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MEASURING THE EFFECTS OF POVERTY: PROPERTY VALUE AS A PROXY OF
SOCIOECONOMIC STATUS

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ABSTRACT

This study explored property value as a proxy of socioeconomic status. The effects of poverty on general health, academic achievement, and child development are devastating. The endurance and growth of poverty can be disheartening. Improvement efforts must be targeted and evidence-based. Dependable evidence requires sound measurement. Traditional measures of socioeconomic status like eligibility for a free or reduced price lunch (FRL), parent income, parent education, and parent occupation leave room for improvement. Hierarchical linear modeling and regression analyses were conducted to compare the effects of FRL eligibility and property value on Math achievement. Geographic Information Systems was utilized to map the effects of property value on student achievement at the school level across a geographical area. The inclusion of visual evidence aids in identifying trends and, eventually, targeting improvement efforts.

Measuring the Effects of Poverty: Property Value as a Proxy of Socioeconomic Status

I. Introduction

Each year thousands of children are born into homes that the federal government has designated as impoverished. In 2013, the poverty guideline for a household of four was \$23,550 in annual income (United States Department of Health and Human Services, 2013). To live beneath this line signifies that needs as basic as food, running water, and seasonally appropriate clothing are often unmet. The children born into these homes do not choose their situations. Generational poverty is concentrated in communities across the United States, and it is more widespread now than ever in the nation's history. The estimated number of U.S. households with children being raised in extreme poverty, defined as an average income of less than \$2 per day per household member, more than doubled between 1996 and 2011 from 636,000 to 1.45 million (Schaefer & Edin, 2012).

The large and growing population of children in extreme poverty is of particular concern to educators. Decades of research have shown that quality teaching and learning are especially scarce in poverty-stricken communities. Students in these communities are likely to be exposed to frequent stress-inducing experiences and adverse living conditions (Evans, Brooks-Gunn, & Klebanov, 2011; Blair & Raver, 2012). Consider the following list of potential risks to healthy child development: low birth weight, single parent, teenage parents, transience, unemployment or low-wage jobs for parents, low parent education levels, poor nutrition, criminal activity, and a high turnover of classmates and teachers.

Poverty is highly related to each of them (Klerman, 1991; Brooks-Gunn & Duncan, 1997; Bradley & Corwyn, 2002; Hodgkinson, 2003). Not surprisingly then, growing up in an impoverished household is damaging to cognitive processes such as memory, language, and attention span (Evans et al., 2011).

The negative effects of poverty on academic achievement are well documented (Ladd, 2012; Sirin, 2005). The odds are stacked against impoverished children from the moment they are born. By the time they enter the public school system, they are already well behind (Lee & Burkam, 2002). The trend continues into high school, where the dropout rate for students living in poverty is about five times greater than their peers from higher income families (Chapman, Laird, Ifill, & KewalRamani, 2011); of those who do graduate, many walk across the stage at significantly lower academic levels than their more affluent peers. The 1983 study *A Nation at Risk* speculated, "If a foreign power attempted to impose the mediocre educational performance that exists in the United States today, it would be viewed as an act of war" (Gardner). Over 30 years later, the educational performance of disadvantaged children remains mediocre at best.

In spite of its failing track record, many parents and children living in poverty cling to the belief that the education system is the ticket out of their current situation. Perhaps it is, perhaps it could be, or perhaps it is their greatest hope. Immense pressure is placed on schools in impoverished communities as they are routinely expected to be the solution to personal, social, and political problems (Gardner, 1983). In some cases, schools seem to have overcome the many challenges of poverty and students are excelling. Unfortunately, these cases

are few and far between. Even more unfortunate, selective student bodies and misinterpretations of test scores are frequently at the root of their success (Rothstein, 2004). “The general case is that poor people stay poor and that teachers and schools serving impoverished youth do not often succeed in changing the life chances of their students” (Berliner, Yeh, & Kitzmiller, 2012).

Apathy and purposeful perpetuation of the status quo are not to blame for the steady failure of the education system to meet student needs. A continual flow of new policies and programs has been adopted and implemented at the federal, state, and district levels in response to the Coleman Report (1966) and other compelling evidence. The 2001 No Child Left Behind Act certainly brought much needed attention to achievement inequalities. Unfortunately, rewards and punishments attached to No Child Left Behind’s mandatory high-stakes testing fueled gaming practices within schools that were detrimental to holistic student growth and development (Berliner, 2011; Ryan & Weinstein, 2009).

Armed with waivers from No Child Left Behind, state legislators and departments of education continue to mandate uniform, simplistic policies that fail to address the complexity of education and the underperformance of disadvantaged students in meaningful ways. Perhaps it is for ease and affordability that student test scores continue to be the primary basis for school reform efforts. It is certainly easier to evaluate school effectiveness with standardized tests than it is to study processes, structures, and interactions within schools. However, accuracy and depth of information are sacrificed when student test scores are aggregated and used to gauge conditions within schools and the

technical work of school personnel. Those most affected by distant, shallow policies are disadvantaged children who rely most heavily on the education system to satisfy basic, educational, and social needs.

The achievement gap between students from affluent and impoverished residences, also known as the income achievement gap, is hard to erase because it has a lot to do with factors outside of school (Berliner, 2009). Until a focus is placed on identifying and fostering conditions within schools *and communities* that mitigate the effects of poverty, disadvantaged children will underperform. Current policies are shortsighted. It is irrational to continue trying to affect student achievement without considering the power of factors other than teachers and schools (Berliner, Yeh, & Kitzmiller, 2012). Measuring and reporting the same outcomes in different ways year after year does not inform school improvement or healthy student development. Raising the stakes on poor measures of school performance year after year is equally detrimental. It has been nearly 50 years since Coleman et al.'s (1966) groundbreaking report on the achievement gap in America; yet the gap remains. The *need* to improve is well documented; *how* to improve remains elusive.

Schools that serve low-income students need increased support. Coleman et al. (1966) speculated that one fine textbook or one excellent teacher probably means far more to a student in extreme poverty than to a student who already has several of both. Under the current tax structure, schools serving the highest percentage of disadvantaged students often have less funding than schools serving their more advantaged peers. There is little incentive for outstanding teachers to

teach in impoverished communities when the pressure to overcome deeply rooted social inequities is imminent and the available resources, especially human and social capital, fail to match the critical needs of students and families.

The achievement gap is persistent. The income achievement gap in America is now nearly twice as large as the black-white achievement gap (Reardon, 2011). Parallel to the income achievement gap, income inequality in America has steadily increased for 40 years. The chasm between those in the 90th percentile and 10th percentile in annual household income is now more than double what it was in 1970 (King et al., 2010; Reardon, 2011). Although America's income gap is now one of the largest in the world, the achievement gap is not just an American issue. Upon examination of 2009 PISA scores, students from more advantaged social class groups substantially outperformed their disadvantaged peers in every country (Carnoy & Rothstein, 2013). The failing education system is directly related to the failure of society to assuage poverty.

The endurance of the achievement gap and the steady growth of income inequality beckon for a thorough understanding of the effects of poverty on child development. Child development is complex, and teaching and learning are complex; poverty only exacerbates the complexity by adding a thick, underlying layer to an already dense process. There is much that remains unknown about the effects of poverty at the individual, neighborhood, and school levels (Brooks-Gunn, Duncan, & Aber, 1997). The more these effects are understood, the less confounding poverty becomes for families, educators, and policy-makers.

Understanding requires profound research, and profound research requires accurate, accessible, and affordable measurement.

II. Review of Literature

Traditionally, the effects of poverty have been measured with various indicators of socioeconomic status (SES). Though there is no consensus definition, SES generally refers to a hierarchical ranking determined by differential access to desired resources such as wealth and social status (Oakes & Rossi, 2003; Mueller & Parcel, 1981). Thus, as its name would suggest, it inherently has a social component and an economic component. It is critical that the operationalization of SES is conceptually and empirically representative of both components.

Conceptualization of Socioeconomic Status

The conceptualization and measurement of SES have been contemplated for decades, but the term's exact roots are difficult to trace; it appears to have subtly emerged into common language and thought prior to its consideration as a scientific construct. Some have stated that the earliest measures of SES in the United States were constructed in the 1940's (Davis, 2010). However, a deeper look at the history of SES research reveals that its measurement was already a "problem of considerable interest" in 1928 (Chapin). Ten years later, Walter S. Neff (1938) declared the relationship between SES and intelligence was "one of the most persistent and perplexing problems in the field." Although a scholarly definition appears in Chapin's 1928 article, his offhand use of the term *socioeconomic status* suggests it was likely an established concept prior to the publication of his study.

In spite of its hazy origin, there have been recent advances in the conceptualization of SES. For nearly two decades, the favored way of thinking

about SES has been as a function of three forms of capital: material capital, human capital, and social capital (Entwisle & Astone, 1994; Bradley & Corwyn, 2002; Oakes & Rossi, 2003). The three combine to encapsulate the cumulative resources available to an individual.

Coleman (1988) aptly summarizes the concepts of material, human, and social capital. According to his explanations, material capital represents the tangible resources available to a person. It includes adequate food, clothing, shelter, books, and other physical resources. Human capital is described as the cognitive environment that aids learning and development. It includes the non-material resources available, such as the knowledge, expertise, and skills possessed by immediate family members, peers, and other acquaintances. Social capital is even more intangible. It is manifest in the relational dynamic between individuals and their environment. Social capital is determined by the amount and quality of resources within an individual's social network and the strength of relationships within the network that allows individuals to claim access to those resources (Bourdieu, 1985). For example, the knowledge, expertise, and skills of immediate family members are of little importance to learning and development in the absence of trusting relationships and meaningful interactions.

Different names are often given to ideas that vary only slightly. This appears to be the case with SES. It has significant conceptual overlap with Marx and Weber's ideas of social class and social stratification. Social class is defined as "a number of people who have in common a specific causal component of their life chances" (Weber, 1920/1946). Social stratification is "the differential ranking of

individuals who compose a given social system and their treatment as superior or inferior relative to one another in certain socially important respects” (Parsons, 1940). The purpose of this study is not to distinguish SES from these concepts. However, a surface understanding of them helps to clarify the basis from which SES emerged.

The following introductory line to the infamous Communist Manifesto suggests the underlying principles of SES are as ancient as human civilization: “The history of all hitherto existing society is the history of class struggles” (Marx & Engels, 1848/1964). The existence of classes requires people to be categorized according to some criteria. In Marx’s view, there are only two main classes: the bourgeois and the proletarian. Class membership is based on one’s relationship to the means of production. The bourgeois are the owners of social production and employers of wage labor. The proletarian are the wage laborers who are forced to sell their labor in order to live. Struggles arise out of unrest between the two classes as a result of differential access to desired resources.

Building on the work of Marx, Max Weber (1920/1946) advanced foundational ideas of class and stratification. As mentioned, he posited that class refers to a group of people with similar life chances. Life chances are determined by an individual’s power in society, and power is the ability of individuals to realize their own will in a communal action, maybe even against the will of others. It is through prestige and social honor that this kind of influence can be obtained. He asserted that everyone strives for power and that it can be economically rooted, socially rooted, or both. Similarly, prestige and honor can be gained economically

or socially. His ideas rely heavily on the combination of social and economic principles. The conceptual similarities between social class, social stratification, and SES are evident, although the origin of the term *socioeconomic status* remains obscure.

