). By accepting that schools are at the heart of communities and tomorrow's future, academics can improve research and begin to better understand what impacts policy can have on public education, what progress can be made in urban and rural school districts, and how best to equalize the equity of opportunity between the wealthiest and poorest of school districts.

Since the middle to late 1960's, school quality became a popular focus of

academic research and policy concerns. Unsurprisingly, urban, suburban and rural schools across the country have faced, and still do face, the effects of social and economic challenges. Such challenges, including increasing unemployment rates, racial segregation, declining home values, shrinking government revenues, crime, and blight, have negatively impacted public school quality, which has thus created one of the strongest urban "push" factors. At the same time, as socio-economically advantaged families move away from cities, the influence of suburban lure as a "pull" factor becomes increasingly stronger (Jargowsky, 2001; Burchell et al., 2002). The combination of push and pull factors within the urban-suburban context perpetuates the cycle of urban decline and suburban emergence. Therefore, a community should not initiate any revitalization initiative without seriously considering how to address school quality.

As the literature review that follows reveals, families strongly consider the quality of schools among their location choices. Typically, the best schools are located in suburbs of major metropolitan areas (Sander, 2006) and, more often than not, undergo positive enrollment and population growth. Some locations, however, offer varying levels of *place attributes*. Such attributes may be natural, such as lakes or rivers, or built, such as universities or parks. These attributes undoubtedly impact location decisions, school quality, and thus define communities. Attributes of place are geographically rooted in a location. But location does not define a community or its people. Instead, communities identify with *places* and there are specific attributes that compose and define these places.

It is with this backdrop of the importance of education, public schools, and place to communities and revitalization efforts that this thesis will address the impact of place

attributes on school quality through empirical analysis of school districts in Michigan. This is not to be read as a policy recommendation or as a flawless analysis of the issue, but it should be read as a means of bringing to light some of the subtle differences among school districts and the way that they "produce" education. It should inform academics, community leaders, politicians, and members of the education community. And lastly, it should be read as an investigation into the ways we, as a community of learners, can assist in improving places and communities so that the education opportunities of children approach parity with respect to zip code.

In taking this step we ought to realize that there are many vested interests in the public education system and therefore must accept that any level of analysis is imperfect and can be used to achieve different ends. Since the 1960's, multiple disciplines have taken a vested interest in the production of education and the variety of differences that impact achievement (i.e. Coleman et al., 1966; Cain & Watts, 1970; Hanushek, 1979; Finn & Achilles, 1990) . Sociologists, interested in the family background differences or community characteristics that influence educational achievement, have also been involved (McWayne et al., 2007). Educational researchers have examined class sizes, curricula and administration, and some have addressed the production of education as it is utilized by other disciplines (Finn & Achilles, 1999; Card & Krueger, 1998). Public finance and political scientists have been interested in organizational structures and the decision making process (Bidwell & Kasarda, 1975; Fowler & Walberg, 1991). Given the nature of academia, there are discrepancies among disciplines appearing throughout the literature. It can be expected that professionals in education may feel threatened by a sociologist's conclusion that school district expenditures are not significant in predicting

educational achievement (Coleman et al., 1966). But, in academia a multidisciplinary approach to research should not be competitive in the sense that it creates divisions, but in a way that it adds to knowledge, regardless of personal values, bias, policy, or discipline. Therefore, this paper takes advantage of the myriad disciplines involved in this area of research. Synthesizing the research across disciplines should shed more light on public education, at least in the case of Michigan.

II. PROBLEM STATEMENT

School quality is not equal across the State of Michigan. Poverty, education levels, and place attributes contribute to this imbalance. Economic development initiatives seemingly strive to revitalize urban areas by focusing on economic and social issues over educational ones. Literature will show, however, that school quality is directly related to location decisions, home prices, and overall prosperity (Bayoh et al., 2006; Brasington, 1999; Zahirovic-Herbert & Turnbull, 2008). Thus, investing in schools is a way to invest in revitalization. A sizable divide exists between planning for education and planning for communities and places. Until this divide is closed, revitalization efforts and school quality improvement efforts will be short-sighted and short-term at best.

School quality is among the leading factors of household choice decisions (Clark & Herrin, 2000; Bayoh et al., 2006; Figlio & Lucas, 2004) and housing values are positively related to school quality (Brasington, 1999). Considering these factors, choosing to reside in a school district with quality schools makes sense economically, through a home and property investment, and socially through the investment in quality

education for children in the family. Thus, urban revitalization will be ineffective and recalcitrant unless the necessary investments are made in improving education alongside the traditional mechanisms.[1] Improving education, however, is not solely the responsibility of cities and their regions. In Michigan, public school districts receive funds from the federal, state and local government.[2] Literature below (Chapter IV, Section B) highlights the conflict between local units of government in planning for public schools, which exacerbates the inequalities between districts (and schools) thus perpetuating the push-pull cycle and dissuading new residential location in urban districts.

The problem of deficient school districts is not limited to urban districts. While there are many initiatives and programs for improving urban education systems, housing, employment opportunities, income, and for promoting new economic development, the fact remains that the problem of poorly performing public schools does not exist solely because urban schools are *bad.* The problem of poor school quality is more complex and is related to the regional interplay of school districts and various socioeconomic conditions.

Educational resources are distributed primarily by the state[3] and differences in funding are not due to location but rather policy. Thus, as the public and policymakers plea for urban revitalization efforts and plans for improving urban school districts, it is necessary to accept that educational opportunity ought to be supplied more equally to all school districts. A new focus and understanding must be reached in order to truly aid the

[1] Such as condominium development, residential redevelopment, tax breaks, and funding community-based organizations.
[2] Typically, the school district is the governmental entity that receives revenue via locally enacted millages.
[3] In this case, Michigan, as in other states as well.

underperforming districts, whether they are technically classified as urban, suburban, small town, or rural. As the literature below reveals, higher expenditures generally do not result in better academic performance. Thus, simply "throwing money at schools" is not a viable option for improving school quality in under-performing districts, but improving quality in urban schools is paramount for raising housing values, and in so doing, increasing property tax revenues for funding (capital) projects within the school district (Weimer & Wolkoff, 2001), thereby creating a cycle of reinvestment in schools and the community.

The literature below should adequately frame the challenges not only school districts face, but also the communities they serve. Studies on school sprawl, which thus far are anecdotal, are beginning to make ripples in the literature (Passmore, 2002; Beaumont, 2002; Gurwitt, 2004; Vincent, 2006). School sprawl is roughly defined as the tendency for school districts to build new facilities at the periphery of cities and usually in "green fields" or spaces with vast open space (Passmore, 2002). The reason school sprawl becomes important in the production of education is because of its similarity to urban sprawl, which has produced many of the same kinds of effects by spreading out population, employment, and income that once resided in cities to newly built areas–the suburbs.

Whereas urban sprawl geographically broadened population growth and job opportunities, thereby dispersing income levels through location choice, school sprawl has worked in conjunction, which has benefited some districts and harmed others. In other words, by households expressing their preference for land, lower taxes, safety, and good schools, the children in those households are sorted based on these preferences.

Those households who cannot afford to move, however, are left behind (Levin, 1998; Saporito, 2003). Essentially, the failing urban school districts of Michigan were left behind as households, employment, income, and children left for greener pastures.

Recent studies provide evidence that planning and policy decisions that were made regarding urban form, development, infrastructure, and school siting have had an impact on children's health and educational achievement. Talen (2001) found that long bus rides negatively affected student achievement. Safety concerns regarding how children get to school have pressed the need for safer routes to school and programs to address safety (Boarnet et al., 2005). Smart Growth advocates have pushed for reforms that emphasize school planning with regard to redevelopment and development plans (Baum, 2004; Kinnell, 2003; Romeo, 2004). Asthma rates have increased 160% in children up to four years old and 74% in children aged 5 to 14 (CDC, 1998). Active commuting to school (walking or biking) has declined by 27.8% from 1969 (McDonald, 2007). In 1969, 48% of students biked to school; today only 1% do (Ewing et al., 2003). The prevalence of and risks associated with childhood obesity are becoming more pronounced and urban form is increasingly found to be related to this trend (Sallis & Glanz, 2006; McMillan, 2007).

Each of the health and safety topics just mentioned hinge on development and growth of communities, which are sustained by a place and its natural and built attributes. From the literature review below, one can conclude that most studies were not able to capture the impact place-based factors have on educational achievement. One reason for exclusion of the topics listed above is simply the lack of data on many of the factors that actually combine to create what is known as a community or a place. Moving forward,

this thesis utilizes place-based characteristics to examine educational proficiency at the school district level in Michigan.

III. OBJECTIVES

The primary goal of this thesis is to uncover policy perspectives that could produce improvements in school quality, which as a consequence, would induce the greatest responses in urban revitalization efforts through attracting more residents and families to cities. Using census, public school district, and place-based data, I will attempt to uncover the relationships between school district achievement and the factors that influence it in these districts. Those familiar with Michigan school districts know that proficiency rates are not observed equally across the state (See Figure 1). What factors influence these differences? This thesis will empirically answer that question and will introduce and explore the concept of *place* in school districts and its impact on proficiency.

The overarching objective of this thesis is to measure the relationship between place attributes and test score proficiency, controlling for socioeconomic characteristics, school inputs, and location status[4] during the year 2000. In other words, what added effect do place attributes exert on test scores when controlling for factors like race, poverty, education level, instructional expenditures, and urban or rural status? Policy implications will arise in the analysis portion, where model improvements that result from adding place-based variables in the school quality model will be observed. In exploring these relationships, I will present an exploratory model that examines test score achievement based on school district socioeconomic and education input variables

[4] School district classified as urban, suburban, or rural.

combined with a place-based factor, which will examine the impact of amenities, such as the presence of a college or university or the amount of open space, has on proficiency while controlling for the previously mentioned categories in the State of Michigan. Having a better understanding of such relationships should assist in determining optimal funding allocation for comprehensive urban development initiatives, thus limiting the cyclic push-pull process that degrades neighborhoods, cities, school districts, and schools.

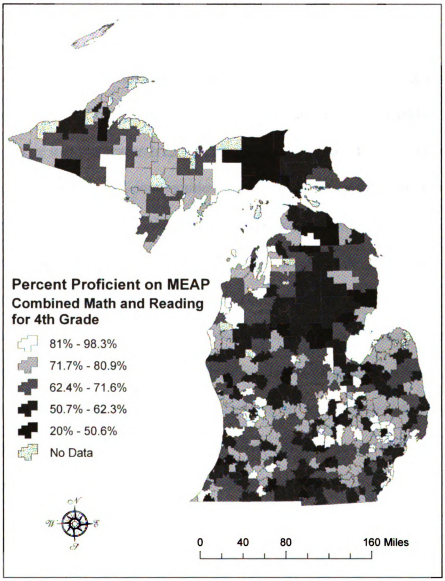

Figure 1: Percent proficient in combined math and reading for 4th grade.

To my knowledge, there are no published articles that have attempted to explore the relationships the way I propose at this unit of analysis. Many studies have examined education outcomes as functions of socioeconomic status (SES) and/or educational inputs, the most influential of which are outlined below. My rationale, therefore, for adding the place-based variable is that amenities, exemplified through community and natural features, play a major role in educational output. Why are rural schools similar to urban schools in terms of proficiency rates on the Michigan Educational Assessment Program (MEAP) exam? Surely, "education is produced differently in urban and rural areas and across different urban areas" (Brasington, 2002, p. 143; Reeves & Bylund, 2005). During a time of budget shortfalls, fiscal stress, and threats to spending on education, I hope that this research can contribute not only to academic literature, but also to Michigan's school districts, communities, and children. Through quantitative research, I seek to empirically answer questions regarding test score proficiency inequalities amongst Michigan school districts while posing new questions and new directions for academic research related to the role of place and school quality.

Place and community factor in the determination of educational proficiency. Place, as it is referred to and examined in this piece, is not defined as a census designated place.[5] Instead, it is referred to as a tangible amenity or characteristic that gives a community character, identity, recreation, or culture. Understanding place and community through school quality, SES, and community characteristics is paramount for

[5] "A Place is a term used by the Census Bureau that includes both Incorporated Places (concentrations of populations having legally defined boundaries) and Census Designated Places (concentrations of population that are locally identifiable by name but not legally incorporated). A place can be of any size population or population density, because it is based on an administrative boundary, not statistical criteria." http://www.fhwa.dot.gov/planning/census/faqa2cdt.htm)

moving Michigan and the nation into the innovation-driven New Economy[6] by providing quality public education thereby preparing children to be successful and happy in whatever they choose to do, regardless of geographic boundaries.

Thus, citizens, school district officials, community leaders, and academics must ask: What are the measurable effects on test score proficiency of a variety of socioeconomic, district, and place-based characteristics? How, and which, socioeconomic characteristics affect school quality and constitute the extent to which school quality is a strong push factor in urban to suburban migration? Understanding these relationships is paramount to being able to establish and promote strong schools in healthy communities that will be able to educate today's youth in a way that they become productive future adults. By understanding such relationships, one should be able to conclude what impact place and socioeconomic status have on school performance.

We all have different definitions of place. But inherent in its definition there must exist the natural or built amenities that make a location desirable, beautiful, or undesirable. Some may prefer water amenities when making a residential location choice whereas others prefer warmth and sunshine. Some aspects of place, as I am defining it, can be measured and others cannot. Obviously, there are some components of a place that just make it great, which may include cultural and social characteristics combined with natural features or amenities. Using available data on natural and built amenities, I will introduce six place-based variables into the school quality function. These variables include the presence of a university or museum and recreational or amusement opportunity, which are classified here as built amenities. Natural amenities used here

[6] Adelaja et al. (2009) define the New Economy as "a global, entrepreneurial and knowledge-based economy, wherein business success comes increasingly from the ability to incorporate knowledge, technology, creativity and innovation into products and services" (p. iii).

include total length of streams, area of lakes, area of publicly owned open space, and whether or not the school district borders any of the Great Lakes.

The introduction of these variables is the primary contribution to the literature that this thesis makes. I hypothesize that education at the district level is not solely a function of socioeconomic status, instructional expenditures, and school district conditions.[7] Rather, some of the place and community based factors that innumerably and subtly contribute to education will be better understood, since, "It takes an entire community to raise a child" (African Proverb).

IV. LITERATURE REVIEW

The remainder of this piece will examine the relevant literature, describe the study area's history and organization, elaborate on the theoretical framework, describe the data used in this study, express the methods used on the data, discuss the results, and conclude with an emphasis on place and community in school districts. But first, it is appropriate to define some terminology.

School quality has been defined in different ways. For this thesis, school quality refers to test scores, measured by the percent of students scoring proficient on math and reading exams. Hence, school quality, proficiency, and attainment are used interchangeably. The vital theme to recognize throughout is that quality is typically defined as some measure of proficiency and the empirical models that have attempted to predict quality have been executed using the educational production function, which is a methodological procedure for predicting educational outcomes, school quality, and achievement based on a set of inputs.

[7] Such as average pupil-teacher ratio and urban, suburban, or rural status.

Before exploring the production function for education, some background literature is presented that frames the issue of good versus poor school quality and the causes of this disparity. Given that the physical and societal landscapes of Michigan have changed drastically over time, the topics of educational inequalities and urban and school sprawl are introduced as background to the research that explicitly measure school quality via the production function of education.

A. Understanding the Causes of School District Inequalities

The education system in the U.S. is incredibly diverse and the extent to which school districts are segregated based on SES, school performance, race and ethnicity is a concern for societal opportunity, equality (Clapp et al., 2008), and health (Muller, 2002). From an economic perspective, education is of vital importance to cities, regions, states and countries because an educated population encourages and promotes economic activity, thus leading to increased competitiveness, increased wages, increased employment stability, and social equality (Hanushek & Kimko, 2000; Hanushek, 2002; Carnevale & Desrochers, 2002; Gradstein & Justman, 2002). Being educated allows one to adapt more quickly to changes in technology and when facing adversity (Nelson & Phelps, 1966). Education is an "important driver of upward mobility" and is believed to determine an adult's future socioeconomic status (Rouse & Barrow, 2006, p. 100). Simply stated, "people with more education have higher wages" (Pritchett, 2001, p. 368).

School quality also influences residential location choices. Bayoh et al. (2006) found that "school quality, as measured by the average combined Math and English scores, has by far the largest marginal effect on household choice probabilities" (p. 114). Clark & Herrin (2000) found that households perceive some school districts to be better

than others, which is reflected in housing price premiums. Moreover, the housing market is acutely responsive to information supplied by "school report cards" (Figlio & Lucas, 2004). Households engaging in moves, whether intra-district, inter-district, or regionally will impact local school districts and local economies. Real estate agents are sure to inform potential buyers of the great school district a house is in (Zahirovic-Herbert & Turnbull, 2008). School districts even run radio and television advertisements vying for families to move within their borders or to attract students with school of choice programs.

Families looking to buy a house are risk-averse and look to the investment in their house as well as the investment in their child's education when making location choice decisions (Ibid). Finding a house in a quality school district would minimize certain risks while maximizing investment potential. Margulis (2001) investigates the changes in inner-ring suburbs around Cleveland.

> "The older, more densely settled contiguous suburbs are experiencing a real estate transition. Total valuations per pupil are falling because high effective millages act as a location disincentive to businesses and high-income households. High effective millages are destabilizing the real property tax base as non-residential owners relocate to escape high taxation and as the tax burden to support local school districts falls more heavily upon older residential properties. Although housing resale prices are currently sustainable, high property taxes and declining student test performance are slowly undermining resale prices" (p. 474).

Margulis' study of the Cleveland area can be applied to other regions in the U.S. to describe how older suburbs, once the growth frontier, are now facing challenges similar to central cities: higher millage rates that discourage residents and businesses from locating there along with the shift from a strong tax base to a weak one balanced on the remaining residents and an older housing stock. Accordingly, "central city housing values are highly elastic with respect to improvements in elementary school quality

(Weimer & Wolkoff, 2001, p. 251). Sander (2006) notes that "central cities and suburbs of large metropolitan areas of the U.S. have significantly higher levels of educational attainment" (p. 323) and those (respondents) "who grew up in a suburb are more than twice as likely to acquire a college degree" than those from a rural area (p. 324). While urban school districts face many challenges, the larger metro-areas fair better on average than rural districts. Therefore, if metro-areas fair better than rural areas but urban school districts struggle, then this would indicate that suburban school districts dramatically make up for the achievement deficiencies of urban districts.

