HOMOGENEITY, SORTING, AND SOCIAL CAPITAL: DIFFERENCES IN RURAL AND URBAN SCHOOL PEER EFFECTS

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HOMOGENEITY, SORTING, AND SOCIAL CAPITAL:
DIFFERENCES IN RURAL AND URBAN SCHOOL PEER EFFECTS

DISSERTATION

A dissertation submitted in partial fulfillment of the requirements for the degree of
Doctor of Philosophy in the Martin School of Public Policy and Administration at the
University of Kentucky

By
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Director: Dr. Eugenia Toma, Wendell H. Ford Professor Martin School of Public Policy
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Lexington, Kentucky

2013

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ABSTRACT OF DISSERTATION

HOMOGENEITY, SORTING, AND SOCIAL CAPITAL:
DIFFERENCES IN RURAL AND URBAN SCHOOL PEER EFFECTS

Rural America contributes greatly to the American Community, yet this population is often overlooked and underrepresented in most types of education literature. Choices about residence shape America’s public school system through the formation of school districts and schools associated with these local jurisdictions. Communities with different population densities may have different overall population composition and, therefore, may sort differently into schools. This paper examines the effect that population density, local jurisdictional sorting, homogeneity, peer characteristics, and community social capital may have on student achievement.

The first part of this dissertation outlines the importance of rural research and the impact of rural education on all of America. These areas have different economies, opportunities, and peer composition than their non-rural counterparts. The statistically average person is different in rural and urban America.

The second part discusses the theoretical implications of locale influence on educational attainment. This theory explains the possible causes of peer effect strength and provides a better predictive model of both rural and urban peer effects. I argue that some level of heterogeneity and high social capital foster strong peer effects, and there is a tradeoff between diverse student body composition and social capital.

In the final portion of this dissertation, I explore student achievement using empirical analysis. Based on the analysis in Chapter 4, it appears that student achievement is impacted by peers with and without controlling for teacher effects and social capital (or type) of a locale without controlling for teacher effects. Chapter 5 examines peer effect differences by locale and finds differences in peer effect strength. Suburbs have significantly stronger classroom mean peer effects in elementary school than towns. Skewness influences appear to be the same across grades and locale, and social capital has a positive impact on student achievement in elementary school and a negative impact on student achievement in middle school. The analyses in Chapter 6 conclude that student achievement is impacted by both the average and the percentage of high and low achievers but not similarly by locale. The final chapter discusses the results and their implications for future research and for policy makers.
KEYWORDS: K-12 Education Policy; Peer Effects; Rural and Urban Locales; Social Capital; Sorting

Student’s Signature

May 10, 2013

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HOMOGENEITY, SORTING, AND SOCIAL CAPITAL:
DIFFERENCES IN RURAL AND URBAN SCHOOL PEER EFFECTS

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Chapter 1

Introduction

1.1 Background

“Today, education is perhaps the most important function of state and local government. Compulsory school attendance laws and the great expenditures for education both demonstrate our recognition of the importance of education to our democratic society... We conclude that in the field of public education the doctrine of ‘separate but equal’ has no place. Separate educational facilities are inherently unequal,” Oliver L. Brown, et al. vs. Board of Education of Topeka, Kansas, United States Supreme Court, May 17, 1954.

Brown v. Board of Education established that all students must be equally protected under the law. Yet nearly 60 years later, policy makers are often unknowledgeable about the unique realities of rural education. This group is underrepresented in education literature and they are often required to adhere to urban policy. Rural students face different economies, opportunities, and possibly different peers and social capital than their urban counterparts. These areas have different unemployment rates, poverty rates, racial demographics, average age of population, and educational attainment rates.

School managers need a better understanding of what is best for their school and district. Rural policy makers cannot necessarily use the information about urban school to make the best policies. Characteristics of rural and urban populations are non-overlapping making it difficult to use studies from one locale type to explain behavior or outcomes for another.
1.2 Research Question

The purpose of this paper is to examine population homogeneity, peer effects, and social capital in different locales, and measure their impacts on education. People choose to live where they do because of job opportunities, local amenities, preference for public goods, the level of taxation, and the characteristics of the citizens in the community. These choices shape America’s public school system through the creation of multiple school districts and distinctive schools, a process which influences the composition of students in public schools.

Social capital is the interaction or relations among actors (Putnam 1993, Portes 1998, Coleman 1988, Woolcock 1998). I discuss social capital at an individual level to explain the impact of student’s interactions with one another on educational attainment, and I describe social capital at the community level to rationalize locale impact on student achievement. These attributes of trust and cooperation that are associated with social capital, are often assumed to be higher in rural communities. Within schools, literature argues that peers are important for learning and especially important for low achievers. These positive peer effects generally stem from the mixing of high with low ability students. Yet, rural communities are typically less diverse than urban communities so the opportunities for these peer effects may be diminished relative to urban areas. Peer effects typically have been examined in urban school districts, but not in rural areas. Population composition, social capital, and peer effects need examination at all types of locales to fully understand student achievement across locales. This research attempts to strengthen the theory of peer effects and fill the void in the literature on peer effects in rural areas, while also examining other aspects of rural communities that may influence education outcomes.
1.3 Organization of the Study

The remainder of this dissertation is broken into 6 parts. In chapter 2, I outline the importance of rural research and the impact of rural education on all of America. I explore the differences between urban and rural area classifications, statistics, and social and economic realities.

Chapter 3 builds upon the existing literature in a way that allows the linking of student outcomes to peer effects among student bodies and to social capital in communities. I recognize their effects on educational achievement and explore the impact of population composition in a locale. These ideas will be examined in both a rural and urban context to decipher if there is a difference in rural and urban peer effects in public schools. I provide an overview of the peer effects literature, population composition theory, and social capital literature. In conjunction with these literatures and ideas, I present a theory and an empirical model for peer effects in both rural and urban locations.

Chapter 4 explores the impacts of student achievement using empirical analysis. Using the model established in Chapter 3, I define the explanatory variables in relation to the sample population and correlate the variables to ensure accuracy. I describe the data used in the analyses of this chapter and in subsequent chapters in this dissertation. Last, I examine peer effect and social capital influence on student achievement. This leads to further analysis in subsequent chapters.

Chapter 5 provides empirical analyses of locale and social capital influences on student achievement and peer effects. I use multiple regressions, with and without teacher effects, to provide insight of locale type influence on students. I correlate locale variables with the explanatory variables, examine each locale type separately, and use both locale and social capital interaction terms. This chapter concludes with a discussion of the findings.
Chapter 6 compares peer effects in rural, town, suburb, and urban locales using high and low ability student classifications. High and low ability students are defined as testing in the top and bottom 20th percentiles, respectively. I examine this two ways. First, I use the percentage of high and low ability students in the district as proxies for locale composition. Second, I use the percentage of high and low ability students in the classroom as proxies for peer characteristics. I conclude with a discussion of the findings.

The final chapter summarizes the theory, empirical analyses, and conclusions of the dissertation. I discuss the results and their implications for future research and for policy makers.
Chapter 2

Comparison of Rural and Urban Schools

2.1 Introduction

“You know, rural Americans are a special people. Their labor puts food on our table and fuel in our gas tanks. Their service in our military sets a powerful example of leadership, honor and sacrifice. Their spirit of community inspires us all.” Tom Vilsack, current United States Secretary of Agriculture and former Governor of Iowa (1999 to 2007).

Rural America contributes greatly to the American Community, yet this population is often overlooked and underrepresented in education literature. In 2010, nearly 60 million people (19% of the population) lived in a rural area and nearly 89 million people (29% of the total population) lived in a rural area or an urban cluster with population of less than 50,000 citizens (United States Census 2010). In over half of the states, rural areas make up a sizeable portion of the population as shown in Figure 2.1.1. Twenty-three states have a rural population of one-quarter to one-half and an additional four states have a rural population of over one-half (Census 2010). Over 30% of American schools (20% of American students) are located in rural communities (National Center for Education Statistics 2000; Johnson and Strange 2007); however, less than 6% of education research includes rural school data (Hardré 2008).
One may argue that the urban population has a greater importance than the rural population because it is a larger proportion of the total population, but that would be incorrect. Worldwide, urban population is greater than the rural population, but only slightly (United Nations 2011). In America, the proportion of rural area population has continuously and severely decreased over the past century, yet the total rural population has grown (Census 2010). See Figure 2.1.2. Both rural and urban areas rely heavily on each other. “As long as cities exist, they will need rural resources – including the rural people and communities that help provide urban necessities. Clean air, water, food, fiber, forest products and minerals all
have their sources in rural areas. Cities cannot stand alone; rural natural resources can. Cities must depend on rural resources,” (Hanlon 2007).

**Figure 2.1.2 Rural Population in the 20th Century**

![Graph showing rural population changes over time](image)

Source: U.S. Census Bureau

It is important to examine educational influences and outcomes in rural areas because of the locale’s unique qualities. These areas have different economies, opportunities, and peer composition. The majority of education literature has examined urban areas and may not reflect rural locale realities. This chapter begins to address the rural void and will examine income, race, educational structure, extracurricular activity, and educational attainment differences in rural and urban locales. First, I outline the different locale classifications used in literature. I conclude with a discussion of peer composition.

---

1 Dr. Ron Wimberley, former Distinguished Professor of Sociology at NC State
2.2 Locale Classification Definitions

To understand locales, I first need to discuss the different definitions of rural and non-rural. I examine the four most used classification systems in the cited literature of this chapter. This list is not exhaustive. See table 2.1.1 for an outline of the definitions. For all classifications discussed, the unit of analysis is the county. The Office of Management and Budget (OMB) developed the Core Based Statistical Area (CBSA) definitions used by the government to define Metropolitan, Micropolitan, and Noncore areas. A Metropolitan Area includes surrounding counties that are socially and economically similar. This often categorizes residential suburbs as part of metropolitan areas. The United States Department of Agriculture, Economic Research Service provided more detail to these classifications by creating Beale Codes. Using the OMB definitions as a basis, it developed three metro and six non-metro categories. Beale codes provide a greater level of detail but many authors group codes together for ease of use (as shown in table 2.2.1). One of the largest points of interest is that the definitions based on the OMB include suburbs and other surrounding counties in the Metro category.

The United States Census defines locales as Urbanized Areas (UA), Urban Clusters (UC), or Rural. An Urban Area includes “…adjacent territory containing non-residential urban land uses as well as territory with low population density included to link outlying densely settled territory with the densely settled core,” (Census 2010). This definition does not categorize residential suburbs as UAs, but classifies them based on their individual size. The National Center for Education Statistics (NCES) uses the Census classifications as a base for its definitions. They use City, Suburb, Town, and Rural categories. NCES is distinctive because it differentiates locales on both size and proximity to an Urban Area. It defines Suburbs as unique entities.
Because of the various definitions, locale nomenclature will not be used interchangeably in this chapter. For the empirical analysis portion of the dissertation, locales are defined by NCES classification.
<table>
<thead>
<tr>
<th>Locale Classifications</th>
<th>Definitions</th>
<th>Proportion of Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beale Codes:¹</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Larger Metro (0,1)</td>
<td>Central or fringe counties or metro areas of 1,000,000 population or more</td>
<td>84% (all metro combined)</td>
</tr>
<tr>
<td>Smaller Metro (2,3)</td>
<td>Counties in metro areas 1,000,000 populations or fewer</td>
<td></td>
</tr>
<tr>
<td>Urban, Non-Metro (4-6)</td>
<td>Urban population of 20,000 or more adjacent or not adjacent to a metro area; urban population of 2,500 to 19,999 adjacent to a metro area</td>
<td>16% (non-metro and rural combined)</td>
</tr>
<tr>
<td>Rural (7-9)</td>
<td>Urban population less than 2,500 either adjacent or not adjacent to a metro area</td>
<td></td>
</tr>
<tr>
<td>CBSA:&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metropolitan</td>
<td>An area of more than 50,000 persons; includes core county and adjacent counties linked through community ties</td>
<td>83.5%</td>
</tr>
<tr>
<td>Micropolitan</td>
<td>County with urban core of 10,000-49,999</td>
<td>10.1%</td>
</tr>
<tr>
<td>Noncore</td>
<td>Counties with no urban core or core has less than 10,000 persons</td>
<td>6.4%</td>
</tr>
<tr>
<td>Census:&quot;&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban Area</td>
<td>Area with a population of 50,000 or more</td>
<td>71%</td>
</tr>
<tr>
<td>Urban Cluster</td>
<td>Area with a population of 2,500 to 50,000</td>
<td>10%</td>
</tr>
<tr>
<td>Rural</td>
<td>Area with a population of less than 2,500</td>
<td>19%</td>
</tr>
<tr>
<td>NCES:&quot;&quot;&quot;&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>City</td>
<td>Population of 50,000 or more; in a principle city</td>
<td>29% (of public school students)</td>
</tr>
<tr>
<td>Suburb</td>
<td>Included in a urban area with a population of 50,000 or more; not in a principle city</td>
<td>35%</td>
</tr>
<tr>
<td>Town</td>
<td>Population of 2,500 to 50,000; 10 or more miles from a city</td>
<td>12%</td>
</tr>
<tr>
<td>Rural</td>
<td>Population of less than 2,500</td>
<td>24%</td>
</tr>
</tbody>
</table>

¹ United States Department of Agriculture 2011  " Office of Management and Budget 2010
"" United States Census Bureau 2010  """" National Center for Education Statistics 2008
2.3 Urban and Rural America

Nonmetropolitan life varies throughout the county, but as a whole it has different demographics, statistics, and opportunities than metropolitan areas. See Table 2.3.1. In non-metro areas, median age is older, the poverty rate is higher, per capita income is significantly lower, and unemployment rates are higher. One of the few similarities between the two areas is that government and government enterprises employ the largest percentage of persons. The remainder of this chapter examines differences in income, race, educational structure, extracurricular activities, and educational attainment by locale.

Table 2.3.1 Metropolitan and Non-Metropolitan Areas at a Glance

<table>
<thead>
<tr>
<th></th>
<th>Metropolitan</th>
<th>Micropolitan</th>
<th>Noncore</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Counties</td>
<td>1,092</td>
<td>694</td>
<td>1,355</td>
</tr>
<tr>
<td>Median Age in years</td>
<td>36.1</td>
<td>37.8</td>
<td>40.1</td>
</tr>
<tr>
<td>Persons in Poverty</td>
<td>12.7%</td>
<td>15.6%</td>
<td>17.0%</td>
</tr>
<tr>
<td>Per Capita Income</td>
<td>$38,564</td>
<td>$27,403</td>
<td></td>
</tr>
<tr>
<td>Unemployment Rate</td>
<td>4.5%</td>
<td>5.1%</td>
<td></td>
</tr>
<tr>
<td>Leading Employer</td>
<td>Government and Government Enterprises</td>
<td>Government and Government Enterprises</td>
<td></td>
</tr>
</tbody>
</table>

Source: Miller 2009

Rural and non-rural persons face different economic realities that could affect childhood education. Rural areas have higher rates of child poverty, more widespread poverty in persons of all ages, higher rates and longer spells of unemployment, and higher barriers to work.

Eighty-two percent of the 730 American counties that suffer with persistent childhood poverty are located in rural America, and most of these counties are in the South and Southwest (Lichter and Johnson 2007). Metropolitan areas have lowest poverty rates, in persons of all ages, followed by Micropolitan then noncore (Miller 2009). Poverty is usually spread across rural
counties while the poor in urban areas tend to be more concentrated to select neighborhoods. Because of the larger area of concentration of childhood poverty in rural areas, the consequences of poverty will likely affect rural and small town children differently than urban children (O’Hare 2009). In rural school districts, there is no option to economically diversify schools. Even if school attendance lines are re-drawn, it is likely to make little to no impact on the composition of the school. These children’s schoolmates, peers, and role models are likely to be poor (O’Hare 2009).

On average, rural areas have higher levels of unemployment and larger proportions of impoverished persons than urban areas (O’Hare and Johnson 2004, Lichter and Johnson 2007). Parents in rural areas are more likely to be underemployed and classified as low-income (at least one parent working full time with a wage below 200% poverty level) than urban parents (O’Hare 2009). Compounding the higher levels of unemployment and underemployment, rural persons are more likely to remain in poverty. Persons in nonmetropolitan areas tend to be in poverty for longer periods of time than persons in metropolitan areas with a 51% longer average poverty length (United States Census 2011). These rates are fueled by geographic isolation, fewer economic opportunities, and barriers to moving from welfare to work. Rural persons experience a lack of transportation and child care services (Pickering, Harvey, Summers, and Mushinski 2006), as well as a lack of stable employment, opportunity for mobility, investment in the community, and diversity in the economy and other social institutions (Tickamyer and Duncan 1990). O’Hare (2009) and Kusmin (2012) found that rural adults are poorer than non-rural adults at every education level. The difference is particularly large for those that did not finish high school. Nonmetropolitan per capita income has been lower than metropolitan per capita income for the last ten years (Miller 2009). In 2009, non-metro household income was 77.9% of
metro resident’s income and transfer payments made up 25% of non-metro income (Kusmin 2012).

While the statistics on rural poverty appear to be inopportune, not all authors are in agreement. Strange (2011) showed that children in cities and towns are more likely to be poor than rural children, and that suburban children are least likely to be poor. However, he agrees that some rural counties do have high poverty rates comparable to the poorest of urban areas. He noted, “... in the 10% of rural and small town districts with high poverty rates, 37% of students live in poverty, comparable to the Bronx.” The authors’ disagreement could be caused by different definitions of rural, different definitions of urban (inner city versus urban areas as a whole), or varying econometric practices and control variables.

Urban and rural locales have different racial compositions. Rural America contains numerous racial and ethnic minorities, but unlike in urban areas, rural minorities are clustered around the county. They are located in the ‘black belt’ of the lower south eastern states and along the Mississippi Delta (Flora, Flora, and Fey 2003; Lichter et al. 2007), Hispanics are clustered along the Rio Grande Valley and sections of the southwest (Saenz and Torres 2003; Miller 2009; Kusmin 2012), and Native Americans are often found on isolated Indian Reservations and the upper great plains and four corners region (Snipp 1989; Miller 2009; Kusmin 2012). Poor white are concentrated in Appalachia (Irvin, Farmer, Leung, Thompson, and Hutchins 2010). This segregation often causes rural areas to be homogenous based on ethnicity and socioeconomic status (Nachtigal 1982).

Child poverty differs by racial and ethnic classifications in rural and urban America. In contrast to urban areas, rural areas have a greater percentage of poor white children than poor black and poor Hispanic children (O’Hare 2009). While whites are dispersed all throughout rural America, minority children are usually concentrated in high-poverty rural counties. Eighty-three
percent of rural poor black and two-thirds of rural poor Hispanic children reside in high-poverty counties (O’Hare 2009). High poverty counties create additional economic obstacles and appear to be affecting minorities disproportionately.

There are differing opinions on all school statistics of rural and urban America. Authors disagree on the education structural and extracurricular activity of schools. Singh and Dika (2003) believe there are fewer academic opportunities for rural students. They have limited resources and fewer options for advanced classes (Seal and Harmon 1995; Roscigno and Crowley 2001) and rural teachers have more complex teaching requirements (Colangelo, Assouline, and New 1999). Because of the small school and class sizes, teachers might have to teach multiple subjects for multiple grade levels. Additionally, small numbers of teachers and staff often hinder the quantity of extracurricular activities (Ballou and Podgursky 1995; Hardré, Crowson, Debacker, and White 2007).

Other authors believe that rural schools are often the center of a community and gathering place for youth activity (Fischel 1992; Elder & Conger 2000; Parker 2001; Lyson 2002). Because of the small number of students, rural children have more pressure to be involved and most rural adolescents are involved in some sort of sport (Kannapel and DeYoung 1999). These students are more involved in activities and leadership roles than students in larger schools (Kannapel & DeYoung 1999; Elder & Conger 2000; Parker 2001).