Measurement of Socioeconomic Status

It is impossible to count out X units of SES. Its intangible nature requires a proxy to be used in its measurement. Proxies are estimators of unobservable quantities of interest; their degree of precision determines the extent to which uncertainty about a particular research question is reduced (Clinton, 2004).

Consider individually each of the capitals that compose SES. Even in isolation, each is measured with a proxy; there is no single indicator that fully encapsulates the material, human, or social capital available to an individual. This is especially apparent with social capital. Any estimation of a person's social network, including frequency of interactions and strength of relationships, will be a proxy of actual conditions. Thus, it follows that any indicator of SES (a combination of material, human, and social capital) must also be a proxy.

Individuals make a series of choices in their lives to improve or maintain their socioeconomic status. While proxies of SES are estimates of available material, human, and social capital, the utilization of available resources varies greatly across individuals. Indicators of SES do not, nor do they intend to, capture how available capital is capitalized. Some individuals are able to maximize seemingly limited material, human, and social resources; others squander seemingly infinite access to resources. Most fall on the continuum somewhere in

between the two extremes. Nonetheless, the role of any proxy of SES is to measure overall access to capital regardless of its management.

Free or reduced price lunch. Various indicators have been used to operationalize SES across multiple fields including education, health, economics, sociology, psychology, and neuroscience. In education research, a common proxy of SES is student eligibility for a free or reduced price lunch (FRL). Student eligibility is determined by annual household income: less than 130% of the federal poverty guideline for a free lunch (\$30,615 for a family of four) and less than 185% for a reduced lunch (\$43,568 for a family of four) (Food and Nutrition Service, 2013). Students may also qualify if they live in a foster home or a household that receives food stamps (FNS, 2012).

The FRL variable is used in approximately 20% of education studies that apply an SES measure (Harwell, Maeda, & Lee, 2004; Sirin, 2005). It is prevalent for many reasons, the most obvious being its relative ease of access and low cost. School districts maintain a record of the FRL eligibility of every student; generally, these data are readily available to researchers. Another reason may be the measure's endorsement at the federal level. It is repeatedly used in reports by the National Center for Education Statistics and in the language of the No Child Left Behind legislation (Harwell & LeBeau, 2010).

Although it is frequently employed, FRL eligibility is conceptually indefensible as an indicator of SES. In fact, it appears to be nothing more than a hasty measure used in lieu of expending necessary resources (time, energy, money) to collect theoretically relevant data. It is fraught with validity issues,

including decreasing participation rates as students age and overall misclassification of up to 20% (Harwell & LeBeau, 2010). Hauser (1994) claimed the FRL variable is fundamentally flawed because the federal poverty guideline is an unstable basis for an indicator of SES. The guideline fails to account for critical geographic differences, both in cost of living (except in Alaska and Hawaii) and in tax rates. Harwell & LeBeau (2010) argue that valuable information is sacrificed because of the variable's dichotomous nature. Students eligible for a free or reduced lunch are distinguished from those who are eligible for neither. Using the 2013 federal poverty guideline, this means a student from a household of four with an annual income of \$43,000 is classified differently than a student from a household of four with an annual income of \$44,000. To employ this method implies that the cumulative resources available to the student from the latter household are more comparable to a student from a household with an annual income of \$200,000 than a student from a household with an annual income of \$43,000. For these reasons, the FRL variable is an inadequate gauge of the material component of socioeconomic status, and its failure to address the human and social capital available to students induces reluctance to even call it a measure of SES.

Parent income, education, and occupation. Across many fields, other indicators of SES are employed on the theoretical basis of material, human, and social capital. These studies typically operationalize SES with some combination of three indicators: parent income, parent education, and parent occupation (Entwisle & Astone, 1994; Hauser, 1994; Mueller & Parcel, 1981; Oakes & Rossi,

2003; Sirin, 2005). Some researchers have used home resources as a fourth indicator, but these studies are less common (Sirin, 2005). It should be stated that these indicators are often applied in education-related studies, but the FRL variable is not used in other fields.

Parent income is primarily an economic indicator and an estimator of material capital (Coleman, 1988). It must be collected and evaluated with care because changes in employment or household composition can cause significant short-term fluctuations (Entwisle & Astone, 1994; Hauser, 1994). The second commonly utilized indicator, parent education, is considered an estimator of human capital (Coleman, 1988). In the United States, it is highly correlated with parent income (Hauser & Warren, 1997). It is a relatively stable indicator because it is generally set at a young age and rarely fluctuates over time (Sirin, 2005). Parent occupation is thought of as both a social and economic indicator. As a result, it is often considered the most reasonable single indicator of SES (Haug, 1977). The economic implications are clear, as wages vary considerably between jobs. The social implications stem from public perception of occupational prestige (Duncan, 1961) and the increasing tendency of social circles to derive from the workplace (Putnam, 2001).

Over the last half-century, various combinations of these indicators have been conceptualized and empirically tested. Some of the better-known measurement methods include the Hollingshead (1957) two-factor index of social position, Duncan's (1961) socioeconomic index, Nam and Powers' (1965) occupational status scores, the Siegel (1971) prestige scale, Rossi et al.'s (1974)

household prestige scale, and the Hollingshead (1975) four-factor index. Building on previous models, further recommendations in SES measurement were proposed by Hauser (1994) and Entwisle & Astone (1994). Most recently, Oakes & Rossi (2003) explored a new measure consistent with the theoretical framework of SES as a function of capital. Their model evaluates SES as a composite variable consisting of the three forms of capital. Each form is treated as a latent variable with multiple scale items prior to inclusion in the composite (see Figure 1). Though it was merely a pilot study with imprecise indicators of the three capitals, the authors' initial empirical test demonstrated it was a stronger predictor of general health than previous measures.

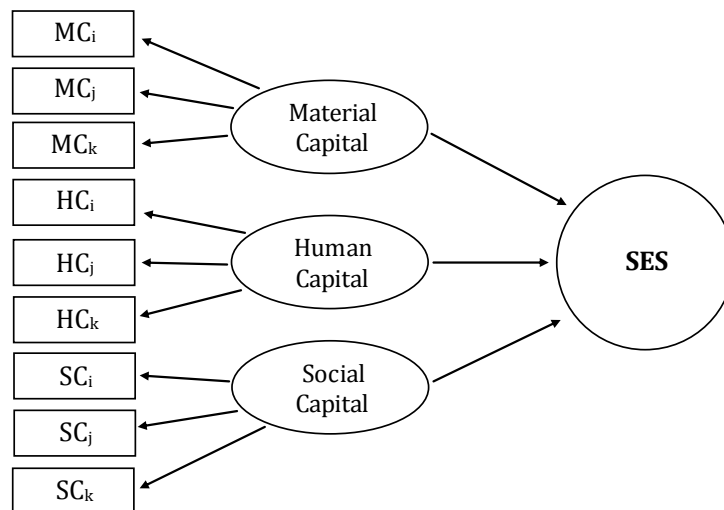


Figure 1. Structural equation model to estimate SES (Oakes & Rossi, 2003)

Multilevel Effects of Socioeconomic Status

The effects of poverty are also substantial in a broader context, independent of individual socioeconomic status (Kaplan, 1996). According to Bronfenbrenner (1994), humans develop through reciprocal interaction with the people, objects, and symbols of the immediate environment. The school and

neighborhood are vital aspects of that environment. Similar to individual SES, school and neighborhood SES are typically measured with some combination of three indicators: median parent income, percent of parents unemployed, and percent of parents with a college degree (Kurki, Boyle, & Aladjem, 2005; American Psychological Association, 2007). At the school level, the percent of students who qualify for a free or reduced lunch is also often utilized. There are fewer measurement limitations in regard to this indicator at the school level because, unlike the FRL variable at the individual level, it is a continuous measure. Still, the lack of conceptual basis for the FRL classification of students at the individual level raises doubts about the interpretability of FRL rate at the school level.

The broader effects of SES have been considered since the publication of Shaw & McKay's (1942) *Juvenile Delinquency in Urban Areas*, but interest has swelled over the last 25 years. It seems obvious that the school and neighborhood environment have great influence on child development. They can be a source of safety, motivation, and purpose or a source of tremendous stress. Stressful environments generally consist of high volumes of low-SES individuals and have high rates of crime, unemployment, and violence (Sampson, Raudenbush, & Earls, 1997). They are characterized by pollution, litter in the streets, noise, stray dogs, the absence of local facilities and amenities, abandoned homes and buildings, vandalism, limited local transportation, and perceived threats to personal safety (Steptoe & Feldman, 2001). Stressful environments are negatively related to all aspects of healthy child development. School dropout rates, low average academic achievement, high volumes of behavior and emotional problems, and high teenage

birth rates are all related to low-SES environments (Jargowsky, 1997; Levanthal & Brooks-Gunn, 2000; Catsambis & Beveridge, 2001; Ainsworth, 2002; Levanthal & Brooks-Gunn, 2004; Sampson, Sharkey, & Raudenbush, 2008).

Measure Development

The lack of consensus about the methodology of socioeconomic status is warranted. There is still significant uncertainty about how to best capture the effects of SES on child development, health, academic achievement, and other desired outcomes. As with any type of measurement, there are trade-offs with traditional SES indicators. An SES measure should be easily and affordably gathered and applied, but ease is no replacement for accuracy, validity, and strength in prediction or explanation. For example, annual income is a fine indicator of material capital with great influence on the physical environment at home. However, the number of nights a child goes to sleep hungry would be a more precise indicator of the effects of poverty (Guo & Harris, 2000). The goal is to discover and utilize the most informative measure that is also reasonably attainable. Most importantly, indicators of SES should be consistent with its conceptual meaning.

“The feasibility of simplifying the calculation of SES should be considered” (Cirino et al., 2002). Alarming, few studies exist on the theoretical foundation and measurement of SES. This is in stark contrast to the thousands of studies across multiple fields that have used SES to predict or explain outcomes (Oakes & Rossi, 2003). Although a strict set of indicators is disputed, certain criteria have helped guide the development of various measures. An ideal SES measure in

education would 1) be consistent with a sound theoretical framework, 2) have similar participation rates across student grade levels and minimal nonresponse, 3) be relatively inexpensive to gather and analyze, 4) be amenable to aggregate levels such as the neighborhood and the school, 5) be relatively stable over time, and 6) be practical and useful (Harwell & Lebeau, 2010; Oakes & Rossi, 2003). The power of SES to predict valuable outcomes at the individual, school, and neighborhood levels in spite of methodological limitations is motivation to explore the possibility of a more precise measure.

III. Conceptual Framework: Property Value as a Proxy of SES

Following the example of others, a new measure of SES must build on the theoretical foundation of material capital, human capital, and social capital (Entwisle & Astone, 1994; Oakes & Rossi, 2003). According to this foundation and the six criteria above, existing indicators leave room for improvement. As mentioned, the free or reduced-price lunch variable has no theoretical justification to be considered a valid indicator of SES. It is only partially related to material capital, and it largely ignores the dimensions of human and social capital. The various combinations of parent income, education, and occupation are certainly an improvement, but any combination of these variables falls short of meeting even half of the aforementioned criteria. In addition, they are considered more economic factors than social (Oakes & Rossi, 2003). It has proven to be quite difficult to capture appropriate weights of social and economic status in a single indicator. Without a strong measure of SES, important inequalities are overlooked or dismissed (May, 2002).