Just as school district quality can affect the local economy, school siting and location decisions also have social impacts. "School locations and the boundaries that create their constituencies dramatically affect the spatial interaction between home, school, and community" (Talen, 2001, p. 465). As early as kindergarten, test score gaps are observed between white, black, and Hispanic children, which can be attributed to SES and resources (Duncan & Magnuson, 2005). Furthermore, neighborhood variables, such as social stress, social danger, racial composition, and property structure composition were significantly associated with educational outcomes for young children (McWayne et al., 2007). Hochschild (2003) provides a rich review of the social dilemmas facing the most disadvantaged of America's schools, which includes literature on vast disparities in and between school districts, failing inner city schools, rising inequalities among school districts and policies that support such inequalities.

School district enrollment is heavily influenced by demographic trends. Growing school districts experiencing an increase in the number of households equates to enrollment growth, thus bringing in more state monies to local school districts thereby

enabling them to spend more on operational expenses. On the other hand, declining enrollments decrease state monies to school districts that are losing students. Therefore, as school districts gain enrollment, they gain foundation allowances, which expands their operating budget (See Arsen & Plank, 2003; Arsen et al., 2005).

The dynamic between socioeconomic change, enrollment change, school funding, school quality, and place-based factors must be explored at the school district level in order to explain how low-performing school districts can improve. The paragraphs and literature presented above show that place and community matter in determining educational achievement.

B. School Districts, Communities and Planning for Schools

From here, it is appropriate to discuss some of the causes and effects that school district policies and decisions have had on the school district landscape. While the overall objective is to quantitatively investigate school district dynamics in Michigan, it is first helpful to ask: how did we get here?

Since World War II, school facilities have grown larger thus requiring larger sites (Ewing, et al., 2003). Furthermore, between 1940 and 1990, the number of elementary and secondary schools decreased from 200,000 to 62,000, despite a 70 percent rise in population (Local Government Commission) and from 1969.to current, active transportation to school (walking or biking) has sharply declined (McDonald, 2007). Indeed, in the past 50 years the United States has seen growth expand from urban to suburban areas (Burchell et al., 2002). There are two planning standards that arguably contributed to the practice of siting impressive facilities on large lots of land that defines many of today's new school sites, which often require private transportation for or

extensive busing of kids.

Gurwitt (2004) discusses how the Council of Educational Facilities Planners International suggested site recommendations of 10 acres for elementary, 20 for middle, and 30 for high schools plus additional acreage for large schools with higher enrollments. Gurwitt quotes Constance Beaumont, the author of *Why Johnny Can't Walk to School*, as saying, "We never could find a definitive answer as to where those acreage standards came from" (Gurwitt, 2004, p. 25). Therefore, with these site standards defined, school districts have been able to support their decisions to build new large facilities. Some communities and local governments have argued against such planning measures.

McClelland & Schneider (2004) discussed the levels of community participation in school districts where new schools were built. They found that in Charlevoix, Michigan, for example, the local school district held few public meetings with little chance for public comment. What resulted was a massive high school located more than three miles out of town, angered citizens, and the likelihood that commercial big-box and residential development will soon follow (Ibid).

Vincent (2006) has identified a "profound disconnect" between schools and cities and a *silo planning phenomenon* between school facility planning and municipal land use planning. Interestingly, Michigan local school boards are not bound by local zoning regulations (Wyckoff, 1990, 1998), which has sometimes resulted in lawsuits between local units of government and school districts.[8] Therefore, school districts essentially have the authority to place schools where they see fit. Norton (2007) provides empirical evidence that pulls together the various problems in the decision-making process that

[8] For example, *Charter Township of Northville v. Northville Public Schools (2003).* Michigan Supreme Court.

affect public school siting with a survey of superintendents and local government officials to compare what factors go into that process.

To illustrate the *silo planning phenomenon* and the level of disconnect between planning bodies, consider what a school board official in North Carolina was quoted as saying, "Our position is very clear. It is the responsibility of the local board of education to make decisions about where schools are sited" (Gurwitt, 2004). Norton's (2007) results conclude that there is little meaningful communication between local units of government and school districts because of the autonomy that school districts have in facility planning. Furthermore, Norton concludes that school boards' decisions are most influenced by a sense of competition with neighboring school districts.

Metropolitan school districts are more competitive (Hoxby, 1994) since they are smaller, which allows households to sort themselves based on schooling, amenities, and property characteristics (Rincke, 2006). Furthermore, while the overall metro area is heterogeneous, individual school districts may be comparatively homogeneous in SES, schools, property values, and income. In addition, small school districts enable household sorting based on any range of preferences, notably school quality, while still residing within a desirable proximity of the employment opportunities that cities offer. School district competition has the capability to influence residential location choices.

There is empirical and anecdotal evidence on subjects that in some way touch upon the potential causes and effects of struggling urban schools. A common thread among articles featuring such evidence is that competition among school districts for pupils has had a positive effect on suburban schools while it has had a negative effect on

urban schools because districts get a minimum foundation allowance from the state[9] per student that is enrolled in the district (Arsen & Plank, 2003). Arsen and Plank (2003) go on to state that districts with community support and demand for lavish schools are able to support them with solid tax bases–something urban schools lack. Inevitably, families that can afford to do so are likely to abandon urban ills (and poor schools) and rural seclusion (long commute times or busing) for suburban school districts that will provide their child the best level of education. Therefore, urban and rural school districts are in danger of increasing the proportion of "at risk" children (Ibid).

While community and social impacts of school location and location change are easy to observe but difficult to measure, there is an aspect that can be directly tied to community and neighborhood prosperity: property values and quality of public school supply. Researchers have used hedonic pricing to study public school quality in terms of location choice (Rosen and Fullerton, 1977; Jud and Watts, 1981; Hayes and Taylor, 1996; Clark and Herrin, 2000; Brasington, 2002). School quality is capitalized into property values (Clark & Herrin, 2000). Using a hedonic or implicit markets model of household behavior in Fresno County, Clark and Herrin (2000) found that "the school district in which the property (residential) is located is an important determinant of residential home sale prices" (p. 401). Brasington (2002) also used a hedonic house price technique. Brasington was the first to estimate a supply curve of public school quality. This study is noteworthy because it finds that "school funding equalization plans cause little change in equilibrium school quality" (p. 375). Thus, instead of equalizing funding across districts, the best way to increase school quality is to shift the supply curve to the right.

[9] Again, this is the case in Michigan.

Brasington's study sheds light on public school quality and district-wide differences in quality because he employs the "across-the-street" (Cushing, 1984; Gill, 1983) comparison of houses. The street acts as a boundary between two school districts. Hence, the houses are in the same neighborhood and community but the children attend different schools in different districts. Therefore, "any difference in price is attributable to differences in public school quality" (Brasington, 2002, p. 369). Shifting the supply curve, thus providing more schools for children to attend within a given district, is consistent with literature supporting smaller schools (Fowler & Walberg, 1991) and advocating smaller classes sizes by reducing the pupil-teacher ratio (Finn et al., 2003; Finn & Achilles, 1990).

Defining what ascribes school quality has been a challenge. Obviously, it influences where families choose to live. It influences business decisions and overtly sorts households based on income and race. Parents and policymakers understand the importance of school quality; the former make decisions based on it while the latter try desperately to find ways to improve it in intricate metropolitan school systems and homogeneous rural ones. Taking a closer look in the literature will offer a better understanding of how school quality, educational achievement, school choice, expenditures, and policy are associated.

C. Increasing Interest in Education

The wave of education-related studies came shortly after the publication of "The Concept of Equality of Educational Opportunity" (Coleman et al., 1966), which is commonly referred to as the "Coleman Report" and was a directive of the Civil Rights Act of 1964. The study was monumental because of the amount of data it encompassed

and its seemingly startling results. The study included survey data on more than 500,000 students, including their achievement levels, and 3,000 schools and school characteristics (Coleman et al., 1966 cited in Hanushek, 1979). The report "directed attention to the importance of the relationship between school inputs and student achievement" and "introduced into the public policy area a bewildering array of technical and esoteric issues such as statistical significance, residual variation, estimation bias, and simultaneous equations" (Hanushek, 1979, p. 352). In addition, the report formally introduced input-output analysis in public education systems, which is useful in making policy decisions (Ibid). The report's policy implications, however, have led to many studies disputing its results and criticizing its methodology.

There should be little surprise as to why criticism came so quickly and fervently. The Coleman Report concluded that educational inputs had little effect on achievement. In other words, money does not matter. The report concluded that what actually matters are peer effects, which were studied more closely in educational psychology by attempting to measure school climate and its impact on mean school achievement (i.e. Brookover, et al., 1978). Aside from criticism found in the literature, Coleman et al.'s (1966) findings still remain the most influential and curious, since common sense would seem to suggest the opposite.

While the policy implications and the methodology that led to the report's results are still questioned, debated, and researched today, such results have produced a wide body of research attempting to adequately specify an education production function model that avoids the methodological issues already criticized in the literature. There is still no consensus on what exact mix of inputs adequately explains educational

achievement (Todd & Wolpin, 2003).

Cain and Watts' (1970) criticism of the Coleman Report is aimed at the analysis and its implications for policy decisions. They argue that the use of regression analysis was erroneous because a theoretical model was not adequately specified. Furthermore, there was not a substantial rationalization for the selection or non-selection of independent variables under different specifications. Secondly, Cain and Watts (1970) find fault in Coleman et al.'s use of the R-Square to report on regression results because this statistic does not provide "guidance for translating the statistical findings into policy action" (Cain & Watts, 1970, p. 229). Regression coefficients are the most useful for this purpose. In his response to Cain and Watts, Coleman (1970) states that no theoretical model, neither by him nor others, has been specified because it was not entirely possible to know the functional relationships between variables. Had it been possible, many policy questions would have been answered (Ibid). Coleman states that he and Cain and Watts operate under different academic disciplines, which would explain the criticism of the theoretical justification and how policy implications can be inferred in and from the report. Rather than using the regression equation

> "as a rather direct model of the causal process, with all causally relevant variables measured without error... We treated the same statistical tool as an aid in the prior process of search for causally relevant variables in a state of knowledge where the structure of the process relating them is not fully known" (Coleman, 1970, p. 249).

The Coleman Report methodology was disputed from many angles, such as the presence of multicollinearity among explanatory variables (Bowles & Levin, 1968; Smith, 1968), an arbitrary decision to use verbal achievement as the dependent variable (Carver, 1975), considering achievement scores the only measurable output of education (Levin, 1970), using "tests and statistics that were biased against finding large differences

associated with schools which might be interpreted as attributable to educational treatment differences" (Carver, 1975, p. 85), and not considering the environmental and organizational structures of school districts (Bidwell & Kasarda, 1975), to list a few. It is little surprise that applying production function estimations related to education can elicit problems. Following the Coleman Report were many studies using the same dataset or samples from the data that applied varying methodologies. Overall, the studies undertaken were of the production function variety.

D. The Education Production Function

What is an educational production function? Monk (1989) discusses the role of the production function from an educational standpoint. He "conceives" what a production function means in education, which is "the maximum level of outcome possible from alternative combinations of inputs" and "provides a standard against which practice can be evaluated on productivity grounds" (Ibid, p. 31). But whereas typical aggregate production functions for firms in economics[10] involve estimating an output *quantity*, educational production functions attempt to estimate (school or educational) *quality* (Summers & Wolfe, 1974). Furthermore, "education is a service which transforms fixed quantities of inputs (i.e., individuals) into individuals with different quality attributes" but "simply because individuals can be ordinally ranked in terms of cognitive test scores does not imply that such a measure is necessarily important" (Hanushek, 1979, p. 355).

Monk (1989) articulates that the mere existence of an education production function is questioned because of inconsistent findings throughout the literature and

[10] $Q = F(K, L; t)$, where Q is output, and a function of K and L, which are physical units of capital and labor, respectively, and t allows for technical change (Solow, 1957).

Hanushek (1986) notes that education decision makers are reluctant to accept the production function methodology. To make matters more complicated, there may be multiple possible production functions due to specification problems, which could also indicate that there is one large and very complex function (Monk, 1989). Furthermore, there may be a production function that is unknowable and ever-changing. Monk concludes that there is indeed an educational production function and its existence cannot be dismissed empirically or conceptually. Moreover, it is typically the basis of policy-oriented research, although it is possible to use it for estimating production function parameters (Todd & Wolpin, 2003). It can be concluded from Monk (1989) that educational production functions are complex, numerous for given situations, ever-changing, and at the heart of educational administrative policy decisions.

In a theoretical piece, Lazear (1977) poses the question of whether education is produced or consumed. In other words, does having a higher education allow one to earn a higher income or do elevated incomes buy schooling? The author finds that "wages are favorably affected by schooling and not merely associated with it as a result of consumption-induced income effects" (Lazear, 1977, p. 587). Thus, individuals attend school to positively impact their wealth even though they do not fully realize their educational potential. This is shown by Caucasians dropping out of school after 11.9 years (instead of 16) and African Americans 8.3 years because additional schooling is seen as unpleasant (Lazear, 1977). Therefore, individuals are trading increased future wealth for fewer years of schooling.

The educational production function, aside from its complications, can be used as a powerful tool for educators and researchers to better understand how education forms

human capital (Bowles, 1968). Moreover, by understanding the inputs that contributed to cognitive development and attitudes of students after completing their education requirements, researchers and policymakers can investigate what is most significant in producing education and to learn why higher-educated individuals earn more income than those less educated (Ibid). Bowles (1968) continues by asserting that the different outputs achieved by various social or racial groups in a production framework can be compared with the inputs into each group to better understand the "determination of the distribution of personal earnings" (p. 3). As will be shown, production functions in education have endured disciplinary criticisms, technical scrutiny, and further theoretical development since their conception. Such attention construes the value of the educational production function, regardless of its shortcomings, and of its import in understanding the production of education across various students, schools, districts, states, and countries.

E. Education Production Function Theoretical Framework

Bowles (1968) provides an early expression of the education production function. $A = f(X_1, \cdots, X_m, X_n, \cdots, X_v, X_w, \cdots, X_z)$ where A= some measure of school output; $X_1, \cdots, X_m$ = variables measuring the school environment (quality of teaching services, physical facilities of the school, etc.); $X_n, \cdots, X_v$ = variables representing environmental influences on learning outside the school (i.e. parents' educational attainment); $X_w, \cdots, X_z$ = variables representing the initial level of learning attained by the student prior to entry into the type of schooling in question. "We are interested in gaining estimates of the structural parameters of the function, *f*" (p. 4). The expression of the function above is different from Hanushek (1979) because it does not consider time or

a unit (district). Regardless, the educational production function can be fit for varying units of analysis. The common theme in most educational production functions pertains to three vectors that produce education: background, which may contain a variety of SES variables; educational inputs, including but not limited to instructional expenditure per student, number of teachers with a Master's degree, or pupil-teacher ratio; and other factors, which typically include innate student abilities or other variables that may be impossible to obtain.

The educational production function has been used in many analyses at various levels. In using the production function to estimate proficiency, it is first necessary to decide whether or not to estimate single or multiple equations. Chizmar and Zak (1983) provide a framework explaining that "the relationship among outputs should dictate the model (and estimating technique) one employs to estimate educational production functions" (Chizmar & Zak, 1983, p. 18). Equation (1) specifies the instance where cognitive and affective achievement is produced with separate inputs and is completely independent. Equation (2) represents a system where outputs are produced simultaneously. A single equation production function model, with multiple outputs and assuming achievement are joint products, is shown in proper functional form in equation (3).

(1) $Y_1 = F(X_1, X_2, \cdots, X_P),\ Y_2 = G(X_1, X_2, \cdots, X_P),$

(2) $Y_1 = F(Y_2, X_1, X_2, \cdots, X_p),\ Y_2 = G(Y_1, X_1, X_2, \cdots, X_q),$
with $X_i (i=1, \cdots, p)$ inputs

(3) $f(Y_1, Y_2) = g(X_1, X_2, \cdots, X_p).$

Ordinary least squares (OLS) is commonly used in educational production functions. This analysis is inappropriate, however, when multiple outputs are simultaneously produced (Hanushek, 1979). Methods to estimate simultaneous equations are more

complicated than OLS. Thus, an alternative is to estimate the reduced-form equation for the different outcomes using OLS (Ibid). "The reduced-form equation... indicates both the direct and indirect impacts (through the other outcomes) of the exogenous variables" (Ibid, p. 361).

The models discussed above typically focus on the achievement (test scores) of individual students with other data measures (inputs) either known about the students or aggregated to the school level. Aggregation has been criticized in the literature (Webster et al., 1996; Woodhouse & Goldstein, 1988) and has been shown to bias coefficient estimates (Hanushek et al., 1996). Richter and Brorsen (2006), however, show that using multilevel analysis (using hierarchical regression modeling) can produce more efficient estimates using aggregated data and dispute Hanushek et al.'s (1996) claim that bias is introduced in aggregate models.

Todd and Wolpin (2003) provide insights into the various ways the educational production function can be modeled, based on the desired output of the model and the assumptions associated with it. The focus of Todd and Wolpin's (2003) study is "to specify and estimate a production function for cognitive achievements in a way that is consistent with theoretical notions that child development is a cumulative process..." (p. 5). The authors also present alternative specifications used throughout the literature. These specifications are helpful in modeling the production function at the district rather than individual level. Estimates at the school district level are different than at the student level. It is assumed, and observed, that students compose schools, which compose districts. Any homogeneity *within* schools is likely to be reduced when examined at the district level.