Authors have different perspectives on rural and urban dropout and graduation rates, while many agree that suburban areas have the highest high school completion rates (Swanson 2009; Strange 2011). Reeves and Bylund (2005) suggest that the disagreement is caused by different control variables and definitions of rural. Gandara et al. (2001) believe that rural students frequently drop out of school with most rural locales having twice the national average dropout rate. At every education level, metropolitan areas have the highest completion rates.
and noncore counties have the lowest (Miller 2009). The gap is narrowing for metro and non-metro high school completion. Metro areas had a 3.5% point higher completion rate while the college gap is widening since 1990 (Kusmin 2012). Rural adolescents are more likely to be involved in drugs and alcohol, have deviant behavior, and drop out of school (Roscigno, Tomaskovic-Devey, and Crowley 2006; Vazxonyi, Trejos-Castillo, and Young 2008). On the other hand, Swanson (2009) reviewed reports from 2005 that showed that rural graduation rates were over 13% higher than urban school graduation rates, and suburban graduation rates were just 1% higher than rural rates. Using the 2004 American Community Survey, Strange (2011) found similar results to Swanson. Jordan et al. (2012) found that once family attributes are controlled for, there is little to no difference in rural and urban graduation rates. The difference in results might be attributed to the various definitions of dropout rates. Common calculations range from the percentage of 9th graders that did not eventually graduate to the percentage of 12th graders that did not graduate.

Additionally, there are differences in dropout rates for high school and college, and geographic regions. Using CPS data, O’Hare (2009) found little difference in rural and urban adults 25-44 that had not finished high school. The difference in locale appeared in college graduation rates. More than one-third of urban adults have college degrees and only one-fifth of rural adults finished college. O’Hare contributes the difference to more students attending colleges located in urban areas and better educated adults leaving rural areas in favor of urban areas. Appalachia, particularly Central Appalachia, has the lowest college graduation rates with counties in Eastern Kentucky having graduation rates less than half of the national average. Authors explain that there are cultural and social reasons for low educational attainment (Lewis 1978; Whisnant 1983; Haaga 2004).
Rural areas face unique disadvantages compared to urban areas. On average, rural areas have higher child poverty rates, higher levels of unemployment and underemployment, longer poverty spells, and face higher barriers of entry to work. They are racially homogeneous within a locale, but minorities are disproportionately located in high poverty counties. There is not an agreement about quantity of and participation in academic and extracurricular activities in rural schools, and graduation rates vary by education level, locale, and geographic region. Even with these differences, rural areas are rarely examined in the education literature. Because urban areas rely on rural areas for natural resources, an educated rural society is needed for progress in all areas of the country.

It is important to examine educational influences and outcomes in rural areas because of the locale’s unique qualities. These areas have different economies, opportunities, and peer composition than their non-rural counterparts. The statistically average person is different in rural and urban America. The theoretical implications of locale influence on educational attainment are discussed in Chapter 3.
Chapter 3

Theory and Literature Review

3.1 Introduction

I propose to build upon the existing literature in a way that allows the linking of student outcomes to peer effects among student bodies and to social capital in communities. I recognize effects of peers on educational achievement and explore the impact of population composition in a locale on these peer effects. These ideas will be examined in both a rural and urban context to decipher if there is a difference in rural and urban peer effects in public schools.

The rest of this chapter is in 4 parts: section 2 outlines the peer effects literature, section 3 explains the student body composition theory, section 4 defines social capital, and section 5 combines the literature and theory into one encompassing theory. Locale classifications may be used interchangeably in this chapter because locales are discussed only in theory. Urban, non-rural, metropolitan, and city all refer to one set of categorizations or locales. Rural and non-urban refer to another set of categorizations or locales.

3.2 Peer Effects Literature

There is a growing body of literature on educational peer effects. Summers and Wolfe (1977) refer to peer effects as the impact of pupil- specific characteristics of the schools’ students on the achievement of specific or individual students. The authors in this field aim to measure the impact of peer characteristics on a student’s educational attainment. They have examined policies that have an effect on peer composition and, subsequently, on peer effects. The empirical analyses have applied mainly urban data sets, but vary greatly with their methods of examination and econometric models, as will be discussed later in this section and in the last
section of this chapter. Even with the varying methods and data, the overwhelming majority of the peer effect literature has the same result: measured by test scores and behavior, students are influenced by one another (Coleman et al. 1966, Summers and Wolfe 1977, Henderson, Mieszkowski, and Sauvageau 1978, Zimmer and Toma 2000, Hoxby 2000a, Hoxby 2000b, Lavy 2008, Lin 2010, Duflo, Dupas and Kremer 2011). According to the literature, educational achievement is a function of peer effects and other factors. This is shown in the following equation, where $\Pi = \text{educational achievement}$, $P = \text{peer effects}$, and $\varepsilon = \text{other factors}$.

(1)

$$\Pi = f(P, \varepsilon)$$

Authors have explained how the community has an impact on classroom composition and how classroom composition influences school and student average test scores. Using a model in which the population sorts into communities voluntarily and government policy reflects the preferences of the median voter, de Bartolome (1990) developed a theoretical model to examine the patterns of sorting of high and low ability families that would emerge. He argued that, in equilibrium, individuals would sort to maximize their own benefits and would fail to account for the positive (or negative) effects they might have on other students in the communities. In other words, the external effects are not priced in public sorting decisions. As a result, communities would be more homogenous than optimal. Epple and Romano (1998) have argued that private schools have an incentive to take these external peer effects into account as they recruit and form classrooms. Higher ability students will pay different tuitions than lower ability students in equilibrium. The latter group will be willing to pay for the peer effects created by the prior, ceterius paribus. Arnott and Rowse (1987) theoretically explored
how schools maximize the average test score. A mixed classroom composition affects all types of students, but in different ways.

Numerous empirical studies have found that mixing students benefits the overall student population (Summers and Wolfe 1977, Henderson, Mieszkowski, and Sauvageau 1978, and Zimmer and Toma 2000). Moreland and Levine’s (1992) survey concludes that ability grouping benefits higher achieving students and lower ability students are harmed by it. Most find that the gains to lower ability students from mixing with higher ability students exceed the losses to the higher ability students from mixing with the lower ability students. The mean of classmates and the variability of ability could be essential. Zimmer (2003) found that homogeneity reduces average peer effects for low and average achieving students and has no impact on high-ability students. While these studies do not typically calculate the precise combination of peers to maximize overall student achievement, they find that a mix of ability is optimal. Plausibly, peer effects are a function of the population homogeneity in a locale and other factors. Refer to equation 2, where $P = \text{peer effects}$, $K = \text{population homogeneity}$ and $\varepsilon = \text{other factors}$.

\[
\begin{align*}
(2) \quad P &= f(K, \varepsilon)
\end{align*}
\]

Authors disagree at what level to define a relevant peer group. Hoxby (2000b) defines peers as students in the same school. She looked at Tiebout sorting in urban locales and considered the composition of the entire school as a student’s peers. These typically big, heterogeneous schools (especially at the high school level) have a large student body and a diverse geographic area from which the school draws. Zimmer and Toma (2000) examine peer
effects by measuring the influence of the students in a classroom. There are stronger peer effects when peers are estimated by classroom rather than by grade level (Burke and Sass, 2008). Additionally, peer effects tend to be smaller with the inclusion of teacher fixed effects. The latter suggests that there are challenges to measuring actual student-level peer effects.

Few authors found no peer achievement effects (Hanushek 1972, 1992), while Gibbons and Telhaj (2008) discovered that most peer effects in the literature were small. Others caution overstatement of the influence of peers. Evans, Oates, and Schwab (1992) conclude that after controlling for the student’s and family’s choice of peers, the statistical significance in the peer influence is diminished. They point out that this does not prove that there is no peer effect, but that the current scientific proof is inadequate. Manski (1993) examined the same issue and found that the problem can only be solved by knowledge of person’s characteristics prior to joining the group, and Moffitt (2001) addressed issues with correlated unobservable, errors in variables, and endogenous group membership. Hanushek et al. (2003) found a peer effect but argue that student and peer achievement are determined simultaneously and family influences helped students choose peers based on their neighborhood and school they attend.

Little educational research has been conducted in rural areas compared to urban and suburban settings (Gándara, Gutiérrez, and O’Hara 2001). Ding and Lehrer (2007) examined peer effects in China and account for rural and urban schools with an interaction term of student’s own characteristic. Zimmer and Toma (2000) used data from both urban and rural locales, and included a dummy variable for rural locations as part of the school inputs. They found no statistically significant peer effect for locale when using peer ability variables such as the mean of the class test scores. When examining socioeconomic variables of peers (mother and father occupation and education), the rural variable was positive and statistically significant. This shows that rural students might perform better than their urban counterparts when
socioeconomic characteristics of peers are controlled. However, neither of these two articles included rural-peer interaction terms.

3.3 Student Body Composition Theory

In 1956, Charles Tiebout introduced his theory on local government choice. He argued, in his simplified world, that people choose communities based on their preferences for a public goods package (i.e. preferences for levels of provision of public goods and taxes to finance the goods). By sorting into locations that match preferences, individuals reveal their preferences for the locally provided public good. A consequence of this sorting is that local communities tend toward homogeneity. In the perfectly homogenous equilibrium, peers’ preferences are identical to a person’s own preferences.

People sort not only on the public goods margin but also according to private job opportunities and amenities. They may choose communities based on racial and religious characteristics as well. Their preferences are different and, subsequently, the package they want from the government is likely different. Through zoning or other mechanisms, people sort within a locale to varying degrees of preference homogeneity based on fiscal concerns (Hamilton 1975 and Fischel 1992).

While these authors predict an equilibrating tendency toward community homogeneity, sorting is not always complete. This can occur for a variety of reasons. Governments provide more than one public good, and individual preferences can vary across a set of goods. There may not be a sufficient population size to justify sufficient cities or jurisdictions to match perfectly to the preferences for the government goods package. Theoretically, people sort into communities based on a combination of public and private goods, but fiscal externalities may cause possible overurbanization (Buchanan and Goetz 1972). Communities may become
heterogeneous on the demand for one good if preferences are neither too weak nor too strong. In areas where people do not have strong preferences, they are willing to accept policies that vary from what they would desire as a means of satisfying their preferences on other margins. Migration might also impact population composition. The community may become (second best) inefficient because of migration in and out of the community (de Bartolome 1990).

According to this theory, the population homogeneity in a locale is a function of the locale type and other factors. This is shown in the following equation, where \( K \) = population homogeneity, \( \Gamma \) = type of locale, and \( \varepsilon \) = other factors.

\[
K = f(\Gamma, \varepsilon)
\]

Sorting and subsequent population composition may vary for several reasons. According to the literature, cites are heterogeneous when considered as a whole but sorting occurs within the city. Locales with higher population density tend to have greater income inequality (Glaeser, Resseger, and Tobio 2008). Rural areas do not have the population density required to capture possible economies of scale necessary for sorting within a given jurisdiction nor do they have the population mobility found in urban areas. Rural areas have extensive travel distances and little to no public transportation (Mahoney et al. 2005). As a whole, these regions are often homogenous based on ethnicity and socioeconomic status (Nachtigal 1982). See Figure 3.3.1 for a diagram of a conceptual presentation of the sorting differences. Each circle represents a geographical area. Assume each locale has one overall governing body. The
population mix in the urban locale is heterogeneous in characteristics and preferences while the rural locale is comprised of persons with less diverse characteristics and preferences.

According to Hamilton (1975) and Fischel (1992), citizens in heterogeneous populations will desire fiscal homogeneity and will sort within the city to obtain it. They will sort within neighborhoods in the city based on income and preferences and may use zoning laws to enforce this sorting tendency. Citizens of rural areas are likely to be populated by persons with more similar preferences as a whole. Additionally, they may not have the population size or economies of scale to sort. See Figure 3.3.2 for a diagram of urban sorting. In the urban locale, it is feasible that citizens have sorted into homogeneous districts within the city while the rural area still contains one district. Each locale still has an overall governing body, but the urban area
has multiple governing bodies. In urban areas people can sort to different communities each with their own voting areas, school districts, or school attendance areas. Citizens of rural areas can sort within the region to some degree, but their government provision, including schools will likely be the same across the locale.

![Urban Area and Rural Area Sorting by District](image)

**Figure 3.3.2 Urban and Rural Area Sorting by District**

Authors have examined urban sorting and its impact on America’s public school system. Alesina, Baqir, and Hoxby (2004) found that most citizens desire homogeneity and forces move communities in that direction. They related citizen preferences to the number of schools in a district and the number of districts in an area. When racial and income heterogeneity increased, so did citizen desire for sorting. A city with high population heterogeneity had a greater number of school districts and schools in each district.
Evidence suggests that racial heterogeneity has an impact on local public education policies (Cutler, Elmendorf, and Zeckhauser 1993, Poterba 1997, Goldin and Katz 1999). In areas with racial diversity, citizens are less likely to combine funds and provide public goods. Even with the strong pressure to consolidate school districts since 1960, more racially diverse communities had less consolidation than racially homogeneous communities (Alesina, Baqir, Hoxby, 2004).

When heterogeneity exists and homogeneity is desired, locales either create a new school district or build additional schools within the existing district. Hoxby (2000b) found that racial and economic sorting occurred at the school level and not at the district level. Alesina, Baqir, and Hoxby (2004) found that sorting increases in racially and income diverse populations, and racial, income, religious, and Hispanic ethnicity heterogeneity increase the number of school attendance areas in a district. They discovered that the greater number of school attendance areas available to a student, the more likely the student will attend class with similar students. The addition of schools in the same district decreases the size of school attendance areas. Because of urban sorting, this allows for preference specific schools. As the number of schools in a district increases, the schools become more homogeneous while the district remains at the same level of heterogeneity. The number of school districts in an area has slightly to no impact on the homogeneity within each school. According to this theory, educational achievement may be a function of the locale and other factors. Refer to equation 4, where \( \Pi = \text{educational achievement} \), \( \Gamma = \text{type of locale} \), and \( \varepsilon = \text{other factors} \).

\[
\Pi = f(\Gamma, \varepsilon)
\]
In figure 3.3.2, each locale contains one school district and the homogeneity pockets (represented by the smaller areas) in the urban locale are school attendance areas. In this scenario, urban locales are creating a homogeneous experience for students within the context of a large, heterogeneous jurisdiction. In rural areas, there are usually few schools and the school attendance area sometimes encompasses the entire district. While heterogeneity in the urban area as a whole is expected to be greater than that in the rural area, it is less clear how to compare the subdivisions within the urban area to that of the rural area.

In addition to a different population mix and sorting preferences, urban and rural locales have opposing economic benefits. Larger jurisdictions have lower per capita costs of public goods, larger markets, and decreased costs of “uninsurable shocks” than smaller jurisdictions. However, it is harder for larger jurisdictions to reach allocative efficiency of heterogeneous populations (Alesina and Spolaore, 2003). There is a trade-off between heterogeneity and size of a locale. By definition, urban areas have more citizens, which allows for economies of scale, but the public goods are provided to the median voter. The increased heterogeneity increases the challenge of satisfying every citizen’s demand for public goods.

### 3.4 Social Capital Theory

Social capital is the interaction or relations among actors (Putnam 1993, Portes 1998, Coleman 1988, Woolcock 1998). There are two main interpretations, or applications, of social capital. Coleman interprets social capital at the individual level as trust between participants. He focuses on the role of social capital in the creation of human capital, norms, and social control. “Social capital is defined by its function. It is not a single entity but a variety of different entities, with two elements in common: they all consist of some aspect of social structures, and they facilitate certain actions of actors – whether persons or corporate actors – within the
structure,” (Coleman 1988, p.598). According to him, social capital includes 1) obligations, expectations, and trustworthiness, 2) information channels, and 3) norms and effective sanctions. It is inferred that the higher the social capital, the more important the actors are to one another or the greater the influence the actors have on one another. Putnam’s definition of social capital focuses on communities and civic trust. “Social capital... refers to features of social organization, such as trust, norms, and networks, that can improve the efficiency of society by facilitating coordinated actions,” (Putnam 1993, p.167). It is generated through the interaction of individuals in a variety of social settings, and may come from church attendance, bowling leagues, social clubs, and other forms of civic engagement. While Coleman’s definition of social capital is cited the most frequently in education literature (Dika and Singh 2002), I refer to both Coleman and Putnam’s definitions because of the nature of this study. I discuss social capital at an individual level to explain the impact of student’s interactions with one another on educational attainment, and I describe social capital at the community level to rationalize locale impact on student achievement.

For purposes of this study, interpersonal social capital is discussed in terms of childhood social capital research. Coleman (1988) examined children and impacts of living in a single parent household or dual working parent household and found that high school students’ tendency to drop out of school was influenced by the level of social capital, particularly in areas with a tight-knit family and community. Morrow (1999) warns that childhood social capital might be downplayed in United States literature and might reflect adult-centered perspectives instead of how children shape their own environments. More recent authors have found explanatory relationships with social capital and childhood outcomes. Adolescent participation in school activities is positively correlated with educational outcomes (Feldmanand Matjasko 2005, Fredricks and Eccles 2006, Gilman, Meyers, and Perez 2004, Holland and Andre 1987,
Mahoney et al. 2005, Vandell, Pierce, and Dadisman 2005), and higher standardized test scores and grades (Cooper, Valentine, Nye, and Lindsay 1999, Jordan and Nettles 2000, Regnerus and Elder 2003).

Some authors predict that peer behavior is positively correlated with juveniles’ actions (Coleman 1990, Crane 1991, G. Becker 1996, and Durlauf 1997). According to the literature, educational attainment is a function of social capital in a locale and other factors. Refer to the following equation, where $\Pi = \text{educational achievement}, \Theta = \text{social capital}, \text{and } \varepsilon = \text{other factors}$.

\[
(5) \quad \Pi = f(\Theta, \varepsilon)
\]

The discussion of social capital at the community level includes crime rates and communities with closed boundaries. Conventional wisdom suggests that social ties are stronger in rural areas as observed by lower criminal activity. Nonmetropolitan counties have the lowest reported violent crime rates and metropolitan statistical areas have the highest, with suburban rates in the middle. Reported property crime rates are highest in suburban areas, with cities as a close second and rural a distant third (United States Census 2009). Onyx and Bullen (2000) found that rural communities have higher levels of feelings of trust and safety, participation in the local community, and neighborhood connections than urban communities, and rural areas have overall stronger levels of social capital. Where there is high social capital, crime is low and there is little need for law enforcement (Coleman 1998 and Putnam 1995).

Similar scholars suggest that closed communities with strong boundaries and identity are likely to have higher social capital (Coleman 1988, Etzioni 1996, and Portes 1998). Often, the longer a person lives in an area, the greater the attachment they have to their community.
Glaeser (2009) explains that people who expect to live in an area for an extended period of time tend to invest more in social capital, while persons who expect to leave an area invest little in social capital. Low levels of social capital then increase a citizen’s chance to leave by making a locale less desirable. Those that do not socially fit in the community tend to leave (Boissevain 1974).