Process of Property Valuation

The purpose of this study is to explore property value as a proxy of SES. An analysis of the complex process of property valuation is a necessary starting point. In the United States, property values are generally revised and reported annually by a county assessor for the purpose of collecting property taxes. County assessors determine the value of residences on the basis of their characteristics and location. The square footage, amount of land, age of the roof, type of countertops and floors, number of bedrooms and bathrooms, presence of a

basement and/or fireplace, and size of the garage are just a few of the seemingly endless characteristics influencing home appraisal (Pagourtzi, Assimakopoulos, Hatzichristos, & French, 2003). No two residences have the same set of characteristics, and the perceived worth of each characteristic varies from one individual to the next. Even if the characteristics of two residences were somehow identical, their values would still differ substantially because of the vital role of location in property valuation.

The influence of location on property values is the result of perceived and actual costs and benefits. Physical and topographical characteristics (e.g. steep or wild terrain) and environmental influences (e.g. air and water pollution) are fairly objective aspects of location that affect values (Pagourtzi et al., 2003). The quality of surrounding residences and the safety of the neighborhood also have influence (Linden & Rockoff, 2008). In addition, proximity to parks, grocery stores, schools, job opportunities, and community centers greatly contributes to the desirability of a residence. Individuals who live nearby these amenities have access to material, human, and social capital that might otherwise be unavailable.

After taking stock of a residence's characteristics and location, there are many methods for generating a property value. The comparable method, the income method, and the cost method are a few traditional techniques that continue to be used frequently (Donnelly, 1989). The methodology of real estate appraisal is a growing field of study with increasingly complex models emerging and much potential for continued development. The multiple regression method, artificial neural networks, the hedonic pricing method, and spatial analysis methods are just

a few examples of advanced valuation procedures (Pagourtzi et al., 2003). The details of these methods are beyond the scope of this study. The property values to be used here were calculated and publicly released by the county assessor. County assessors use the comparable method almost ubiquitously, particularly when assessing residential properties.

The comparable method is named for its reliance on the comparison of similar properties within the same market area. The value of a given property is determined by adjusting the selling price of similar properties according to slight differences in characteristics and location (Pagourtzi et al., 2003). The likelihood of identifying a set of properties with minimal differences is dependent on market activity and an adequate sample of sales because individual transactions can include over or under-payment (Donnelly, 1989). Assessors do not start from scratch each year; values are merely adjusted to correspond with the current market.

Property Value and the Scale of Desirability

The finished product of this complex process is essentially a ranking system that mirrors the early ideas of Max Weber. He noted,

It is the most elemental economic fact that the way in which the disposition over material property is distributed among a plurality of people, meeting competitively in the market for the purpose of exchange, in itself creates specific life chances. According to the law of marginal utility this mode of distribution excludes [lower classes] from competing for highly valued goods. (1946, p. 64-65)

With property values, every residence falls somewhere on a socially constructed and ever-changing scale of desirability. A common unit of measurement is applied to the scale to standardize the ranking process in a given area, i.e. monetary value. The most desirable properties have the highest values while the least desirable properties have the lowest. In theory, it is the use of monetary values to rank properties that introduces an economic component to property valuation. Without it, residences are placed on the continuum strictly via comparison and subjective ideas of desirability. In reality, the economic and social components of a property value cannot be considered separately. Once the economic component is introduced, it too becomes a factor that influences the desirability of a residence. Thus, property values are both socially and economically determined.

Not only do values of residences vary on the scale of desirability, accessibility varies along the scale. It is this function of property valuation that completes the theoretical link to socioeconomic status. By definition, SES is predicated upon differential access to desired resources. In regard to property value, properties increase in value as they become more desirable. As value increases, a larger portion of the population is excluded from residence. Conversely, the least desirable residences have low values and are available to nearly everyone (see Figure 2). The relationship between accessibility and property values may or may not be linear, but the general trend is consistent. Everyone has to live somewhere, and every residence falls somewhere on the continuum.

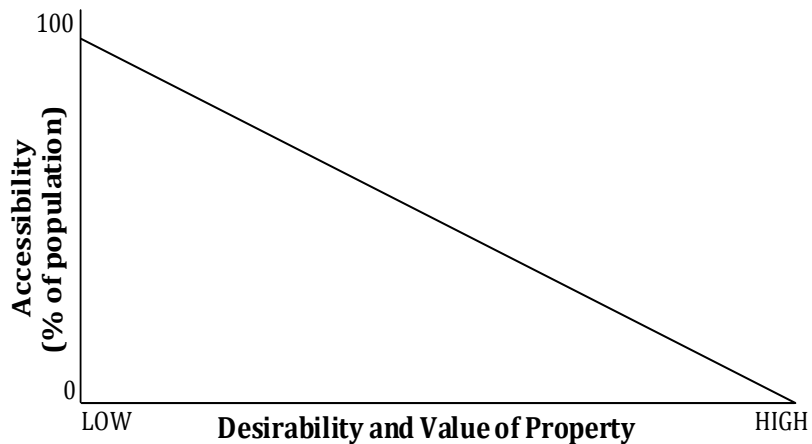


Figure 2. Accessibility along the scale of property desirability and value

Property Value and Access to Capital

Through this process, property values behave as a status estimate. That is, the ability to access a certain residence in a certain area is reflective of overall access to material, human, and social capital. The residence itself is material capital. Although it is just one of many possessions that make up material capital, it is often an individual's most valued and costly possession. The social norm in the United States is to live at, or even above, capacity. It is not common practice for people to choose to live in a less desirable residence than they are able to afford. The utilization of property value as a proxy for SES assumes that, in general, individuals will seek to maximize their living situation. As such, property value is an estimate of overall access to material capital.

It takes a corresponding amount of human capital to gain access to a desired residence. Traditional indicators of SES have relied on education and occupation to estimate human capital. The idea here is the same, but it is taken one step further. A level of income is required to match a desired property's value, an occupation is required to maintain an income level, and an education is

required to obtain an occupation. Educational attainment is highly related to income (Hauser & Warren, 1997). Education is converted to income through occupation (Jones & McMillan, 2001). The level of income determines the accessibility of various properties (see Figure 3). These principles are woven into daily life. Proof of a steady income (typically via occupation) is a common requirement to qualify for a home loan or to rent an apartment. Thus, the property value of individuals is related to their human capital and “a home is location in a well-developed status ecology and a telltale clue to one’s location in the occupational hierarchy” (Laumann, Siegel, and Hodge, 1970).

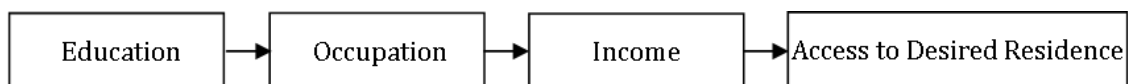


Figure 3. Relationship between traditional SES indicators and property value

Social capital is engrossed in property valuation primarily through the influence of location on values. The potential availability of social capital is dependent on the amount and quality of resources within an individual’s social network (Bourdieu, 1985). Social networks are largely determined by location of residence because relationships are built through interaction, and interaction requires proximity.

In America, the dominating trend is for like-minded people with similar resources to cluster together in neighborhoods and communities (Bishop, 2008). If afforded the opportunity, concerns about the problems of poverty lead people to select neighborhoods with as few low SES residents as possible (Jencks & Mayer, 1990). As a result, the broader context, i.e. the neighborhood and community,

often mirrors that of the individual. “Physical proximity often represents social similarity in interaction” (Logan, 1978). Areas of concentrated poverty and concentrated wealth emerge, with social norms unique to their contexts (Massey, 1996). Residences on the high end of the distribution are likely in close proximity to valued goods and services and social networks that provide access to copious material resources, knowledge, and skills. Conversely, properties with low values are more likely to be in high-crime neighborhoods (Shaw & McKay, 1942). Even if social networks within these low-value clusters are characterized by strong relationships, there is little to gain in terms of the amount and quality of material resources, knowledge, and skills. Consequently, available social capital is differentiated across the scale of desirability in direct opposition to accessibility (see Figure 4).

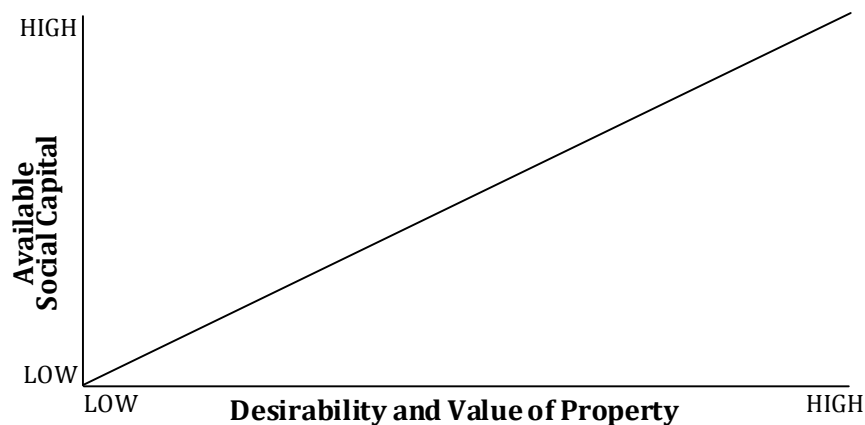


Figure 4. Distribution of available social capital according to property value

In sum, property value is related to each of the three capitals. However, the purpose of this study is to explore property value as a proxy of SES not as a proxy of each capital separately. Theoretically, the power of property value as a proxy of SES is its ability to encapsulate the three capitals within a single indicator. Oakes &

Rossi's (2003) model posits SES as a composite variable consisting of the three capitals. Composite indicators can be extremely useful and informative. However, as in Algebra, there is great danger in combining unlike terms. Assigning weights to the various components of composite indicators can be problematic (Marks, McMillan, Jones, & Ainley, 2000). Rather than computing a composite variable of SES with subjective weights assigned to indicators of each form of capital, property value may be a common metric that already estimates the three in combination (see Figure 5).