F. Reviews and Meta-Analysis of Education Production Functions

Since the Coleman Report, literally hundreds of production function studies of education were published that found varying and inconsistent results. Hanushek (1981, 1986, 1989, 1997) has reviewed the gamut of production functions (130, 147, 187, 377, respectively by year of publication) by comparing common inputs, the statistical significance, and signs of the results. Hanushek (1986) analyzed 147 equations and found various and inconsistent results on the significance and sign (positive or negative) of inputs such as teacher-pupil ratio, teacher education, teacher experience, teacher salary, and expenditures per pupil on some measure of output. "The results are startlingly consistent in finding no strong evidence that teacher-student ratios, teacher education, or teacher experience have an expected positive effect on student achievement (Ibid, p. 1162) when differences in family background are controlled for (Hanushek, 1989).

Overall, Hanushek consistently found the same results in each piece–that performance is not related to expenditures, which may have to do with public school inefficiency or changing socioeconomic trends in the broader society (Betts, 1996). Regardless, such a finding–that money does not matter–has been subject to fierce debate (Hedges et al., 1994; Greenwald et al., 1996, Kremer, 1995; Hanushek, 1994). Deviating from traditional educational production functions so extensively reviewed by Hanushek, Figlio (1999) uses a variation that is not limited by homotheticity and additivity and finds a significant and positive (although very small) relationship between school inputs and performance. Figlio, citing Hanushek (1994), concludes that the ways by which education is delivered in schools is likely a better change instrument than simply supplying additional resources.

An exchange between Hedges et al. (1994) and Hanushek (1994) debates the matter of money related to producing school outcomes. Hedges et al. (1994) contend that Hanushek's reviews are the "pillar upon which the counterintuitive notion that money does not matter in schools has been constructed" (p. 5). Indeed, Hanushek's 1986 article has been cited more than 1,600 times (at time of writing). But Hedges et al. (1994) question the method of "vote counting" used by Hanushek, which they argue has serious flaws. "The structure of Hanushek's argument is essentially one of accepting (at least approximately) a null hypothesis after attempts to reject it have failed" (Ibid, p. 6). Using combined significance tests and combined estimation methods, Hedges et al. (1994) attempt to replicate Hanushek's studies. They find that, contrary to Hanushek, there are "systematic positive patterns in the relations between educational resource inputs and student outcomes" (p. 8) and that "the production function studies of the relation between resource inputs and school outcomes examined by Hanushek do not support his conclusion that resource inputs are unrelated to outcomes" (p. 13).

Hanushek (1994) replies with a resounding critique of Hedges et al. (1994) both on methodological and policy grounds. Hanushek's strongest rebuttals are that more sophisticated techniques do not lead to correct results, that Hedges et al.'s conclusions are potentially deceptive regarding policy decisions, and that their use of meta-analysis was misguided. The replication technique used by Hedges et al. (1994) illustrates that different methodologies can lead to different results. Thus, whereas some bodies of research tried (and are perhaps still trying) to specify the ideal educational production function, it is constantly subject to various criticisms and methodologies.

In the literature and among the public, it is difficult to accept that more money

does not equate to higher achievement. Hence, it makes sense to target specific inputs that have the potential to impact educational outcomes most positively, such as instruction expenditure, improving student-teacher ratios, improving teacher credentials (Wenglinsky, 2002), spending more on computers and technology (Elliott, 1998) or all of the above (Verstegen & King, 1998). These studies suggest that specific investments or qualities of schools are the link between spending and achievement (Condron & Roscigno, 2003). Thus, school districts are inefficient in their production of education and incentives are lacking to improve efficiency (Hanushek, 1979).

Greenwald et al. (1996) were not satisfied with Hanushek's many syntheses and results. They continue to assert that his method of vote counting is archaic and misleading in the policy realm. Therefore, instead of using a sample of the educational production functions surveyed by Hanushek, Greenwald et al. (1996) composed a universe of production function studies and utilized an involved meta-analysis procedure that tried to answer the question of whether or not resources matter. The authors find that "school resources are systematically related to student achievement and that these relations are large enough to be educationally important" (p. 384) but warn that policy cannot be informed by their results–only that it can affirm the notion that money matters but may depend on where it is spent.

Greenwald et al. (1996) responded to Hanushek in a more sophisticated and empirically grounded reply while building on their previous piece (Hedges et al., 1994). The conflicting results and the dialogue contained in these pieces illustrate the contention between disciplines and methodologies and it certainly adds to the confusion and conflict in the policy realm. Literally thousands of references have been made to Hanushek's

conclusion that money does not matter. But how constructive is such a conclusion? Obviously money does matter and is necessary to operate school systems. Therefore, while the literature continues to debate the effect of additional resources, policymakers and administrators are making decisions based on one conclusion or another. If anything, production function estimations have created a wide body of inquiry into the efficiency of public school systems.

G. Applications of the Education Production Function

The educational production function essentially exists in three separate categories in the literature. The first is the application of the function, anywhere from the individual or classroom up to the country being the unit of analysis. Second is the theoretical aspect, where merits, weaknesses, functional form, specification, and other technical issues arise related to the application of the model. Third is the underlying aspect of the function in exploratory endeavors that may or may not make any mention of a production function but use a framework built upon in previous studies. Monk (1989) touches upon this last category and notes that using this approach avoids many of the technical challenges associated with the theoretical aspect, which happens to be an unexplored area of research with interesting applications to policy.

Findings from any one of the above categories are often compared to Hanushek's (among others) conclusion that money does not matter in explaining the variance of performance-related measures. However, the vast collection of these production functions are estimated using widespread predictor measures along with a variety of dependent variables. In some sense, educational production functions are opportunistic merely due to data availability. Omitting and aggregating variables, combined with

measurement error in a production function poses challenges in interpreting coefficients thereby, once again, creating another problem in transcribing coefficients into policy-relevant results.

H. Challenges of Education Production Functions

Technical articles analyzing educational production functions commonly focus on either the left or right side of the equation. Left side critiques generally question the appropriateness of standardized test scores as the dependent variable (Hanushek et al., 1996) and pose and test alternative measures of achievement, such as earnings (Card & Krueger, 1992, 1996, 1998). Assessment of the right side is widespread in the literature, such as inclusion or exclusion of variables related to district size (Driscoll et al., 2003), time of instruction (Coates, 2003; Fredrick & Walberg, 1980), parental income (Dewey, et al., 2000), previous student performance or achievement (Hanushek et al., 1996), ignoring family background effects (Hanushek & Taylor, 1990) and using aggregate data (Hanushek et al., 1996).

Levin (1970) highlights some of the problems with using a production function to estimate educational achievement. His most pressing criticism is the choice of using a single achievement-related dependent variable because schools do not only produce proficient reading skills, for example. Educational quality can be measured by other outcomes and since a typical high school may push literacy and science proficiency while a vocational school strives for academically different goals, the merits of such measures can be debated. Moreover, it is impossible to exactly know how specific educational inputs affect a wide array of potential outcomes. "Specification of the educational production model must depend more on intuition and hunch than on a body of well-

developed behavioral theory" (Levin, 1970, p. 5).

Input specification is not consistent throughout much of the literature and there is lacking consensus among the academic community regarding both its specific formulation in a production function of education and how variables ought to be measured and used in the function (Hedges et al., 1994). Conceptually, clarity is lacking and models are often defined based on availability of data (Hanushek, 1979). In addition, input data may be lacking (learning capacity of a student) or proxies are substituted for unavailable direct measures, which ultimately can lead to measurement error (Ibid).

When appraising the educational production function at the student level, it is typically expressed as: $A_{it} = f(B_i^{(t)}, P_i^{(t)}, S_i^{(t)}, I_i)$ where, for the ith student, A_{it} = achievement at time t; $B_i^{(t)}$ = vector of family background influences cumulative to time t; $P_i^{(t)}$ = vector of influences of peers cumulative to time t; $S_i^{(t)}$ = vector of school inputs cumulative to time t; and I_i = vector of innate abilities (Hanushek, 1979, p. 363). Hanushek states that this specification makes sense until the definition and measurement of variables takes place and the functional form relationships are established. Figlio (1999) finds some evidence that previous studies may have estimated inappropriate function forms and that overall, many studies (at the individual level) make numerous "simplifying assumptions," such as estimating additive inputs to production (Figlio, 1999, p. 242). And since I_i is difficult, if not impossible, to measure and is omitted from the regression, bias is introduced in the regression coefficients. "The importance (size of bias) is related both to the strength of the variable on achievement and the correlation of the omitted variable with other included variables in the model" (Ibid, p. 365).

Coates (2003) argues that one misspecification problem is due to ignoring time in

the production of education. Studies have examined time in assorted ways. Fredrick and Walberg (1980) emphasize time in producing education and attempt to explain the variance in achievement as functions of years of schooling, days of instruction at school, hours of classes during the day, and minutes of study during class. Other examples include time spent on homework (Betts, 1995) or years spent in a specific subject (Walberg et al., 1986).

Coates (2003) argues that previous studies used too simple a measure of time spent and instead expands the time-framework to include more specific measures, such as time spent on English, math, science, and social studies. The author affirms the use of time in the educational production function model and finds that minutes of instruction are positively related to outcomes, although they are small relationships. However, whether or not their findings add to the misspecification problem in the production function model is not proven.

Dewey et al. (2000) argue that many production functions are not correctly specified due to the inclusion of income as an independent variable. Remembering that educational production functions typically estimate the impact of additional educational inputs (higher teacher salaries, lower pupil-teacher ratio, more instructional time) on student achievement but must control for other inputs (race, SES, parents' education), Dewey et al. (2000) reveal that including parental income in the model can bewilder interpretation and significance of the school input coefficients. "The inclusion of the extraneous variable should render finding school inputs significant more difficult" (Ibid, p. 42). Hence, the authors find a positive relationship between school inputs and achievement.

Hedges and Greenwald (1996) point out that family background trends have changed over time. For example, the authors note that it is possible parental inputs into education have declined over time. Such declines are exemplified by the rising prevalence of single-parent households and higher labor force participation among females. Empirically, it would be interesting to measure the impact parental influence has had on educational outputs. In other words, have changes in family structure neutralized the effect of increasing expenditures while test scores have remained stagnant? However, education levels among parents have increased over time (Burtless, 1996) as well, which theoretically, would act to neutralize the potential effects of destabilized family structures.

When estimating the impact of school inputs on some performance measure, it is necessary to control for family background, community environment, and student performance because education occurs in and out of school (Hanushek et al., 1996). Furthermore, since education is cumulative over time, it is important to have a measure of previous performance in the estimation (Ibid). These variables are often difficult to obtain and therefore value-added models are instead utilized (Ibid). Overall, by not controlling for effects such as academic preparation, family inputs, and others, bias will result when estimating the effects of school characteristics on achievement. "In addition, the failure to account for differences in local and state institutional structures for their schools will also introduce bias," which increases with the level of aggregation (Ibid, p. 615). Overall, Hanushek et al. (1996) find that "studies which contain more information about community characteristics and which use less aggregated data are likely to produce more reliable estimates of the true impact of school expenditure on attainment" (p. 625).

Hanushek and Taylor (1990) analyze problems with aggregate data commonly used in educational production functions. The authors explain that as data become more aggregated, specifically up to the state level, estimates are either biased or overestimated (Ibid; Hanushek et al., 1996). Four common problems in the educational production function are outlined. The first case is where family data are left out of the analysis. Family inputs are typically strongly correlated with school quality; therefore, leaving out family background variables results in overestimation of achievement (Hanushek & Taylor, 1990). The second problem is time varying inputs. Students may have been educated in a different district, which would influence their SAT score in their current school. Such problems do not allow the direction of bias to be determined a priori (Ibid). The third case involves school input measurement error. Poor measurement of school input variables biases the estimation toward zero or to finding no relationship (Ibid). This case is the primary focus of Hanushek (1986). The fourth and final problem involves nonrandom test taking. SAT and ACT tests are not mandatory and can therefore bias estimates, the direction of which cannot be known a priori (Hanushek & Taylor, 1990). Kremer (1995) likens nonrandomness to a scenario in the Kenyan education system, where schools are graded based on eighth grade exam scores. School administrators allow the top students into the eighth grade to complete the test while holding back lower performing students, either to give them more time to improve or to keep them from influencing the test scores.

The problems outlined above introduce the issues of aggregation, measurement error and misspecification in the production function of education. To illustrate, Hanushek and Taylor (1990) focused on state-by-state rankings of education and

concluded that mathematics test scores are not appropriate measures for state-by-state variation because they are prone to "bias from misspecification and sample nonrandomness" (Ibid, p. 198). This is a considerable finding since many studies favor the of use math scores as achievement variables due to their objectiveness (Ibid).

There are different measurements of output, or dependent variables, used in the production function of education. Standardized test scores are most commonly used as an output measure but are criticized both for their inability to not discriminate among test takers and whether these tests actually relate to the knowledge and skills valued by society (Hanushek, 1979). Bowles (1969) argues that achievement while a student is in school is not the ideal output measure. Instead, he argues that achievement (measured by test scores) can only serve as a proxy that indicates "post-school economic behavior (p. 14). Other studies examine outputs measured by student attitudes (Levin, 1970; Chizmar & Zak, 1983), future earnings (Card & Krueger, 1992, 1999; Grogger, 1996), the effect of spending on whether students enroll in postsecondary education (Deke, 2003), and even the effect of compulsory school attendance on post secondary enrollment and earnings (Angrist & Krueger, 1991).

Studies commonly use state administered tests (Coates, 2003; Unnever et al., 2000; Driscoll et al., 2003; Hogrebe et al., 2008) or tests specifically designed for an experiment (Finn et al., 2001; Finn & Achilles, 1990). Test score data are presented in various fashions. One example is a variable solely portraying percent proficient in math (like a sample of a population), while another is the standardized score in reading among all students. In the educational production function, a scale indicating how students are different is preferable over one that merely ranks them (Ibid). Hanushek (1979) indicates

that test scores are an adequate measure for elementary grades where cognizance is still in a developmental stage. Interestingly, he notes that test scores are inappropriate measures for post-secondary education attainment and few experts find them useful at this stage of education.

One result of aggregate data and computing school district averages across students is heteroscedastic disturbances (Jacques & Brorsen, 2002). The authors are interested in estimating coefficients for expenditures using maximum likelihood estimation (MLE) over ordinary least squares in order to "gain asymptotically efficient parameter estimates and valid hypothesis tests" (Ibid, p. 998). The authors assert that correcting for heteroscedasticity provides more powerful statistical tests and, thus, legitimizes their finding that instructional expenditures are significantly related to achievement.

The purpose of the paragraphs above is to introduce the concept of the educational production function and the problems associated with it. The two primary problems with the application of the production function in education is the exclusive concentration on one attribute of schools or the learning process, and/or ignoring or excluding the attributes related to inputs and student outcomes that simultaneously affect outcomes (Hanushek, 1979). Many of the challenges associated with the educational production function come back to disciplinary approaches of how the overall problem in public education is viewed.

Whether investigating the relationship between what resources go into schools and what level of education results is deemed a production function, or not at all, is trivial. But to be sure, the production function, theoretically and conceptually, is real and

is vital in the public school system. Without the educational production function, "changes in the selection and deployment of resources will have no predictable effect" (Monk, 1989, p. 32). In other words, without an educational production function, there can be no principle that logically guides resource allocation for administrators and policymakers.

The conclusion of many production functions of education has been that school districts are economically inefficient in their use of resources, which supports the notion that school district bureaucracies are inefficient and serve the interests of teachers and administrators (Chubb & Moe, 1990a). The conclusion that money does not matter in producing education has led researchers to believe that there is some unobservable factor contributing to this conclusion (Millimet & Collier, 2008). Declining test scores in the 1970's in the face of rising expenditures unsurprisingly subjected public schools to vigorous and widespread analysis. Results of such research have pointed toward new paths in the form of school choice, magnet schools, and voucher programs (Chubb & Moe, 1990b) and whether or not free market approaches in the supply of education (Tweedie et al., 1990) are superior. The market reform theory in education suggests that families, which are sensitive to quality and service of schools, will enroll their children in private schools in the face of poor public school performance and is reflected in voucher programs and charter schools (Hess & Leal, 2001). The matter of inefficiency has been widely studied and various prescriptions have been offered but the causes and costs of inefficiency in public school systems have received less attention (Duncombe et al., 1997).

Traditional production function estimates in education do not consider the

political environment, which is noteworthy since budget negotiations and politics (typically between administrators and teachers unions) are at the heart of public school (and public good) allocation within a system. In private markets, however, competition is believed to make the market efficient (Ibid). Therefore, as the educational production function fails to consider politics and decision-making, Duncombe et al. (1997) present a methodology for "estimating cost efficiency which can be used to evaluate hypotheses regarding sources of inefficiency derived from the public choice literature" (p. 5). The methodology used here is beyond the scope of this piece but it serves as a valuable research direction that attempts to disentangle the factors that lead to inefficiency in schools.

Duncombe et al. (1997) found that school district size, percent tenured teachers, district wealth, nonresidential property values, and labor intensity were negatively related to efficiency. Furthermore, at least in New York, school districts with "less harsh environments" are typically more inefficient (p. 15) suggesting that a higher proportion of less at-risk students makes managing resources easier, particularly for states with central control of educational finances where formulas determine the amount allocated to school districts.

I. Class Size

There are myriad examples in the literature using the educational production function to research specific aspects of education related subjects. One of these areas has been class size, which is a variable subject to change through policy implementation. Naturally, educators and policymakers looked to reduce class sizes as a policy change that could improve educational achievement. Collectively, however, results are once

again cloudy regarding the relationship between class size and achievement, but surely, there must be some point at which a classroom becomes overly large and ineffective for learning (Lazear, 2001). Indeed, class size can reach a level of congestion which would negatively impact achievement. Furthermore, assuming that student behavior affects the optimal pupil-teacher ratio, in a class with well-behaved students, a higher pupil-teacher ratio is justified and makes economical sense (Ibid).