In nonmetropolitan areas, people usually know each other longer and are more likely related (Beggs et al. 1996). Many rural residents prefer staying close to family than relocating for a higher paying job (DeYoung 1995, Seal and Harmon 1995). Because of isolation and fewer public services, rural areas require family cooperation and stronger family ties than urban families (Coward and Rathbone-McGuan 1985, Lee et al. 1994). Plausibly, social capital is a function of the population homogeneity in a locale and other factors. Equation 6 outlines this notion, where \( \Theta = \text{social capital}, K = \text{population homogeneity}, \) and \( \varepsilon = \text{other factors}. \)

\[
\Theta = f(K, \varepsilon)
\]

Some authors disagree with these findings because closed communities do not have all elements of social capital. They often lack acceptance of differing cultures and lack diversity of population. Rural areas are less racially diverse than metropolitan areas (Fuguitt et al. 1989). While rural areas might have stronger ties, people in inner city areas are likely more accepting of others who are unlike themselves. Cox (1995) argues that a completely civil society require social trust and acceptance. Onyx and Bullen (2000) detected a small but significant connection with civil society and tolerance of differences. They found that inner city areas had higher levels
social capital and tolerance of diversity. Authors argue that greater diversity and population size provide additional resources for citizens and are positively related to social capital (Bø 1996, Borgotti, Jones, and Everett 1998, Lin 1999).

3.5 Combination of Theories

Peer effects are difficult to measure because of their unique properties. They are hard to quantify because of their abstract nature. Scholars have attempted various strategies of measurement that are often discredited by other authors in the field. The empirical models are controversial due to different definition of a student’s peer, classification of disadvantaged students, endogeneity in the model from student or family choice of peers, reverse causal relationships between students and peers, and data limitations.

For this analysis, a student’s ability is not defined as advantaged or disadvantaged but rather classified based on his or her test scores. I define a student’s peers as other students in their classroom. Literature states that peers have an effect on student performance, but most literature has been examined in urban locales, and econometric practices vary greatly. Thus, this analysis examines the extent to which peer ability impacts performance by degree of rurality of locales.

Although, there is not a clear consensus on the proper model (see Hanushek 1979, 1981 and Becker 1983 for reviews of the educational production function literature), I will begin the explanation of my model with the following modified standard education production function established by Zimmer and Toma (2000). Educational achievement is a function of student ability, family and school inputs, and peers, where \( \Pi = \) educational achievement, \( I = \) school and family inputs, \( p = \) proportion of more able students, and \( \alpha = \) ability. Inputs include teacher, school, district, and parental characteristics. The proportion of more able students variable
refers to peer ability characteristics. Student’s characteristics are influenced by past and present attainment, peer and teacher interactions, and current classroom atmosphere (Linnenbrink and Pintrich 2002, Maehr and Midgley 1996).

\[ \Pi = f(I, \rho, \alpha) \]  

According to the literature and theories in this chapter there are additional explanatory variables that can explain student achievement such as peer effects, type of locale, and social capital. This is shown by combining equations (1), (4), and (5) into one unified equation as follows, where \( \Pi = \) educational achievement, \( P = \) peer effects, \( \Gamma = \) locale variable, \( \Theta = \) social capital, and \( \varepsilon = \) other factors.

\[ \Pi = f(P, \Gamma, \Theta, \varepsilon) \]  

To better understand each of these variables and their relationship with population homogeneity (variable \( K \)), I compare equations (2), (3), and (6).

\[ P = f(K, \varepsilon) \]  

\[ K = f(\Gamma, \varepsilon) \]
According to the theory, peer effects, type of locale, and social capital can all be partially explained by population homogeneity of a community. It is unlikely that all three variables can simply be replaced with the population composition variable because it may only explain a fraction of these variables, and will not encompass other characteristics of peer effects, size or type of locale, and social capital. However, it is likely that homogeneity can add to the explanation of educational attainment, but may or may not be included into an equation because of collinearity with the other variables. Peer effects, locale, and social capital may be correlated with one another, but this can only be proven or disproven through further empirical research.

The theory in this chapter and from peer effects literature explains that there are multiple possible variables that can explain student achievement. They include student ability, school and family inputs, peer effects, type of locale, and locale social capital. Combining equation (7) and (8) yields the equation that will be used in the following chapter, where \( \Omega = \) student standardized test score, \( \beta = \) student inputs, \( \gamma = \) teacher characteristics, \( \Theta = \) social capital, \( \Gamma = \) locale variable, \( \delta = \) classroom composition, \( i = \) individual, and \( t = \) time.

\[
\Omega_{it} = f(\beta_{it}, \gamma_{it}, \theta_i, \Gamma_i, \delta_{it})
\]
This theory explains the possible causes of peer effect strength and provides a better predictive model of both rural and urban peer effects. I argue that some level of heterogeneity and high social capital foster strong peer effects, and there is a tradeoff between diverse student body composition and social capital. Education researchers have typically included effects of classroom or school peers on student outcomes. I expect these to be different in rural schools because of population sorting. More homogeneity leads to smaller effects. But community effects (which are not typically included) may work in the opposite direction. Literature suggests that homogeneity from sorting would lead to higher social capital in rural areas.

Theoretically, it is difficult to determine whether peer effects are higher in rural areas or in urban areas because the theories of different disciplines at times contradict one another as to the direction of the strength of peer effects. Overall, metropolitan cities are more diverse than rural communities; however, homogeneity might be similar in rural and urban schools because of urban sorting into smaller communities and schools. No known empirical studies have examined student body composition with a locale context. It is unknown which locale type is more homogeneous at the school level, but this theory suggests that student body composition might be similar. Authors suggest that social capital is greater in a rural context or in areas with closed boundaries (Coleman 1988, Etzioni 1996, Portes 1998, and Onyx and Bullen 2000). This provides a rural advantage for stronger peer effects. If all other characteristics are relatively equal, measured peer effects should be greater in rural areas than urban areas. Whether the sorting of urban areas offset these advantages can only be determined empirically.

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Chapter 4

Empirical Analysis: Verification of Model

4.1 Introduction

This chapter is guided by three specific goals. The first goal is to establish an empirical model and define variables in relation to the sample population. To accomplish this, I explore whether peer effects, type of locale, and social capital are correlated. Theoretically, all three variables may be correlated with homogeneity. It is expected that social capital is correlated with rurality, but peer ability is not correlated with either variable. The rural citizens face additional challenges to social capital. They may not have the fiscal resources or infrastructure necessary for higher levels of social capital. While peer ability may be statistically different by locale type, individuals are unique and their ability is determined by other factors than just the type of locale. The second goal is to describe the data used in the analyses of this chapter and in the subsequent chapters in this dissertation. The last goal is to examine if peers and social capital influence student achievement. Based on literature and theory, it is expected that both variables will be related to and predict student achievement.

4.2 Model

According to the theory in the last chapter, there are other possible variables that can explain student achievement. Adding social capital and locale type variables to the standard education production function yields the following equation, where $\Omega = \text{student standardized test score}$, $\beta = \text{student inputs}$, $\gamma = \text{teacher characteristics}$, $\Theta = \text{social capital}$, $\Gamma = \text{locale type variable}$, $\delta = \text{classroom composition}$, $i = \text{individual}$, and $t = \text{time}$.
The data is from Kentucky elementary and middle schools. Student inputs include previous test scores, free and reduced price lunch status (FRP), and ethnicity. A student’s prior score is a measure of their characteristics and ability. A student’s knowledge and inspirations build from a sequence of good teaching. Last year’s education should have an effect that should not go away. The data set does not include family characteristics, but this might partially be controlled for with the student’s lagged test score, free and reduced price lunch status, and ethnicity.

Teacher inputs include years of experience and the highest degree the teacher earned.\textsuperscript{23} The social capital variable is a measure created by Rupasingha and Goetz (2008) and is defined as a “...collective manifestation of individual behaviors, attitudes, and values of individual members of a community,” (Rupasingha, Goetz, and Freshwater 2006, p85). They measure social capital by civic trust, associational (both political and social) activity, and density at a local level. This analysis will use their 2005 social capital variables by county. Their variable was quantified through association participation, the percentage of voters who voted in presidential elections, response rate to the census, and the number of non-profit organizations. While not all school districts in the data are county wide, all but 1 district are, and this measure will likely reflect the social capital of a locale within the county. There is no known measure of social capital in Kentucky schools.

\textsuperscript{2} The highest degree the teacher earned is numerically provided on a scale of 1 to 7. See Appendix A for an index code and a tabulation of the teacher education level.

\textsuperscript{3} The data includes teacher salary, but salary schedule is a function of experience and highest degree earned.
Social capital varies by region of the United States. Using this measure, Rupasingha, Goetz, and Freshwater (2006) found the southeast has the lowest levels of social capital, the northeast has the highest, and rural areas are positively correlated with social capital. In this sample from the southeast, social capital is relatively low and cities have higher social capital than rural areas. The low levels of social capital were expected, and the negative rural correlation may be a regional effect. The citizens in this sample face additional challenges to social capital. The rural counties are among the poorest areas in America and they may not have the fiscal resources or infrastructure necessary for higher levels of social capital.

The locale type variable is a series of dummy variables based on a classification by the National Center of Educational Statistics (NCES). Refer to Table 2.1.1. for a sample of locale definitions. The NCES classification is determined by size and proximity to a principal city. It provides a more precise measurement of locale type and may reflect other socioeconomic factors such as accessibility to jobs, infrastructure, and shopping districts. This classification system is consistent with educational statistics.

A student’s test score can possibly be influenced by their peers’ current scores. Peers’ scores might account for the classrooms characteristics and ability. Classroom composition includes class size and the mean, standard deviation, and skewness of other students test scores in the classroom to see the impact the students have had on each other that year. The mean measures the average composition of the classroom, the standard deviation refers to the homogeneity of the class, and the skewness suggests student outliers in the classroom. Skewness is not often examined in this area of research; however, it is used in financial literature to determine investment risk and is applicable to this study.

The classroom variables exclude the data of the student being analyzed. The student is not a peer to himself or herself. Including the student in these variables would impact the true
values of a student’s peer group. The impact would be greater in small classrooms than large classrooms. Because students at various grade levels might be impacted differently by peers, the analysis was segmented into two different groups: elementary and middle school students. Elementary school students are defined as in grades 3 through 5 and middle school students are in grades 6 through 8.

4.3 Data

To examine the possible relationship between classroom peers and student achievement by locale, I use individual student-teacher level observations from nine Kentucky school districts for the school years 2000-2001 through 2007-2008. I examine math classes in elementary and middle schools in rural, town, suburb, and urban locales. Most of the districts sampled for the study are small, rural districts typically with a single high school but multiple elementary schools. Because Kentucky lacked a system that allowed students to be matched to their teachers over this time period, roster data were obtained directly from the school districts which are located in central and eastern Kentucky. The roster data include the school year, the name and section of the math course, the teacher for that section, and all students enrolled in that section. The ability to match students to teachers varied by district over the sample period as some districts retained data for longer periods. The resulting data set is a

4 Because of limited statistical ability, these values were calculated using multiple equations. See appendix C for calculations.
5 Grades 1 and 2 did not take either standardized tests.
6 This project is supported by the National Science Foundation under grant number DUE-0830716.
7 Science and Reading data exist, but were dropped due to sample size.
8 Classes were classified as either strictly one subject or comprehensive. If the course had a math component, it was included in the analysis.
9 High school roosters exist, but were dropped due to non-consecutive testing.
10 Kentucky has traditionally had small, county-based school districts with additional districts for the county seats (typically the largest town) in many cases. 8 of the 9 districts in this sample are county-based.
mixed panel. The roster files were then matched to several state-level administrative data bases.\textsuperscript{11} Included in these data bases are student characteristics and testing data, teacher characteristics and credentials, as well as school level data. The matched data set includes observations of each student who tested in math in a given year for which we can identify the teacher who taught his or her math class.

Standardized math tests (known as Kentucky Core Content Tests) are administered annually in all schools in Kentucky but not at all grade levels each year. From the 2000-2001 to the 2005-2006 school years, the state tested math in grades 5, 8, and 11. Nationally standardized tests (the CTBS) were also administered to students in grades 3, 6, and 9 over the same years. Beginning in 2006-2007, state math testing was instituted annually in grades 3-8 and retained for 11th graders as well. Because I use the student’s prior test score as an explanatory variable, this testing schema limits the numbers of years in which I can observe student achievement changes. See Table 4.3.1 for Kentucky’s testing schedule.

Table 4.3.1 Kentucky Test Schedule

<table>
<thead>
<tr>
<th>Grade</th>
<th>Math</th>
</tr>
</thead>
<tbody>
<tr>
<td>4\textsuperscript{th} Grade</td>
<td>CATS (2007 – 2008)</td>
</tr>
<tr>
<td>5\textsuperscript{th} Grade</td>
<td>CATS (2001 – 2008)</td>
</tr>
<tr>
<td>7\textsuperscript{th} Grade</td>
<td>CATS (2007 – 2008)</td>
</tr>
<tr>
<td>8\textsuperscript{th} Grade</td>
<td>CATS (2001 – 2008)</td>
</tr>
<tr>
<td>9\textsuperscript{th} Grade</td>
<td>CTBS (2001 – 2006)</td>
</tr>
<tr>
<td>10\textsuperscript{th} Grade</td>
<td></td>
</tr>
<tr>
<td>11\textsuperscript{th} Grade</td>
<td>CATS (2001 – 2008)</td>
</tr>
</tbody>
</table>

\textsuperscript{11} Kentucky only recently began using common identifiers for students and teachers. Much of the matching required name and birth date or other person-specific characteristics.
Like many states, the scaling of the tests also changed over the time period examined here. The change in the state’s test in 2007 was such that the scale of score in years prior cannot reliably be reconciled with those of 2007 and onward.\(^\text{12}\) In addition, each grade level test involves scores with different scales. A 500 on a math test of a 5\(^{\text{th}}\) grader was not designed to be equivalent to a 500 on the math test of an 8\(^{\text{th}}\) grader. This means that grade levels must be examined separately for evaluation purposes. Given the changing scale of the test score data over the time period we observe and the multiple exams (state and national), I convert raw scores to z-scores. Z-scores are a non-linear transformation and are frequently used for standardizing student test score data across multiple exams and scaling changes.

The Kentucky Education Professional Standards Board (EPSB) provided teacher-level data that begin in the 2000–2001 school year and continue until 2007–2008. The available teacher-level data are quite comprehensive, but I limit the data to teacher experience and highest degree achieved. All other characteristics of the teachers, such as Praxis scores, gender, and race, are time invariant and are captured in the teacher fixed effects model used later in this chapter and in subsequent chapters. Table 4.3.2 provides descriptive statistics for the students, teachers, and schools for the 9 districts.

\(^{12}\) This conclusion has been affirmed by officials of the KDE.
**Table 4.3.2 Descriptive Statistics for All Grade Levels**

<table>
<thead>
<tr>
<th></th>
<th>Obs.</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Student Characteristics:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student Z-score</td>
<td>110047</td>
<td>0.02</td>
<td>1.00</td>
<td>-20.87</td>
<td>6.57</td>
</tr>
<tr>
<td>Student Lag Z-score</td>
<td>77739</td>
<td>0.003</td>
<td>0.98</td>
<td>-6.42</td>
<td>5.29</td>
</tr>
<tr>
<td>Female</td>
<td>110047</td>
<td>0.49</td>
<td>0.43</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Missing Gender</td>
<td>110047</td>
<td>0.25</td>
<td>0.44</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>FRP Recipient</td>
<td>110047</td>
<td>0.50</td>
<td>0.50</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Missing FRP</td>
<td>110047</td>
<td>0.02</td>
<td>0.14</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>African American</td>
<td>109944</td>
<td>0.14</td>
<td>0.32</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Hispanic</td>
<td>109944</td>
<td>0.03</td>
<td>0.15</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Asian or Pacific Islander</td>
<td>109944</td>
<td>0.02</td>
<td>0.11</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Native American</td>
<td>109944</td>
<td>0.001</td>
<td>0.03</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Other Non-White</td>
<td>110047</td>
<td>0.01</td>
<td>0.10</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Missing Ethnicity</td>
<td>110047</td>
<td>0.38</td>
<td>0.49</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td><strong>Teacher Characteristics:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teacher Education Level*</td>
<td>110047</td>
<td>3.41</td>
<td>1.12</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>Teacher Years of Experience</td>
<td>110047</td>
<td>10.49</td>
<td>8.56</td>
<td>0</td>
<td>36</td>
</tr>
<tr>
<td><strong>Peer Characteristics:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Classroom Size</td>
<td>110047</td>
<td>21.72</td>
<td>5.39</td>
<td>7</td>
<td>40</td>
</tr>
<tr>
<td>Peer Mean (Z-score)</td>
<td>110047</td>
<td>0.02</td>
<td>0.61</td>
<td>-4.00</td>
<td>3.08</td>
</tr>
<tr>
<td>Peer Std. Dev. (Z-score)</td>
<td>110047</td>
<td>0.76</td>
<td>0.28</td>
<td>0.0004</td>
<td>4.89</td>
</tr>
<tr>
<td>Peer Skewness (Z-score)</td>
<td>109291</td>
<td>-0.19</td>
<td>1.03</td>
<td>-16.50</td>
<td>11.71</td>
</tr>
<tr>
<td>Proportion of High Ability Peers in the Classroom</td>
<td>110047</td>
<td>0.20</td>
<td>0.22</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Proportion of Low Ability Peers in the Classroom</td>
<td>110047</td>
<td>0.17</td>
<td>0.18</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td><strong>District Characteristics:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social Capital</td>
<td>110047</td>
<td>-0.71</td>
<td>0.81</td>
<td>-2.25</td>
<td>-0.004</td>
</tr>
<tr>
<td>Rural</td>
<td>110047</td>
<td>0.36</td>
<td>0.48</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Town</td>
<td>110047</td>
<td>0.08</td>
<td>0.27</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Suburb</td>
<td>110047</td>
<td>0.02</td>
<td>0.14</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Urban</td>
<td>110047</td>
<td>0.55</td>
<td>0.50</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Proportion of High Ability Students in the District</td>
<td>110047</td>
<td>0.20</td>
<td>0.04</td>
<td>0.11</td>
<td>0.24</td>
</tr>
<tr>
<td>Proportion of Low Ability Students in the District</td>
<td>110047</td>
<td>0.18</td>
<td>0.01</td>
<td>0.15</td>
<td>0.23</td>
</tr>
</tbody>
</table>

*Degree Level is given in increments of 1 where BA is 1, 5th year is 2, planned 6th year program is 3, MA is 4, Rank I is 5, specialist is 6, and Ph.D. is 7.

The statistics look reasonable. The current and lagged individual z-score means are not 0.00 because z-scores were assigned to the entire dataset regardless of class size. Because the
standardized test scores had to be converted to z-scores, it is impossible to compare average test scores from year to year. It is unknown if the average test score increased or decreased over the years. In this sample, the average teacher has been teaching for over 10 years and over 73% of teachers have a master’s degree. The average classroom has a standard deviation of 0.76 and a skewness of -0.19 and the ranges of these two variables are sizeable. This leads me to conclude that these classrooms are not homogeneous. The social capital variables in this sample are negative because the values were standardized across the country.

While there is no known class size limitation in the state of Kentucky, there is a student to teacher ratio used for funding. Statute KRS 157.360 provides funding for teachers based on the ratios; however, a school may waive the max class size at any time (Kentucky Department of Education 2012). The average class size for the data used is under 22 students, which is low for state class average funding guideline especially considering class sizes with less than seven students with lag scores were dropped. However, these class sizes are based on the number of observations of a student taking a test in a class. Roster data was captured at the beginning of the year and students that did not test were dropped. There may be more students in the classroom that either did not take a standardized test that year (grade levels in math classrooms may be mixed) or the test score was not reported in this data. On the other hand, the class average is high for the district class average. See Table 4.3.3 for a description of the average class sizes in each district in the analysis. The math classes in the sample appear to have higher class size averages than other subjects.