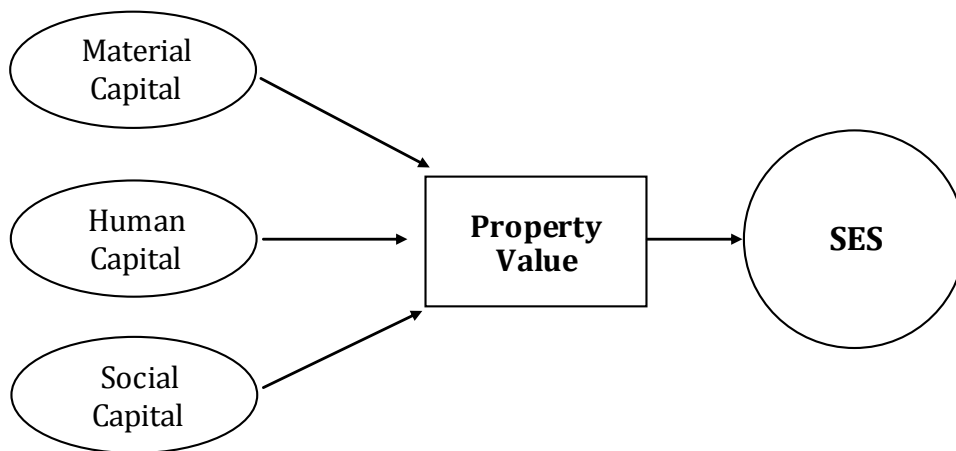


Figure 5. Conceptual model of property value as a proxy of SES

Suitability of Property Value as a Proxy of SES

Using property value to measure SES is somewhat of a return to original ideology. The earliest attempts to capture SES were through scales rating the quality of the home environment, such as the Living Room Scale (Chapin, 1928; Chapin, 1932). More recently, Guo & Harris (2000) claimed that the physical environment at home is a mediating factor between family poverty and intellectual development. Residences with low property values are more likely to have cracks in the walls, holes in the floor and ceiling, and exposed wires; they are less likely to

have enough bedrooms and bathrooms for the number of inhabitants (Mayer, 1997). A safe, high-quality residence is conducive to learning and development (Skeels, 1940; Brooks-Gunn, Klebanov, & Liaw, 1995).

It is worth exploring property value as an indicator of SES to see how strongly it might correlate with desired outcomes. In measurement, accuracy is often sacrificed for simplicity to the detriment of validity, reliability, and usefulness. Property value is certainly a simplified proxy of SES in comparison to Oakes & Rossi's structural equation model. Exploration is required to determine if measurement precision is gained or sacrificed.

Prior to any empirical tests, the appropriateness of property value as a measure of SES can be assessed according to the same six criteria mentioned previously. As a proxy of SES in education research, property value would 1) be theoretically sound, 2) have similar participation rates across grades and minimal nonresponse because rates of homelessness are low in all grades, 3) be relatively inexpensive to gather and analyze because data are already compiled and updated by the county assessor, 4) be amenable to aggregate levels such as the school or neighborhood depending on the methods employed, 5) be relatively stable over time because values can be standardized and changes in value are due to whole market trends and social perception, and 6) conceivably inform policy and practice, depending on empirical results. In theory, property value summarizes the material, human, and social capital available to an individual. Both in its formulation and its practical application in society, it appears to be strongly

related to the conceptual foundation of socioeconomic status. However, uncertainty is only reduced through sound empirical tests and credible evidence.

IV. Method

The setting of the study was a midwestern city in the United States with a population of approximately 400,000 residents (U.S. Census Bureau, 2014). The treatment of property value as a proxy of student and school socioeconomic status was evaluated empirically. The sample consisted of 9,419 students in grades 3 through 8 from 81 schools and three contiguous public school districts. Variables of particular interest were property value, Math achievement, and free or reduced lunch eligibility. Student data were aggregated to the school level to determine average property value, average Math achievement, and free or reduced lunch rate. ArcGIS was used to map property values across the region and again to supplement regression analyses and hierarchical linear models with a visual depiction of relationships between variables. Regression analyses and hierarchical linear modeling were conducted using IBM's SPSS Statistics 19 and HLM 7 from Scientific Software International.

Data Source and Sample Description

Property values were made public by the county assessor and accessed via a well-organized compact disc obtained from the assessor's office for a small fee. The disc contained a searchable database of properties as well as GIS shape files that could be displayed on a county map. A data spreadsheet was exported from GIS into SPSS with information about each property including latitude and longitude, full address, market value, taxable value, total acreage, total area, zoning type, number of units, and county-assigned parcel number. Only the address and market value were critical indicators for analyses. The number of units was also

taken into account, but only to explore a method for the valuation of individual apartment dwellings.

Property value data were collected from only one county, so the study was confined to the geography of that county's boundaries. Still, there were over 250,000 properties within the county and fourteen school districts with at least some part of their borders falling within county lines. Some districts were contained entirely while others had only a small overlap. Since the focus of the study was the city and not the entire county, student data was gathered from the three public school districts that encompassed the city both geographically and demographically. It was imperative that all three districts were contained almost entirely within the county. Any information for students living beyond county boundaries had to be discarded. Only a small population of students in the sample resided outside the county, so few cases were excluded. The sample was large enough that it was reasonable to assume the validity and reliability of data were not threatened by their exclusion.

The student sample consisted of 3rd through 8th grade students. Students younger than 3rd grade were excluded because they did not take standardized state assessments, and high school students were excluded on the basis of taking various tests within and across grades, making it difficult to track and compare results. For example, one 9th grade student may have studied Algebra II while another took Algebra I. Although their scores are reported on a standardized scale, it is difficult to compare the Math achievement of the two students. Had the student who took the Algebra II exam taken the Algebra I exam, an outstanding

score would be expected. Instead, the Algebra II test may have presented an appropriate challenge and the student's score may have been average. What would be an appropriate method of comparing these two students? Is an average score on a more difficult test comparable to an outstanding score on an easier assessment for students in the same grade? Perhaps weights could be assigned to certain tests based on the age or grade of students, but this type of analysis would constitute another study altogether. It would be irresponsible to make inferences about the effects of SES on Math achievement with cases such as these included in the sample. High school students were excluded to maintain the validity and reliability of Math achievement as an outcome variable.

Valuation of Apartment Dwellings

Another query of considerable interest was the treatment of residences without an assigned value, i.e. individual apartment units. If students residing in apartments were to remain in analyses, the values of apartment residences had to be computed systematically and verified according to the scale of desirability. To ensure true measurement precision, the same method of comparability used by the county assessor to determine other values would have to be applied to the valuation of each apartment unit. This was unrealistic. However, the advantages of including these students in the sample, such as a full representation of the student body and an increase in sample size, merited exploring an alternative method of valuation. A preliminary method was applied and tested to determine if students residing in apartments units could be positioned along the scale of desirability and preserved in the sample.

Data from the county assessor contained values for apartment complexes as a whole. The alternative method to determine the value of individual units was to divide the assessed value of the complex by the total number of units. The resultant value was assigned to every unit within that particular complex. This method allowed for variation across apartment complexes but not within them. This is a severe limitation; it assumes all apartments within a given complex are of the same size, quality, and desirability. Most complexes offer a wide range of apartments with considerable differences. Nonetheless, the method was employed because the sacrifice of variability within apartment complexes was less than the variability that would be lost if students from apartment residences were excluded from the study altogether. There may be alternatives to determining the value of individual apartments in lieu of this method; however, no alternative methods were known, discovered, or created at the time of the study.

Although using this method to determine values appeared to be simple and straightforward, difficulties arose from the data. First, a cross-examination was conducted to determine the accuracy of the data received from the county assessor. Phone calls were placed to three area apartment complexes to verify if the actual number of units was consistent with the number reported in the data from the county assessor. This simple verification led to the disappointing discovery that each complex was assessed differently. In some cases, the entire complex was assessed under a single address, but in other cases, the complex was sectioned into several adjoining properties and each section was assessed discretely. The end result was multiple address listings, each with a value, for the

same apartment complex. Without names of apartment complexes associated with addresses in the data file, it was difficult to combine the various sections within the same complex to determine the total value from the data at hand. To add a layer of complexity, addresses of apartment residents often differed from the address used to value the apartment complex. This made it impossible to connect apartment residents to complexes. Thus, in the absence of a valid and reliable method to assign values, apartment residences had to be excluded from the study.

Sample Preparation

At the outset, the study was to be conducted using data solely from District 1, the city's central public school district. The student sample for the district consisted of all 5th grade students at each elementary school and a random sample of 100 8th grade students from all middle and junior high schools. A total of 2,556 students from 60 schools were sampled; this number was reduced to 1,680 students with the removal of those who resided in apartments, resided outside county boundaries, or failed to complete the end-of-year Math assessment. From this sample, a basic examination of descriptive statistics revealed that there was limited variability within the district in regard to property value, academic achievement, and free or reduced-price lunch rate. There was great potential to increase the strength of the study by gathering data from surrounding districts.

The inclusion of two additional districts in the analyses introduced more variance in property values and ensured an adequate representation of the city as a whole. The boundaries of the three districts were contiguous; where one's boundaries ended, another's began with no area unclaimed. Student data were

gathered for all 3rd to 8th grade students in Districts 2 and 3. In District 2, the total of 6,193 initial cases was reduced to 4,587, excluding students who resided in apartments, resided outside county boundaries, or failed to complete the end-of-year Math assessment. In District 3, the sample went from 4,352 students to 3,352 students via the same criteria.

The combined number of sampled students from the three districts was 9,619. After running preliminary analyses, the data were skewed significantly by a small percentage (2%) of outlying highly valued properties worth up to \$3,000,000. These properties spanned a range of 2.5 million dollars while less than \$500,000 separated the other 98% of cases. As a result, the outliers were expunged. The final sample consisted of 9,419 students with property values ranging from \$7,500 to \$500,000.

The final decision of interest was the treatment of property value as an ordinal or continuous measure. The limitations of the FRL variable as a result of its dichotomous nature signaled the need for a continuous indicator of SES. In his review of the effects of SES on academic achievement, Sirin (2005) concluded that artificially restricting SES through the use of categorical indicators limits the magnitude of the relationship between SES and academic achievement. Categories may aid in simplifying the thinking around socioeconomic status, but the fact is there are no official categories occurring naturally in society. A continuous indicator of SES mirrors its formation and behavior. Thus, property value was treated as a continuous variable. Standardized values were calculated to aid in interpreting hierarchical linear models and regression output. Most analyses were

conducted with standardized values although actual property values were necessary for descriptive purposes.

Design and Procedure

The validity of property value as a proxy of SES was explored through descriptive analyses and a multilevel evaluation of its effects on Math achievement. In all analyses, its behavior and effects were directly compared to the free or reduced lunch variable. Initially, descriptive statistics were analyzed at the individual, school, and district levels to serve as an outline for interpreting results. A strong understanding of the characteristics of the sample aided the development of regression equations and hierarchical linear models.

Intraclass Correlation Coefficients (ICC-1) are essentially reliability estimates of group means (Koch, 1982). They are most often used for determining inter-rater reliability. In this case, the ICC(1) was calculated to determine the total amount of variance in individual Math achievement attributed to school differences. A Random Effects ANOVA provided the values for τ and σ^2 , and the following equation was used to compute the value:

$$ICC(1) = \frac{SS_B}{SS_B + SS_W} = \frac{\tau}{\tau + \sigma^2}$$

where τ represents the sum of squares between groups, or school level variance, and σ^2 represents the sum of squares within groups, or individual level variance. The variance attributed to schools is divided by the total variance to determine the ICC(1) value. For this study, the magnitude of the coefficient represents the usefulness of aggregating property value and FRL eligibility to the school level. A

low ICC(1) value signifies limited variability in Math achievement across schools; therefore, an investigation of school level predictors of Math achievement would be meaningless. The opposite would be true for a high ICC(1) value.