Between 1940 and 1990, the average pupil-teacher ratio decreased from 28 to roughly 16, which was partly a reaction to additional special education classes (Hanushek, et al., 1996; Hanushek & Rivkin, 1997). Previous research on the effect of class size has concluded that, overall, a pupil-teacher ratio of less than 20 is associated with improved academic achievement (Finn et al., 2003). Decreasing the pupil-teacher ratio leads to more teachers hired, which corresponds with a rapid increase of total spending per student (Hanushek, 1986). In fact, from 1970 to 1990, instructional costs increased 85% due to the reduction of pupil-teacher ratios (Hanushek & Rivkin, 1997). Meanwhile, test score performance has not trended positively in relation to the level of inputs (expenditures on students) (Hanushek, 1986). It is this mismatch that has spurred research to investigate class sizes, inputs, and performance. Findings on the effect of class size on achievement thus far are mixed and, if anything, point toward a moderate positive relationship between pupil-teacher ratio reduction and achievement gains (Glass & Smith, 1979; Robinson & Wittebols, 1986).

The effect of class size, measured via the pupil-teacher ratio, has been examined closely in the educational production framework (Krueger, 1999; Folger & Breda, 1989; Finn & Achilles, 1990; Finn et al., 2003; Nye et al., 2000) and the effects on achievement

are also debated (Finn & Achilles, 1999). Early in the debate, administrators advocated for increasing class sizes, teachers were worried about class sizes, and research was inconclusive, sometimes supporting bigger class sizes and sometimes smaller (Glass & Smith, 1979). Science-based results, however, equated to policy action following a monumental experiment. The largest attempt to study such effects was the Tennessee Student/Teacher Achievement Ratio experiment (STAR).

> "Project STAR was a longitudinal study in which kindergarten students and their teachers were randomly assigned to one of three groups beginning in the 1985-1986 school year: small classes (13-17 students per teacher), regular-size classes (22-25 students), and regular/aide classes (22-25 students) which also included a full-time teacher's aide. After their initial assignment, the design called for students to remain in the same class type for four years" (Krueger, 1999, p. 498)

Project STAR cost more than $12 million over four years, included a sample of 11,600 students over 80 schools, and was carefully designed (Ibid). Despite a few deviations from its original study design, which Krueger attempted to correct in his study, the results proved that smaller class sizes produced better standardized test scores early in the education process. This may be explained by a "school socialization effect," meaning that when students are accustomed to a small class size early, they perform better in the future.

Since class size studies are at the micro-level (classroom), they can be hampered by experiment designs. Finn and Achilles (1990) point out that the number of students in a class may not actually be the number involved in participation, indicating that class size is either over-counted or that not all students are equally engaged in the classroom. The authors warn that many studies do not indicate the nature of the data and point out that correlation of the "number of students" variable with others must be viewed with skepticism. Thus, understanding experiment design is crucial to interpreting findings in

this line of research.

Differently designed studies can yield completely opposite results (Shapson et al., 1980). Finn and Achilles (1990) find that smaller class sizes are beneficial to kindergarteners and first graders, especially among minorities. Nye et al. (2000), using STAR data, assert that small class sizes would benefit all students in all grades in all classes. They also affirm that small classes are cumulatively beneficial to students enrolled in small classes from the beginning of their education. Coates (2003), while examining instruction times, found larger class sizes to be negatively related to achievement. Shapson et al. (1980) found, however, that class sizes make no observable difference in various subjects.

Finn and Achilles (1990) concede that their own findings do not imply whether or not the increased costs of class sizes are offset by educational achievement benefits. This question may be hard to answer since student involvement and behavior in classrooms varies widely based on district, city versus suburb versus rural, and among different regions in the U.S. The STAR experiment was analyzed in-depth by many researchers. Are the results from this experiment, based in Tennessee, applicable to California or New Jersey? Regardless of state and demographic differences and applicability of findings, the results from research on Project STAR data have proven to be the most influential and comprehensive yet.

The widely cited results from Project STAR have drawn criticism regarding design randomization and estimation bias (Hanushek, 1999). Hanushek argues that policy has focused too much attention on reducing class sizes without discussing the costs and expected benefits. Indeed, after federal funding first allowed allocations for

reducing class sizes, California aggressively pursued such initiatives. Findings indicate that small class sizes in grade three carried over to positive, but small, gains in achievement in grade four in California from 1998 to 1999 (Stecher & Bohrnstedt, 2000). But Hanushek (1999) argues that the evidence on class size is subject to vary based on methodological and experimental grounds. He maintains that the results generated from Project STAR run contrary to aggregate and non-experimental evidence.

The aggregate evidence (most educational production functions), however, uses the pupil-teacher ratio (almost always available) as a variable for class size, which is subject to variability (Ibid). For example, the pupil-teacher ratio may or may not include teaching aides or other non-teacher positions that assist in the education of children. But since this variable is widely available, it is commonly used in analyses. The overall aggregate evidence points to no positive relationship between inputs and student achievement (Hanushek, 1981, 1986, 1989, 1997, 1999). The majority of research studying Project STAR's data, however, does find a positive relationship. Hanushek (1999) argues that one problem with the STAR experiment was that it lacked a pre-test for entering kindergarten and added students during the study's time period, thereby providing no prior evidence or control of prior education. Another problem was its lack of randomness. Hanushek argues that the study was not fully candid on the subject of how randomness was achieved among schools, students, and teachers.

Hanushek (1999) was not harsh in his critique of Project STAR and commended its efforts. What is enlightening regarding his critique is the disciplinary perspective that it arises from. Hanushek has spent decades analyzing and reviewing the educational production literature from an econometric standpoint and has continuously found and

supported the conclusion that money is not related to achievement. From the educational literature, however, Project STAR evidence is an antidote to econometric findings. Besides anecdotal remarks, comparing aggregate econometric findings to an in-depth experiment may not be appropriate. Project STAR has its shortcomings, as Hanushek called attention, but it is at the opposite end of the research spectrum compared to the typical educational production function estimates–both methodologically and in scale.

Findings from aggregate evidence have been widely criticized among many disciplines and are still inconclusive. Therefore, Project STAR evidence offers more in-depth and thoughtful evidence into the debate of class size and educational achievement than do aggregate production functions. More experiments similar to Project STAR at varying grades, in varying subjects, and among different states would prove beneficial in providing additional confirmation of the role of class size in educational achievement.

The pupil-teacher ratio is an easily manipulated variable and administrators have been able to lower it in hopes to observe better returns on the production of education. Administrators, teachers, and parents generally agree that smaller class sizes are beneficiary therefore making it a politically imperturbable subject (Folger & Breda, 1989). Reducing class size is expensive though, thereby introducing budget constraints to school districts (Ibid). Indeed, there is a relationship between decline in the pupil-teacher ratio and the rise of expenditures over time. Hiring more teachers is a considerable budgetary burden.

It is now clearly evident that class size reduction requires more teachers and more space. Early on, administrators seemed to encourage larger class sizes–probably to achieve better economies of scale (Glass & Smith, 1979). Later, however, class size

reduction became commonplace. Thus, lowering the pupil-teacher ratio—which is not a panacea to increasing educational achievement across all instances—to assist in improving achievement among special education or at-risk students or to bolster more success in specific subjects, has been a prime culprit in the efficiency debate. School sprawl (discussed earlier) is related to the need for more classroom space. If administrators perceive small class sizes to be good for any combination of students and class subjects, then many more classrooms are required. Furthermore, in a centralized education system like Michigan, higher enrollment leads to more money delivered (to the district), part of which pays teacher salaries. Hence, the class size issue, being a variable subject to manipulation by administrators and policymakers, has led to increased expenditures but with little return seen in terms of educational achievement (as shown by Hanushek).

Based on the findings above, however, the highest returns to reducing the pupil-teacher ratio occur at lower grades, for certain groups of students, and for certain subjects. Thus, the blanket application of class size reduction is inappropriate at all scales and may reduce efficiency. On the other hand, school districts may be able to achieve economies of scale while decreasing the overall pupil-teacher ratio. One way to achieve this could be accomplished by increasing the district size to encapsulate more students, thereby bringing in more student-based state revenue and by increasing school sizes to allow for more students to share facilities and access to educational materials. More teachers must be hired to teach the additional students, but if cost reductions are achieved by utilizing larger facilities and expanding boundaries then a more efficient fiscal balance can be accomplished. Driscoll et al. (2003), however, found that district

size had a negative impact on standardized test scores among Californian students. This finding, however, is probably unique to California since its districts are large in both area and enrollment compared to many other states. Achieving economies of scale and efficiency through competition are discussed in more detail on page 51.

J. Achievement Defined by Outcomes

Another direction in the educational production function research strives to measure outcomes or returns to education, rather than achievement, as a function of school quality (and the inputs that likely compose school quality). This method requires that information is known about students after they graduate from the school system and enter the labor market, which can be difficult to obtain (Card & Krueger, 1998). In an extensive attempt to explain the returns on education, Card and Krueger (1992), controlling for unobserved differences across cohort and state of birth groups, find that school quality does indeed affect earnings. Also, Grogger (1996) finds that school spending matters a little, where a 10% increase in spending would raise earnings by 0.68%–a very low social return. These findings are significant since they support the view that educational inputs affect earnings later in life but are not good predictors of standardized achievement tests (Card & Krueger, 1992). Such findings are encouraging for life after school, but they do not lend helpful policy guidance to school administrators aiming to improve test scores, which again, are important determinants of residential location choice and inform state and federal agencies evaluating the effectiveness and or appropriation of school resources.

Akin and Garfinkel (1977) find evidence that increased expenditures lead to increased earnings but express caution that their model did not allow clarity in examining

the causal chain that produced such results. Therefore, they caution that interpretation in the policy realm is impractical. The specific inputs that lead to higher earnings later in life, however, are not specifically prescribed by Card and Krueger (1992). Card and Krueger (1998) review the empirical literature regarding earnings and school quality. They develop a helpful framework that interprets much of the previous literature on schooling, school quality, and earnings (see also Card & Krueger, 1996). This framework is summarized with four theoretical propositions (Card & Krueger, 1998, p. 42-43):

1. Earnings rise with educational attainment.
2. The marginal payoff to additional schooling is higher for those who attend higher-quality schools.
3. If the monetary payoff to an additional year of schooling rises, some students will attend school longer.
4. A portion of the observed association between earnings and education is due to unobserved factors that are jointly correlated with both variables.

Card and Kruger's estimates were contrary to previous educational production estimates.

Such results garnered interest from Betts (1995), who questioned the use of statewide aggregate data to measure earnings at such a large scale. Among the studies that examine earnings (i.e. Card & Krueger), Betts (1995) states that the majority do not examine the attributes of the school attended. How can aggregate or statewide data, therefore, determine potential earnings for an individual? The problematic result of using aggregate data is that "a positive and statistically significant relationship between achievement and school resources rises dramatically along with the level of aggregation" (Hanushek, et al., 1996, p. 611). After reviewing the outcome and earnings literature, Card and Krueger (1998) are unable to refute the longstanding conclusions put forward by Hanushek that resources do not matter.

K. Desegregation and Segregation

A brief journey out of the production function literature reveals a web of literature

on school desegregation. The intent of desegregation research is much less involved in economics and the production function of education, but it is directly related to outcomes of students, perceived school quality, and school district location choice. It is interesting to observe the time between the milestone decision of *Brown v. Board of Education of Topeka* in 1954 and the publication of the monumental Coleman Report twelve years later. The court decided that separating children and schools based on race was inherently unequal. Yet, at the time of the Coleman Report, segregation was still pervasive (Coleman et al., 1966). At the time of the Coleman Report, emphasis was placed on the South, where racism was more outwardly and publicly expressed than in the North. Clotfelter (1999) points out that much of the desegregation and race-related literature focused on between-school differences (opposed to between-district) and that, historically, was where segregation was most obvious.

After the *Brown v. Board* decision, segregation could be blamed on policy as much as school district boundaries. In other words, segregation shifted from being intra-district to inter-district. This is not to assert that racial inequalities do not continue to exist within districts but rather to assert that such inequalities are more widespread and observable at the metropolitan or regional level, which are topics directly related to urban sprawl. Today, while racism and segregation are not as openly explicit, such topics underlie school district boundaries and school buildings, especially in Michigan's (among others) urban districts. To ignore these underlying grievances when discussing school quality is to seriously err in understanding the factors that motivate school quality, location choice, and school choice.

Similar to the debate on whether or not increased expenditures produces better test

scores, there is a parallel argument on whether private choice exacerbates racial segregation. Arguments against increased private school competition and vouchers contest the divisiveness of sorting between religious or racial groups, which leads to the separation of socioeconomic classes. Proponents argue that private schools offer a better education with defined morals and values (Coleman et al., 1982). What is not defined, however, is what is meant by *better*. Coleman et al. (1982) astutely make the point that if private schools are better, then the majority of families would choose to send their children to those schools. Again, there is no specific mention of what better means. Therefore, private schools appear to be perceived as better in that they offer (usually) religious curricula and are homogeneous in their social, racial, and religious composition.

School choice literature thus far has been more or less supportive of the notion that choice increases educational opportunities for all families and children, regardless of social class and race. Critics, however, contend that increased choice leads to increased segregation, where wealthy (and typically) white students will use the choice option to retain their social standing and detach themselves from minorities (Taeuber & James, 1982). Saporito (2003) finds this separation evident among Philadelphia magnet schools. He finds that "the private choices of individual families for schools are patterned by the race of families seeking alternative schools as well as the racial composition of the schools they leave" (p. 198). Is it possible that race is less a deterrence than poverty rates, average test scores, or safety? Saporito (2003) accounts for these characteristics and still finds that the avoidance of minority schools is not reduced, therefore leading him to critique school district policies that allow unrestricted moves between schools.

L. Competition and Choice

Socioeconomic inequalities and failing school districts are perpetuated by geographic boundaries that define a school district's operational area. Regions with many small school districts around urban areas have highly fragmented political and racial differences among districts, "where heterogeneous areas that are broken into smaller, less diverse entities often have large discrepancies in school quality. These disparities are due to differential school funding, parental involvement, teacher quality, student behavior, class size, facilities, or some combination of these factors" (Bischoff, 2008, p. 183). Households sort themselves based, in part, on public expenditures that appeal to their "preference pattern for public goods and a 'consumer-voter' with children will choose to live in a community that expends a lot on public schools" (assuming that households are fully mobile) (Tiebout, 1956, p. 418). Tiebout sorting is the "most powerful force in American schooling" (Hoxby, 2000a, p. 1209).

One purported way to make schools more efficient and to produce better quality is through competition, which can occur through private schools, school voucher programs, charter schools, and inter- or intra-district choice. There has been and still is a debate whether competition, either from private or public entities, is beneficial toward generating improved school quality (i.e. Coleman et al., 1982; Tauber & James, 1982; Hoxby, 1994; Levin, 1998). Choice in schooling is a politically manageable way to increase education options and has been called upon by school administrators as a way to reduce inefficiency (Millimet & Collier, 2008). While the findings on the effects of school choice are limited, Millimet and Collier (2008) conclude that choice does make a difference through increasing efficiency in neighboring districts thereby providing an

incentive for other school districts to improve. They note, however, that this effect has not been proven for voucher programs or other distinct choice models. In reality, some school districts are harmed by school choice since resources are removed when families move away or send a child to a private school.

Holmes et al. (2003) observe that the effects of choice are not well enough understood for students who have exercised school choice, especially for those who have not. The authors find that close proximity of a charter school to a traditional school improves achievement in the traditional school (using a sample of North Carolina schools). Bettinger (2005), however, finds the opposite when examining Michigan charter schools. As is typical, results on the effects of competition are often disputed in the literature, usually due to unit of analysis or specification issues, such as using a pre-charter competitiveness variable in the equation (Holmes, 2003). By and large, charter schools and other modes of schooling are a response to calls for increased choice in education.

i. Household Sorting

The Tiebout model of sorting is particularly relevant in school district policies and decision making, demographics, and enrollment. The desire for enhanced school choice among policymakers and parents is not necessarily a response to the perception of poorly performing schools. Instead, it is pushed as a reform that increases competition among and within school districts as a way to increase educational attainment and make public school districts more productive and efficient. Tiebout choice has been ever-present in school district dynamics and proposals seeking increased competition are not new types of reforms but rather extensions of the current system (Hoxby, 2000a). In other words,

households have always been sorting themselves based on preference for school quality. Examining housing market values, Brasington (2000, p. 410) shows that "parents do not choose schooling based on which school districts are best able to improve students' academic achievement; instead, they appear to choose school systems based on peer group effects, valuing the type of children who attend the school district." Similarly, Driscoll et al. (2003) found that parents (in California school districts) are attracted to districts already performing well over those improving in performance. This conclusion seems to support a lag effect, where it takes time for a district to improve its perception of quality.

Tiebout choice models and competition reform merely introduce the concept of choice empirically. The school choice debate is sometimes heated due to the deeply rooted position schools have in local communities. Examining this issue from a broader standpoint, however, allows one to see that household location choices are heavily influenced by school quality and that these choices are a primary characteristic of Tiebout choice. This broader view of competition offers hope and danger. The proponents of school reform via increased competition support the goal of achieving higher school quality while the "opponents fear that students would sort themselves among schools in a way that would impair the educational prospects of *some* students" (Hoxby, 2000a, p. 1209, emphasis mine).

In a competitive school district system there are likely to be increased household or family costs. For example, schools of choice districts may not offer transportation to non-district residents. Depending on the travel time for parents, this could be a serious expense in both fuel and time. Therefore, the choice reform assumes some level of

flexible mobility. Other intra-district choice models, such as vouchers and charter schools, may relax transportation and time burdens to parents and students, but still potentially pull resources away from traditional public schools while continuing to sort households in the district. Whether efficient or inefficient, school districts still have the goal of being productive and "the incentives that schools have to be productive are generally increased by Tiebout choice because it gives households more information and leverage in the principal-agent problem that exists between them and the people who run their local schools" (Hoxby, 2000a, p. 1210).

ii. Vouchers

Dissatisfaction with inner-city schools led the initial scheme on vouchers (Levin, 1998). Milton Friedman (1955, 1962) is credited with conceptualizing the voucher plan. Voucher programs provide funds for families to choose either public or private schools. Publicly funded voucher programs tend to be more controversial than privately funded systems, likely because they shift the incentive to attend free (tax financed) (Ladd, 2002) public schools over to a variety of other choices. Voucher programs received positive responses at the time Friedman proposed them due to the plights urban inner city schools faced at the time. Unsurprisingly, however, the voucher debate has been argued more on political and ideological grounds rather than on theoretical or empirical motives (Levin, 1998). On one side, there is the argument that competition and freedom to *choose* education will improve efficiency and achievement within a school system. Levin (1998), throughout years of research on the subject, agrees with this assertion. On the other side, opponents fear increased racial and social sorting (Tauber & James, 1982; Saporito, 1998).