---

13 See appendix A for a tabulation of the teacher education level in the data.
14 Special Education classrooms were not included in the analysis.
15 See Appendix B for teacher student ratios in statute KRS 157.6360.
Table 4.3.3 Average Class Sizes

<table>
<thead>
<tr>
<th>District</th>
<th>NCES Locale Classification</th>
<th>Student to Teacher Ratio¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kentucky1</td>
<td>Rural</td>
<td>15.2</td>
</tr>
<tr>
<td>Kentucky2</td>
<td>Rural</td>
<td>13.6</td>
</tr>
<tr>
<td>Kentucky3</td>
<td>Urban</td>
<td>13.4</td>
</tr>
<tr>
<td>Kentucky4</td>
<td>Town</td>
<td>14.2</td>
</tr>
<tr>
<td>Kentucky5</td>
<td>Town</td>
<td>13.8</td>
</tr>
<tr>
<td>Kentucky6</td>
<td>Rural</td>
<td>14.2</td>
</tr>
<tr>
<td>Kentucky7</td>
<td>Rural</td>
<td>12.4</td>
</tr>
<tr>
<td>Kentucky8</td>
<td>Rural</td>
<td>15.6</td>
</tr>
<tr>
<td>Kentucky9</td>
<td>Suburb</td>
<td>16.1</td>
</tr>
</tbody>
</table>

¹ Source: Legislative Research Commission 2010

Small classes were dropped for a variety of reasons. Moments are needed to calculate mean, standard deviation, and skewness. The standard error of the variance needs the fourth moment and the standard error of the skewness needs the sixth moment (Stuart and Ord 1987). Thus, a classroom needs a class size of five to calculate variance and a class size of seven to calculate skewness correctly. Classrooms with less than seven students were not included. A two sample t-test with unequal variances showed that there was a significant difference in the test scores of students in small classes and students in all other class sizes. Additionally, there was a significant difference in the mean test scores of small classrooms and the mean classroom test scores of all other classroom sizes. See Table 4.3.4. It is possible that these classrooms contain special education students and independent study courses. These observations were dropped.
### Table 4.3.4 Two-Sample T-Test with Unequal Variances for Classrooms with Fewer than 7 Test Scores

<table>
<thead>
<tr>
<th></th>
<th>Individuals</th>
<th></th>
<th>Class Averages</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Obs.</td>
<td>Mean</td>
<td>Std. Dev.</td>
<td>Obs.</td>
</tr>
<tr>
<td>Non-Small Classroom</td>
<td>110582</td>
<td>0.02</td>
<td>1.00</td>
<td>110582</td>
</tr>
<tr>
<td>Small Classroom</td>
<td>3046</td>
<td>-0.87</td>
<td>1.36</td>
<td>3046</td>
</tr>
<tr>
<td>t</td>
<td>35.70</td>
<td></td>
<td>41.42</td>
<td></td>
</tr>
<tr>
<td>df</td>
<td>3135.42</td>
<td></td>
<td>3090.2</td>
<td></td>
</tr>
<tr>
<td>p</td>
<td>&lt;0.001</td>
<td></td>
<td>&lt;0.001</td>
<td></td>
</tr>
</tbody>
</table>

The data included math class sizes of up to 86 students. This is approximately 6 times the average class size in these districts (see Table 4.3.3) and 2 to 3 times greater than the student to teacher funding ratio.\(^{16}^{17}\) It is possible that a large number of students can be in the same class together with the limitation of the physical size of a classroom. Large classrooms of 40 or more students are not likely reasonable to be in the same room at the same time.

Because of roster data limitations, it is likely that these large classrooms are actually two different sections of a class with the same teacher. Two sample t-test with unequal variances showed that there was a significant difference in the test scores of students in these classes and students in all other classroom sizes. See Table 4.3.5. There was a significant difference in the mean test scores of these classrooms and the mean test scores of all other classrooms. Because it is unlikely there was a classroom that could hold that large of a number of students and these classrooms are statistically different, these observations were not used in the analysis. For this analysis, I used approximately 77,000 observations of a student taking a standardized test with a known teacher and classmates in 9 districts and 103 schools. Over 32,000 observations were dropped because of a missing lag test score.

\(^{16}\) See Appendix B for teacher student ratios in statute KRS 157.360.
\(^{17}\) The average class size was determined by the Kentucky Legislative Research Commission. The student to teacher funding ratio provides a funding paradigm for teachers; however, a school may waive the max class size at any time.
Table 4.3.5 Two –Sample T-Test with Unequal Variances for Classrooms with Greater than 40 Test Scores

<table>
<thead>
<tr>
<th></th>
<th>Individuals</th>
<th></th>
<th>Class Averages</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Obs.</td>
<td>Mean</td>
<td>Std. Dev.</td>
<td>Obs.</td>
</tr>
<tr>
<td>Non-Large Classroom</td>
<td>113093</td>
<td>-0.01</td>
<td>1.02</td>
<td>113093</td>
</tr>
<tr>
<td>Large Classroom</td>
<td>535</td>
<td>0.20</td>
<td>0.98</td>
<td>535</td>
</tr>
<tr>
<td>t</td>
<td>-5.00</td>
<td></td>
<td></td>
<td>-14.07</td>
</tr>
<tr>
<td>df</td>
<td>539.48</td>
<td></td>
<td></td>
<td>551.94</td>
</tr>
<tr>
<td>p</td>
<td>&lt;0.001</td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

For multiple counties, there was missing data for student gender (approximately 28,000 observations), ethnicity (approximately 42,000 observations), and free and reduced priced lunch status (approximately 2,000 observations). None of these variables are the focus of this analysis. The number of missing ethnicity data appears large, but the only racially diverse district contained student ethnicity data. The districts with missing ethnicity data are racially homogeneous. The missing dummy variables were replaced with school level data for ethnicity and free and reduced price lunch status. Gender was replaced with the average in the known sample population. To control for the substitute, dummy variables for missing data were included.

There is possible endogeneity in the model when examining urban schools because parents often choose the neighborhood in which to locate and, subsequently, which school their child attends. However, parents have limited knowledge of each school. While school mean scores can be obtained by parents, classroom mean cannot. Standard deviation and skewness of classrooms are not observable or readily attained by parents. In a rural locale the endogeneity of parental school choice and student peer choice are expected to present smaller problems than in an urban locale for the following reasons. First, there is not a high degree of competition among schools in rural areas. In many of these areas, there are only a handful of
primary schools and one or two secondary schools. Second, the geographic area from which rural schools collect students is considerably larger than in urban schools so specific neighborhood selection is expected to have a small impact on school attended. Last, rural school districts have fewer students than urban districts creating a smaller number of peers for a student from which to choose. For these reasons, this analysis is different than what is in the current literature. Endogeneity exists, but it should be largely an urban issue. A difference in the results may be attributable to real peer effects or to the fact that urban locales have a possible endogeneity issue.

This research strengthens the existing literature through the inclusion and quantification of locales with different population densities, and additional measurements of student composition in each classroom. The inclusion of these variables allows for a rural and urban comparison of peer effects. Because peer effects, size of locale, and social capital can all be partially explained by population homogeneity of a community, I correlated all of the variables to see if they correlate in the expected ways and to check for possible multicollinearity. See Table 4.3.6.
### Table 4.3.6 Pairwise Correlation Matrix

<table>
<thead>
<tr>
<th></th>
<th>Z-score</th>
<th>Lag</th>
<th>Female Student</th>
<th>FRP Student</th>
<th>African American Student</th>
<th>Hispanic Student</th>
<th>Asian Student</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z-score</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lag</td>
<td>0.69 ***</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female Student</td>
<td>0.02 ***</td>
<td>0.02 ***</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FRP Student</td>
<td>-0.31 ***</td>
<td>-0.31 ***</td>
<td>0.01 **</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>African American Student</td>
<td>-0.18 ***</td>
<td>-0.17 ***</td>
<td>0.01 ***</td>
<td>0.14 ***</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hispanic Student</td>
<td>-0.07 ***</td>
<td>-0.07 ***</td>
<td>-0.004</td>
<td>0.10 ***</td>
<td>-0.03 ***</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>Asian Student</td>
<td>0.11 ***</td>
<td>0.09 ***</td>
<td>-0.001</td>
<td>-0.09 ***</td>
<td>-0.05 ***</td>
<td>-0.02 ***</td>
<td>1.00</td>
</tr>
<tr>
<td>Native American Student</td>
<td>-0.01 ***</td>
<td>-0.01</td>
<td>-0.005</td>
<td>0.01 ***</td>
<td>-0.01 ***</td>
<td>-0.01 **</td>
<td>-0.004</td>
</tr>
<tr>
<td>Other Non-White Student</td>
<td>0.01 *</td>
<td>0.002</td>
<td>-0.003</td>
<td>-0.01 *</td>
<td>-0.04 ***</td>
<td>-0.02 ***</td>
<td>-0.01 ***</td>
</tr>
<tr>
<td>Teach. Education Level</td>
<td>0.04 ***</td>
<td>0.03 ***</td>
<td>-0.003</td>
<td>-0.02 ***</td>
<td>-0.07 ***</td>
<td>-0.03 ***</td>
<td>0.01 ***</td>
</tr>
<tr>
<td>Teacher Experience</td>
<td>0.08 ***</td>
<td>0.08 ***</td>
<td>0.004</td>
<td>-0.05 ***</td>
<td>-0.12 ***</td>
<td>-0.05 ***</td>
<td>0.03 ***</td>
</tr>
<tr>
<td>Class Size</td>
<td>0.13 ***</td>
<td>0.13 ***</td>
<td>0.02 ***</td>
<td>-0.13 ***</td>
<td>-0.03 ***</td>
<td>0.01 *</td>
<td>0.03 ***</td>
</tr>
<tr>
<td>Peer Mean (Z-score)</td>
<td>0.56 ***</td>
<td>0.49 ***</td>
<td>0.02 ***</td>
<td>-0.31 ***</td>
<td>-0.17 ***</td>
<td>-0.08 ***</td>
<td>0.15 ***</td>
</tr>
<tr>
<td>Peer Std. Dev. (Z-score)</td>
<td>-0.10 ***</td>
<td>-0.11 ***</td>
<td>-0.01 ***</td>
<td>0.11 ***</td>
<td>-0.02 ***</td>
<td>0.01 ***</td>
<td>-0.03 ***</td>
</tr>
<tr>
<td>Peer Skew. (Z-score)</td>
<td>-0.14 ***</td>
<td>-0.09 ***</td>
<td>0.0004</td>
<td>0.01 ***</td>
<td>-0.04 ***</td>
<td>-0.02 ***</td>
<td>-0.01 *</td>
</tr>
<tr>
<td>City Dummy</td>
<td>0.07 ***</td>
<td>0.05 ***</td>
<td>0.002</td>
<td>-0.23 ***</td>
<td>0.38 ***</td>
<td>0.18 ***</td>
<td>0.12 ***</td>
</tr>
<tr>
<td>Suburb Dummy</td>
<td>0.02 ***</td>
<td>0.04 ***</td>
<td>-0.0002</td>
<td>-0.06 ***</td>
<td>-0.06 ***</td>
<td>-0.03 ***</td>
<td>-0.01 ***</td>
</tr>
<tr>
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<td>-0.04 ***</td>
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<td>0.04 ***</td>
<td>-0.10 ***</td>
<td>-0.04 ***</td>
<td>-0.04 ***</td>
</tr>
<tr>
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<td>-0.05 ***</td>
<td>-0.04 ***</td>
<td>-0.002</td>
<td>0.25 ***</td>
<td>-0.32 ***</td>
<td>-0.16 ***</td>
<td>-0.10 ***</td>
</tr>
<tr>
<td>Social Capital</td>
<td>0.08 ***</td>
<td>0.07 ***</td>
<td>0.002</td>
<td>-0.25 ***</td>
<td>0.36 ***</td>
<td>0.18 ***</td>
<td>0.12 ***</td>
</tr>
</tbody>
</table>

* significant at the 0.10 level  ** significant at the 0.05 level  *** significant at the 0.01 level
## Table 4.3.6 Pairwise Correlation Matrix (continued)

<table>
<thead>
<tr>
<th></th>
<th>Native American Student</th>
<th>Other Non-White Student</th>
<th>Teacher Educatio Level</th>
<th>Teacher Experience</th>
<th>Class Size</th>
<th>Peer Mean (Z-score)</th>
<th>Peer Std. Dev. (Z-score)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z-score</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lag</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Z-score</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female Student</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FRP Student</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>African American Student</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hispanic Student</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asian Student</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Native American Student</td>
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</tr>
<tr>
<td>Other</td>
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<td></td>
</tr>
<tr>
<td>Non-White Student</td>
<td>-0.004</td>
<td>-0.01 ***</td>
<td>1.00</td>
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<td></td>
</tr>
<tr>
<td>Teach. Education Level</td>
<td>-0.004</td>
<td>-0.01 ***</td>
<td>0.18 ***</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teacher Experience</td>
<td>-0.004</td>
<td>-0.01 ***</td>
<td>0.18 ***</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class Size</td>
<td>-0.001</td>
<td>0.02 ***</td>
<td>-0.01 ***</td>
<td>-0.003</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peer Mean (Z-score)</td>
<td>-0.01 ***</td>
<td>0.01 ***</td>
<td>0.07 ***</td>
<td>0.14 ***</td>
<td>0.21 ***</td>
<td>1.00</td>
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</tr>
<tr>
<td>Peer Std. Dev. (Z-score)</td>
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<td>-0.01 *</td>
<td>-0.03 ***</td>
<td>0.01 ***</td>
<td>-0.07 ***</td>
<td>-0.23 ***</td>
<td>1.00</td>
</tr>
<tr>
<td>Peer Skew. (Z-score)</td>
<td>-0.01 *</td>
<td>&lt;0.001</td>
<td>0.01 ***</td>
<td>0.02 ***</td>
<td>-0.02 ***</td>
<td>0.11 ***</td>
<td>-0.13 ***</td>
</tr>
<tr>
<td>City Dummy</td>
<td>0.02 ***</td>
<td>0.09 ***</td>
<td>-0.07 ***</td>
<td>-0.11 ***</td>
<td>0.13 ***</td>
<td>0.12 ***</td>
<td>-0.13 ***</td>
</tr>
<tr>
<td>Suburb Dummy</td>
<td>-0.01 *</td>
<td>-0.01</td>
<td>0.06 ***</td>
<td>0.11 ***</td>
<td>-0.01 ***</td>
<td>0.03 ***</td>
<td>-0.02 ***</td>
</tr>
<tr>
<td>Town Dummy</td>
<td>-0.002</td>
<td>-0.03 ***</td>
<td>-0.01 **</td>
<td>0.04 ***</td>
<td>-0.06 ***</td>
<td>-0.11 ***</td>
<td>-0.04 ***</td>
</tr>
<tr>
<td>Rural Dummy</td>
<td>-0.01 ***</td>
<td>-0.07 ***</td>
<td>0.06 ***</td>
<td>0.06 ***</td>
<td>-0.10 ***</td>
<td>-0.07 ***</td>
<td>0.16 ***</td>
</tr>
<tr>
<td>Social Capital</td>
<td>0.01 ***</td>
<td>0.08 ***</td>
<td>-0.06 ***</td>
<td>-0.10 ***</td>
<td>0.12 ***</td>
<td>0.14 ***</td>
<td>-0.13 ***</td>
</tr>
</tbody>
</table>

* significant at the 0.10 level  ** significant at the 0.05 level  *** significant at the 0.01 level
<table>
<thead>
<tr>
<th></th>
<th>Peer Skew (Z-score)</th>
<th>City Dummy</th>
<th>Suburb Dummy</th>
<th>Town Dummy</th>
<th>Rural Dummy</th>
<th>Social Capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z-score</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lag Z-score</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female Student</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FRP Student</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>African American Student</td>
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<td></td>
<td></td>
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<tr>
<td>Hispanic Student</td>
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<td></td>
</tr>
<tr>
<td>Asian Student</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Native American Student</td>
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<td></td>
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</tr>
<tr>
<td>Other</td>
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<tr>
<td>Non-White Student</td>
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</tr>
<tr>
<td>Teach. Education Level</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
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<td>Teacher Experience</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Class Size</td>
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<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Peer Mean (Z-score)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Peer Std. Dev. (Z-score)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Peer Skew. (Z-score)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>City Dummy</td>
<td>-0.06 ***</td>
<td>1.00</td>
<td></td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suburb Dummy</td>
<td>0.004</td>
<td>-0.15 ***</td>
<td>-0.04 ***</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Town Dummy</td>
<td>0.01 ***</td>
<td>-0.32 ***</td>
<td>-0.04 ***</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural Dummy</td>
<td>0.05 ***</td>
<td>-0.82 ***</td>
<td>-0.10 ***</td>
<td>-0.22 ***</td>
<td>1.00</td>
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</tr>
<tr>
<td>Social Capital</td>
<td>-0.06 ***</td>
<td>0.96 ***</td>
<td>-0.02 ***</td>
<td>-0.35 ***</td>
<td>-0.80 ***</td>
<td>1.00</td>
</tr>
</tbody>
</table>

* significant at the 0.10 level  ** significant at the 0.05 level  *** significant at the 0.01 level
In this sample, social capital is highly correlated with the city and rural variables. Suburb and town variables are not highly correlated but behave in the same direction as rural. Even though both cities and suburbs are classified as UA by the census, the social capital varies if the UA is a principle city or located outside a principle city. Thus, the NCES labels are more robust.

The high correlation between the social capital and locale type variables alters the equation slightly, where \( \Omega = \) student standardized test score, \( \beta = \) student inputs, \( \gamma = \) teacher characteristics, \( \Theta = \) social capital, \( \delta = \) classroom composition, \( i = \) individual, and \( t = \) time.

\[
\Omega_{it} = f(\beta_{it}, \gamma_{it}, \Theta_t, \delta_{it})
\]

4.4 Analysis and Results

For my analysis, I first ran an OLS regression with student current test score as the dependent variable to gain insight into factors influencing student test scores. Second, I ran an OLS regression with teacher fixed effects and teacher between effects. I used the same dependent and independent variables and included teacher effects to account for other characteristics of teachers that could be affecting student performance. Table 4.4.1 and Table 4.4.2 present the results.
### Table 4.4.1 Regression Analysis Predicting Student Achievement

<table>
<thead>
<tr>
<th></th>
<th>Elementary School</th>
<th>Middle School</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Student Characteristics:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student Lag Z-score</td>
<td>0.49 ***</td>
<td>0.52 ***</td>
</tr>
<tr>
<td>Female</td>
<td>0.07 ***</td>
<td>0.02 **</td>
</tr>
<tr>
<td>Missing Gender</td>
<td>0.13 ***</td>
<td>-0.004</td>
</tr>
<tr>
<td>FRP Recipient</td>
<td>-0.15 ***</td>
<td>-0.09 ***</td>
</tr>
<tr>
<td>Missing FRP</td>
<td>-0.03 ***</td>
<td>-0.07 ***</td>
</tr>
<tr>
<td>African American</td>
<td>-0.09 ***</td>
<td>-0.10 ***</td>
</tr>
<tr>
<td>Hispanic</td>
<td>0.07 *</td>
<td>0.03</td>
</tr>
<tr>
<td>Asian</td>
<td>0.03</td>
<td>0.11 ***</td>
</tr>
<tr>
<td>Native American</td>
<td>-0.05</td>
<td>-0.003</td>
</tr>
<tr>
<td>Other Non-White</td>
<td>-0.08</td>
<td>0.02</td>
</tr>
<tr>
<td>Missing Ethnicity</td>
<td>-0.11 ***</td>
<td>-0.02 ***</td>
</tr>
<tr>
<td><strong>Teacher Characteristics:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teacher Education Level</td>
<td>0.02 ***</td>
<td>-0.004</td>
</tr>
<tr>
<td>Teacher Years of Experience</td>
<td>-0.01 ***</td>
<td>-0.001</td>
</tr>
<tr>
<td>Teacher Years of Experience$^2$</td>
<td>0.0002 **</td>
<td>0.00005</td>
</tr>
<tr>
<td><strong>Peer Characteristics:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Classroom Size</td>
<td>-0.01 ***</td>
<td>-0.0001</td>
</tr>
<tr>
<td>Peer Mean (Z-score)</td>
<td>0.48 ***</td>
<td>0.48 ***</td>
</tr>
<tr>
<td>Peer Std. Dev. (Z-score)</td>
<td>0.11 ***</td>
<td>-0.02 **</td>
</tr>
<tr>
<td>Peer Skewness (Z-score)</td>
<td>-0.17 ***</td>
<td>-0.13 ***</td>
</tr>
<tr>
<td><strong>District Characteristics:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social Capital</td>
<td>0.2 **</td>
<td>-0.02 ***</td>
</tr>
<tr>
<td><strong>N</strong></td>
<td>21888</td>
<td>55311</td>
</tr>
<tr>
<td>R-Squared</td>
<td>0.51</td>
<td>0.59</td>
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</tbody>
</table>

Note: Coefficients with robust standard errors in parentheses are presented in the table.