The validity of property value as a proxy of SES was further explored through an in-depth comparative analysis between property value and FRL eligibility. As a dichotomous variable, FRL eligibility has limited total variability at the individual level. To assess the consequence of this limitation, the distribution of property value and the strength of its relationship with Math achievement were evaluated within each FRL category. In addition, the stability of the measures was tested. Using two models that vary only slightly, each variable was included as a group-mean centered predictor of Math achievement. The models are shown below:

Random Intercepts ANCOVA

$$\text{Level 1: } Y_{ij} = \beta_{0j} + \beta_{1j}X_{ij} + r_{ij}$$

$$\text{Level 2: } \beta_{0j} = \gamma_{00} + u_{0j}$$

$$\beta_{1j} = \gamma_{10}$$

Random Intercepts and Slopes Regression Model

$$\text{Level 1: } Y_{ij} = \beta_{0j} + \beta_{1j}X_{ij} + r_{ij}$$

$$\text{Level 2: } \beta_{0j} = \gamma_{00} + u_{0j}$$

$$\beta_{1j} = \gamma_{10} + u_{1j}$$

The coefficient β_{1j} is fixed in a Random Intercepts ANCOVA, while a Random Intercepts and Slopes Regression Model allows it to vary across schools. The value of the coefficient should not be significantly reduced with this small change. If FRL eligibility and property value are in fact related to Math achievement, their relationship should be demonstrable and interpretable in multiple measurement models.

According to the criteria for an improved SES measure, a stable indicator of SES would be consistent across multiple levels of analysis (Harwell & LeBeau, 2010; Oakes & Rossi, 2003). Using HLM, a multilevel Random Intercepts and Slopes Regression Model allowed for the input of school level and individual level variables in a single equation (Luke, 2004; Raudenbush & Bryk, 1986). The equation below was executed to determine the strength of variables in predicting Math achievement:

$$\begin{aligned}\text{Level 1: } \textit{MathAchievement} &= \beta_0 + \beta_1 \textit{FRL} + \beta_2 \textit{PropertyValue} + r \\ \text{Level 2: } \beta_0 &= \gamma_{00} + \gamma_{01}(\textit{FRLRate}) + \gamma_{02}(\textit{MeanPropValue}) + u_0 \\ \beta_1 &= \gamma_{10} + u_1 \\ \beta_2 &= \gamma_{20} + u_2\end{aligned}$$

At the individual level, predictor variables were group-mean centered and allowed to vary across schools. At the school level, variables were grand-mean centered. With standardized values for all variables except for FRL eligibility at the individual level, the resulting coefficients were comparable and their relative strength in predicting Math achievement could be examined. The overall reduction in individual and school level variance was also of interest.

Geographic Information Systems was employed to serve as a bridge to connect valuable research findings with understandable, practical policy implications. Study results displayed on maps can depict relationships and draw attention to areas in need of improvement (Graham, Carlton, Gaede, & Jamison, 2011). Two maps were included in the analysis. The first was a general overview of the distribution of property values across the city. The second was a school level map depicting average property value and average Math achievement. The geographic component associated with property value must be utilized with care

because the depiction of individual locations with study data could be a violation of privacy. In education research, it is highly recommended that maps be displayed at the neighborhood or school level at a minimum. Still, using GIS to map data can aid improvement efforts and inform policy decisions to help target the needs of specific areas.

V. Results

First, property values were mapped across the city to observe their spatial distribution (see Figure 6). With only commercial properties excluded, over 190,000 cases were mapped regardless of their inclusion in the student sample. Values were color-coded on a scale from red to yellow to green, with dark red representing the lowest values and dark green representing the highest values. White areas represent airports, schools, corporations, or unassessed government properties; black lines represent major highways. In general, this descriptive analysis revealed a gradual increase in property value spanning the city from north to south. Concentrations of lowly and highly valued properties formed what appeared geographically to be neighborhoods and often spread into surrounding regions. The clustering of similarly value properties provided preliminary evidence in support of aggregating property value to group levels, e.g. school or neighborhood.

Descriptive Statistics

Descriptive statistics were calculated to examine the range of property values and other characteristics of the sample (see Table 1). For the sample as a whole, the average property value was \$157,347 with a minimum of \$7,500 and a maximum of \$500,000. This was an adequate range of values and a fairly representative sample; a limited range would have stunted the utility of the proxy. Math achievement ranged from 400 to 990 with an average scale score of 761. Free or reduced-price lunch eligibility ranged from 0 (ineligible for a free or reduced-price lunch) to 1 (eligible) with an overall FRL rate of 41%. District 1

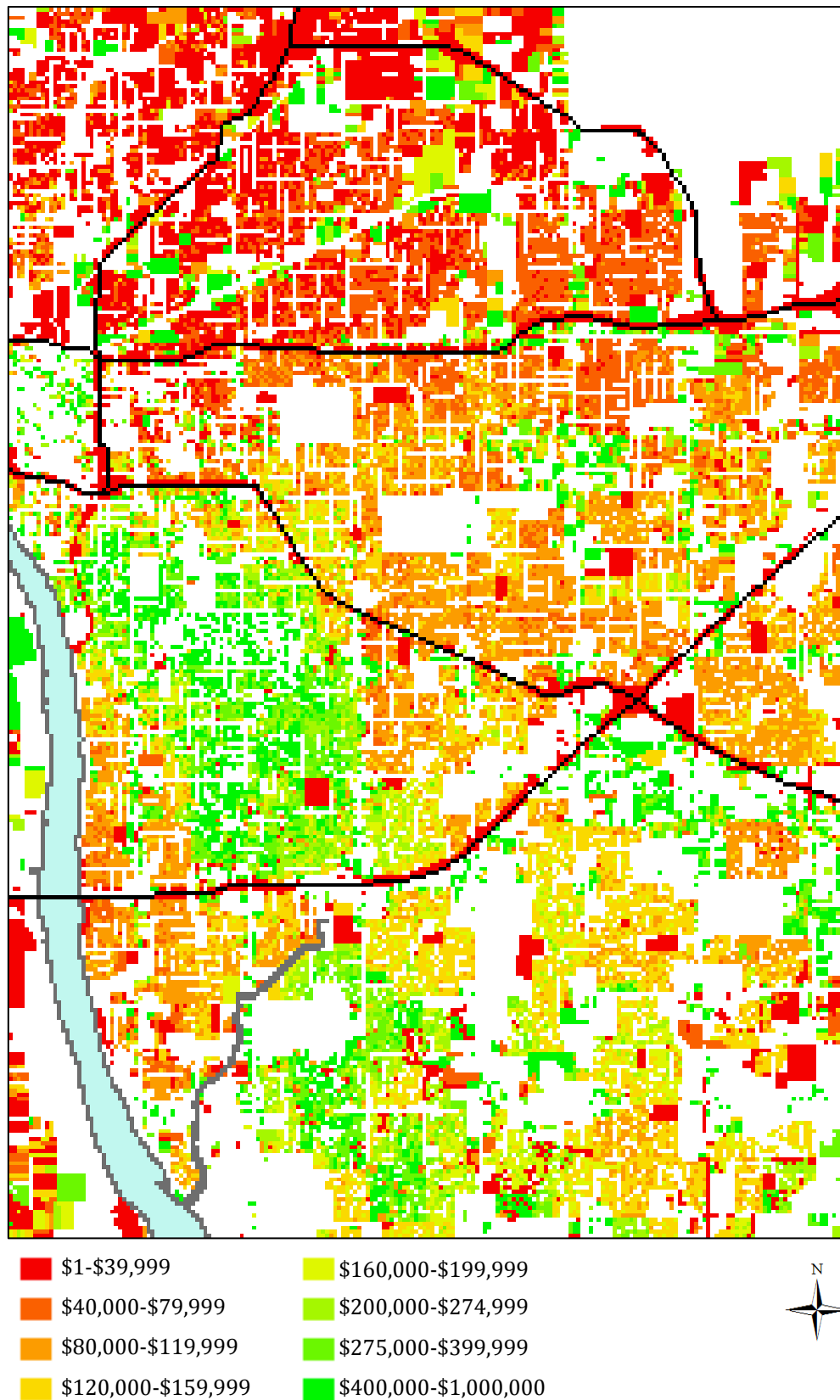


Figure 6: Spatial distribution of property values across the city

exhibited limited variance in student FRL status; 66% of students qualified for a free or reduced-price lunch. The average property value for a student in the district was \$119,859. In contrast, the majority of students in District 3 did not qualify for a free or reduced-price lunch. The FRL rate was 20% and the average property value was \$178,271. District 2 functioned as a descriptive middle ground, with a FRL rate of 47% and an average student property value of \$156,120.

	N (sample size)	Mean Math Achievement	Mean Property Value	FRL Rate (% Eligible)
DISTRICT 1	1,680	669	\$119,859	66%
DISTRICT 2	4,587	755	\$156,347	47%
DISTRICT 3	3,352	816	\$178,271	20%
TOTAL	9,419	761	\$157,347	41%

Table 1. Descriptive statistics by district

The measures also demonstrated a wide range of school level averages (see Table 2). The minimum average for property value within a school was \$78,250 while the maximum was \$203,098. In regard to Math achievement, the minimum school average was 550 scale points and the maximum was 893 scale points. The percentage of students qualifying for a free or reduced-price lunch within a school ranged from 3% to 97%. These dramatic disparities between schools provided strong descriptive evidence in support of aggregating measures to conduct school level analyses.

	Minimum	Maximum
Mean Math Achievement	550	893
Mean Property Value	\$78,250	\$203,098
FRL Rate (% Eligible)	3%	97%

Table 2. Range of school level means

Random Effects ANOVA

To ensure an analysis at the school level would be substantive, a Random Effects ANOVA was conducted to partition the variance in Math achievement to the individual and school levels. As mentioned in the design section, the ICC(1) value was of particular interest as it represented the variance in Math achievement attributed to differences in schools. An unconditional hierarchical linear model was run with standardized Math scale scores as the outcome variable in the equation. This model generated the total explainable variance at the individual level ($\sigma^2 = 0.51$) and at the school level ($\tau = 0.70$). Using these values and the appropriate equation from the design section, the ICC(1) value was calculated to be 0.58, i.e. 58% of the variance in individual Math achievement was due to school level differences. This was a significant portion of the overall variability in Math achievement and certainly provided evidence in favor of school level analyses.

Individual Level Analyses

Next, zero order correlations were examined to observe the bivariate relationships among all three variables. Table 3 shows the Pearson correlation coefficients between the variables at the individual level. Relationships between

all variables were statistically significant ($p < 0.01$). Accordingly, as an individual's property value increased, a simultaneous increase in Math achievement was expected. Inversely, eligibility for a free or reduced-price lunch was associated with a decrease in Math achievement. The relationship between FRL eligibility and property value was relatively small but still significant.

	Math Achievement	Property Value	FRL Eligibility
Math Achievement	1.00	0.37**	-0.52**
Property Value		1.00	-0.22**
FRL Eligibility			1.00

Notes: N = 9419 students, ** Significant at the 0.01 level (2-tailed)

Table 3. Zero order correlation matrix: individual level

A closer examination of the correlation between property value and Math achievement revealed a curvilinear relationship. This meant that the strength and, in this case, direction of the relationship between the two variables varied across the spectrum of property values. Figure 7 shows the line of best fit for both the linear and curvilinear regression output. A quadratic regression equation fit the data with greater precision than a linear equation. The amount of variability explained by the equation went from 13% to 17% when the quadratic was applied. In the figure, there appears to be a threshold property value of about \$325,000 after which Math achievement begins to trend downward. Before reaching this threshold, an increase in property value is associated with an increase in Math achievement with the steepest slope occurring at the low end of the property value distribution.