Thus, there appears to be a tradeoff. Researchers agree that competition improves school quality to *some* degree whereas others fear that social and racial separation is too severe to approve voucher programs. Goldberger and Cain (1982), however, argue that studies regarding the achievement levels of students enrolled at private schools are flawed due to selection bias. In other words, high-achieving students are more likely to attend private schools anyway. Hoxby (2002) introduces the idea of allocation-related remedies, which attempt to manage students and school resources when choice is introduced.

Voucher programs are not necessarily ubiquitous in their application. In cities experimenting with voucher programs, low-income students and districts are often the targets (Nechyba, 2000). As of 2002, Milwaukee, Cleveland, New York City, Dayton, Ohio, and Washington D.C. were the main cities or districts participating in some form of publicly[11] or privately[12] funded voucher system (Ladd, 2002). A voucher program experiment in New York City is cited as the best of its kind to date (Krueger & Zhu, 2004). Krueger and Zhu (2004) analyze data made available from the experiment and conclude that the positive effect of vouchers on African American students is less robust than previous studies had concluded (Howell & Peterson, 2002; Howell et al., 2002). The authors concede that their results are subject to limitations of statistical analysis and offer guidance for future analysis. Rouse (1998) used the implementation of a choice program in Milwaukee to answer whether low-income students in private schools performed better than those not selected to attend a private school.[13] She found that

[11] Milwaukee, Cleveland, and in the State of Florida
[12] New York, Dayton, and Washington D.C.
[13] Rouse (1998) discusses how Wisconsin's decision to allow low-income students to utilize vouchers to attend a private school provided researchers with a "treatment" and "control" group, which created an ideal

students in private schools did, on average, 1.5 to 2.3 percent better than students in the control group (public schools) in mathematics but found but inconclusive results for reading.

The often cited objection regarding voucher programs, and school choice in general, is that households will sort themselves more than is currently occurring. There is no consideration, however, of the possibility that increased school choice could actually loosen locational choice decision restrictions applied to households by poorly performing school districts (Nechyba, 1999, 2000). In other words, by relaxing the confinement or exclusion of school district boundaries, it is conceivable that parents would choose to live in an urban district for close proximity to amenities and employment while having a choice of where to send their children to school. Such effects will not be observed, however, unless more freedom is granted to school choice programs. Anecdotally, it is simple to think of how many parents may residentially or vocationally prefer urban districts but avoid them solely due to perceived or real school quality problems. Ideally, such evidence would be gleaned from the case study cities and districts listed above. School vouchers remain publicly contentious and deserve rigorous analysis and experimentation to test their merit.

iii. Private, Charter and Magnet Schools

Private schools should not be thought of as a response to failing urban schools. In 2000, private school enrollment accounted for roughly 11.56% of total enrollment in the U.S., which was down from 12.1% in 1990.[14] History has had a large part in shaping the existence and operation of private schools, most notably Catholic schools, which made up

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experiment where students were randomly assigned to a group thus avoiding selection issues (see Goldberger & Cain, 1982).

[14] National Center for Education Statistics: Fast facts. http://nces.ed.gov/fastfacts/display.asp?id=65

80% of private school enrollment in 1980 (Hoxby, 1994). Places with a high proportion of Catholics, for example, will have a higher propensity to send their children to a Catholic school–not necessarily because public schools are perceived to be poor, but because parents support school systems in agreement with their values and beliefs (Ibid).

Therefore, it is necessary to remember that while private schools are mentioned in the competition debate, they are not to be seen as answers to school choice but rather as an option that has historically existed. Furthermore, studies (i.e. Willms & Echols, 1992; Echols & Willms, 1995) have found that not all parents who enroll their children in private schools are seeking better school quality. Instead, these parents may be looking for a strict religious curriculum or other criteria for which data are not collected and experiments are rarely carried out (Levin, 1998). Still, if an increase in the supply of private schools were to occur, then it could be possible that public schools would improve and that increased sorting of students among schools would occur (Hoxby, 1994). Moreover, poor public school quality can increase demand for private schools (Ibid).

Public school quality is related to the presence of private schools. In urban districts where graduation rates and test scores are lower, parents may be inclined to enroll their child in a private school. Indeed, the "market reform" theory suggests that "poor public school performance prompts families to exit public school systems in favor of private schools... and some public schools may not be driven to improve by declining market share if parents do not respond to school quality" (Hess & Leal, 2001, p. 250). However, other studies found that religious affiliation and racial factors drive private school enrollment more than public school quality (Smith & Meijer, 1995; Wrinkle et al., 1999). Hess and Leal (2001) conclude that "families are slightly more likely to turn to

private schools" in urban districts where graduation rates are lower (p. 258). Furthermore, they note that a lag time may be in effect so that "changes in quality do not readily translate into enrollment changes" (p. 259).

Brasington (2000) finds that public schools do improve when private choice is introduced. However, he also finds that public school competition does not improve nearby public school quality. This finding has negative implications for charter and magnet schools. Conversely, Jeon and Shields (2005) conclude that private schools do not improve efficiency in a homogeneous region, such as the Upper Peninsula of Michigan.

The idea of school district choice, however, would be non-existent should political boundaries not exist. School district boundaries have not been widely studied (Brown & Knight, 2005) but their presence defines inequality gaps that exist within regions. The mere idea that neighboring school districts vary so widely in proficiency could not be properly explained without the context of geographical boundaries. The geopolitical boundaries that mark lines on a map are necessary to researchers, policymakers, and residents because they provide a unit that conveys differences in demographics and socioeconomic status (Bischoff, 2008). The majority of studies performed on public education would have no basis if boundaries did not exist. This seems hard to imagine, but difference in school quality, proficiency, income, housing values, and all the metrics used in any quantitative endeavor would be impossible if boundaries were not delineated. Fortunately, boundaries allow in-depth analysis of school districts. Unfortunately, these invisible borders also drive the sorting of households based on race and income, which undoubtedly has led to inequality in public schools.

The socioeconomic composition of jurisdictions is commonly viewed as a proxy of school quality by households considering a move within that boundary (Ibid). It is reasonable to argue that household mobility and Tiebout choice are executed out of personal freedom, which in effect is a component of the free market. In other words, households are merely making individualistic choices that maximize their net utility. Conversely, residential immobility limits location choice thereby effectively limiting the potential to maximize utility. What remain are impoverished and residentially undesirable cities and school districts defined by the haves and have-nots. This social divide is what drives the push and pull factors of urban and suburban districts. Heterogeneity in income, race, ethnicity, and religion are the "main fault lines of preferences and political conflict in the United States" (Alesina et al., 2004; citing Huckfeldt & Kohfeld, 1989; Hacker, 1992; Wilson, 1996).

M. School District Changes

In the 1949-1950 school year there were 83,642 school districts nationally. In 1980-1981, there were 15,987 (Kenny & Schmidt, 1994). Bell (1988) characterizes this decline as a matter of school district boundary choice rather than an issue of geography or accident, which is significant since the number of cities has historically been increasing (Kenny & Schmidt, 1994). School districts are typically sized based on economies of scale. Larger school districts can share libraries, athletic facilities, teachers, administrators, and buildings. As school districts grow larger, however, they face increasing heterogeneity and therefore a tradeoff, which may force parents to mix among other social classes and make district-wide decisions together. This position can become a diseconomy of scale if pushed too far (Alesina et al., 2004). Alesina et al. (2004) found

that "people are willing to give up economies of scale in order to avoid being in a jurisdiction with significant racial or income heterogeneity" (p. 350), where racial heterogeneity matters more than income.

Within the context of Michigan, this can be seen on a school district map. School districts in more highly populated urban areas are typically much smaller than the rural and lesser populated districts in the northern parts of the state. "The more school districts there are, the less troublesome are free-rider problems, which tend to make Tiebout equilibria break down" (Hoxby, 2000a, p. 1211). Evidence of the racial, social, and political tensions in and around Detroit during the 20th Century and some jurisdictional disputes regarding school districts can be found in Darden et al. (1987). Alone, the Public School District of Detroit is homogeneous. Accordingly, many of the neighboring school districts are too. From a regional perspective, however, the region is segregated based on income and race (See Figure 2). Indeed, "heterogeneous areas that are broken into smaller, less diverse entities often have large discrepancies in school quality," which is due to differences in "school funding, parental involvement, teacher quality, student behavior, class size, and facilities" (Bischoff, 2008, p. 183).

The school choice argument is related to efficiency in public school systems. Hanushek's suite of articles has opened the door for criticisms regarding efficiency. The reason schools appear inefficient is because administrators do not have incentives to reduce costs and maximize profit nor do they "understand the production process and therefore can't be expected to be on the production frontier" (Hanushek, 1979, p. 370).

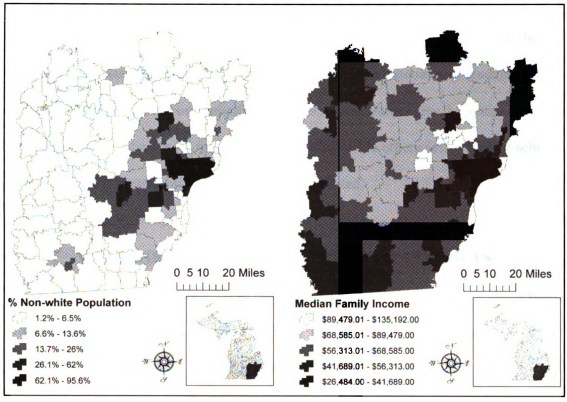

Figure 2: Percent non-white and median family income in Southeast Michigan

The discussion above illustrates that two choice models underlie the potential achievement levels of school districts. First, Tiebout choice is a decision made privately by households determining what level of public goods they can afford. Social, economic, and racial compositions of school districts are also considered in this choice model. Having numerous and smaller school districts allows households to sort themselves based on the level of schooling and property they can afford (Hoxby, 2000b). The second choice model is characterized in the public sphere. Public school districts can offer varying levels of choice to parents for educating their children. Inter- or intra-district choice, charter schools, and private schools are the second layer of choices made by households once they have made a household location choice based on demographic composition of a given district. The major problem with the choice model is it assumes

mobility, which is lower among non-white populations (Bischoff, 2008). Overall, the notion of choice has affected school quality and educational outcomes of students across districts, whether implicitly or explicitly. Perhaps some parents view the social and economic structure of a school district before moving while others solely look at school quality. In reality, these motivations are likely correlated.

V. BACKGROUND ON MICHIGAN SCHOOL DISTRICTS

The purpose of this chapter is to introduce the methods by which Michigan funds primary and secondary public education. The issues presented here are relevant to both the literature presented above and the analysis performed below. The policies affecting public education are related to Tiebout choice and the processes families follow when selecting their residence. Fluctuating enrollments, through state policy, can either benefit or harm school districts. State and local tax structures influence location choice and perceived school quality. In short, school quality is indirectly related to policy via the actions and choices families and households make. School district policies are not part of the analysis presented in this paper. These policies, however, deserve mention since they are related to the process of how school quality is perceived among households.

In the case of Michigan public school districts, the state is in charge of administering funds to local education agencies. Thus, quantitative research investigating the relationships between proficiency, inputs, SES, and attributes of place become relevant at the state and local levels of decision-making.

A. History

Similar to national trends mentioned above, the number of school districts in Michigan has also decreased over time. The greatest number of school districts occurred in 1912, when there were 7,362 school districts with 555,137 enrolled pupils (CRC, 1990). Figure 3 illustrates the rise and fall in the number of Michigan school districts. While there were thousands of school districts, they were not comprehensive, meaning that they did not offer a full K-12 curriculum. The number of comprehensive school districts has been more stable.

In the early 1900's, administrators began to realize the excess number of districts, at which time there were 1,004 districts enrolling fewer than 15 pupils (CRC, 1990). One of the main reasons for keeping districts so small and numerous was to keep families close to the schoolhouse (Ibid). Since then, the main reason for reducing the number of districts, through consolidation, annexation, or dissolution, has been to locate all children in a K-12 district (Ibid). Looking at the graph below, there is a relationship between the sharp reduction in school districts and the end of WWII, which was when widespread suburban growth commenced. This reduction is also likely related to achieving better economies of scale.

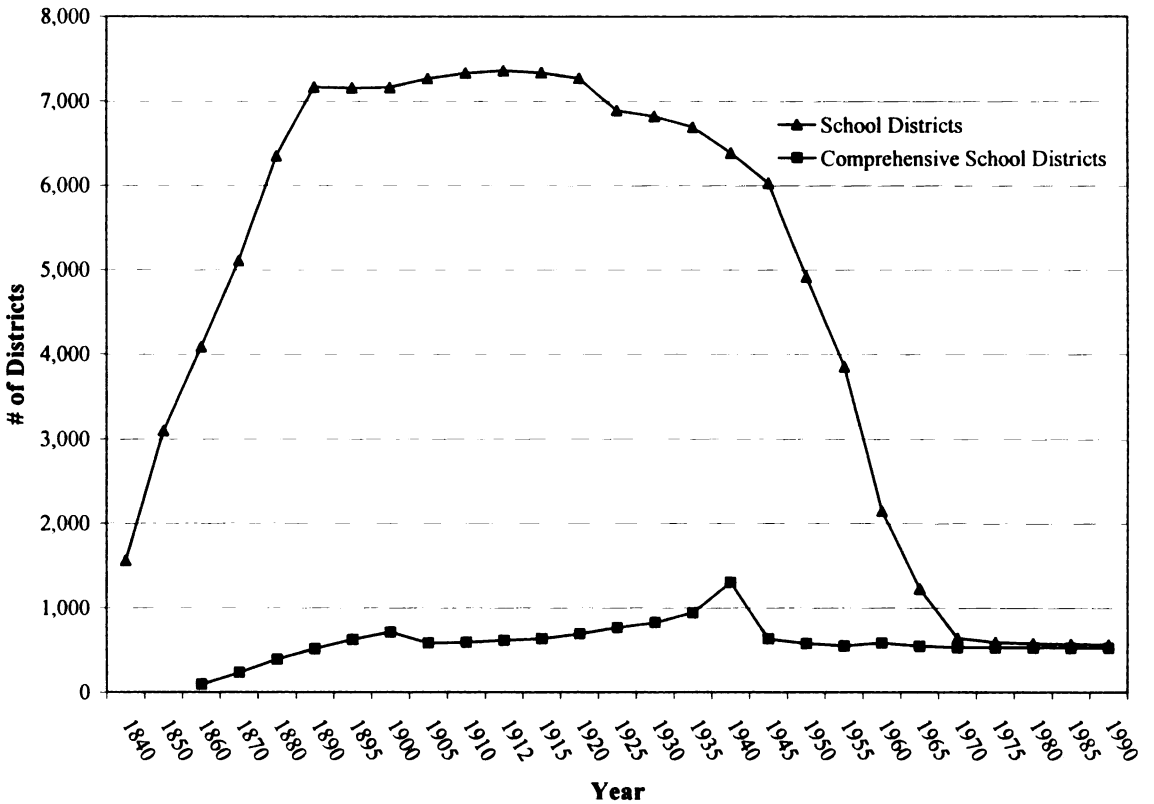

Figure 3: School districts trends in Michigan: 1840-1990. Source: CRC (1990)

B. Study Area

School districts in Michigan range from small and isolated (Bois Blanc Island) to large, dense, and urban (Detroit). In analyzing such drastically different districts, it is vital to understand the underlying local factors combined with educational input factors that "produce" quality education among districts. The geographical size of districts varies widely. Metropolitan areas tend to have school districts with small geographical size, higher densities, and varying socioeconomic characteristics. The non-metro areas of the state, which include towns, villages, and rural areas, have less variation in geographical size and SES. School districts in Northern Lower Michigan and the Upper

Peninsula tend to be large compared to those in Southern Michigan. Concerns arise regarding transportation costs and school access in these larger areas (Talen, 2001). Additionally, school districts in rural areas–particularly those losing enrollment–constantly have to consider the possibilities of closing schools, consolidating school districts, or finding other ways to cut costs. These issues have become particularly relevant due to the economic conditions presently confronting state and local governments.

C. District Organization

Public funding of education in Michigan has been analyzed in various forms, such as academic articles (Courant & Loeb, 1997; Cullen & Loeb, 2004), policy reports (Arsen & Plank, 2003; Arsen et al., 2005), and a government report (Lockwood, 2002). This section will describe school funding in the State of Michigan. An important story in school funding centers on the passage of Proposal A in 1994. Prior to this year, Michigan residents and businesses were paying high property taxes relative to the nation and were beginning to demand lower taxes and better educational funding methods (Lockwood, 2002). Prior to Proposal A, Michigan property taxes were 34.4 percent higher than the national average (Arsen & Plank, 2003). Former Governor John Engler spearheaded Proposal A, which had three immediate aims: relieve property taxes, reform choice, and shift school funding from local sources to state funding (Lockwood, 2002, Courant & Loeb, 1997). The latter consequence made school funding more equitable across school districts (Arsen & Plank, 2003) and spending per pupil generally increased the most in poorer districts (Courant & Loeb, 1997). Proposal A provided property tax relief by shifting the tax structure. Since Proposal A's passage, the average Michigan homeowner

pays roughly $2,000 less in property taxes per year (Arsen & Plank, 2003). The state sales tax increased from four to six percent, with the entirety of the additional two percent designated for schools via the School Aid Fund (SAF). Other taxes also contribute to the SAF, including tobacco, liquor, and property taxes. All properties are required to pay at least 6 mills and non-homestead property 18 mills. All net revenue from the state lottery is contributed to the SAF (Ibid).