*significant at the 0.10 level  ** significant at the 0.05 level  *** significant at the 0.01 level
Table 4.4.2 Predicted Student Achievement with Teacher Between Effects and Teacher Fixed Effects\textsuperscript{18}

<table>
<thead>
<tr>
<th></th>
<th>Elementary School</th>
<th>Middle School</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Teacher Between</td>
<td>Teacher Fixed</td>
</tr>
<tr>
<td></td>
<td>Effects</td>
<td>Effects</td>
</tr>
<tr>
<td>Lag Z-score</td>
<td>0.37 ***</td>
<td>0.51 ***</td>
</tr>
<tr>
<td>Female</td>
<td>0.15 *</td>
<td>0.06 ***</td>
</tr>
<tr>
<td>Missing Gender</td>
<td>0.13 **</td>
<td>-0.06</td>
</tr>
<tr>
<td>FRP Recipient</td>
<td>-0.06</td>
<td>-0.19 ***</td>
</tr>
<tr>
<td>Missing FRP</td>
<td>-0.03</td>
<td>(omitted)</td>
</tr>
<tr>
<td>African American</td>
<td>0.09</td>
<td>-0.20 ***</td>
</tr>
<tr>
<td>Hispanic</td>
<td>0.18</td>
<td>-0.03</td>
</tr>
<tr>
<td>Asian</td>
<td>-0.03</td>
<td>0.07</td>
</tr>
<tr>
<td>Native American</td>
<td>-1.77</td>
<td>-0.002</td>
</tr>
<tr>
<td>Other Non-White</td>
<td>-0.58</td>
<td>-0.13 **</td>
</tr>
<tr>
<td>Missing Ethnicity</td>
<td>-0.05</td>
<td>-0.18 ***</td>
</tr>
<tr>
<td><strong>Teacher Characteristics:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teacher Education Level</td>
<td>0.01 (omitted)</td>
<td>-0.003</td>
</tr>
<tr>
<td>Teacher Years of Experience</td>
<td>0.005</td>
<td>-0.02 ***</td>
</tr>
<tr>
<td><strong>Peer Characteristics:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Classroom Size</td>
<td>-0.003</td>
<td>-0.002</td>
</tr>
<tr>
<td>Peer Mean (Z-score)</td>
<td>0.60 ***</td>
<td>0.32 ***</td>
</tr>
<tr>
<td>Peer Std. Dev. (Z-score)</td>
<td>-0.03</td>
<td>0.04 *</td>
</tr>
<tr>
<td>Peer Skewness (Z-score)</td>
<td>-0.08 ***</td>
<td>-0.24 ***</td>
</tr>
<tr>
<td><strong>District Characteristics:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social Capital</td>
<td>0.04 (omitted)</td>
<td>-0.03</td>
</tr>
<tr>
<td>N(Groups)</td>
<td>573</td>
<td>573</td>
</tr>
<tr>
<td>F Statistic</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Note: Coefficients with robust standard errors in parentheses are presented in the table.

* significant at the 0.10 level
** significant at the 0.05 level
*** significant at the 0.01 level

The regressions indicate that a student’s own characteristics and the characteristics of their classroom and school district are significant in determining a student’s performance. The teacher’s measured characteristics are only significant in middle school without teacher effects and elementary school with teacher fixed effects. The results show that if a student performed

\textsuperscript{18} Fixed effects are collinear with social capital because teachers rarely move to other school districts in the dataset.
well last year, he/she is likely to perform well this year holding other factors constant. African American and FRP recipient students are more likely to perform worse than their counterparts. These results were expected and are often found in the education literature. Females, on average, perform better (except in middle school with teacher between effects). However, the missing gender variable is significant in two of the regressions for elementary school so interpretation is difficult.

Across the grade levels, peer characteristics are correlated with student achievement. Peers may influence student academic performance. The results show that if the class average test score was high at the end of the current year, the average student was positively influenced. Increasing class average by 1 z-score increases student performance by 0.48 z-score. That is almost the same magnitude as the influence of the student’s prior test score (0.49 in elementary school and 0.51 in middle school). The significance levels of the effects of classroom average and skewness on a student does not change with the inclusion of teacher between and fixed effects. With teacher between effects, the coefficient for middle school peer mean is quite large at 0.89. Increasing a classrooms average z-score by 1 nearly increases a student’s performance by the same amount.

The impact of the class skewness on a student is significantly negative for all instances. The results show that if the test scores of a class are positively skewed, the average student performs worse. If the test scores of a class are negatively skewed, the average student performs better. Skewed classes might signify either a very small number of exceptionally well performing or poor performing students in a class. The magnitude of the classroom skewness variable is quite smaller than the magnitude of the classroom average variable. The skewness coefficient is smaller and the range is larger. There does not appear to be a large difference in peer effect magnitude by grade level for either of these measures.
Because of contradictory coefficient signs, it is hard to interpret class variance influence on student performance. In elementary school, these variables are significant and positively related with and without teacher effects and with teacher fixed effects. They are significant and negatively related with teacher between effects. In middle school, with and without teacher effects, class variance and student performance were significant and negative. Large variances in classroom achievement were positively associated with student achievement in elementary school and negatively associated with student performance in middle school.

Social capital’s influence on student achievement varies by grade level. In elementary school, students performed better in locales with greater social capital. However, in middle school, the opposite is true. Students perform better with lower levels of social capital. Increasing a locale’s social capital value by 1 (which is half of the range in this sample) increases an elementary school student’s performance by 0.2 z-score and decreases a middle school student’s performance by 0.02 z-score. The influence of social capital on student achievement by grade level does not change with the inclusion of teacher between effects. It only removes the statistical significance.

This chapter was guided by two specific goals. The first goal was to determine if peer effects, type of locale, and social capital are correlated. This analysis found that the social capital and locale dummy variables were correlated. The second goal was to examine if peers and social capital influence student achievement. Based on the findings in this analysis, it appears that student achievement is impacted by peers with and without teacher effects and social capital without teacher effects.
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Chapter 5
Empirical Analysis: Peer Effects by Locale

5.1 Introduction

The purpose of this chapter is to compare peer effects in rural, town, suburb, and urban locales. Previous literature examined the influence of peers on student achievement using data exclusively from urban locales. These studies provided little to no information about peer effects in other types of locations. While this analysis is limited to a narrow scope of the country, it is one of the first examinations of differences in peer effects in different types of locales. Rural and urban areas vary on population size, homogeneity, sorting, and social capital; therefore, it is incorrect to assume peers have the same level of influence.

To answer this question, I ran a series of tests using the data from the prior chapter. First, I correlated locale variables with student and teacher characteristic variables to provide an insight to locale differences. Second, I examined each locale separately. This data does not have balanced observations for locales; thus, running the regressions separately eliminates locales from driving data and allowed me to examine each locale. See Table 5.1.1. Then, I interacted locale and classroom characteristic variables to examine peer effect differences by locale. Last, I interacted social capital and classroom characteristic variables to examine social capital’s influence on peer effects. It is important to note that locale variables and social capital variables were never used in the same regression because there is a high correlation of the variables.
Table 5.1.1 Total Students and Number of Schools in Data by District Locale

<table>
<thead>
<tr>
<th>District Locale</th>
<th>Total Students</th>
<th>Primary Schools</th>
<th>Middle Schools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural</td>
<td>16,428</td>
<td>32</td>
<td>13</td>
</tr>
<tr>
<td>Town</td>
<td>4,163</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Suburb</td>
<td>1,015</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Urban</td>
<td>30,050</td>
<td>36</td>
<td>12</td>
</tr>
</tbody>
</table>

5.2 Peer Effects by Locale

First, I correlated locale type variables with student and teacher characteristic variables to provide an insight to locale differences. See Table 5.2.1. The correlations between standardized test scores and locale decline as the locale density decreases. This shows that the higher population density in an area, the more likely a student performs well in this sample. Similar correlations are present with class size, and the inverse is occurring with FRP recipients. The correlation coefficients between class size and locale decline as the locale density decreases. Large class sizes are associated with urban areas and it appears that rural areas have the smallest class sizes. This is consistent with Streams et al. (2011). In the analysis, rural areas have the highest and urban areas have the lowest proportions of FRP students. There is a 0.25 correlation between a rural observation and an FRP recipient and a -0.23 correlation between an urban observation and an FRP recipient. Based on the ethnicity variables, it appears diversity is only associated with an urban locale. Finally, teachers with the most experience and greatest education level are found in suburb and rural areas.
Table 5.2.1 Pairwise Correlation Matrix for All School Levels

<table>
<thead>
<tr>
<th></th>
<th>Math Test Score</th>
<th>FRP</th>
<th>Black</th>
<th>Hispanic</th>
<th>Asian</th>
<th>Class Size</th>
<th>Teacher Ed. Level</th>
<th>Teacher Years of Exp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban</td>
<td>0.07***</td>
<td>-0.23***</td>
<td>0.38***</td>
<td>0.18***</td>
<td>0.12***</td>
<td>0.13***</td>
<td>-0.07***</td>
<td>-0.11***</td>
</tr>
<tr>
<td>Suburb</td>
<td>0.02***</td>
<td>-0.06***</td>
<td>-0.06***</td>
<td>-0.03***</td>
<td>-0.01***</td>
<td>-0.01***</td>
<td>0.06***</td>
<td>0.11***</td>
</tr>
<tr>
<td>Town</td>
<td>-0.07***</td>
<td>0.02***</td>
<td>-0.10***</td>
<td>-0.04***</td>
<td>-0.04***</td>
<td>-0.06***</td>
<td>-0.01***</td>
<td>0.04***</td>
</tr>
<tr>
<td>Rural</td>
<td>-0.05***</td>
<td>0.25***</td>
<td>-0.32***</td>
<td>-0.16***</td>
<td>-0.10***</td>
<td>-0.10***</td>
<td>0.06***</td>
<td>0.06***</td>
</tr>
</tbody>
</table>

* significant at the 0.10 level  
** significant at the 0.05 level  
*** significant at the 0.01 level

Second, I examined each locale separately. I ran an OLS regression with student current test score as the dependent variable. This gave me an overall understanding of what was impacting student test scores by locale. Then, I ran an OLS regression with teacher fixed effects. I used the same dependent and independent variables and included teacher fixed effects to account for other characteristics of teachers that could be affecting student performance. For this analysis, I am particularly interested in locale impact on peer influence. See Table 5.2.4 and Table 5.2.5 for a comparison of peer effect results by locale.

---

19 Teacher fixed effects could be used because neither social capital nor locale variables were used in the regression.
Table 5.2.2 Peer Impact on Student Performance by Locale\(^\text{20}\)

<table>
<thead>
<tr>
<th>Student Z-score</th>
<th>Urban</th>
<th>Suburb</th>
<th>Town</th>
<th>Rural</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Elementary Classrooms</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peer Mean (Z-score)</td>
<td>0.41</td>
<td>0.64</td>
<td>0.32</td>
<td>0.50</td>
</tr>
<tr>
<td>Peer Std. Dev. (Z-score)</td>
<td>0.29</td>
<td>0.23</td>
<td>0.11</td>
<td>-0.13</td>
</tr>
<tr>
<td>Peer Skewness (Z-score)</td>
<td>-0.11</td>
<td>-0.31</td>
<td>-0.25</td>
<td>-0.26</td>
</tr>
<tr>
<td><strong>Middle Classrooms</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peer Mean (Z-score)</td>
<td>0.47</td>
<td>0.44</td>
<td>0.53</td>
<td>0.51</td>
</tr>
<tr>
<td>Peer Std. Dev. (Z-score)</td>
<td>0.01</td>
<td>-0.12</td>
<td>-0.04</td>
<td>-0.10</td>
</tr>
<tr>
<td>Peer Skewness (Z-score)</td>
<td>-0.11</td>
<td>-0.16</td>
<td>-0.20</td>
<td>-0.14</td>
</tr>
</tbody>
</table>

* significant at the 0.10 level  
** significant at the 0.05 level  
*** significant at the 0.01 level

Table 5.2.3 Peer Impact on Student Performance by Locale with Teacher Fixed Effects\(^\text{21}\)

<table>
<thead>
<tr>
<th>Student Z-score</th>
<th>Urban</th>
<th>Suburb</th>
<th>Town</th>
<th>Rural</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Elementary Classrooms</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peer Mean (Z-score)</td>
<td>0.31</td>
<td>0.76</td>
<td>0.12</td>
<td>0.29</td>
</tr>
<tr>
<td>Peer Std. Dev. (Z-score)</td>
<td>0.23</td>
<td>0.32</td>
<td>0.28</td>
<td>-0.15</td>
</tr>
<tr>
<td>Peer Skewness (Z-score)</td>
<td>-0.17</td>
<td>-0.49</td>
<td>-0.31</td>
<td>-0.32</td>
</tr>
<tr>
<td><strong>Middle Classrooms</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peer Mean (Z-score)</td>
<td>0.43</td>
<td>0.43</td>
<td>0.45</td>
<td>0.40</td>
</tr>
<tr>
<td>Peer Std. Dev. (Z-score)</td>
<td>0.03</td>
<td>-0.13</td>
<td>-0.03</td>
<td>-0.13</td>
</tr>
<tr>
<td>Peer Skewness (Z-score)</td>
<td>-0.13</td>
<td>-0.15</td>
<td>-0.20</td>
<td>-0.17</td>
</tr>
</tbody>
</table>

* significant at the 0.10 level  
** significant at the 0.05 level  
*** significant at the 0.01 level

In the both sets of regressions I found that characteristics of a student’s classroom are significant in determining their test performance. Like the analysis in the last chapter, there was a statistically significant and positive correlation of the average class test score and student performance in all locales. In elementary school, the coefficient for suburb locale peer mean is

\(^{20}\) See Appendix E for complete regression analyses.  
\(^{21}\) See Appendix F for complete regression analyses
notably larger than the coefficient of the town locale. Rural and urban peer effects are similar and are in between town and suburb in magnitude. In middle school, peer effects appear to be more similar by locale. Increasing the average class z-score by 1 increases the average elementary school student’s z-score by 0.32 to 0.64 and the average middle school student’s z-score by 0.44 to 0.53. In a suburb elementary school, the classroom mean peer effect has a greater magnitude than the student’s prior test score. In elementary school, the influences of the classroom average on a student performance move to the extremes with the inclusion of teacher fixed effects. The suburb coefficient increases and the town coefficient decreases.

The influence of the skewness of the class on a student’s performance is significantly negative for all instances. The magnitude of the skewness variable is the greatest in suburb locales in elementary school and town locales in middle school. Because of a lack of statistical significance, it appears that class variance does not have an influence on student performance in suburb and town locales. In urban locales, standard deviation is positively associated with student achievement and statistically significant in elementary school (with and without teacher effects). In rural locales, it is statistically significant and negative for all instances. These results are consistent with the results in this chapter and prior chapters.

5.3 Peer Effects with Locale Interaction Terms

I interacted locale and classroom characteristic variables to examine if peer effect strength is different by locale. I ran an OLS regression with student current test score as the dependent variable with and without teacher fixed effects and teacher between effects. See Table 5.3.1 and Table 5.3.2 for results.

---

22 Fixed effects are collinear with locale because teachers rarely move to other school districts in the dataset.
Table 5.3.1 Regression Analysis Predicting Student Achievement

<table>
<thead>
<tr>
<th></th>
<th>Elementary School</th>
<th>Middle School</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Student Characteristics:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student Lag Z-score</td>
<td>0.49 ***</td>
<td>0.52 ***</td>
</tr>
<tr>
<td>Female</td>
<td>0.06 ***</td>
<td>0.02 **</td>
</tr>
<tr>
<td>Missing Gender</td>
<td>0.13 ***</td>
<td>-0.01</td>
</tr>
<tr>
<td>FRP Recipient</td>
<td>-0.15 ***</td>
<td>-0.09 ***</td>
</tr>
<tr>
<td>Missing FRP (omitted)</td>
<td></td>
<td>-0.01</td>
</tr>
<tr>
<td>African American</td>
<td>-0.13 ***</td>
<td>-0.10 ***</td>
</tr>
<tr>
<td>Hispanic</td>
<td>0.04</td>
<td>0.02</td>
</tr>
<tr>
<td>Asian</td>
<td>0.05</td>
<td>0.12 ***</td>
</tr>
<tr>
<td>Native American</td>
<td>-0.04</td>
<td>-0.01</td>
</tr>
<tr>
<td>Other Non-White</td>
<td>-0.10 *</td>
<td>0.03</td>
</tr>
<tr>
<td>Missing Ethnicity</td>
<td>-0.09 ***</td>
<td>-0.002</td>
</tr>
<tr>
<td><strong>Teacher Characteristics:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teacher Education Level</td>
<td>0.02 ***</td>
<td>-0.004 *</td>
</tr>
<tr>
<td>Teacher Years of Experience</td>
<td>-0.01 ***</td>
<td>-0.001</td>
</tr>
<tr>
<td>Teacher Years of Experience$^2$</td>
<td>0.00001 *</td>
<td>0.00001</td>
</tr>
<tr>
<td><strong>Peer Characteristics:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Classroom Size</td>
<td>-0.01 ***</td>
<td>0.00002</td>
</tr>
<tr>
<td>Peer Mean (Z-score)</td>
<td>0.45 ***</td>
<td>0.46 ***</td>
</tr>
<tr>
<td>Peer Std. Dev. (Z-score)</td>
<td>0.15 ***</td>
<td>-0.01</td>
</tr>
<tr>
<td>Peer Skewness (Z-score)</td>
<td>-0.10 ***</td>
<td>-0.11 ***</td>
</tr>
<tr>
<td><strong>District Characteristics:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural</td>
<td>-0.01</td>
<td>0.09 ***</td>
</tr>
<tr>
<td>Town</td>
<td>-0.05 *</td>
<td>0.02</td>
</tr>
<tr>
<td>Suburb</td>
<td>-0.11</td>
<td>(omitted)</td>
</tr>
<tr>
<td><strong>Interaction Terms:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural $^\times$ Class Mean</td>
<td>0.0004</td>
<td>0.06 ***</td>
</tr>
<tr>
<td>Rural $^\times$ Class Std. Dev.</td>
<td>-0.15 ***</td>
<td>-0.06 ***</td>
</tr>
<tr>
<td>Rural $^\times$ Class Skewness</td>
<td>-0.13 ***</td>
<td>-0.04 ***</td>
</tr>
<tr>
<td>Town $^\times$ Class Mean</td>
<td>0.17 ***</td>
<td>0.05 ***</td>
</tr>
<tr>
<td>Town $^\times$ Class Std. Dev.</td>
<td>-0.04</td>
<td>-0.07 ***</td>
</tr>
<tr>
<td>Town $^\times$ Class Skewness</td>
<td>-0.09 ***</td>
<td>-0.04 ***</td>
</tr>
<tr>
<td>Suburb $^\times$ Class Mean</td>
<td>0.27 ***</td>
<td>-0.01</td>
</tr>
<tr>
<td>Suburb $^\times$ Class Std. Dev.</td>
<td>-0.06</td>
<td>-0.09</td>
</tr>
<tr>
<td>Suburb $^\times$ Class Skewness</td>
<td>-0.09 **</td>
<td>-0.03</td>
</tr>
<tr>
<td>N</td>
<td>21888</td>
<td>55311</td>
</tr>
<tr>
<td>R-Squared</td>
<td>0.51</td>
<td>0.59</td>
</tr>
</tbody>
</table>