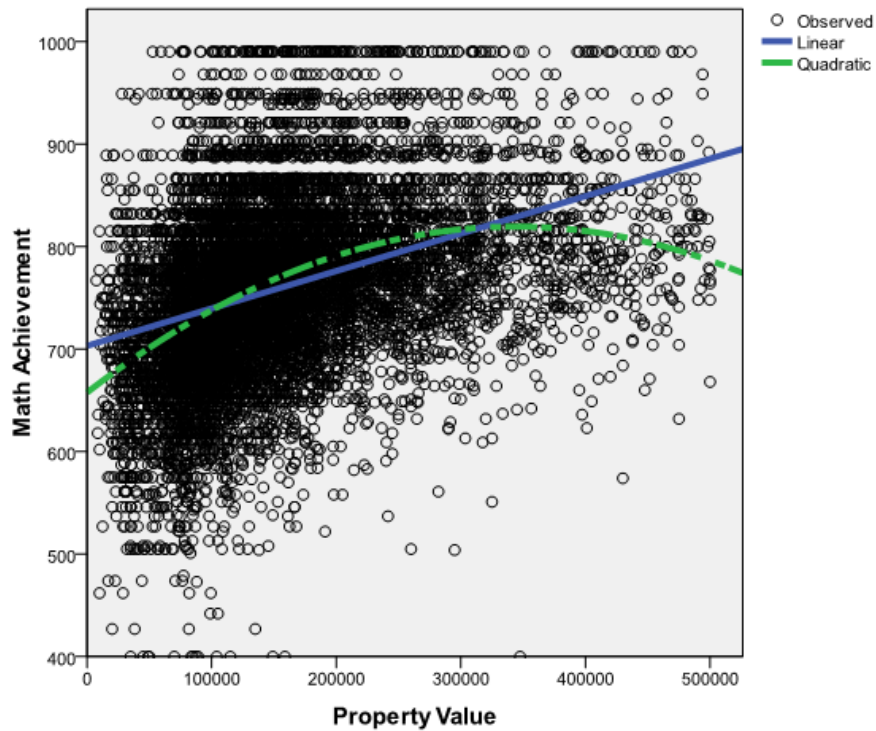


Figure 7. Curvilinear relationship between property value and Math achievement

School Level Analyses

The school level bivariate correlations were of special interest as a result of the high ICC(1) value. With a significant percentage of variance in Math achievement attributed to differences in schools, it is incumbent on researchers to discover school characteristics that affect student achievement. The nature of this study limited the school level variables to mean Math achievement, mean property value, and free or reduced lunch rate. As seen in Table 4, the relationships between all three of these variables were strong and statistically significant at the 0.01 level. The average property value within a school explained 83% of the variance in average Math achievement. As the average property value in a school increased, the average Math achievement increased simultaneously (see Figure 8). Also of note was the spike in the bivariate correlation between property value and

free-reduced lunch eligibility from the individual to the school level. Although they were related at the individual level, the two variables were very highly correlated at the school level with a correlation coefficient of -0.88. Part of this increase might be due to the change in nature of the FRL variable from dichotomous at the individual level to continuous at the school level.

	Mean Math Achievement	Mean Property Value	FRL Rate
Mean Math Achievement	1.00	0.91**	-0.88**
Mean Property Value		1.00	-0.88**
FRL Rate			1.00

Notes: N = 81 schools, ** Significant at the 0.01 level (2-tailed)

Table 4. Zero order correlation matrix: school level

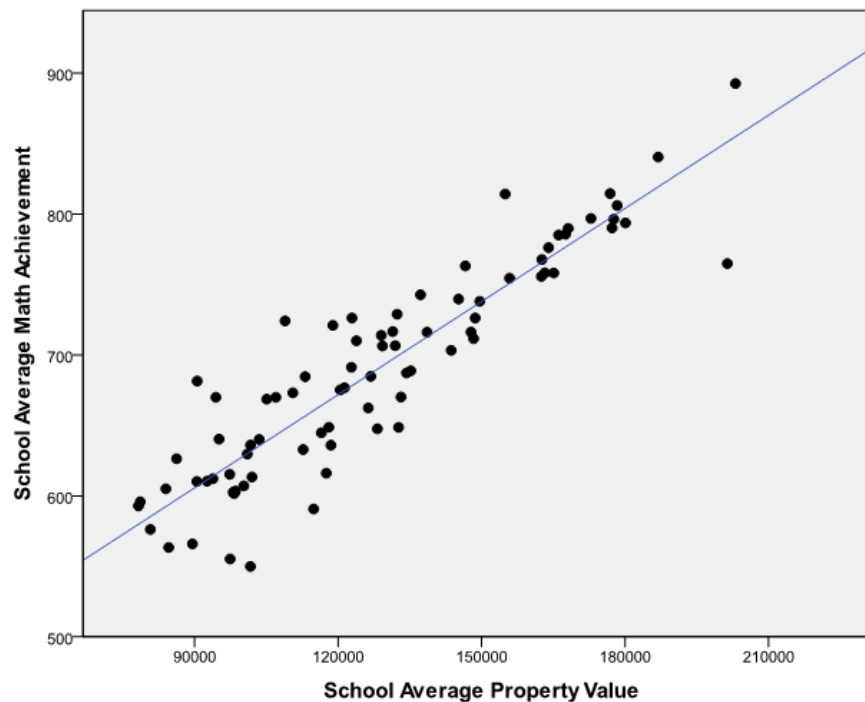


Figure 8. School level relationship between mean property value and mean Math achievement

Comparison of FRL Eligibility and Property Value

The purpose of the study was to test the validity of property value as a proxy of SES in lieu of previous measures, so the relationship between property value and free or reduced lunch eligibility at the individual level was further analyzed. Although statistically significant, the bivariate correlation coefficient between the two variables was fairly low (-0.22). This was surprising for two reasons. First, both measures were intended to be a proxy of socioeconomic status. Second, the descriptive statistics for all three districts indicated that average student achievement increased as average property value increased and free or reduced lunch rate decreased. Their small relationship with one another is indication that they could be measures of different concepts.

Analyses within FRL categories. The notion that FRL eligibility and property value might be different concepts was explored by comparing the frequency distribution of property values within each category of FRL eligibility (see Figure 9). If property value and FRL eligibility were highly related, a skewed distribution would be expected for both categories, with data skewed in opposite directions. Students who qualified for a free or reduced lunch were likely to live in residences with lower values, much as it appears on the right half of Figure 9. Conversely, it was assumed that students who pay full price for lunch would live primarily in highly valued residences. However, the histograms revealed a similar pattern of distribution across the spectrum of property values regardless of FRL eligibility. This is more evidence that the two variables measure different concepts. If both measures are, in fact, indicators of SES, then one of the measures

is significantly less precise. The conceptual foundation and continuous nature of property value defend its application as an appropriate proxy.

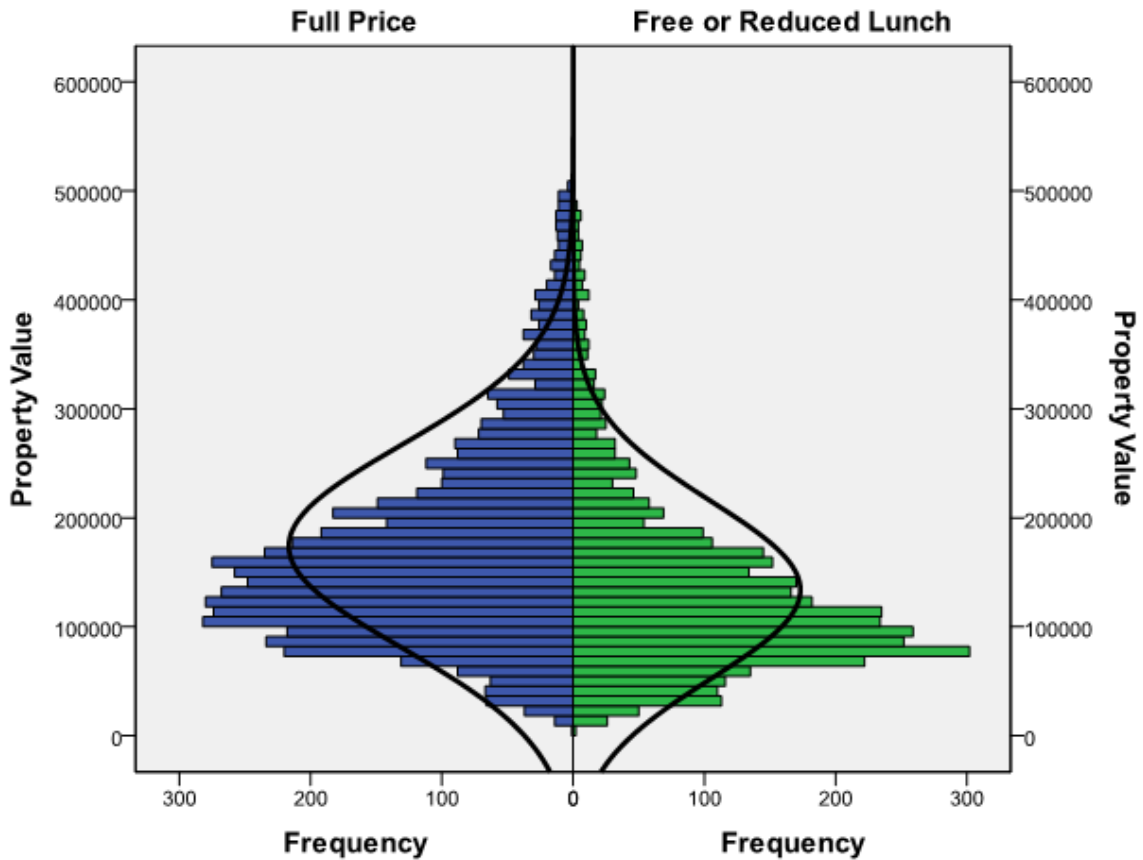


Figure 9. Frequency histograms by FRL eligibility across the spectrum of property values

Next, basic linear regression was performed to analyze the behavior of property value within each of the dichotomous categories of the FRL variable. Prior to any treatment of the FRL variable, the bivariate correlation between property value and Math achievement was 0.37. Thus, property value explained approximately 14% of the variance in Math achievement. With the sample restricted to those who qualify for a free or reduced lunch, the bivariate correlation between property value and Math achievement was 0.34. Thus, the strength of the relationship between property value and Math achievement was

hindered only slightly when the sample included only students who qualified for a free or reduced lunch.

The same test was run with the group of students who did not qualify for a free or reduced lunch, returning a correlation coefficient of 0.29. The relationship between property value and Math achievement was slightly weaker for the group of students who did not qualify for a free or reduced lunch than it was for those who did, but it was statistically significant at the 0.01 level within both categories of the dichotomous FRL variable. The relationship between property value and Math achievement is relatively consistent regardless of FRL status. This is more evidence that the two intended proxies of SES likely measure different concepts. Their effects on a commonly employed outcome variable were both statistically significant but largely unrelated to one another.