Proposal A had support from both sides of the political aisle. Previously, liberal constituencies were unhappy with the stark contrast between Michigan's richest and poorest districts in terms of spending per pupil. That variation in funding was strongly correlated to school district wealth (Courant & Loeb, 1997). Conservatives were unhappy with taxes on wealthy school districts that subsidized lower-wealth districts (Ibid). Proposal A passed with overwhelming support from Michigan voters. This is noteworthy, since between 1972 and 1993, Michigan voters turned down 12 ballot proposals that would have decreased property taxes as a source for schools (Ibid). Following the passage of Proposal A, its impacts seemed widely positive. Except for Detroit and some other urban districts, which experienced tax increases, the overall result increased spending in already low-spending districts (Ibid). Following approval of Proposal A, Michigan's economy was performing well and the state of the state's public education system was looking better.

Soon after the proposal's passage, however, the SAF had structural problems in its ability to raise revenue and keep its commitment to school districts. Since Proposal A was passed, the Legislature transferred approximately $560 million each year to close SAF funding gaps (Arsen & Plank, 2003). At the time Arsen and Plank (2003) published

Michigan School Finance Under Proposal A the state was in a recession, which harmed the state's funding formula and exposed structural problems of the funding scheme. Such problems would persist even if the state rose out of recession (Ibid). Each year, districts receive an increase in their foundation allowance, which is a minimum amount that each district receives from the state, per pupil. The allowance must increase each year by at least the rate of inflation. The state found it impossible, however, to keep revenues tied to increasing expenditures.

The foundation allowance is distributed to school districts on a per-pupil basis and is, therefore, tied directly to school district enrollment. It is for this reason that enrollment changes among Michigan school districts are important. Many urban districts, typically declining in enrollment, are seeing allowances taken away based solely on enrollment change. Conversely, suburban districts growing at a fast rate are seeing new state monies come in every year. Arsen and Plank define four general categories that befall school districts regarding enrollment change: increasing real foundation allowance, increasing enrollment;[15] declining real foundation allowance, increasing enrollment;[16] increasing real foundation allowance, declining enrollment;[17] and slow increases in real foundation allowance, declining enrollment[18] (Arsen & Plank, 2003, p. 24, 25).

Enrollment change from one district to another is directly related to the Tiebout choice model and school sprawl. Proposal A did help low spending districts but it also

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[15] This group is defined as the "luckiest" group, since the real foundation allowance and enrollment are increasing rapidly. School districts in this class enjoy rapid revenue growth.
[16] Districts in this category have not seen dramatic increases in their foundation allowance but have seen rapid gains in enrollment, which still increases revenues.
[17] School districts in this group are experiencing a negative impact on the foundation allowance due to diminishing enrollments. Any gains in the foundation allowance were offset by enrollment declines.
[18] School districts such as Detroit, Flint, and Lansing fall into this category. Severe budget problems are the result of hemorrhaging enrollments combined with slowly growing foundation allowances. (Arsen & Plank, 2003)

created an obscure policy effect. Policymakers and citizens likely had no idea that both school aid funding would fall short and that Proposal A would actually work to encourage sprawl (Arsen & Plank, 2003). Arsen and Plank (2003) describe how growing school districts can expand their services simply by growing enrollment while districts with declining enrollment are faced with staffing and program reductions and building closures. These cuts and closures do not help public perception of or positively reflect on school districts. To make matters worse, when students and families exit one school district for another, they are leaving behind a greater proportion of risk children that may demand more in terms of expenditures and attention (Arsen & Plank, 2003). As a result, households consider these negative factors when making residential decisions and are drawn to growing and flourishing districts over ones that are or are perceived to be failing. Other districts, however, are simply faced with making cuts to staff and classrooms, which negatively reflects upon their ability to provide effective education. On the other hand, growing districts no doubt need the increasing foundation allowance to offset the influx of enrollment–but at what rate?[19]

One aspect of public school finance remained exclusively under local control: capital spending. Revenues for construction and other capital projects are primarily collected from local sources (and some from the School Bond Loan provided by the state), meaning that the construction of new schools, athletic facilities, and other capital projects are expressed through local desire and ability to pay via local millages (Arsen et al., 2005). Whereas Proposal A equalized the gaps between Michigan's richest and poorest districts by centrally providing operational funds, it did little to address how

[19] See McClelland and Schneider (2004) for more evidence of Michigan's "School Construction Boom" during the years following the passage of Proposal A.

districts fund capital projects. Districts finance capital projects through local taxes.

Michigan's urban school districts face the most need for capital spending. "The average millage rate in the poorest 20 percent of school districts is nearly three times higher than the average millage rate in the richest 20 percent of districts" (Arsen et al., 2005, p. ii). In other words, residents of poor urban districts must tax themselves at much higher rates compared to wealthy districts just to provide capital. "In 29 of Michigan's wealthiest districts the per-pupil value of taxable property is more than $500,000. In 75 districts, the per-pupil value of taxable property is less than $100,000. In six districts including Detroit the per-pupil value of taxable property is less than $50,000" (Ibid, p. i). Clearly, urban residents must endure a heavy tax burden to provide the capital needed to maintain or construct buildings and undertake other capital projects.

Another area where Proposal A had a major impact was school choice-related reform. The passage of Proposal A established charter schools and implemented schools of choice programs. Charter schools are accountable to the state government but are able to function similar to private schools (Lockwood, 2002). Students can choose any charter school they wish to attend (their foundation allowance follows them) and have an equal chance of being enrolled (Ibid). Charter schools are typically organized by teachers, parents or entities such as universities, community colleges, or non-profits. They are chartered by a public entity, such as the local school board, a public university, the State Board of Education, or the state government (Ibid).

Charter schools often differ from traditional schools in their curriculum and methods of instruction. As far as choice is concerned, charter schools provide a locally-based alternative to traditional public schools. School of choice programs allow students

to attend schools in districts other than their principle residence. Again, all students have an equal chance of acceptance and must rely on their own transportation (Lockwood, 2002). School districts have the option of "opening their doors" to students in neighboring school districts, as long as those districts are in the same intermediate school district (Ibid).

VI. ANALYSIS CONDUCTED

The analysis carried out from this point is not to be viewed strictly as an educational production function. Rather, the educational production model and literature is supportive of the investigative path taken in this analysis of Michigan public school districts. The educational production framework provides the theory needed to answer questions about the factors that influence overall school quality. This study deviates from the majority of studies in that it does not measure output of individual students or schools, but rather entire school districts.

School districts are the entities that contain students, who attend schools, which produce a measure of output for the entire district. There are obvious differences with this level of analysis in comparison to traditional educational production functions. Some complications resulting from this difference may be ignoring cumulative impacts of education over time[20] or missing the effect peers have on the learning process. For this analysis, however, these problems are not assumed to be severe since school districts are likely to vary year to year in their school quality measures and peer effects are impossible to measure at such a level. Furthermore, time-series data are left out of this analysis for simplicity. However, I believe that these complications can be resolved with the

[20] In this case, would test scores from the previous year have any impact on test score this year?

assumption that households make choices largely based on school district test scores. In the discussion regarding household location choice above, there are other factors that may influence household location choice, such as social or racial composition of the district. These variables are included, even though the goal is not to model choice, but are still believed to be associated with school quality.

Educational achievement, measured by MEAP score proficiency for combined math and reading scores at the fourth and seventh grade are the dependent variables used in two separate models. The traditional predictors of achievement, such as SES, parents' education, race, educational expenditures, among others are included as explanatory variables in the model. The inclusion of each of these predictors is supported based on the review of the literature. The primary contribution this paper makes is the introduction of place in the school quality framework while controlling for SES, race, educational inputs, and location.

A. Data

Data were obtained from a variety of sources for this study.[21] Data are from the U.S. Census 2000 School District Tabulation (STP2)[22], the U.S. Census 2000 School District Tabulation Supplement (STP2S)[23], the National Center for Education Statistics (NCES) Common Core of Data (CCD)[24], the Michigan Office of the State Budget Center for Educational Performance and Information (CEPI)[25], the Michigan Department of Education (MDE)[26], the Michigan Center for Geographic Information (CGI)[27], National

[21] I am grateful to the Land Policy Institute for providing these data.
[22] All demographic and socioeconomic variables derive from this source.
[23] Same as above.
[24] Provided variable for median family income and urban/suburban/rural status.
[25] Provided data on the percent of students eligible for free or reduced lunches.
[26] Provided MEAP score data and financial information, such as expenditures per student. Data obtained are from the 1999-2000 Bulletin 1014.

Establishment Time Series (NETS)[28], The Nature Conservancy (TNC)[29], Michigan Department of Natural Resources (DNR)[30], the National Oceanic and Atmospheric Administration (NOAA)[31], and Environmental Systems Research Institute (ESRI).[32]

Scores from the Michigan Educational Assessment Program (MEAP) are used for this study. MEAP scores are solid measures of performance in Michigan School Districts and are ideal in this analysis because all students take the test, which allows for comparative evaluation across schools and districts, in the same subjects, at the same time. MEAP scores are the most accurate measure by which to compare school districts in Michigan. ACT and SAT scores have been used in other studies, but these tests are voluntary and are typically taken by college-bound students. The MEAP scores used in this study are from the "Winter Grades 4 and 7" and "Winter Grades 5 and 8 MEAP Test Results".[33] Scores are represented as percent of students scoring proficient out of the total number of students that took the exam. Thus, to create a measure for combined reading and math scores, the two corresponding columns were summed and divided by two. This transformation was done for fourth graders and seventh graders.[34]

The place-based variables from NETS were converted to binary values (1 and 0) to indicate presence or absence. Each case for the NETS variables originated as

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[27] Provided the school district shapefile used for spatial variable calculations.
[28] Provided the place-based variables: number of universities and museums, and amusement/recreation opportunities per school district, which were converted to dummies to signify presence or absence.
[29] Publicly-owned open space. Data obtained from The Great Lakes Conservation and Recreation Lands (CARL) layer, which was created by Ducks Unlimited, Inc. Data were further refined by the Nature Conservancy in Michigan.
[30] Lake area as vector digital data. Published by the DNR, Fisheries Division, Institute of Fisheries Research.
[31] Stream length. NOAA's Coastal Geospatial Data Project, Rivers, Great Lakes.
[32] Used school district shapefile with combination of ESRI lake shapefile to spatially select school districts bordering the Great Lakes shoreline. Districts bordering Lake St. Clair and Detroit River are included.
[33] Downloaded January 6, 2009 from http://www.michigan.gov/mde/0,1607,7-140-22709_31168_31530---,00.html.
[34] Fifth and 8th grades were tested in other subjects not used in this analysis.

geocoded addresses on a map. A spatial join was performed that summed the total number of cases per school district. Next, a conditional formula was implemented that merely denoted the presence (1) or absence (0) of any of these facilities, for each of the three variables. Universities and museums were combined into a new binary variable, which indicates whether a school district contains either a university or a museum, or both. This combination was created since many school districts lack a university but museums offer a form of education outside of the classroom. Furthermore, universities are sparsely located throughout the state and the majority of them are located in metropolitan regions.

The variable OSpace is a measure of publicly owned or managed open space. Some examples of ownership or management include wildlife refuges, national or state forests, the Michigan Department of Natural Resources, municipal parks, and recreational users (golf courses, bike trails, lakes, etc). Private open space is not included in this measure. Lake is a measure of the total area of inland lakes within a school district. Stream is the total length of streams (in miles) in a school district. These three variables were computed the same way as the NETS variables. Spatial joins on open space acres, lake acres, and stream length provided the total of each for all school districts.

GreatLk is a binary variable that indicates whether a school district borders any of the Great Lakes or not. A spatial selection was used in ArcGIS that selected these districts. The place data used in this study were not already aggregated to a specific level, such as a county. Therefore, spatial joins allowed the data to be calculated at the school district level. Much more place-related data exists, but if it is already aggregated to, say the county, then the geographic processes required to transform that data into

usable measures for school districts would have been difficult and likely controversial. Lastly, locale codes provided by NCES CCD were simplified into urban, suburban, or rural dummy variables. Granted, these three classifications are limited and do not define every school district in Michigan, but they do allow easier analysis by only entering urban or rural into the model.

B. Hypothesis

Since place has not been studied in this way before, hypothesizing the signs of the coefficients a priori is not appropriate. Thus, a change in the R-square statistic is used to affirm or reject the null hypothesis. Generally speaking, I would argue that place-based characteristics positively contribute to the educational attainment of children thus helping explain variation in school district test scores. It is thus hypothesized that when accounting for place-based attributes in school districts, the R-square of the models will increase.

Table 1: Variable Descriptions

Variable	Description	Source
Cmbd_Elem	Combined Math & Reading MEAP scores for 4th graders	MDE
Cmbd_Mid	Combined Math & Reading MEAP scores for 7th graders	MDE
PCTNWHI00	Percent of Non-white Population	U.S. Census
SCH_BACH_PER	Percent of Population with Bachelor's Degree or higher	U.S. Census
AVG_ITOT	Average Instruction Expenditure per Pupil	B 1014
AVG_P_TCHR	Average Pupil-Teacher Ratio	B 1014
PCT_ENR	Percent of Students Eligible for Free or Reduced Lunch	CEPI
URB_DUM	Dummy variable: 1= urban; 0= not	NCES
RUR_DUM	Dummy variable: 1= rural; 0= not	NCES
UniMus_dum	Dummy variable: Presence of University or Museum	NETS
Amuse_dum	Dummy variable: Presence of Amusement or Recreation Facility	NETS
$\log_{10}$OSpace	Total Acres of Publicly Owned Open Space	TNC
$\log_{10}$Stream	Total Stream Length in Miles	NOAA
$\log_{10}$Lake	Total Acres of Inland Lakes	DNR
GreatLk_dum	Dummy variable: 1= adjacent to Great Lakes; 0= not	MCGI, ESRI

Showing that place-based attributes affect educational production, a two-fold reaction can occur. School districts that possess high levels of place-based amenities could elevate achievement through the out-of-class educational opportunities that are usually specified as "other influences" in production functions. In addition, districts having desirable places will naturally attract households and children. Within this framework, it may seem that urban districts are placed at a disadvantage. To compensate, it is assumed that cities are desirable places for employment, cultural and entertainment activities, and a social connection with others. Within this assumption, however, it must also be assumed that suburban districts offer similar amenities and offer a better "choice." Thus, remembering that location choice decisions are heavily influenced by school quality (test scores), understanding the role place has in predicting school quality will help policymakers, school administrators, planners, and citizens improve the inputs that produce educational outcomes.

C. Theoretical Construct

Following the educational production function of individual students established by Hanushek (1979) $A_{it} = f(B_i^{(t)}, P_i^{(t)}, S_i^{(t)}, I_i)$, I propose a school quality function at the school district level $Q_{jt} = f(S_j, I_j, L_j, P_j)$, where for the jth district, Q= quality measured by MEAP proficiency rate on combined math and reading tests, S = a vector of socioeconomic characteristics, I= a vector of educational inputs, L= location (urban, suburban or rural) and P= a vector of place-based attributes, at time t. However, this model can be made more specific by separating the potential additional effect place can have on education. The function below takes into account the effect place-based characteristics has on educational proficiency. The equation can be written as:

$Q_{jt} = f(S_j, I_j, L_j \mid P_j)$, where the symbol | indicates the hierarchy of the function, where the first block of independent variables enter the model, followed by the second block of independent variables pertaining solely to place.

This model deviates from traditional educational production functions in that it does not use as many predictor variables because coefficients are estimated at the school district level. When estimating school quality outcomes for individuals or schools, more variables are necessary to account for peer effects, school to school differences, family background differences, time spent in the classroom, and previous attainment levels. For example, whereas traditional production functions of education consider teacher salary to be a vital input, it is not examined here. Instead, the variable 'average instructional salary per student' is used, which measures the average expenditure per student for teaching core subjects.[35]

Additionally, it can be argued that the median family income of a school district would be beneficial in the model. This variable, however, is omitted because it is highly correlated with both the percentage of the population receiving Bachelor's degrees or higher (positive) and with the percent of students eligible to receive free or reduced lunches (negative). The percent of students eligible to receive free or reduced lunches is thus used as an income/ poverty proxy. Student background effects, as a vector, are not explicitly defined for this study since I am examining school districts, not individuals. One variable included in the socioeconomic vector (*S*) includes percent of population with a Bachelor's degree or higher, which ought to provide a proxy for family background – at least with regards to education, which could be argued leads to higher

[35] Furthermore, including the variable for teacher salary has a significant linear relationship with AVG_ITOT at roughly 0.82.

income and earning potential. School districts cover larger areas than schools; they are composed of many students and sometimes many schools. Therefore, the individual characteristics of students and schools are assumed to be already aggregated at the school district level, thus excusing their inclusion in this model. Remembering that the overall goal of this thesis is to explore the impact of place on education, the models are specified with this objective in mind.

Two models are introduced. Both have the same independent variables and are not simultaneously estimated. The first model uses combined reading and math scores at the fourth grade where the second model uses the same combination at the seventh grade level. These equations are estimated using OLS. The empirical versions of these models are expressed,

(1) $\text{Cmbd\_Elem} = \alpha_0 + \beta_1 \text{PCTNWHI00} + \beta_2 \text{PCT\_ENR} + \beta_3 \text{SCH\_BACH\_PER} + \beta_4 \text{AVG\_ITOT} + \beta_5 \text{AVG\_P\_TCHR} + \beta_6 \text{URB\_DUM} + \beta_7 \text{RUR\_DUM} + \beta_8 \text{UniMus\_dum} + \beta_9 \text{AmuseDum} + \beta_{10} \log_{10}\text{OSpace} + \beta_{11} \log_{10}\text{StreamLength} + \beta_{12} \log_{10}\text{Lake Acres} + \beta_{13} \text{GreatLk\_dum} + \mu_1$

(2) $\text{Cmbd\_Mid} = \delta_0 + \gamma_1 \text{PCTNWHI00} + \gamma_2 \text{PCT\_ENR} + \gamma_3 \text{SCH\_BACH\_PER} + \gamma_4 \text{AVG\_ITOT} + \gamma_5 \text{AVG\_P\_TCHR} + \gamma_6 \text{URB\_DUM} + \gamma_7 \text{RUR\_DUM} + \gamma_8 \text{UniMus\_dum} + \gamma_9 \text{AmuseDum} + \gamma_{10} \log_{10}\text{OSpace} + \gamma_{11} \log_{10}\text{StreamLength} + \gamma_{12} \log_{10}\text{Lake Acres} + \gamma_{13} \text{GreatLk\_dum} + \mu_2$

where variables are defined in Table 1, α and δ are intercepts, β's and γ's are regression coefficients, and μ's are normally distributed error terms.