Note: Coefficients with robust standard errors in parentheses are presented in the table.
* significant at the 0.10 level
** significant at the 0.05 level
*** significant at the 0.01 level
### Table 5.3.2 Predicted Student Achievement with Teacher Between Effects and Teacher Fixed Effects

<table>
<thead>
<tr>
<th></th>
<th>Elementary School</th>
<th>Middle School</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Teacher Between Effects</td>
<td>Teacher Fixed Effects</td>
</tr>
<tr>
<td><strong>Student Characteristics:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lag Z-score</td>
<td>0.37 ***</td>
<td>0.51 ***</td>
</tr>
<tr>
<td>Female</td>
<td>0.16 *</td>
<td>0.06 ***</td>
</tr>
<tr>
<td>Missing Gender</td>
<td>0.14 **</td>
<td>-0.01</td>
</tr>
<tr>
<td>FRP Recipient</td>
<td>-0.06</td>
<td>-0.19 ***</td>
</tr>
<tr>
<td>Missing FRP</td>
<td>-0.08</td>
<td>(omitted)</td>
</tr>
<tr>
<td>African American</td>
<td>0.03</td>
<td>-0.20 ***</td>
</tr>
<tr>
<td>Hispanic</td>
<td>0.21</td>
<td>-0.04</td>
</tr>
<tr>
<td>Asian</td>
<td>0.08</td>
<td>0.08</td>
</tr>
<tr>
<td>Native American</td>
<td>-1.69</td>
<td>0.002</td>
</tr>
<tr>
<td>Other Non-White</td>
<td>-0.63</td>
<td>-0.13 **</td>
</tr>
<tr>
<td>Missing Ethnicity</td>
<td>-0.07</td>
<td>-0.16 ***</td>
</tr>
<tr>
<td><strong>Teacher Characteristics:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education Level</td>
<td>0.01</td>
<td>(omitted)</td>
</tr>
<tr>
<td>Years of Experience</td>
<td>0.01</td>
<td>-0.02 **</td>
</tr>
<tr>
<td>Years of Experience²</td>
<td>-0.0002</td>
<td>0.0002</td>
</tr>
<tr>
<td><strong>Peer Characteristics:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Classroom Size</td>
<td>-0.003</td>
<td>-0.002</td>
</tr>
<tr>
<td>Peer Mean (Z-score)</td>
<td>0.56 ***</td>
<td>0.34 ***</td>
</tr>
<tr>
<td>Peer Std. Dev. (Z-score)</td>
<td>0.01</td>
<td>0.17 ***</td>
</tr>
<tr>
<td>Peer Skewness (Z-score)</td>
<td>-0.06</td>
<td>*</td>
</tr>
<tr>
<td><strong>District Characteristics:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural</td>
<td>-0.02</td>
<td>(omitted)</td>
</tr>
<tr>
<td>Town</td>
<td>0.01</td>
<td>(omitted)</td>
</tr>
<tr>
<td>Suburb</td>
<td>(omitted)</td>
<td>(omitted)</td>
</tr>
<tr>
<td><strong>Interaction Terms:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural × Peer Mean</td>
<td>0.01</td>
<td>-0.08 **</td>
</tr>
<tr>
<td>Rural × Peer Std. Dev.</td>
<td>-0.12</td>
<td>-0.26 ***</td>
</tr>
<tr>
<td>Rural × Peer Skewness</td>
<td>-0.07</td>
<td>-0.13 ***</td>
</tr>
<tr>
<td>Town × Peer Mean</td>
<td>0.10</td>
<td>-0.09</td>
</tr>
<tr>
<td>Town × Peer Std. Dev.</td>
<td>-0.09</td>
<td>-0.07</td>
</tr>
<tr>
<td>Town × Peer Skewness</td>
<td>-0.01</td>
<td>-0.04 *</td>
</tr>
<tr>
<td>Suburb × Peer Mean</td>
<td>0.29</td>
<td>0.26 **</td>
</tr>
<tr>
<td>Suburb × Peer Std. Dev.</td>
<td>0.005</td>
<td>-0.11</td>
</tr>
<tr>
<td>Suburb × Peer Skewness</td>
<td>0.17</td>
<td>-0.11 **</td>
</tr>
<tr>
<td>N(Groups)</td>
<td>21888</td>
<td>21888</td>
</tr>
<tr>
<td>F Statistic</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Note: Coefficients with robust standard errors in parentheses are presented in the table.
* significant at the 0.10 level ** significant at the 0.05 level *** significant at the 0.01 level
In these regressions student and classroom characteristics, and the interaction terms significantly influence a student’s performance. Student prior test scores and female gender (except with the inclusion of between effects in middle school) are positively associated with student achievement. However, like the analysis in the prior chapter, gender is difficult to interpret because the missing gender variable is significant in half of the regressions and it varies in direction. Free and reduced priced lunch recipients and African American students are negatively associated with student performance in all regressions, but the variables are not statistically significant with the inclusion of between effects. For African American students, the variable is no longer significant and the correlation switches to positive.

Teacher effects are hard to interpret because they vary in direction and significance between the regressions. Teacher education level is positively associated with student performance in elementary school and negatively associated with student performance in middle school. When either teacher between or fixed effects are included, most of the teacher characteristics become insignificant. The expected difference between the teachers and the unchanged characteristics of teachers eliminates the possible impact these variable have on students achievement.

These OLS regressions are consistent with the central thesis of this dissertation - peer effects are different by locale. In this sample, suburbs have the greatest peer effects. It is challenging to interpret the other locales (including the reference locale – urban) because of the different levels of significance. Unlike the previous analyses, the current class average score has a confounding effect on a student’s current test score. Without teacher effects, the class average by locale is positively associated with student achievement (except the statistically insignificant interaction with suburb in middle school). With the inclusion of teacher effects the signs are equally positive and negative and only half are statistically significant. With teacher
between effects, the coefficient for middle school peer mean, across all locales, is quite large at 0.91. This is consistent with the results in Chapter 4. While not always statistically significant, classroom standard deviation and skewness are negative (except in a few instances). For skewness, this is consistent with the results of the previous analyses in Chapter 4. The results show that if the test scores of a class are skewed, the average student performs worse. Standard deviation had mixed results in the prior chapter.

5.4 Peer Effects with Social Capital Interaction Terms

For the last test, I interacted social capital and classroom characteristic variables to examine peer effect differences by level of social capital. I ran an OLS regression with student current test score as the dependent variable with and without teacher fixed and between effects. See Table 5.4.1 and Table 5.4.2 for results.
### Table 5.4.1 Regression Analysis Predicting Student Achievement

<table>
<thead>
<tr>
<th></th>
<th>Elementary School</th>
<th>Middle School</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Student Characteristics:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student Lag Z-score</td>
<td>0.49 ***</td>
<td>0.52 ***</td>
</tr>
<tr>
<td>Female</td>
<td>0.06 ***</td>
<td>0.02 **</td>
</tr>
<tr>
<td>Missing Gender</td>
<td>0.09 ***</td>
<td>-0.003</td>
</tr>
<tr>
<td>FRP Recipient</td>
<td>-0.16 ***</td>
<td>-0.09 ***</td>
</tr>
<tr>
<td>Missing FRP</td>
<td>-0.04</td>
<td>-0.09 ***</td>
</tr>
<tr>
<td>African American</td>
<td>-0.11 ***</td>
<td>-0.11 ***</td>
</tr>
<tr>
<td>Hispanic</td>
<td>0.05</td>
<td>0.02</td>
</tr>
<tr>
<td>Asian</td>
<td>0.08</td>
<td>0.12 ***</td>
</tr>
<tr>
<td>Native American</td>
<td>-0.03</td>
<td>-0.005</td>
</tr>
<tr>
<td>Other Non-White</td>
<td>-0.08</td>
<td>0.02</td>
</tr>
<tr>
<td>Missing Ethnicity</td>
<td>-0.07 ***</td>
<td>-0.02 **</td>
</tr>
<tr>
<td><strong>Teacher Characteristics:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teacher Education Level</td>
<td>0.02 ***</td>
<td>-0.004 *</td>
</tr>
<tr>
<td>Teacher Years of Experience</td>
<td>-0.01 ***</td>
<td>-0.001</td>
</tr>
<tr>
<td>Teacher Years of Experience$^2$</td>
<td>0.0002 ***</td>
<td>0.00005</td>
</tr>
<tr>
<td><strong>Peer Characteristics:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Classroom Size</td>
<td>-0.01 ***</td>
<td>0.0001</td>
</tr>
<tr>
<td>Peer Mean (Z-score)</td>
<td>0.46 ***</td>
<td>0.46 ***</td>
</tr>
<tr>
<td>Peer Std. Dev. (Z-score)</td>
<td>0.28 ***</td>
<td>0.01</td>
</tr>
<tr>
<td>Peer Skewness (Z-score)</td>
<td>-0.11 ***</td>
<td>-0.11 ***</td>
</tr>
<tr>
<td><strong>District Characteristics:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social Capital</td>
<td>-0.15 ***</td>
<td>-0.06 ***</td>
</tr>
<tr>
<td><strong>Interaction Terms:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social Cap. $^\times$ Peer Mean</td>
<td>-0.02</td>
<td>-0.05 ***</td>
</tr>
<tr>
<td>Social Cap. $^\times$ Peer Std. Dev.</td>
<td>0.23 ***</td>
<td>0.05 ***</td>
</tr>
<tr>
<td>Social Cap. $^\times$ Peer Skewness</td>
<td>0.08 ***</td>
<td>0.02 ***</td>
</tr>
<tr>
<td><strong>N</strong></td>
<td>21888</td>
<td>55311</td>
</tr>
<tr>
<td><strong>R-Squared</strong></td>
<td>0.51</td>
<td>0.59</td>
</tr>
</tbody>
</table>

Note: Coefficients with robust standard errors in parentheses are presented in the table.

* significant at the 0.10 level
** significant at the 0.05 level
*** significant at the 0.01 level
Table 5.4.2 Predicted Student Achievement with Teacher Between Effects and Teacher Fixed Effects

<table>
<thead>
<tr>
<th></th>
<th>Elementary School</th>
<th></th>
<th>Middle School</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Teacher Between</td>
<td>Teacher Fixed</td>
<td>Teacher</td>
<td>Teacher Fixed</td>
</tr>
<tr>
<td></td>
<td>Effects</td>
<td>Effects</td>
<td>Between</td>
<td>Effects</td>
</tr>
<tr>
<td>Lag Z-score</td>
<td>0.38 ***</td>
<td>0.50 ***</td>
<td>0.15 ***</td>
<td>0.54 ***</td>
</tr>
<tr>
<td>Female</td>
<td>0.15 *</td>
<td>0.06 ***</td>
<td>-0.24 ***</td>
<td>0.02 ***</td>
</tr>
<tr>
<td>Missing Gender</td>
<td>0.13 **</td>
<td>0.04</td>
<td>-0.02</td>
<td>-0.36 **</td>
</tr>
<tr>
<td>FRP Recipient</td>
<td>-0.10</td>
<td>-0.18 ***</td>
<td>-0.09</td>
<td>-0.10 ***</td>
</tr>
<tr>
<td>Missing FRP</td>
<td>-0.05</td>
<td>(omitted)</td>
<td>0.01</td>
<td>(omitted)</td>
</tr>
<tr>
<td>African American</td>
<td>0.10</td>
<td>-0.20 ***</td>
<td>0.10</td>
<td>-0.11 ***</td>
</tr>
<tr>
<td>Hispanic</td>
<td>0.18</td>
<td>-0.04</td>
<td>0.17</td>
<td>0.001</td>
</tr>
<tr>
<td>Asian</td>
<td>0.21</td>
<td>0.08</td>
<td>-0.54</td>
<td>0.14 ***</td>
</tr>
<tr>
<td>Native American</td>
<td>-1.49</td>
<td>-0.01</td>
<td>-0.04</td>
<td>0.01</td>
</tr>
<tr>
<td>Other Non-White</td>
<td>-0.53</td>
<td>-0.13 **</td>
<td>-0.18</td>
<td>0.03</td>
</tr>
<tr>
<td>Missing Ethnicity</td>
<td>-0.04</td>
<td>-0.14 ***</td>
<td>-0.003</td>
<td>-0.02</td>
</tr>
</tbody>
</table>

**Student Characteristics:**

**Teacher Characteristics:**

- Education Level: 0.01 (omitted) -0.003 (omitted)
- Years of Experience: 0.004 -0.03 *** 0.001 0.004
- Years of Experience²: -0.001 0.0003 -0.001 -0.0001

**Peer Characteristics:**

- Classroom Size: -0.004 -0.001 -0.001 0.0002
- Peer Mean (Z-score): 0.56 *** 0.34 *** 0.90 *** 0.42 ***
- Peer Std. Dev. (Z-score): 0.10 0.24 *** -0.10 0.02
- Peer Skewness (Z-score): -0.06 ** -0.18 *** -0.004 -0.13 ***

**District Characteristics:**

- Social Capital: -0.15 (omitted) -0.05 (omitted)

**Interaction Terms:**

- Social Cap. x Peer Mean: -0.02 0.03 0.03 0.002
- Social Cap. x Peer Std. Dev.: 0.23 ** 0.23 *** 0.03 0.08 ***
- Social Cap. x Peer Skewness: 0.3 0.08 *** 0.06 *** 0.03 ***

N(Groups): 573 573 422 422
F Statistic: <0.001 <0.001 <0.001 <0.001

Note: Coefficients with robust standard errors in parentheses are presented in the table.

* significant at the 0.10 level
** significant at the 0.05 level
*** significant at the 0.01 level

The statistical significance of social capital on peer effect strength is diminished with the inclusion of teacher effects. Social capital has a negative influence on class mean peer effect strength without teacher effects. Social capital interactions with standard deviation and
skewness are positively associated with student achievement. Both of these results are opposite to the peer effects results in the prior analyses. According to this analysis, social capital is switching the coefficient sign. It is negatively associated with peer effects. This is partially consistent with social capital’s influence on student achievement outlines in Chapter 4. In this analysis, social capital is negatively correlated with performance in elementary school and middle school (not just middle school). In this data, higher levels of social capital are associated with higher locale density, but it is difficult to interpret locale impact. Urban should have greater peer effects than rural areas, but suburb and town locales were not correlated with social capital and inferences cannot be made about these two locales.

This chapter was guided by a question: do locales of different population densities and geographic locations have the same peer effect strength? To answer this question, I ran a series of tests. First, I correlated locale variables with student and teacher characteristic variables to provide an insight to locale differences and found that the areas vary greatly on student and teacher characteristics. Second, I interacted locale and classroom characteristic variables to examine peer effect differences by locale and found differences in peer effect strength. Third, I examined each locale separately and found that suburbs might have significantly stronger classroom mean peer effects in elementary school than towns. Skewness influences appear to be the same across grades and locale. Last, I interacted social capital and classroom characteristic variables to examine social capital’s influence on peer effects. In this analysis, social capital has a negative impact on peer influence.

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Chapter 6
Empirical Analysis: High and Low Ability Peers

6.1 Introduction

The purpose of this chapter is to compare peer effects in rural, town, suburb, and urban locales using high and low ability student classifications. High and low ability students are defined as testing in the top and bottom 20th percentiles, respectively. I examine this two ways. First, I use the percentage of high and low ability students in the district as proxies for locale composition. Second, I use the percentage of high and low ability students in the classroom as proxies for peer characteristics.

In the first analysis, I use an OLS regression with student current test score as the dependent variable. I use the same explanatory variables as in the prior chapters including student, teacher, and peer characteristics. This analysis differs in the locale characteristics. Instead of using either social capital or locale dummy variables, I use the percentage of high and low ability students in the locale. I conduct this OLS regression with and without teacher fixed effects and teacher between effects. In the second analysis, I use a similar regression as found in Chapter 5.2. I examine each locale classification separately with and without teacher fixed effects. I use an OLS regression with student current test score as the dependent variable and student, teacher, and peer characteristics as explanatory variables. This differs from Chapter 5.2 because I use the percentage of high and low ability students in the classroom as peer characteristics. In previous chapters, this research discovered a possible impact of class averages and skewness on student achievement, but did not examine peers who perform at the top and bottom fifth. This examination will provide information about the impacts of academically non-average peers.
6.2 Peer Effects by Locale Ability

Chapter 3 explained income, race, educational structure, extracurricular activity, and educational attainment differences in rural, town, suburb, and urban locales. To extend this analysis, I examine both the mean test score and the top and bottom 20th percentiles of test scores in each locale type. See Table 6.2.1 and Figure 6.2.1. High and low ability peer are defined synonymous with Zimmer and Toma (2000). Based on standard z-score definition, the top and bottom 20th percentiles are classified as students who scored above 0.8416 and below -0.8416, respectively. Students are classified in comparison to other observations in the sample. They are not classified on the total population.

Table 6.2.1 Student Mean Test Scores by Locale Type

<table>
<thead>
<tr>
<th></th>
<th>Urban</th>
<th>Suburb</th>
<th>Town</th>
<th>Rural</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Z-score</td>
<td>0.08</td>
<td>0.15</td>
<td>-0.21</td>
<td>-0.04</td>
</tr>
</tbody>
</table>
Table 6.2.1 shows the mean scores in each locale. As expected, suburb has the highest average score followed by urban, rural, and then town. This is consistent with proportion of high and low ability peers shown in Figure 6.2.1. However, Figure 6.2.1 illustrates that the percentage of average ability students does not vary greatly between the locales while the high and low ability proportions are quite different. The distinction in the districts is not only in the mean test score, but in the extremes.

Another way to examine ability by locale type is to measure the correlation of high and low ability with locale and social capital. See Table 6.2.2 for the correlation matrix of high and low achievers with locale dummies and social capital.
Table 6.2.2 Correlation Matrix

<table>
<thead>
<tr>
<th></th>
<th>High Achievers</th>
<th>Low Achievers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social Capital</td>
<td>0.09 ***</td>
<td>-0.04 ***</td>
</tr>
<tr>
<td>Urban</td>
<td>0.08 ***</td>
<td>-0.03 ***</td>
</tr>
<tr>
<td>Suburb</td>
<td>0.02 ***</td>
<td>-0.01 ***</td>
</tr>
<tr>
<td>Town</td>
<td>-0.06 ***</td>
<td>0.04 ***</td>
</tr>
<tr>
<td>Rural</td>
<td>-0.05 ***</td>
<td>0.01 ***</td>
</tr>
</tbody>
</table>

* significant at the 0.10 level
** significant at the 0.05 level
*** significant at the 0.01 level

Town and rural locales are negatively associated with high achievers and positively correlated with low achievers. Urban and suburb locales are the exact opposite. They are positively associated with high achievers and negatively correlated with low achievers. This is consistent with the mean test score as presented in Table 6.2.1. I believe the extremes are skewing the average. Like urban and suburb locales, social capital is positively correlated with high achievers and negatively correlated with low achievers.