Basic linear regression and test of stability. An additional test of the relationship between property value and FRL status was the inclusion of both variables in a single linear regression equation as predictors of Math achievement. Individually, the bivariate correlation coefficients of property value and FRL status with Math achievement were 0.37 and -0.52, respectively. In combination, the model revealed that they were even stronger predictors of student Math achievement ($r = 0.58$). More than one-third of the variance in Math performance was explained by student property value and FRL status.

The stability of property value in comparison to FRL was also tested. For each variable, the results from a Random Intercepts ANCOVA were compared with a Random Intercepts and Slopes Regression Model to observe volatility at the

individual level (see Table 5). As demonstrated in the design section, the models were nearly identical in their construction; their only difference was the treatment of the level 2 coefficient as fixed or varying across schools. Predictor variables were group-mean centered in both models.

		Coefficient	Standard Error	<i>t</i> -ratio	Approx. <i>df.</i>	<i>p</i> -value
Model 1	Property Value slope, Intercept	0.19	0.01	13.24	9337	<0.001
	FRL slope, Intercept	-0.55	0.05	-10.64	9337	<0.001
Model 2	Property Value slope, Intercept	0.18	0.02	10.30	80	<0.001
	FRL slope, Intercept	-0.33	0.04	-8.252	80	<0.001

Table 5. HLM comparison of two models, test of variable stability

For property value, the coefficient in the final estimation of fixed effects with robust standard errors dropped from 0.19 to about 0.18 from model 1 to model 2. An individual's property value had a nearly identical relationship to Math achievement in both models. Its effects on achievement were modest, but they were consistent. For FRL status, the coefficient dropped from 0.55 to 0.33 when schools were allowed to vary at level 2. This sharp decline and large difference made it hard to make judgments about the relationship between FRL Status and Math achievement. The variable was unstable with only a small change in the model.

Multilevel Hierarchical Linear Model

The final test among variables consisted of multilevel modeling to observe the combined effects of individual and school level variables on student Math achievement. An adequate proxy of SES would be stable at multiple levels of

analysis and a strong predictor of an outcome variable. With units of analyses at both the individual and school level, a Random Intercepts and Slopes Regression Model was conducted with students nested in schools (see equation in the design section). The results are shown in Table 6.

	σ^2	τ	Fixed Effect	Coefficient	Standard Error	t-ratio	Approx. df.	p-value
Unconditional Model	0.51	0.70	Intercept	0.19	0.01	13.24	9337	<0.001
Random Intercepts and Slopes Regression Model	0.41	0.08	For Intercept, β_0					
			Intercept, γ_{00}	-0.79	0.03	-23.06	78	<0.001
			FRLRate, γ_{01}	-1.16	0.26	-4.47	78	<0.001
			Mean PropValue, γ_{02}	1.47	0.22	6.79	78	<0.001
			For FRL slope, β_1 Intercept, γ_{10}	-0.33	0.04	-8.252	80	<0.001
			For PropValue slope, β_2 Intercept, γ_{20}	0.18	0.02	10.30	80	<0.001

Table 6. HLM unconditional model and multilevel model, test of explained variance

At first glance, the model appears to be faulty with school level coefficients greater than one for both FRL rate and mean property value. Typically, this suggests multicollinearity. As demonstrated by the zero order correlation matrix, the relationship between the two variables is strong at -0.88. However, the two are conceptually different, and their composition is unrelated. The primary result to note from the model is the change in τ , or total variance attributed to schools. The model produced an 88% reduction in unexplained variance at the school level. At the individual level, unexplained variance was reduced by 20%. The effects of each variable in the model on Math achievement were strong and significant. Although undocumented above, a similar reduction in variance was seen at both levels when the FRL variable was removed from the model. Regarding the comparison between the FRL variable and property value, mean property value at

the school level was a slightly stronger predictor of Math achievement than FRL rate. This was a better comparison of the two indicators than at the individual level because both were evaluated on the same scale as continuous variables.

Spatial Distribution of Property Value and Achievement

To facilitate appropriate interpretation of results, a map was constructed to depict average Math achievement and average property value of schools (see Figure 10). The information was displayed at the school level so values of individual properties and the achievement of residents remained unidentifiable. The map was subdivided according to elementary school boundaries. The inclusion of middle schools or junior highs in the map would have muddled the display because of boundary overlaps with elementary schools.

The map consists of 46 elementary schools from District 1. The average property value of each school was color-coded from red to yellow to green and applied as a background fill within each school's catchment area. A circle representing average Math achievement was placed within each school's boundaries. The circles were color-coded on a scale similar to average property value, from red to yellow to green. Since the correlation between the two variables was so high, it was expected that the circle's color would often match that of the background.

This method of display emphasizes anomalies. If school average Math achievement were high in spite of a low average property value, it would be reasonable to assume school conditions were conducive to overcoming the powerful effects of poverty. Further exploration into the structure and

interactions within these schools would be necessary. In this way, mapping data facilitates the process of knowledge creation and helps target school improvement efforts.

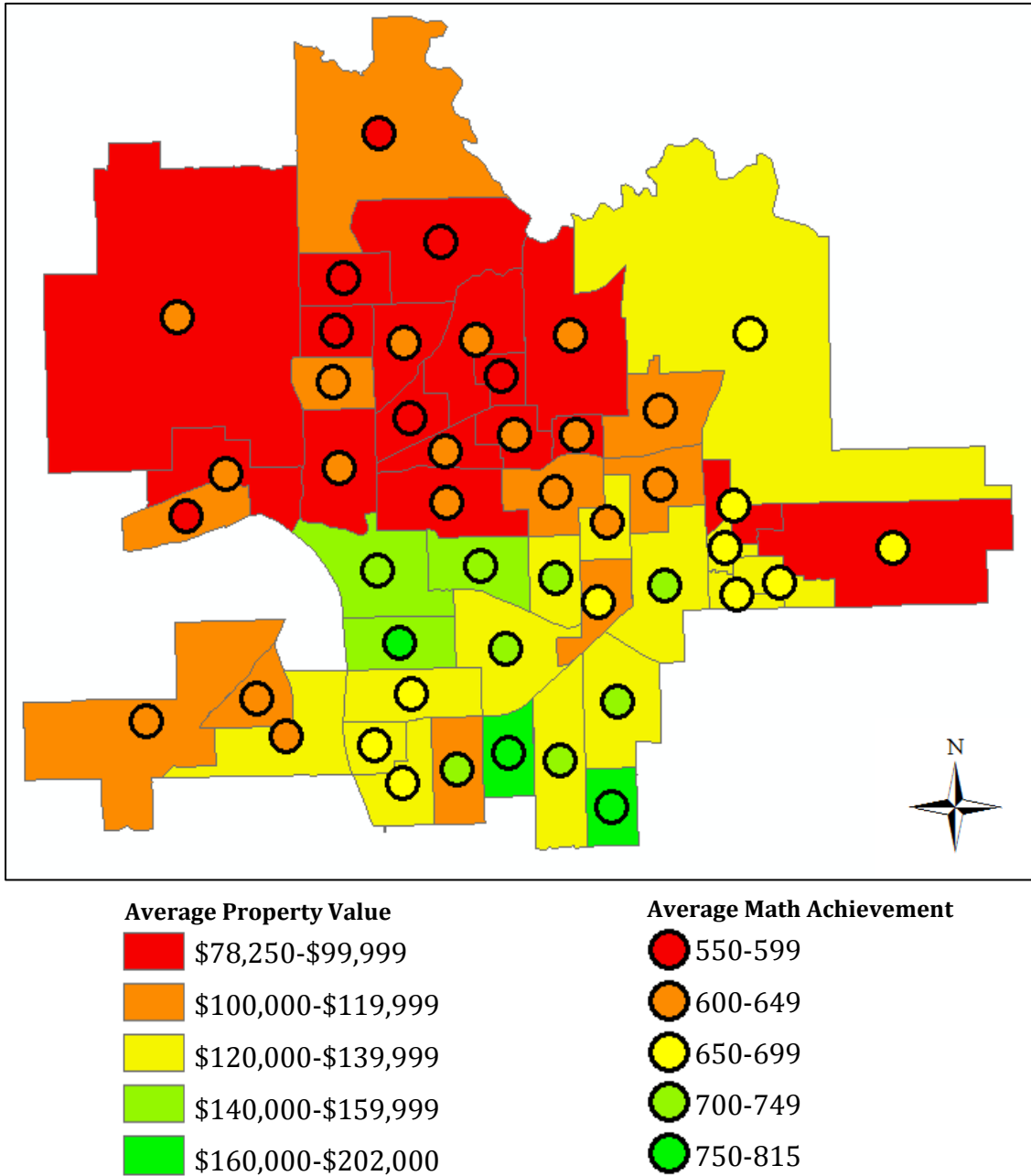


Figure 10: Average property value and Math achievement by elementary school in District 1 (sectioned and displayed by catchment area)

VI. Discussion

The empirical tests present strong evidence in support of property value as a proxy of SES. While it is only an introduction to its use, the conceptual foundation and empirical confirmation of the measure suggest it is worth exploring further. Its benefits as a continuous variable are evident in its stability across statistical models, and its strength at aggregate levels is illustrated in its nearly perfect correlation with school mean Math achievement. Even with strong statistical evidence, the interpretation of results entails some conjecture and speculation as the proxy is in its earliest stage of development.

The curvilinear relationship between property value and Math achievement at the individual level is compelling. It is important to think about property value in terms of access to capital. Theoretically, as an individual amasses more capital, the social capital available in the immediate environment also increases (Fry & Taylor, 2012). The curvilinear relationship between property value and Math achievement suggests the accumulation of capital is only beneficial to a certain point. One reason for this might be that there is simply a ceiling on Math achievement. However, the downward trend in Math scale scores for students with a property value above the threshold property value of \$325,000 suggests there could be something detrimental about residing in a home above this value.

The opportunity to gain access to capital does not always result in actual access. In regard to the threshold effect, at a certain point the opportunity for growth may be less appealing. It is possible that individuals no longer seek to capitalize on the capital available to them. Perhaps the threshold signifies the level

at which self-reliance becomes an option and social networks are naturally weaker as a result; thus, a self-inflicted limit on available social capital is imposed.

Without an explicit empirical test of the threshold effect, underlying factors and behaviors are pure speculation. Nonetheless, it is food for thought.

FRL Eligibility and SES

The comparison of FRL eligibility and property value shed light on the limitations of the FRL variable. Although it was a strong predictor of Math achievement at the individual level, its dichotomous nature negatively affected its stability and interpretability. The statistically significant relationship between property value and Math achievement within each category of FRL eligibility demonstrated the sacrifice in measurement precision due to the dichotomy. FRL rate at the school level was less volatile because it was a continuous variable. Still, school mean property value was a stronger predictor of mean Math achievement than FRL rate. In addition, property value's solid theoretical foundation renders study results practical and applicable.

The quantitative evidence does not refute the use of FRL eligibility as a measure. However, the evidence strongly suggests it is not a measure of socioeconomic status. In relation to SES, FRL eligibility is at best a relative measure of family income. Assigning students to one of two groups, those from families whose income is less than 185% of the federal poverty guideline and those who are not, is hardly informative to policy or practice. The lacking theoretical foundation and the simplistic composition of the FRL variable mean that any

attempts to interpret the relationships between FRL eligibility and outcome indicators are nothing more than speculation.