D. Method

The notion of place has not been introduced in previous educational quality studies. Therefore, rather than merely choosing the appropriate variables and forcefully entering them into one equation, an alternative technique is employed. Hierarchical

regression modeling allows 2 or more blocks of independent variables to be analyzed separately. Hierarchical regression modeling (HRM) is not foreign to education-related studies. Raudenbush and Bryk (1986) emphasize that educational data are often expressed at various levels and that parameters estimated at one level can be used at the next level in the model. This approach in educational research is common and mainly focuses on the added effects of outcomes, but is not the same used here. Instead, HRM is used to measure the change in R-square and determine the additional impact place has on education.

Table 2: Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Dependent Variables					
Cmbd_Elem	449	35.00	98.30	68.0133	11.43208
Cmbd_Mid	449	16.85	88.25	57.2526	11.99909
Control Variables					
PCTNWHI00	449	.00901	.87631	0.07335	0.09622
SCH_BACH_PER	449	.04475	.67276	0.19025	0.10502
AVG_ITOT	449	3069	6528	4128.91	470.098
PUP_T_RATIO	449	10.03911	30.62073	21.09374	2.49303
PCT_ENR	449	.02	.83	.2858	.15386
URB_DUM	449	0	1	.04	.207
RUR_DUM	449	0	1	.53	.500
Place Variables					
UniMus_dum	449	0	1	.36	.481
Amuse_dum	449	0	1	.92	.265
$\log_{10}$OSpace	449	-0.32057	6.00255	3.71204	0.95428
$\log_{10}$Stream	449	0.55630	2.61532	1.72424	0.33725
$\log_{10}$Lake	449	-0.52578	5.71483	3.00650	1.06510
GreatLk_dum	449	0	1	.24	.428

The first block of predictors includes variables that are traditionally found in production functions of education, such as average instruction per pupil, race, income, education levels, and percent of students eligible for free or reduced lunches.[36] Next, a separate block of variables "enter" the equation. Here, variables include those pertaining to characteristics of place. This method allows one to adequately answer the question: What added influence does place have on school quality when accounting for traditional inputs to education? Changes in the R-square and F-ratio will help answer this question alongside the examination of the regression coefficients.

The second block of variables is not force-entered into the equation. Instead, they are allowed to enter the equation in a stepwise process. Since literature does not offer theory on place in predicting school quality, the stepwise process allows the researcher to let statistical software enter the variables into the equation based on significance. The purpose of using stepwise in this case is exploration of the place-based data, which Hays (1994) notes is acceptable when used for exploratory studies.

Multiple regression is utilized to explore the relationship between a set of predictors variables against a dependent variable. The general equation is specified as

$$Y = a + \sum_{i=1}^{k} b_i X_i + u$$

where Y is the dependent variable; $X_1, X_2 \ldots X_i \ldots X_k$ are k independent variables; a and b are regression coefficients; and u is a stochastic disturbance term. When using multiple regression, specific assumptions must be considered. First, each value of X_i and of Y must be observed without measurement error. Second, the relationships between the

[36] These variables are classified, and referred to throughout this chapter, as control variables.

dependent and independent variables are linear. Third, the distribution of u has a mean of zero. Fourth, the distribution of u is homoscedastic. Fifth, the values of u are serially independent. Last, the independent variables are linearly independent of each other (Poole & O'Farrell, 1971). Another assumption for regression is that data are normally distributed (Osborne & Waters, 2002). Having severely skewed data can create heteroscedasticity problems, which would violate the homoscedasticity assumption of regression. See Table 3 for correlations of independent variables.

The residual plots for each regression are mostly homoscedastic. However, visual inspection is ambiguous at best and does hint at the presence of heteroscedasticity. Thus, both models were tested for heteroscedasticity using White's Test, which "examines whether the error variance is affected by any of the regressors, their squares, or their cross-products" (Kennedy, 1998, p. 121). Using White's Test, the null hypothesis is confirmed, concluding that heteroscedasticity is not present in both models.[37]

In order to satisfy the normality assumption, three place-based variables were transformed using the common logarithm.[38] Without this transformation, each variable had extremely skewed data that would have performed poorly in the regression design. Multiple cases, however, had a value of zero. Therefore, when using the $\log_{10}$ transform, such cases were dropped.[39] Regardless, it is argued that removing these cases is justified since measuring the added effect of place on educational performance is the overarching goal of this analysis. Cases not having any value or a zero value are not useful in the research design.

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[37] Model (1): Test statistic: TR^2 = 71.236241, with p-value = P(Chi-square(32) > 71.236241) = 0.000082
Model (2): Test statistic: TR^2 = 109.559614, with p-value = P(Chi-square(85) > 109.559614) = 0.037720

[38] Log base 10

[39] This is why the sample size is 449. Taking the $\log_{10}$ of zero is mathematically impossible, which creates null values in those cases in SPSS. See Appendix B for descriptive statistics of all dropped cases.

Table 3: Pearson Correlation of Independent Variables

	1	2	3	4	5	6	7	8	9	10	11	12	13
PCTNWHI00	1.000	.071	.416**	-.061	.413**	.401**	-.223**	.208**	.037	-.058	-.123**	-.128**	.114*
SCH_BACH_PER	.071	1.000	.195**	.001	-.535**	.139**	-.350**	.357**	.178**	-.122**	-.291**	.004	.010
AVG_ITOT	.416**	.195**	1.000	-.440**	.308**	.243**	-.108*	.132**	-.036	.121*	-.096*	.012	.189**
PUP_T_RATIO	-.061	.001	-.440**	1.000	-.256**	.063	-.206**	.047	.194**	-.153**	-.091	-.176**	-.117*
PCT_ENR	.413**	-.535**	.308**	-.256**	1.000	.163**	.184**	-.075	-.134**	.321**	.241**	.215**	.141**
URB_DUM	.401**	.139**	.243**	.063	.163**	1.000	-.228**	.196**	.062	-.060	-.068	-.028	.005
RUR_DUM	-.223**	-.350**	-.108*	-.206**	.184**	-.228**	1.000	-.297**	-.186**	.201**	.180**	.175**	.010
UniMus_dum	.208**	.357**	.132**	.047	-.075	.196**	-.297**	1.000	.199**	.010	-.012	.061	.117*
Amuse_dum	.037	.178**	-.036	.194**	-.134**	.062	-.186**	.199**	1.000	-.011	-.048	-.010	.063
$\log_{10}$OSpace	-.058	-.122**	.121*	-.153**	.321**	-.060	.201**	.010	-.011	1.000	.474**	.583**	.203**
$\log_{10}$Stream	-.123**	-.291**	-.096*	-.091	.241**	-.068	.180**	-.012	-.048	.474**	1.000	.365**	-.035
$\log_{10}$Lake	-.128**	.004	.012	-.176**	.215**	-.028	.175**	.061	-.010	.583**	.365**	1.000	.104*
GreatLk_dum	.114*	.010	.189**	-.117*	.141**	.005	.010	.117*	.063	.203**	-.035	.104*	1.000

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Transforming the three place-based variables shown above was not done arbitrarily. When it became known through the use of histograms that these variables were extremely skewed, each was transformed using the common log. Next, and only for model (2) was the Akaike Information Criterion (AIC) used to determine the best model.[40] OLS was ran three separate times, where the first run included all variables untransformed, the second included all variables transformed to $\log_{10}$, excluding those already represented as a percentage or a dummy variable, and the third was done using only a log transformation of those three place-based variables.

AIC is a popular method of finding "the set of explanatory variables that minimizes a specific function of the sum of squared errors and the number of explanatory

[40] Place variables are not significant in 4th grade model, thus 7th grade model was used to test the best set of explanatory variables.

variables" (Kennedy, 1998, p. 96). AIC minimizes ln (*SSE/T)* + 2*K/T*, where SSE is sum of squared errors, T is the sample size and K is the number of regressors (Ibid, p. 103). The regression having the lowest AIC is best fitted based on the given explanatory values. In this case, the last regression had the lowest AIC thus justifying the log transform of only the place-based variables.[41]

E. Results

The tables below display the multiple regression output for equations (1) and (2). Coefficients found to be significant up to the $p<0.10$ level are discussed in more detail.

i. Model 1: 4th Grade Proficiency

In the first model, the null hypothesis, that place improves the R-square of the overall model, is not rejected. Place, in this model, does not add any explanation of variance in *Y*. Twenty-seven percent of the variance in the dependent variable is explained by the predictor variables in the first model. Autocorrelation is not problematic in this model, as indicated by the Durbin-Watson statistic in Table 5.[42] The variable SCH_BACH_PER has the greatest effect on Cmbd_Elem in the equation, as seen by having the largest standardized coefficient. Furthermore, the variable is statistically significant and positive indicating that the education (of those 25 and older) is powerful in explaining combined math and reading scores. An increase of one percent of people with a bachelor's degree or higher would raise proficiency 29.6%. Moreover, AVG_ITOT is found to be significant at the $p<0.10$ level, which shows that increasing average instructional expenditure per pupil by one dollar would increase combined math and reading scores by 0.002%. This result adds to the production function literature that

[41] Regression 1 AIC= 3211.940; Regression 2 AIC= 3201.064; Regression 3 AIC= 3199.158

[42] The Durbin-Watson (DW) test tests first-order autocorrelation. Values close to two are optimal, indicating no autocorrelation of residuals.

investigates the impact of expenditures on school quality. The greatest threats to proficiency are related to race and poverty, both of which are significant and negative. An additional 1% of students that are eligible to receive free or reduced lunches lowers proficiency by approximately 19.4%.

While specific place variables did not have a significant impact on 4th grade proficiency, location did. School districts classified as urban were likely to have test scores 4.4% lower than suburban districts. Rural classification was not significant. The pupil-teacher ratio, a variable often used to measure class size and crowdedness, is insignificant and wrongly signed; since literature suggests that larger class sizes are detrimental to proficiency.

Table 4: Regression Results for 4th Grade Model

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
(Constant)	54.944	8.490		6.472	.000
PCTNWHI00	-17.146	6.235	-.144	-2.750	.006
SCH_BACH_PER	29.638	6.228	.272	4.759	.000
AVG_ITOT	.002	.001	.097	1.823	.069
PUP_T_RATIO	.236	.221	.052	1.069	.285
PCT_ENR	-19.422	4.631	-.261	-4.194	.000
URB_DUM	-4.393	2.516	-.079	-1.746	.082
RUR_DUM	-.531	1.051	-.023	-.505	.614

Table 5: Model Summary of Table 4

				Change Statistics			
R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	Sig. F Change	Durbin-Watson
.531	.281	.270	9.76695	.281	24.682	.000	1.929

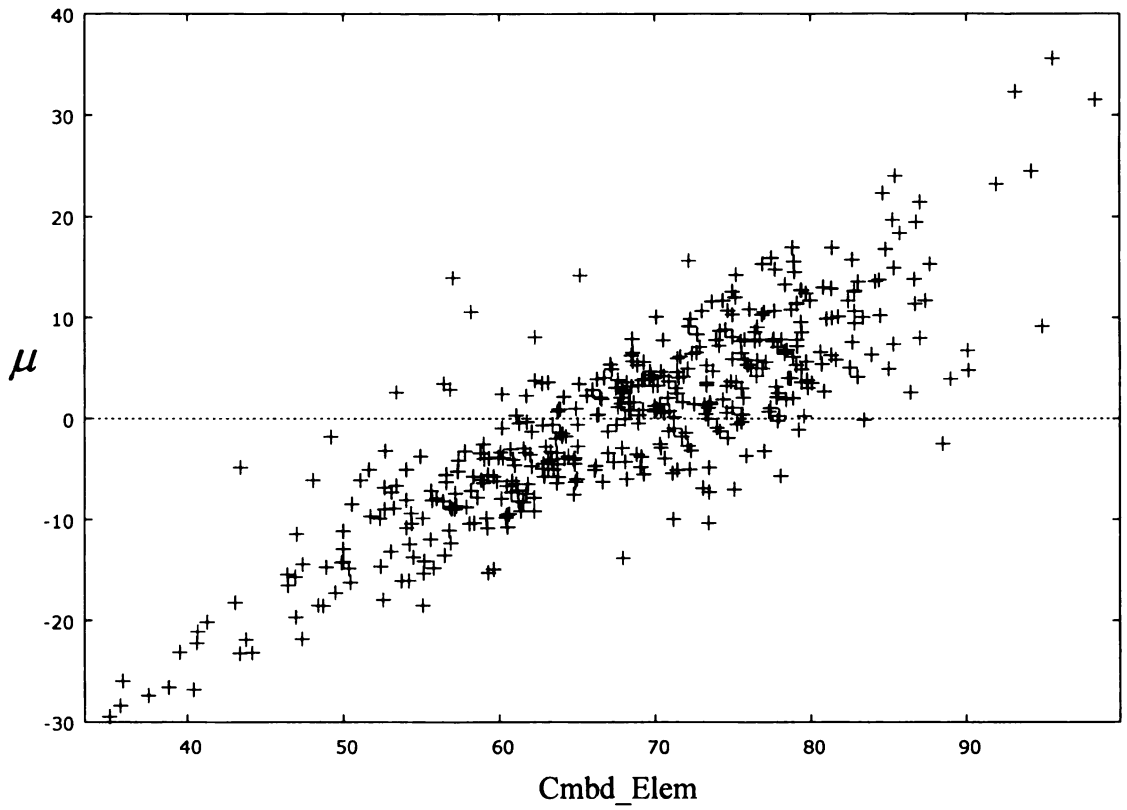


Figure 4: Graph of residuals versus predicted values for 4th grade model.

ii. Model 2: 7th Grade Proficiency

The results for the second model are more robust (See Table 7). When predicting combined math and reading scores for 7th graders, place has a much greater impact. In the final model, the R-square increased 0.061 when introducing place, thus rejecting the null hypothesis. Five out of six place-based variables are significant in the final model, when controlling for socioeconomics, school inputs, and location. The variable Amuse_dum was not significant and did not enter into the final model. An increase in the R-square statistic rejects the null hypothesis but does not answer whether or not the model with place included is better than the model without place. An increase in the

number of independent variables will not allow the R-square to decrease (Kennedy, 1998). An F-test is implemented to address this issue. The F-statistic is computed,

$$\frac{[SSE \text{ (constrained)} - SSE \text{ (unconstrained)}] / J}{SSE \text{ (unconstrained)} / (T - K)}$$

where J is a set of linear constraints in a regression with K parameters (including the intercept) and T observations, with degrees of freedom J and $T - K$ (Kennedy, 1998, p. 56). The F-change in Table 8 significantly increases with each model iteration, thus showing that the inclusion of place attributes significantly helps to explain the variance of the dependent variable.

Interpreting the regression coefficients, it is observed that an increase of one unit of $\log_{10}$Stream would increase combined test scores 6.4 percent. An additional unit of $\log_{10}$Ospace is positively related to test scores by 1.8 percent. A school district located adjacent to a Great Lake can be expected to score 2.8 percent higher than those that are not. Also statistically significant but showing negative signs are $\log_{10}$LakeAcres and UniMus_dum. An additional unit of $\log_{10}$LakeAcres is negatively associated proficiency by 1.8%. Likewise, the presence of a university or museum is negatively related by 2.2%.

The control variables also deserve mention. The seventh grade model contrasts the fourth grade model in terms of its finding for the variable AVG_ITOT. In this model, when place variables are significant, the variable for average instruction expenditure per pupil is not. Test scores in rural districts can be expected to be 2.5 percent lower than suburban school districts. Model (2) is similar to the first model by having the largest coefficients related to poverty, race, and education. An additional 1% of non-white

population is related to a decline of 29.7 percent in proficiency rates. Having an additional 1% of the population having a Bachelor's degree or higher is positively related to proficiency by 51.1 percent. An additional 1% of students eligible for free or reduced lunches can be expected to drop proficiency rates by 23.8 percent. Clearly, while place and education matter, the racial and socioeconomic characteristics of school districts are major predictors of district-wide school quality.