Because these districts have different proportions of high and low ability students and this may be a factor in student achievement, I ran a regression analysis using the percentage of high and low achievers in locale as a proxy for type of locale. See Table 6.2.3 and Table 6.2.4.
Table 6.2.3 Regression Analysis Predicting Student Achievement

<table>
<thead>
<tr>
<th></th>
<th>Elementary School</th>
<th>Middle School</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Student Characteristics:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student Lag Z-score</td>
<td>0.51 ***</td>
<td>0.52 ***</td>
</tr>
<tr>
<td>Female</td>
<td>0.06 ***</td>
<td>0.02 **</td>
</tr>
<tr>
<td>Missing Gender</td>
<td>0.16 ***</td>
<td>-0.02</td>
</tr>
<tr>
<td>FRP Recipient</td>
<td>-0.14 ***</td>
<td>-0.09 ***</td>
</tr>
<tr>
<td>Missing FRP</td>
<td>-0.07 *</td>
<td>-0.12 ***</td>
</tr>
<tr>
<td>African American</td>
<td>-0.11 ***</td>
<td>-0.10 ***</td>
</tr>
<tr>
<td>Hispanic</td>
<td>0.04</td>
<td>0.03</td>
</tr>
<tr>
<td>Asian</td>
<td>0.02</td>
<td>0.11 ***</td>
</tr>
<tr>
<td>Native American</td>
<td>-0.06</td>
<td>-0.003</td>
</tr>
<tr>
<td>Other Non-White</td>
<td>-0.10</td>
<td>0.03</td>
</tr>
<tr>
<td>Missing Ethnicity</td>
<td>-0.12 ***</td>
<td>-0.004</td>
</tr>
<tr>
<td><strong>Teacher Characteristics:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teacher Education Level</td>
<td>0.02 ***</td>
<td>-0.003</td>
</tr>
<tr>
<td>Teacher Years of Experience</td>
<td>-0.01 ***</td>
<td>-0.001</td>
</tr>
<tr>
<td>Teacher Years of Experience²</td>
<td>0.0001 **</td>
<td>0.0001 *</td>
</tr>
<tr>
<td><strong>Peer Characteristics:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Classroom Size</td>
<td>-0.01 ***</td>
<td>-0.0001</td>
</tr>
<tr>
<td>Peer Mean (Z-score)</td>
<td>0.48 ***</td>
<td>0.48 ***</td>
</tr>
<tr>
<td>Peer Std. Dev. (Z-score)</td>
<td>0.11 ***</td>
<td>-0.03 ***</td>
</tr>
<tr>
<td>Peer Skewness (Z-score)</td>
<td>-0.17 ***</td>
<td>-0.13 ***</td>
</tr>
<tr>
<td><strong>Locale Characteristics:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage of High Ability Students in Locale Type</td>
<td>1.48 ***</td>
<td>-1.25 ***</td>
</tr>
<tr>
<td>Percentage of Low Ability Students in Locale Type</td>
<td>1.47 **</td>
<td>-2.95 ***</td>
</tr>
</tbody>
</table>

N       | 21888            | 55311         |
R-Squared | 0.51             | 0.59          |

Note: Coefficients with robust standard errors in parentheses are presented in the table.
*significant at the 0.10 level
**significant at the 0.05 level
***significant at the 0.01 level
Table 6.2.4 Predicted Student Achievement with Teacher Between Effects and Teacher Fixed Effects

<table>
<thead>
<tr>
<th>Student Characteristics:</th>
<th>Elementary School</th>
<th>Middle School</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Teacher Between Effects</td>
<td>Teacher Fixed Effects</td>
</tr>
<tr>
<td>Lag Z-score</td>
<td>0.37 ***</td>
<td>0.51 ***</td>
</tr>
<tr>
<td>Female</td>
<td>0.15 *</td>
<td>0.06 ***</td>
</tr>
<tr>
<td>Missing Gender</td>
<td>0.15 **</td>
<td>-0.06</td>
</tr>
<tr>
<td>FRP Recipient</td>
<td>-0.03</td>
<td>-0.19 ***</td>
</tr>
<tr>
<td>Missing FRP</td>
<td>-0.03</td>
<td>(omitted)</td>
</tr>
<tr>
<td>African American</td>
<td>0.05</td>
<td>-0.20 ***</td>
</tr>
<tr>
<td>Hispanic</td>
<td>0.13</td>
<td>-0.03</td>
</tr>
<tr>
<td>Asian</td>
<td>-0.09</td>
<td>0.07</td>
</tr>
<tr>
<td>Native American</td>
<td>-1.82</td>
<td>-0.002</td>
</tr>
<tr>
<td>Other Non-White</td>
<td>-0.67</td>
<td>-0.13 **</td>
</tr>
<tr>
<td>Missing Ethnicity</td>
<td>-0.07</td>
<td>-0.18 ***</td>
</tr>
<tr>
<td>Teacher Characteristics:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Education Level</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td>Years of Experience</td>
<td>0.005</td>
</tr>
<tr>
<td></td>
<td>Years of Experience$^2$</td>
<td>-0.001</td>
</tr>
<tr>
<td>Peer Characteristics:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Classroom Size</td>
<td>-0.004</td>
</tr>
<tr>
<td></td>
<td>Peer Mean (Z-score)</td>
<td>0.59 ***</td>
</tr>
<tr>
<td></td>
<td>Peer Std. Dev. (Z-score)</td>
<td>-0.03</td>
</tr>
<tr>
<td></td>
<td>Peer Skewness (Z-score)</td>
<td>-0.08</td>
</tr>
<tr>
<td>Locale Characteristics:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Percentage of High Ability Students in Locale Type</td>
<td>2.38</td>
</tr>
<tr>
<td></td>
<td>Percentage of Low Ability Students in Locale Type</td>
<td>3.63</td>
</tr>
<tr>
<td>N(Groups)</td>
<td>573</td>
<td>573</td>
</tr>
<tr>
<td>F Statistic</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Note: Coefficients with robust standard errors in parentheses are presented in the table.

* significant at the 0.10 level
** significant at the 0.05 level
*** significant at the 0.01 level

Elementary school students perform better in a heterogeneous type of locale and middle school students perform better in a homogeneous type of locale. In elementary school, both the proportion of high ability students and the proportion of low ability students in the
type of locale are positively and significantly correlated with student achievement. In middle school, the proportions of both high ability students and low ability students in the type of locale have a statistically significant negative correlation with achievement. When teacher between effects are included, none of these results continue to be significant. A large proportion of achievers in the extremes (both high achievers and low achievers) is beneficial to elementary school students and harmful to middle school students on average.

Urban and suburb areas have the greatest proportion of high and low achieving students and towns have the smallest as shown in Figure 6.2.1. This is intriguing because in elementary school, suburbs have the highest levels of class mean and skewness peer influence and towns have the lowest. Class mean and skewness correlations are nearly equal by locale in middle school with town locales slightly higher than other areas. See Table 3.2.4 and Table 3.4.5.

6.3 Peer Effects by Classroom Ability

In this section, I use the percentage of high- and low- ability students in the classroom as proxies for peer characteristics. I examine the impact of the proportion of classroom peers in the top and bottom 20\textsuperscript{th} percentiles. Chapter 5 explained how peer mean and skewness may affect student achievement. Examining the high- and low-ability percentage of peers allows for an understanding of the impact of students at the extremes instead of at the middle. Skewness might pick up these observations but it measures outliers not high versus low achievers. I ran an OLS regression with student current test score as the dependent variable and student, teacher, and peer characteristics as the explanatory variables. I examined each locale separately. This gave me an overall understanding of what was impacting student test scores by locale. Then, I
ran an OLS regression with teacher fixed effects. I used the same dependent and independent variables and included teacher fixed effects to account for other characteristics of teachers that could be affecting student performance. For this analysis, I am particularly interested in locale impact on peer influence. See Table 6.3.1 and Table 6.3.2 for a comparison of peer effect results by locale.

Table 6.3.1 Peer Impact on Student Performance by Locale

<table>
<thead>
<tr>
<th>Student Z-score</th>
<th>Urban</th>
<th>Suburb</th>
<th>Town</th>
<th>Rural</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Elementary Classrooms</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage of High-Ability Peers in Classroom</td>
<td>0.85 ***</td>
<td>1.42 ***</td>
<td>1.16 ***</td>
<td>1.09 ***</td>
</tr>
<tr>
<td>Percentage of Low-Ability Peers in Classroom</td>
<td>-0.67 ***</td>
<td>-1.36 ***</td>
<td>-0.90 ***</td>
<td>-1.24 ***</td>
</tr>
<tr>
<td><strong>Middle Classrooms</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage of High-Ability Peers in Classroom</td>
<td>0.68 ***</td>
<td>0.75 ***</td>
<td>0.84 ***</td>
<td>0.98 ***</td>
</tr>
<tr>
<td>Percentage of Low-Ability Peers in Classroom</td>
<td>-1.05 ***</td>
<td>-1.08 ***</td>
<td>-1.08 ***</td>
<td>-1.09 ***</td>
</tr>
</tbody>
</table>

* significant at the 0.10 level
** significant at the 0.05 level
*** significant at the 0.01 level

---

23 Teacher fixed effects could be used because neither social capital nor locale variables were used in the regression.
24 See Appendix F for complete regression analyses.
Table 6.3.2 Peer Impact on Student Performance by Locale with Teacher Fixed Effects

<table>
<thead>
<tr>
<th>Student Z-score</th>
<th>Urban</th>
<th>Suburb</th>
<th>Town</th>
<th>Rural</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Elementary Schools</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage of High-Ability Peers in Classroom</td>
<td>0.81 ***</td>
<td>1.71 ***</td>
<td>1.24 ***</td>
<td>1.26 ***</td>
</tr>
<tr>
<td>Percentage of Low-Ability Peers in Classroom</td>
<td>-0.66 ***</td>
<td>-0.87</td>
<td>-0.80 ***</td>
<td>-0.83 ***</td>
</tr>
<tr>
<td><strong>Middle Schools</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage of High-Ability Peers in Classroom</td>
<td>0.70 ***</td>
<td>0.77 ***</td>
<td>0.81 ***</td>
<td>0.84 ***</td>
</tr>
<tr>
<td>Percentage of Low-Ability Peers in Classroom</td>
<td>-0.93 ***</td>
<td>-0.93 ***</td>
<td>-0.92 ***</td>
<td>-0.93 ***</td>
</tr>
</tbody>
</table>

* significant at the 0.10 level
** significant at the 0.05 level
*** significant at the 0.01 level

In the both regressions I found that characteristics of a student’s classroom are significant in determining their test performance. There is a positive correlation of proportion of high ability classmates and student performance, and a negative correlation of proportion of low ability classmates. This was found in all grades and locales regardless of statistical significance. Increasing the percentage of high-ability peers by 1 increases a student’s performance by 0.85 to 1.42 z-score in elementary school and 0.68 to 0.98 z-score in middle school. Increasing the percentage of low-ability peers by 1 decreases a student’s performance by 0.67 to 1.36 z-score in elementary school and 1.05 to 1.09 z-score in middle school. Positive peer effects are typically stronger in elementary school and negative peer effects are always stronger in middle school. This is consistent with the results of proportion of high and low ability students in each locale in Chapter 6.2. The influence of the high and low ability in the classroom on a student performance is relatively similar with the inclusion of teacher fixed effects. It

---

25 See Appendix G for complete regression analyses.
removed the statistical significance of the percentage of low ability students in the elementary school class in a suburb locale.

According to these results, rural, town, and suburb locales have stronger peer effects than urban areas. Urban coefficients have a smaller magnitude than all other locales for all grade levels with and without the inclusion of teacher fixed effects. The difference is strongest in elementary school. This might be caused by the larger proportion of high and low peers in urban locale than in other locales. This result is only partially consistent with the analysis by locale with classroom mean, standard deviation, and skewness in Chapter 5. In the prior analyses, the urban peer mean coefficient is the second smallest and the urban classroom skewness coefficient is the smallest.

This chapter was guided by two specific goals. The first goal was to determine if the proportion of high and low ability students in the locale type was associated with student achievement. This analysis found that the proportion of high and low achieving students was positively correlated with student achievement in elementary school and negatively correlated with student achievement in middle school. The second goal was to examine the proportion of high and low ability peers in the classroom influence student achievement. Based on the findings in this and prior analyses in this dissertation, it appears that student achievement is impacted by both the average and the percentage of high and low achievers but not similarly by locale.
Chapter 7
Conclusions and Further Research

7.1 Dissertation Summary

“More than half of America’s rural counties are losing population and with it, political representation,” Tom Vilsack, current United States Secretary of Agriculture and former Governor of Iowa (1999 to 2007).

Policy makers are often not knowledgeable about the unique realities of rural education. This group is underrepresented in education literature and they are often required to adhere to urban policy. Rural students face different economies, opportunities, and possibly different peers and social capital than their urban counterparts. These areas have different unemployment rates, poverty rates, racial demographics, average age of population, and educational attainment rates.

The purpose of this dissertation is to examine population homogeneity, peer effects, and social capital in different locales, and measure their impacts on education. People choose to live where they do because of job opportunities, local amenities, preference for public goods, the level of taxation, and the characteristics of the citizens in the community. These choices shape America’s public school system through the creation of multiple school districts and distinctive schools, a process which influences the composition of students in public schools. With the majority of peer effects literature focused on urban locales and the comparison of public versus private schools, this analysis begins to fill the void that others have left open. No known education literature has examined peer effects or social capital in schools by locale. This paper examines peer effects in urban, suburb, town, and rural public school districts.
To determine the effect of peers on educational attainment, I developed a theory of peer effects in both rural and urban locations, and provided empirical evidence of the influence of peer on student achievement by locale type. According to the theory, peer effects, type of locale, and social capital influence student achievement. I expect there to be different peer effects in rural and urban schools because of population sorting and peer composition. I found statistically significant correlations of student achievement with student characteristics, peer effects, type of locale, and social capital. See Table 7.1.1 for a conclusion summary of the variables in this dissertation.
### Table 7.1.1 Conclusion Summary

<table>
<thead>
<tr>
<th>Variables</th>
<th>Impact on Student Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Student Characteristics:</strong></td>
<td></td>
</tr>
<tr>
<td>Student Lag Z-score</td>
<td>Large positive influence</td>
</tr>
<tr>
<td>Female</td>
<td>Relatively small positive influence</td>
</tr>
<tr>
<td>Missing Gender</td>
<td>Often statistically significant; difficult gender interpretation</td>
</tr>
<tr>
<td>FRP Recipient</td>
<td>Small to medium negative influence</td>
</tr>
<tr>
<td>Missing FRP</td>
<td>Rarely statistically significant</td>
</tr>
<tr>
<td>African American</td>
<td>Small to medium negative influence</td>
</tr>
<tr>
<td>Hispanic</td>
<td>Rarely statistically significant</td>
</tr>
<tr>
<td>Asian or Pacific Islander</td>
<td>Rarely statistically significant</td>
</tr>
<tr>
<td>Native American</td>
<td>Rarely statistically significant</td>
</tr>
<tr>
<td>Other Non-White</td>
<td>Rarely statistically significant</td>
</tr>
<tr>
<td>Missing Ethnicity</td>
<td>Often statistically significant; difficult ethnicity interpretation</td>
</tr>
<tr>
<td><strong>Teacher Characteristics:</strong></td>
<td></td>
</tr>
<tr>
<td>Teacher Education Level</td>
<td>Difficult to interpret; vary in direction and significance between the regressions</td>
</tr>
<tr>
<td>Teacher Years of Experience</td>
<td>Difficult to interpret; vary in direction and significance between the regressions</td>
</tr>
<tr>
<td><strong>Peer Characteristics:</strong></td>
<td></td>
</tr>
<tr>
<td>Classroom Size</td>
<td>Small negative influence; rarely statistically significant with teacher effects</td>
</tr>
<tr>
<td>Peer Mean (Z-score)</td>
<td>The higher the average peer test score, the more likely the student will perform well</td>
</tr>
<tr>
<td>Peer Std. Dev. (Z-score)</td>
<td>Small to medium positive influence in elementary school and small negative influence in middles school; not always statistically significant</td>
</tr>
<tr>
<td>Peer Skewness (Z-score)</td>
<td>Negative skewness is associated with high performance and positive skewness is associated with low performance</td>
</tr>
<tr>
<td>Proportion of High Ability Peers in the Classroom</td>
<td>Large positive influence</td>
</tr>
<tr>
<td>Proportion of Low Ability Peers in the Classroom</td>
<td>Large negative influence</td>
</tr>
<tr>
<td><strong>District Characteristics:</strong></td>
<td></td>
</tr>
<tr>
<td>Social Capital</td>
<td>Small positive influence in elementary school and small negative influence in middles school; rarely statistically significant with teacher effects</td>
</tr>
<tr>
<td>Rural</td>
<td>Negatively associated; not always statistically significant</td>
</tr>
<tr>
<td>Town</td>
<td>Negatively associated; not always statistically significant</td>
</tr>
<tr>
<td>Suburb</td>
<td>Negatively associated; not always statistically significant</td>
</tr>
<tr>
<td>Urban</td>
<td>Positively associated; control group in regression</td>
</tr>
<tr>
<td>Proportion of High Ability Students in the District</td>
<td>Medium positive influence in elementary school and medium negative influence in middles school; not statistically significant with teacher effects</td>
</tr>
<tr>
<td>Proportion of Low Ability Students in the District</td>
<td>Medium positive influence in elementary school and medium negative influence in middles school; not statistically significant with teacher effects</td>
</tr>
</tbody>
</table>
A student’s own characteristics are significant in determining a student’s performance (Summers and Wolfe 1977; Henderson, Mieszkowski, and Sauvageau 1978; Zimmer and Toma 2000). The analyses in this dissertation show that if a student performed well last year, he/she is likely to perform well this year holding other factors constant. This correlation has a large magnitude. African American and FRP recipient students are more likely to perform worse than their counterparts. These results were expected and are often found in the education literature. Females, on average, perform better; however, the missing gender variable is significant in many of the regressions so interpretation is difficult.

Teacher effects are hard to interpret because they vary in direction and significance between the regressions. When either teacher between or fixed effects are included, most of the teacher characteristics become insignificant. The expected difference between the teachers and the unchanged characteristics of teachers eliminates the possible impact these variable have on students achievement. Teachers matter in ways that are not easily observable (Rivkin, Hanushek, and Kain 2005).

The analyses show that peers influence a student’s performance. This is consistent with education literature (Coleman et al. 1966, Summers and Wolfe 1977, Henderson, Mieszkowski, and Sauvageau 1978, Zimmer and Toma 2000, Hoxby 2000a, Hoxby 2000b, Lavy 2008, Lin 2010, Duflo, Dupas and Kremer 2011). The class average test score and student performance are positively and significantly correlated. The peer mean coefficient is almost as large as individual lag scores. Based on the standard deviation variable, elementary school likes heterogeneity and middle school likes homogeneity. However, this variable is not always statistically significant. The impact of the class skewness on a student is significantly negative for all instances. Negative skewness is positively associated with student achievement and positive skewness is negatively associated with skewness.
While locale type is not always statistically significant in determining student performance, it does make an impact on peer effect strength. The suburb has the greatest peer effects magnitude, and the towns and urban locales have the smallest peer effect magnitude. Peer effects vary greater by locale type in elementary school than they do in middle school. The suburb locale has a greater elementary school peer mean magnitude than a student’s own prior test score. The suburb may have the greatest peer effects because the students may be more economically and racially homogeneous than students in other locale types, particularly in comparison to the urban area. Suburban students may relate more to one another. There is no known comparison research of peer effects by locale type.