The evidence confirmed that FRL eligibility has strong predictive power, as reflected in its bivariate correlation with Math achievement. However, this relationship was quite volatile. In the test of stability, the strength of its relationship with Math achievement dropped substantially with only a small change in the measurement model. When the coefficient was allowed to vary across schools, its ability to explain differences in Math achievement was reduced significantly. It is likely that a similar reduction would occur with the introduction of more variation in FRL status, but its dichotomous nature restricts potential distinctions among individuals.

Conceptually, FRL eligibility is a reflection of Marx's view of a categorical status estimate. His view of society was of the bourgeois and the proletarian, the haves and the have nots, the 1's and the 0's. However, the bisection of the given population is the extent of the similarity between FRL eligibility and Marxist society. Empirically, the composition of FRL eligibility is inconsistent with Marx's designation of status. In statistical tests, the assignment of a 1 or a 0 to represent SES biases estimates of its relationship to variables of interest. Rather than embodying a normal distribution, it essentially pushes every student to one extreme or the other. If every student is assigned to be an outlier, there are no more outliers. By comparing one extreme to the other, the difference between the two categories is deceptively maximized and dramatic estimates of outcomes are obtained.

Another explanation for the volatility of FRL status is related to its dichotomy. In schools with mostly homogenous populations, the FRL variable is likely to be less stable. If the vast majority of students are eligible for a free or reduced lunch, a small percentage of students will be ineligible. In this case, each score for the small number of students in the minority can dramatically affect the average achievement within the category. The same would be true if the majority of students did not qualify for a free or reduced lunch. The sample of eligible students would be small, and outlying scores would have significant influence on the mean score within the category.

Ultimately, it is the lack of a theoretical foundation that most hinders the applicability of FRL eligibility as a proxy of SES. It is possible that the FRL indicator captures some aspect of the socioeconomic status of students and their respective families. However, it is just as likely that it is a measure of self-concept. Students who qualify for a free or reduced-price lunch might view themselves as inferior to their peers. Self-concept is strongly related to student achievement (Purkey, 1970). It may be equally reasonable to apply FRL eligibility in studies of self-concept as it is in studies of socioeconomic status. In order to be practical, a measure must be interpretable. Without a theoretical foundation, it is nearly impossible to interpret results with any certitude. FRL eligibility is neither practical nor theoretically sound.

GIS and Policy Implications

The initial mapping of property values across the city was visual confirmation that “physical proximity often represents social similarity” (Logan,

1978). This analysis showed that access to capital, as represented by the value of a property, is not only reflected in the value of an individual's property but in the value of immediate surroundings as well. This descriptive evidence supports the claim that property value is representative of the material and human capital of the occupant as well as the social capital available within the proximal community. This initial mapping alone has potential to be informative to social and education policy. Entire regions of cities lack access to capital while other regions thrive.

Housing policy, education policy, and SES should be considered simultaneously. A mountain of evidence reports the negative effects of low SES on student achievement and child development (Duncan & Murnane, 2011). If we know property value is representative of SES, and its effects are especially powerful in concentration, schools with high concentrations of low or high SES students should be identified within cities. In addition, the well-documented rise in residential segregation by income beckons for the application of property value to studies of neighborhood SES (see Fry & Taylor, 2012 and Bishop, 2008).

Future Research

The ability of property value to account for significant variance in Math achievement at the school level foreshadows the potential worth of studying property value in neighborhoods. In fact, schools and neighborhoods are interrelated; high-SES parents who can afford to reside nearly anywhere (according to the scale of desirability) often choose a home based on the quality of the local school (Lareau, 2014). In the past, neighborhood effects have been difficult to isolate for two primary reasons: (1) a plentitude of potentially

confounding influences on child development and (2) difficulty in defining neighborhood boundaries. As a result, the usefulness of neighborhood level research has been limited in spite of compelling empirical and anecdotal evidence that it matters for child development.

The neighborhood represents just one level in a complex system of influences on child development (Aber, Gephart, Brooks-Gunn, & Connell, 1997). Other sources of guidance include a child's family, peer group, and school. With each level of distance from the child, the number of potentially confounding variables increases and measurement imprecision is compounded. This makes it difficult to distinguish ecological effects from psychometric properties (see Raudenbush & Sampson, 1999). It has been especially arduous to isolate the influence of the neighborhood from that of the family (Jencks & Mayer, 1990). The stability of property value at the individual level and its performance when aggregated to the school level are indications that average property value within a neighborhood may be an adequate ecological measure of SES. Although average property value is merely an aggregate of an individual metric, the concentrated nature of similar values within geographic areas and the wide range of means across geographic areas suggest there is potential for unique norms and conditions to form within neighborhoods. These norms and conditions may have consequences for general health and child development.

The second complexity in neighborhood effects research is the definition of neighborhood boundaries. Individuals have varying ideas of what constitutes the neighborhood. Depending on the purpose of study, neighborhoods are defined as

the block on which an individual resides, the group of blocks immediately surrounding a residence, or the surrounding physical area including commercial centers, community facilities and amenities, and schools (Gephart, 1997). In practice, the availability of data tends to dictate neighborhood borders. Studies that use census data often use census tracts, census block groups, or zip codes to group residences. These save time and resources, but relying on simple administrative boundaries does not really characterize neighborhoods (Kaplan & Lynch, 1997). The optimal placement of boundaries is needed to correctly classify neighborhoods (Clapp & Wang, 2006).

Property values could be applied to define the optimal placement of boundaries. Using cluster analysis, residences with similar values within a contiguous area could be grouped into neighborhoods. Natural boundaries, highways, and local knowledge would then be used to refine the clusters (Mujahid, Diez Roux, Morenoff, & Raghunathan, 2007; Raudenbush & Sampson, 1999). Since the purpose of measurement at the neighborhood level is to analyze data spatially, the manner in which residences are grouped has significant implications for how data can be interpreted.

The difficulties in identifying neighborhood boundaries and isolating neighborhood effects are detrimental to the understanding and betterment of areas of concentrated poverty. Wilson (1987) defined neighborhoods in concentrated poverty as those in which at least 40% of residents are poor. There is concern that socioeconomic harms become substantially greater beyond this threshold (Galster, Cutsinger, & Malega, 2006). "Neighborhood effects are much

larger at the bottom of the neighborhood distribution than elsewhere” (Crane, 1991). These concentration effects are partly created by joblessness and a lack of exposure to conventional role models, and they are reinforced by social isolation from mainstream social networks (Wilson, 1987). Children in these neighborhoods are especially vulnerable. Improvements in the measurement and interpretation of neighborhood effects are imperative if the negative effects of concentrated poverty are to be addressed.

A second avenue for future research would involve additional school level analyses. School conditions thought to alleviate the effects of poverty, such as trust (Forsyth, Adams, & Hoy, 2011), should be tested with property value as a control variable. Schools are charged with the task of providing an outstanding education to students regardless of SES. Researchers must identify school conditions under which children thrive to overcome the strong relationship between SES and student achievement. Applying a stable indicator of SES as a control variable would help avoid biased empirical results and cloudy interpretations.

Another valuable research focus would be a test of property value’s ability to capture appropriate weights of material, human, and social capital in a single indicator. Indicators of each of the three capitals would be employed and their relationship with property value would be examined. The same type of analysis could be done with traditional indicators of SES including parent income, parent education, and parent occupation. It is possible that property value is highly related to one or two of the capitals and hardly related to another.

Further studies should examine the geographical scope of property value, testing it across adjacent counties, cities, and perhaps even states. It is standard practice for county assessors to determine property value by comparing a given property to similar properties within the region. The values themselves are not generalizable beyond the immediate region, but the *idea* to use property value as a proxy of SES is generalizable to other cities and states. Once studies are conducted in multiple areas, properties with comparable statuses according to their respective local scale of desirability could be analyzed across regions.

The validity of property value should also be tested longitudinally. Property values fluctuate with market trends and social perception. The subjective nature of property value could be a benefit in the long run because it would reflect societal norms (Rossi & Berk, 1987). However, it may also affect generalizability and longitudinal comparison. The stability of property value at all levels of the distribution should be evaluated over time.

Limitations

There were many limitations of the study with varying degrees of importance. The primary limitation with certain implications was the exclusion of students residing in apartments. At the individual level, there were no holes in the distribution so it is speculated that the exclusion of apartment residents was less influential. At the school level, however, the effects of their exclusion are unknown. It is likely that the overall FRL rate was lower while average property value and average Math achievement were inflated.

The scope of the study was also limited. Because property values are determined locally, they had to be evaluated locally. The results of this study are specific to the explored region. Variation in tax structures and in the cost of living makes values inconsistent across geographic regions. In addition, certain characteristics of homes do not hold their value from one location to another. For example, a pool may be more valuable in Phoenix, Arizona than it is in Anchorage, Alaska. The opposite might be true of a hot tub as an amenity. If location were irrelevant, a 1500 square foot house with a pool would be equally valuable in any locale. In reality, a \$200,000 home in Los Angeles is not comparable to a \$200,000 home in rural Idaho. As a result, the generalizability of the study is restricted until similar empirical explorations of property value have been conducted in other regions.

Conclusion

It cannot be reiterated enough that no measure of SES is exhaustive. Social capital in itself is not a one-dimensional concept (Putnam, 2001; Oakes & Rossi, 2003); attempting to capture the combination of material capital, human capital, and social capital in a single concept, SES, is complex. Trade-offs in accessibility, simplicity, and accuracy must be carefully considered, and theory must drive the development of measures. The only complete certainty with regard to SES is that no indicator is perfect, but improvement is long overdue. Without meaningful SES measurement, poverty will continue to define the life chances of generations to come.

The achievement gap has been acknowledged for decades, yet it remains unresolved. It is not the fact that there is a gap that is disheartening. Gaps in achievement are to be expected; the goal is not to have every student score identically on achievement tests. The real issue with the achievement gap is that the bottom portion of the distribution is performing at appallingly low levels, and their low performance damages opportunities for continued education and reliable employment. Schools have tremendous influence on the achievement of students, but a single dimensional approach to addressing the achievement gap has not made a dent for over half a century. The picture is bigger than students and schools; it includes families, homes, and neighborhoods; churches, peers, and coaches; policy-makers, legislators, and employers (Anyon, 2005). The life chances of low-SES students do not have to be defined by their property value. If strong social networks were in place across communities to reduce the social isolation of low-SES residents, property value would be a less powerful predictor.

It is important to reflect on the purpose of SES measurement. “To be good, a theory must also be practical” (Bronfenbrenner, 2006). Precise measurement is meaningless without subsequent, appropriate action. It is not worth the trouble of measuring SES to simply identify gaps in general health and academic performance. Labeling students from low-SES backgrounds often leads to excuses for their academic performance or lowered expectations. Documenting the strong relationship between SES and achievement is not meant to discourage schools and students, and it is certainly not meant to lower the bar. Measuring SES is intended

to identify areas of need and call on society as a whole to take responsibility so that no neighborhood, no school, and no child is left behind.

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