Table 6: Regression Results for 7th grade model (without place)

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
(Constant)	54.870	7.715		7.112	.000
PCTNWHI00	-32.649	5.666	-.262	-5.762	.000
SCH_BACH_PER	42.401	5.660	.371	7.492	.000
AVG_ITOT	.002	.001	.065	1.406	.160
PUP_T_RATIO	-.134	.201	-.028	-.666	.506
PCT_ENR	-21.089	4.208	-.270	-5.011	.000
URB_DUM	-4.454	2.286	-.077	-1.948	.052
RUR_DUM	-2.018	.955	-.084	-2.113	.035

Table 7: Regression Results for 7th grade model (with place)

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
(Constant)	44.698	7.911		5.650	.000
PCTNWHI00	-29.707	5.623	-.238	-5.283	.000
SCH_BACH_PER	51.098	5.869	.447	8.707	.000
AVG_ITOT	.001	.001	.039	.878	.380
PUP_T_RATIO	-.129	.192	-.027	-.672	.502
PCT_ENR	-23.804	4.349	-.305	-5.473	.000
URB_DUM	-3.248	2.181	-.056	-1.489	.137
RUR_DUM	-2.477	.924	-.103	-2.679	.008
$\log_{10}$Stream	6.368	1.441	.179	4.421	.000
GreatLk_dum	2.797	.980	.100	2.853	.005
$\log_{10}$Lake	-1.847	.489	-.164	-3.781	.000
$\log_{10}$OSpace	1.771	.580	.141	3.052	.002
UniMus_dum	-2.246	.934	-.090	-2.403	.017

Table 8: Model Summary of Table 7

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics			Durbin-Watson
					R Square Change	F Change	Sig. F Change	
1	.679	.461	.453	8.87591	.461	53.964	.000	
2	.698	.487	.477	8.67456	.025	21.710	.000	
3	.704	.496	.486	8.60447	.009	8.197	.004	
4	.711	.505	.494	8.53700	.009	7.967	.005	
5	.718	.516	.503	8.45510	.011	9.526	.002	
6	.722	.522	.509	8.40927	.006	5.776	.017	2.109

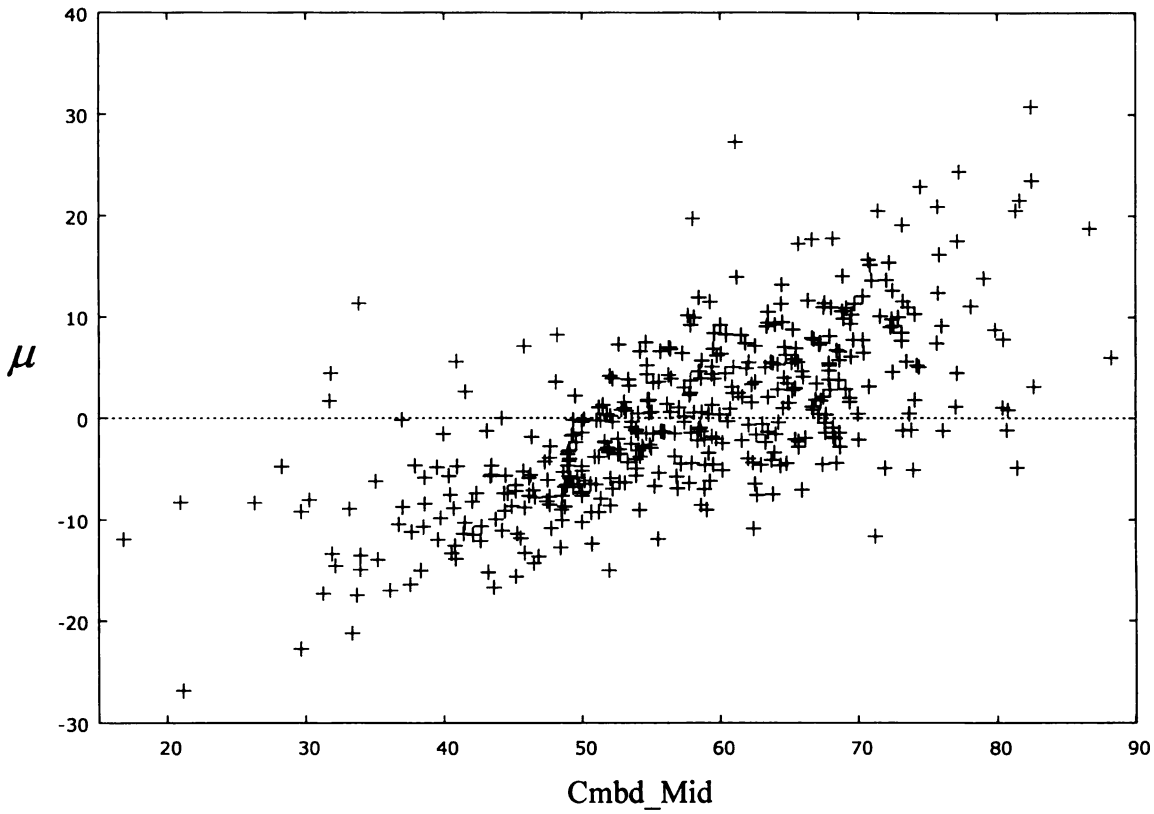


Figure 5: Graph of residuals against predicted values for 7th grade model.

VII. DISCUSSION

The difference between the fourth grade and seventh grade equations is intriguing. In the former, place has no significant impact on combined math and reading scores. In the second equation, however, all place-based variables except the presence of an amusement or recreational facility are statistically significant and add to the power of the model. What factors help explain this difference? First, I would argue that as students mature, they begin to have more choice in their daily activities; they have more freedom from their parents, and have an increased range spanning from their home. In other words, they have the freedom to "use" the attributes of place that surround them.

Explaining why place does not matter for 4^{th} graders in this model is confounding since the descriptive statistics show similar variance. One reason for this difference is partly supported by literature, which shows smaller class sizes benefit elementary grades more than others. Moreover, finding that the variable AVG_ITOT was significant for the fourth grade model and place attributes were not, whereas the opposite is true for the seventh grade model, may be related to the evidence that inputs matter more at the elementary grade levels. From here, I will discuss the model of 7^{th} grade proficiency first since place is significant and adds to the school quality model. The 4^{th} grade model is also discussed, but in less detail.

A. Discussion of Second Model – 7^{th} Graders

The case where the coefficient for universities and museums is negative may be explained by the peer effect university students and settings can have on kids, such as increased access to alcohol or higher instances of parties. Are museums and universities more likely to be found in urban districts thus making the coefficient negative? It is

logical to assume that the presence of universities and museums would provide certain out-of-class educational opportunities for children. However, perhaps the presence of such institutions is not as important as the people that are associated with these places. People that work at universities and administer museums are more likely to positively impact education, as is seen by the effect of SCH_BACH_PER. Furthermore, it is possible that while 7th grade test scores are not positively associated with universities, high school test scores may be. While significant, it is still difficult to understand why the presence of a university or museum would negatively impact MEAP scores. This study, however, did not set out to measure the impact having more professors or curators per school district would have on proficiency. In conclusion, the mere presence of a university or museum corresponds to lowered test scores, but does not conclude the social impact that institutions of higher learning may have on society as a whole.

Public open space is positively associated with better test scores. This result ought to be encouraging for planners, citizens and Smart Growth advocates seeking to curb urban sprawl. Based on the results, publicly owned open spaces, which are more "natural" in stature, have a significantly positive relationship with MEAP scores. One may argue that these results are inconclusive or spurious since urban and denser school districts may lack access to such open space. But poor test scores are not confined only to urban areas (remember Figure 1). Hence, the lack of open space in an urban district, due to higher densities and smaller land area, and an abundance in rural districts, which have low densities and more land area, do not matter in this output. Does the majority of open space exist in suburban school districts? No.[43] The majority of open space acres are primarily observed in Upper Peninsula and Northern Lower Michigan, where test

[43] See Appendix C, D and E for maps of open space, rivers, and lakes.

score proficiency widely varies. Thus, it can be concluded that the impact, as measured by this model, is positive and significant, whether in urban, suburban, or rural districts. Such findings are promising given the interest in "place-making," New Urbanism, and creating vibrant and community-based spaces in urban areas.

Streams are an interesting place-based variable that significantly increases the power of the second model. As a policymaker, what does this mean? No school district can increase the total miles of rivers within its borders and thus the effort to improve school quality in this way is void. However, this estimate does provide another interesting implication in education: choice and desire for natural amenities. School districts endowed with many streams may attract residents and population with recreation and beauty. Moreover, planning bodies in school districts that actively pursue sustainable economic development near streams, volunteer organizations that clean rivers, and developers that look to improve access on rivers may unknowingly be doing beneficial activities that are related to better test scores. While this study did not take into account the quality of streams, it makes sense that residents and businesses would be attracted to pristine water quality over poor and degraded ones.

Oddly, the total acreage of lakes was found to have negative impact on combined math and reading proficiency at the 7^{th} grade. One would assume that lakes would be similar to open space and streams by being positively related to educational proficiency. It would be interesting, and perhaps revealing, to examine whether or not the intensity of shoreline development changes the coefficient of the estimate. In other words, do school districts with greater numbers of lake homes have a more positive impact on test scores than secluded and uninhabited lakes? This question is ultimately related to wealth, since

lakefront property tends to be more expensive, which house summer residents who visit for part of the year. These residents, while they contribute economically during their presence, do not have children taking tests in that district. Therefore, school districts that have a lot of lakes and enjoy the economic benefits of a healthy tourism economy are still only fully inhabited part of the year. Those individuals, families, and students that reside there year-round may not enjoy the same affluence of the summer visitors, which may indicate why the coefficient for this variable was negative.

Since the total acres of inland lakes was included in the model, it also made sense to test the effect Great Lakes have on predicting school quality. Michigan is commonly recognized for having unfettered Great Lakes access, scenic shorelines, sand dunes, sandstone rock formations, and splendid sunsets. Each year, tourists flock to cities and campgrounds located close to Lake Michigan, Lake Huron, and Lake Superior. Such attraction to and appreciation of the Great Lakes by people give those places something special that cannot typically be measured. Based on the results, school quality is greater in school districts located on the Great Lakes.

B. Discussion of First Model – 4th Graders

The results show that place has no effect on math and reading MEAP proficiency at the 4th grade level. Some explanation is offered at the beginning of this chapter. The most striking difference between these models is that in the first model, AVG_ITOT is significant and positive where it is insignificant in the second. This finding has considerable implications. Krueger (1999) found that a lower student-teacher ratio was beneficial to students in lower elementary grades than it was to students in higher grade levels. This suggests that educational inputs are more important at the fourth grade level

than place factors. In both models, educational attainment, race, and poverty contribute the most impact on MEAP scores. This result is not surprising and it addresses the gravest disparities in the poorest and most challenged school districts of Michigan. Furthermore, that place is not significant is a concern. In Michigan, at least, are combined math and reading scores basically a function of race, income, and education? What changes can policymakers and education officials make in school districts to improve test scores at the 4th grade level?

C. Implications

Spending more money on instruction at the fourth grade level would have a negligible impact on combined MEAP scores if more students and families were to slip into poverty. On the other hand, increasing the proportion of the population with a Bachelor's degree or higher ought to lead to higher test score gains. The schism between the rich and poor, educated and uneducated, and white and non-white residents has the greatest impact on test scores. Unfortunately for policymakers, these are variables that are difficult and at the very least, time consuming changes to implement. Furthermore, the policies that impact poverty, education, and segregation are not responsibilities of school districts. Instead, these are complexities that occur within a dynamic society. Thus, while households exhibit choice and preference through sorting, struggling school districts are left with elements of SES and policies that hamper instead of bolster test scores.

Finding certain place variables to be significant at the seventh grade level ought to have implications for economic development, urban revitalization, Smart Growth, rural development, and improving education. Even though this study is exploratory, it poses

some interesting policy perspectives for communities. Open space, rivers, and Great Lake adjacency are positively related to better test scores. These physical elements of place – things that makes places desirable – are also responsible for helping to explain school quality. Economics literature has strived for decades to better understand the relationship of natural amenities on wages, employment, tourism, income distribution, and population growth, (i.e. Rosen, 1974, 1979; Graves, 1979, 1980, 1983; Roback, 1982, 1988; Deller, 2001; Marcouiller, 2004) which hypothesizes that there is something more substantial than just job opportunities that attracts rapid population growth. Thus, it should not be surprising that these amenities also help in explaining test scores. Whether or not wealthier and more educated residents were attracted to and could afford these places is not known. However, knowing that some elements of place are positively related to proficiency ought to strengthen arguments for preserving open space, curbing sprawl, and revitalizing river fronts. Considering that most of Michigan's large cities are built on rivers should encourage urban residents and decision makers to reinvest in and revitalize waterfronts. Parks, forests, and streams are just a few of the many amenities that compose places, which play a major role in community identity.

D. Future Research

This study shows that place has an impact on school district proficiency rates. Further research that attempts to answer why this phenomenon occurs would be a logical next step. Since it has been shown that place matters at the school district level, which is broad and encompasses many schools and students, studies that examine intra-district place differences could provide more insight into the relationship place has on education. One example of such a study may compare a given number of schools that are similar in

control variables and test scores, but vary in levels of place-based attributes. Do schools located in areas with more open space or with close access to a Great Lake score better than those that do not? Such research would likely explain why place matters *and* would get past the strong influences race, poverty, and SES have on proficiency.

Any future research would benefit from having access to a wider array of place-based variables. The variables used in this study were more representative of natural amenities than social or community characteristics. Therefore, data that depict not only place but also community variations will go further in helping to explain proficiency differences across districts, schools, and students. Research exploring and explaining test score variance and school quality inequalities is not likely to cease in the coming years or decades. Future research should continue to use the traditional elements in school quality or educational production functions but must eventually accept the roles place and community have as inputs in explaining quality or output. Data availability can be a constant hindrance. But with the progression of GIS technology and innovation, new and enlightening variables can be introduced into the school quality function that would have in previous years been difficult to obtain.

E. Limitations

Multiple regression is a powerful statistical technique and is most commonly used to imply causation, which is more powerful than merely implying correlation. It is necessary, however, to comment on the limitation that multiple regression presents, especially in cross-sectional analysis. The results of this study are only as strong as the model used to reach them. While the seventh grade model performs well, as indicated by the significance of variables, the change in R-square, and the F-statistic, it should not be

regarded as absolute reality. While significant and positive, it cannot be said that more streams in a school district *cause* better test scores. There is a strong and positive relationship, which ought to guide and inform policy and research, but not prompt excavation and the digging of ditches to increase stream miles with the hopes of increasing proficiency. In addition, the results presented here pertain only to combined math and reading scores. The same analysis could be performed on math, reading, writing, science, or social studies alone or combined in some other way. Literature, however, suggested that math and reading scores are objective and adequate measures of achievement.

Additionally, production function theory was used to inform the analysis presented here but was not concise in its application since the right-hand side variables were not truly exogenous, which may have produced biased equations. For example, perhaps in some school districts, the pupil-teacher ratio was set by administrators as a result of poor MEAP scores in some previous year. Thus, the variable PUP_T_RATIO would not be truly exogenous.

From the start, the goal of this analysis was exploratory in that I set out to introduce place into the set of explanatory variables that helps explain the variance in fourth and seventh grade combined math and reading scores. What about science or writing scores? Why did place not matter for fourth graders but it mattered so much for seventh graders? These are interesting questions, but the scope of this thesis did not explicitly strive to answer these questions. Regardless, these questions alone may provide incentive for investigating why place may matter at different ages.

VIII. CONCLUSION

Since place has been shown to influence proficiency rates for seventh graders in Michigan, it should follow that educators, administrators, and decision makers realize the importance quality of place and quality of life have in determining school quality. Vast research has been undertaken on school choice with the assumption that choice improves opportunity through competition. If such policies become more popular among politicians and citizens, public schools will be forced to compete with private schools. But if public schools in struggling places want to reestablish themselves as an influential and proud institution, they must embrace the attributes that make communities unique while helping to provide alternative options to traditional education. School district politics are understandably focused on the education of children. But administrators and citizens alike must realize the aspect place has in producing quality education and attracting future families and students.

Districts having lower school quality face many struggles and may not be endowed with the desirable attributes that make other districts more attractive to students and residents. However, elements of desirable places can be incorporated into these districts. Denser urban areas with underutilized space may find it beneficial to convert abandoned land to parks, ponds, or recreational space. While such efforts may seem simplistic, bland or trivial, research now at least supports the notion that such places matter. Any attempt to improve places in underperforming districts ought to be realized as an attempt to improve education in ways that we citizens may not quite yet understand. Remembering that it takes a community to raise a child, we must also remember that strong communities have pride in their places. By improving and building on these

attributes of place, at the very least we can hope for more cohesive communities and, most importantly, more inspired and prepared children.

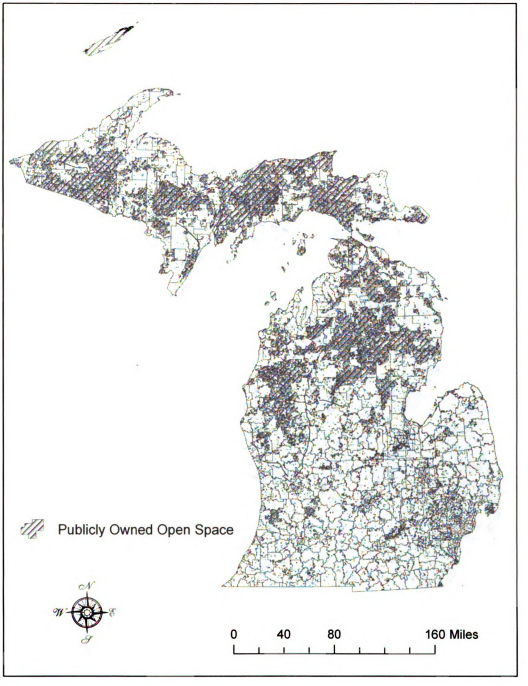
IX. APPENDIX

A. Reference Map of Michigan School Districts and Counties

B. Descriptive Statistics for Removed Cases

	N	Minimum	Maximum	Mean	Std. Deviation
Dependent Variables					
Cmbd_Elem	69	20	94	64.70	15.397
Cmbd_Mid	69	9.60	91.00	53.2058	17.26740
Control Variables					
PCTNWHI00	69	.01438	.95611	.1704688	.23011505
SCH_BACH_PER	69	.04978	.69562	.2152468	.15002819
AVG_ITOT	69	3460	6468	4473.58	624.870
PUP_T_RATIO	69	13.82857	27.25055	21.2165469	2.76726451
PCT_ENR	69	.02	.87	.2999	.22895
URB_DUM	69	0	1	.03	.169
RUR_DUM	69	0	1	.25	.434
Place Variables					
UniMus_dum	69	0	1	.26	.442
AmuseDum	69	0	1	.96	.205
$\log_{10}$Ospace	65	1.13630	4.59776	2.6976519	.85402203
$\log_{10}$Stream	9	.83885	1.85612	1.4398053	.29358857
$\log_{10}$Lake	51	-.47108	4.57076	1.8575654	1.33305634
GreatLk_dum	69	0	1	.12	.323

C. Publicly owned open space in Michigan



D. Rivers of Michigan

E. Inland lakes of Michigan

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