Social capital’s influence on student achievement varies by grade level. In elementary school, students performed better in locales with greater social capital. In middle school, the opposite is true. However, the magnitudes of these variables are small. The influence of social capital on student achievement by grade level does not change with the inclusion of teacher between effects. It only removes the statistical significance. Social capital may benefit elementary school students because it indicates a tight-knit family and community. Social capital may harm middle school students because the societal ties may be a distraction to school work. There is no known empirical research of social capital influence on peer effects.

7.2 Policy Implications

Peers may contribute to the differences in individual’s school performance. Because resource variance between schools has diminished and is often found to be an insignificant factor in explaining differences in student performance (Coleman et al. 1966; Hanushek 1981, 1986, 1989, 1997; Rothstein 2004), it is thought that peers account for some of the differences in student and school performance. Student body composition is one reason why people
choose to live in certain neighborhoods, or send their children to private school. It is a possible cause of the increased number of private or charter school students, and may cause a decreased number of students in the regular public school system (Figlio and Stone 2001). Policies, such as voucher and tracking programs, can influence peer composition (Epple and Romano 1998; Nechyba 2000; Katz, Kling, and Liebman 2001; Angrist and Lang 2004; Hoxby and Weingarth 2005). Because students are influenced by one another (Coleman et al. 1966, Summers and Wolfe 1977, Henderson, Mieszkowski, and Sauvageau 1978, Zimmer and Toma 2000, Hoxby 2000a, Hoxby 2000b, Lavy 2008, Lin 2010, Duflo, Dupas and Kremer 2011) these policies can affect student and school performance. As shown in this dissertation, peer effects are different by locale type. Policies might not have the same impact in different types of locales.

Students may sort into facilities that meet their needs, segregating high ability and low ability students. However, this may come at a cost to lower ability students. Sorting may cause the high ability students to be removed from the students who benefit from them the most (Hoxby 2000b). Voucher programs may be used to promote low-income students in homogeneous areas by providing the tuition for these students to attend private schools. Epple and Romano (1998) found that vouchers increased private school attendance, students sorting, and the largest gains, relative to income, were high-ability students with low-income. The greatest loss is to students who remain in the public sector because of a decline in peer quality.

The mechanism of tracking students into high achieving classrooms and lower achieving classrooms has a positive impact for low-ability students, but it is offset by peer effects (Zimmer 2003). Classroom homogeneity reduces average peer effects for low and average achieving students (Zimmer 2003). Arnott and Rowse (1987) theoretically concluded that a mixed classroom composition affects all types of students, but in different ways. Mixing students
benefits the overall student population, but at a cost to higher ability students (Summers and Wolfe 1977; Henderson, Mieszkowski, and Sauvageau 1978; Zimmer and Toma 2000).

7.3 Limitations and Future Research

These findings suggest that urban, suburb, town, and rural locations should not be lumped together in analyzing the influences of peers and social capital on education achievement. What is found beneficial for one locale is not necessarily good for another. There are some limitations to this study and possibilities for future research. They include, but are not limited to: possible endogeneity in the model, lack of family characteristics, the average test score’s potential influence on peer effects, and little applicability outside of the sample.

There is possible endogeneity in the model when examining urban schools because parents often choose the neighborhood in which to locate and, subsequently, which school their child attends. However, parents have limited knowledge of each school. While the means of school level scores can be attained by parents, classroom mean cannot. Standard deviation and skewness of classrooms are not observable or readily attained by parents. In a rural locale the endogeneity of parental school choice and student peer choice are expected to present smaller problems than in an urban locale for the following reasons. First, there is not a high degree of competition among schools in rural areas. In many of these areas there are only a handful of primary schools and one or two secondary schools. Second, the geographic area from which rural schools collect students is considerably larger than in urban schools so specific neighborhood selection is expected to have a small impact on school attended. Last, rural school districts have fewer students than urban districts creating a smaller number of peers for a student from which to choose. For these reasons, this analysis is different than what is in the current literature. Endogeneity exists, but it should be largely an urban issue. A difference in the
results may be attributable to real peer effects or to the fact that urban locales have a possible endogeneity issue. However, this is unlikely because urban areas did not have the strongest or weakest peer effects except in the last regression in Chapter 6.3.

One may still argue that a flaw in my analysis is that we are not including family characteristics. The data set does not include family characteristics, but it might partially be controlled for with the student’s lagged test score, free and reduced price lunch status (FRP), and ethnicity. A student’s prior score is a measure of their characteristics and ability. A student’s knowledge and inspirations build from a sequence of good teaching. Last year’s education should have an effect that should not go away. FRP indicates family income level and ethnicity provides family demographics.

It is possible that peer effects are being influenced, not by locale, but by average test score. Urban and suburb areas have the greatest proportion of high and low achieving students and towns have the smallest as shown in Figure 6.2.1. This is intriguing because in elementary school, suburbs have the highest levels of class mean and skewness peer influence and towns have the lowest. On the other hand, class mean and skewness correlations are nearly equal by locale in middle school with town locales slightly higher than other areas. See Table 3.2.4 and Table 3.4.5. Further research must be conducted to determine if the average district test score is driving the results.

The study is not applicable to outside of the sample because of the limitations in some locale types and the unique qualities of social capital. I only have 1 suburb (over 2,000 observations) and 1 urban district (over 60,000 observations) in the sample. Social capital varies by region of the United States. Using this measure, Rupasingha, Goetz, and Freshwater (2006) found the southeast has the lowest levels of social capital and the northeast has the highest. They calculated that urban areas have lower levels of social capital than rural areas. However,
in this sample, cities have higher social capital than rural areas. This may be a regional affect. These citizens face additional challenges to social capital. The rural counties are among the poorest areas in America and they may not have the fiscal resources or infrastructure necessary for higher levels of social capital. Future studies are needed in other geographic areas of the country.
## Appendix A Tabulation of Math Teacher Education Level

<table>
<thead>
<tr>
<th>Education Level</th>
<th>Degree</th>
<th>Frequency</th>
<th>Percent</th>
<th>Cumulative</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bachelor’s</td>
<td>14,131</td>
<td>12.84</td>
<td>12.84</td>
</tr>
<tr>
<td>2</td>
<td>5th Year</td>
<td>10,723</td>
<td>9.74</td>
<td>22.58</td>
</tr>
<tr>
<td>3</td>
<td>Planned 6th Year</td>
<td>3,442</td>
<td>3.13</td>
<td>25.71</td>
</tr>
<tr>
<td>4</td>
<td>Master’s</td>
<td>80,475</td>
<td>73.13</td>
<td>98.84</td>
</tr>
<tr>
<td>5</td>
<td>Rank I</td>
<td>959</td>
<td>0.87</td>
<td>99.71</td>
</tr>
<tr>
<td>6</td>
<td>Specialist</td>
<td>31</td>
<td>0.03</td>
<td>99.74</td>
</tr>
<tr>
<td>7</td>
<td>Doctorate</td>
<td>286</td>
<td>0.26</td>
<td>100.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>110,047</td>
<td>100.00</td>
<td></td>
</tr>
</tbody>
</table>
## Appendix B KRS 157.360 Teacher/Student Ratio for Funding

<table>
<thead>
<tr>
<th>Grade</th>
<th>Student/Teacher Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary</td>
<td>24:1</td>
</tr>
<tr>
<td>4</td>
<td>28:1</td>
</tr>
<tr>
<td>5 and 6</td>
<td>29:1</td>
</tr>
<tr>
<td>7 through 12</td>
<td>31:1</td>
</tr>
</tbody>
</table>
Appendix C Calculations without the Observed Student\textsuperscript{26 27}

\( X = \) score \hspace{1cm} \text{mean of class scores}
\( k = \) of observation \hspace{1cm} -k = \) without observation
\( j = \) individual observations \hspace{1cm} n = \) class size
\( s = \) standard deviation \hspace{1cm} v = \) variance
\( w = \) skewness

**Sample Mean**

(1) \( n\bar{x} = \sum_{j=1}^{n}(x_j) \)

(2) \( (n - 1)\bar{x}_{-k} = \sum_{j=1}^{n}(x_j) - x_k \)

(3) \( \bar{x}_{-k} = \frac{\sum_{j=1}^{n}(x_j) - x_k}{n-1} = \frac{n\bar{x} - x_k}{n-1} \)

**Sample Variance**

(1) \( (n - 1)s^2 = \sum_{j=1}^{n}(x_j^2) - n\bar{x}^2 \)

(2) \( (n - 2)s_{-k}^2 = \sum_{j=1}^{n}(x_j^2) - x_k^2 - (n - 1)\bar{x}_{-k}^2 \)

(3) \( (n - 2)s_{-k}^2 = \sum_{j=1}^{n}(x_j^2) - x_k^2 - (n - 1)\left[\frac{n\bar{x} - x_k}{n-1}\right]^2 \)

(4) \( (n - 2)s_{-k}^2 = \sum_{j=1}^{n}(x_j^2) - x_k^2 - \frac{(n\bar{x} - x_k)^2}{n-1} \)

(5) \( s_{-k}^2 = \left[\sum_{j=1}^{n}(x_j^2) - x_k^2 - \frac{(n\bar{x} - x_k)^2}{n-1}\right]/(n - 2) \)

\textsuperscript{26} These equations were calculated by J.S. Butler, Professor for the Martin School at the University of Kentucky
\textsuperscript{27} With the lagged variables, n is not the class size but rather the number of students in the class with lagged scores.
Variance Calculation for Skewness\(^{28}\)

(1) \( v = \left( \frac{1}{n} \right) \left[ \sum_{j=1}^{n} (x_j^2) - n\bar{x}^2 \right] \)

(2) \( v_{-k} = \left( \frac{1}{n-1} \right) \left[ \sum_{j=1}^{n} (x_j^2) - x_k^2 - (n - 1)\bar{x}_{-k}^2 \right] \)

Skewness

(1) \( \bar{x}_{-k} = \frac{\sum_{j=1}^{n} (x_j - x_k)}{n-1} = \frac{n\bar{x} - x_k}{n-1} \)

(2) \( v_{-k} = \left( \frac{1}{n-1} \right) \left[ \sum_{j=1}^{n} (x_j^2) - x_k^2 - (n - 1)\bar{x}_{-k}^2 \right] \)

(3) \( w_{-k} = \left( \frac{1}{n-1} \right) \left[ \sum_{j=1}^{n} (x_j - \bar{x}_{-k})^3 - (x_k - \bar{x}_{-k})^3 \right] \frac{1}{v_{-k}^{1.5}} \)

\(^{28}\) note the sample variance is divided by \( n \) (not \( n-1 \)) in accordance with Stata calculations for skewness
Appendix D Regression Analyses Predicting Student Achievement by Locale using Classroom Averages

Urban Locale

<table>
<thead>
<tr>
<th></th>
<th>Elementary School</th>
<th>Middle School</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Student Characteristics:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student Lag Z-score</td>
<td>0.52 ***</td>
<td>0.51 ***</td>
</tr>
<tr>
<td>Female</td>
<td>0.04 ***</td>
<td>0.01 **</td>
</tr>
<tr>
<td>Missing Gender</td>
<td>(omitted)</td>
<td>(omitted)</td>
</tr>
<tr>
<td>FRP Recipient</td>
<td>-0.15 ***</td>
<td>-0.08 ***</td>
</tr>
<tr>
<td>Missing FRP</td>
<td>(omitted)</td>
<td>(omitted)</td>
</tr>
<tr>
<td>African American</td>
<td>-0.13 ***</td>
<td>-0.11 ***</td>
</tr>
<tr>
<td>Hispanic</td>
<td>0.03</td>
<td>0.01</td>
</tr>
<tr>
<td>Asian</td>
<td>0.07</td>
<td>0.12 ***</td>
</tr>
<tr>
<td>Native American</td>
<td>0.10</td>
<td>-0.004</td>
</tr>
<tr>
<td>Other Non-White</td>
<td>-0.12 **</td>
<td>0.02</td>
</tr>
<tr>
<td>Missing Ethnicity</td>
<td>-0.11 ***</td>
<td>-0.01</td>
</tr>
<tr>
<td><strong>Teacher Characteristics:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teacher Education Level</td>
<td>0.01 *</td>
<td>-0.001 **</td>
</tr>
<tr>
<td>Teacher Years of Experience</td>
<td>-0.01 ***</td>
<td>-0.005 ***</td>
</tr>
<tr>
<td>Teacher Years of Experience$^2$</td>
<td>0.0002 **</td>
<td>0.0001 ***</td>
</tr>
<tr>
<td><strong>Peer Characteristics:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Classroom Size</td>
<td>-0.004 **</td>
<td>0.0003</td>
</tr>
<tr>
<td>Peer Mean (Z-score)</td>
<td>0.41 ***</td>
<td>0.47 ***</td>
</tr>
<tr>
<td>Peer Std. Dev. (Z-score)</td>
<td>0.29 ***</td>
<td>0.01</td>
</tr>
<tr>
<td>Peer Skewness (Z-score)</td>
<td>-0.11 ***</td>
<td>-0.11 ***</td>
</tr>
<tr>
<td>N</td>
<td>9367</td>
<td>29036</td>
</tr>
<tr>
<td>R-Squared</td>
<td>-0.58</td>
<td>0.64</td>
</tr>
</tbody>
</table>
## Suburb Locale

<table>
<thead>
<tr>
<th></th>
<th>Elementary School</th>
<th>Middle School</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Student Characteristics:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student Lag Z-score</td>
<td>0.50 ***</td>
<td>0.51 ***</td>
</tr>
<tr>
<td>Female</td>
<td>(omitted)</td>
<td>(omitted)</td>
</tr>
<tr>
<td>Missing Gender</td>
<td>(omitted)</td>
<td>(omitted)</td>
</tr>
<tr>
<td>FRP Recipient</td>
<td>-6.23</td>
<td>-13.17 ***</td>
</tr>
<tr>
<td>Missing FRP</td>
<td>(omitted)</td>
<td>(omitted)</td>
</tr>
<tr>
<td>African American</td>
<td>-17.74 (omitted)</td>
<td>(omitted)</td>
</tr>
<tr>
<td>Hispanic</td>
<td>-106.41 ***</td>
<td>(omitted)</td>
</tr>
<tr>
<td>Asian</td>
<td>15.50</td>
<td>-190.56 ***</td>
</tr>
<tr>
<td>Native American</td>
<td>(omitted)</td>
<td>(omitted)</td>
</tr>
<tr>
<td>Other Non-White</td>
<td>(omitted)</td>
<td>(omitted)</td>
</tr>
<tr>
<td>Missing Ethnicity</td>
<td>(omitted)</td>
<td>(omitted)</td>
</tr>
<tr>
<td><strong>Teacher Characteristics:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teacher Education Level</td>
<td>0.09 **</td>
<td>-0.11 **</td>
</tr>
<tr>
<td>Teacher Years of Experience</td>
<td>-0.05 ***</td>
<td>0.01</td>
</tr>
<tr>
<td>Teacher Years of Experience²</td>
<td>0.001 ***</td>
<td>-0.0004</td>
</tr>
<tr>
<td><strong>Peer Characteristics:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Classroom Size</td>
<td>-0.03 **</td>
<td>0.000009</td>
</tr>
<tr>
<td>Peer Mean (Z-score)</td>
<td>0.64 ***</td>
<td>0.44 ***</td>
</tr>
<tr>
<td>Peer Std. Dev. (Z-score)</td>
<td>0.23</td>
<td>-0.12</td>
</tr>
<tr>
<td>Peer Skewness (Z-score)</td>
<td>-0.31 ***</td>
<td>-0.16 ***</td>
</tr>
<tr>
<td>N</td>
<td>535</td>
<td>1169</td>
</tr>
<tr>
<td>R-Squared</td>
<td>0.52</td>
<td>0.66</td>
</tr>
</tbody>
</table>

*Ɨ* may not be accurate predictor because of small n
Town Locale

<table>
<thead>
<tr>
<th>Student Characteristics:</th>
<th>Elementary School</th>
<th>Middle School</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student Lag Z-score</td>
<td>0.48 ***</td>
<td>0.51 ***</td>
</tr>
<tr>
<td>Female</td>
<td>0.12 **</td>
<td>0.07 **</td>
</tr>
<tr>
<td>Missing Gender</td>
<td>0.21 ***</td>
<td>-0.26 ***</td>
</tr>
<tr>
<td>FRP Recipient</td>
<td>-0.18 ***</td>
<td>-0.10 ***</td>
</tr>
<tr>
<td>Missing FRP</td>
<td>(omitted)</td>
<td>(omitted)</td>
</tr>
<tr>
<td>African American</td>
<td>-3.71 ***</td>
<td>3.56 **</td>
</tr>
<tr>
<td>Hispanic</td>
<td>-2.66</td>
<td>8.96 ***</td>
</tr>
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<td>Asian</td>
<td>23.76 ***</td>
<td>27.25 **</td>
</tr>
<tr>
<td>Native American</td>
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<td>(omitted)</td>
</tr>
<tr>
<td>Missing Ethnicity</td>
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<td>(omitted)</td>
</tr>
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</table>

| Teacher Characteristics: | | |
|--------------------------| | |
| Teacher Education Level  | 0.01 | 0.04 *** |
| Teacher Years of Experience | 0.002 | -0.01 |
| Teacher Years of Experience² | -0.0001 | 0.0002 ** |

| Peer Characteristics: | | |
|-----------------------| | |
| Classroom Size        | -0.01 *** | -0.003 |
| Peer Mean (Z-score)   | 0.32 *** | 0.53 *** |
| Peer Std. Dev. (Z-score) | 0.11 | -0.04 |
| Peer Skewness (Z-score) | -0.25 *** | -0.20 *** |

N 1852
R-Squared 0.51

¹ may not be accurate predictor because of small n
### Rural Locale

<table>
<thead>
<tr>
<th>Student Characteristics:</th>
<th>Elementary School</th>
<th>Middle School</th>
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<tbody>
<tr>
<td>Student Lag Z-score</td>
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<td>0.53 ***</td>
</tr>
<tr>
<td>Female</td>
<td>0.10 ***</td>
<td>0.01</td>
</tr>
<tr>
<td>Missing Gender</td>
<td>0.08 ***</td>
<td>-0.01</td>
</tr>
<tr>
<td>FRP Recipient</td>
<td>-0.16 ***</td>
<td>-0.11 ***</td>
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<tr>
<td>Missing FRP</td>
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<td>(omitted)</td>
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<td>0.04</td>
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<tr>
<td>Hispanic</td>
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<tr>
<td>Asian</td>
<td>0.23</td>
<td>0.15</td>
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<tr>
<td>Native American</td>
<td>-0.74</td>
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<td>Other Non-White</td>
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<tr>
<td>Teacher Education Level</td>
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<td>0.01 **</td>
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<tr>
<td>Teacher Years of Experience</td>
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<td>0.003</td>
</tr>
<tr>
<td>Teacher Years of Experience²</td>
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<table>
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<td>0.001</td>
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<tr>
<td>Peer Mean (Z-score)</td>
<td>0.50 ***</td>
<td>0.51 ***</td>
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<tr>
<td>Peer Std. Dev. (Z-score)</td>
<td>-0.13 ***</td>
<td>-0.10 ***</td>
</tr>
<tr>
<td>Peer Skewness (Z-score)</td>
<td>-0.26 ***</td>
<td>-0.14 ***</td>
</tr>
</tbody>
</table>

| N                        | 10134             | 20820        |
| R-Squared                | 0.43              | 0.48         |

1 may not be accurate predictor because of small n
Appendix E Regression Analyses Predicting Student Achievement by Locale using Classroom Averages and Teacher Fixed Effects

Urban Locale

<table>
<thead>
<tr>
<th></th>
<th>Elementary School</th>
<th>Middle School</th>
</tr>
</thead>
<tbody>
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<td><strong>Student Characteristics:</strong></td>
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<td></td>
</tr>
<tr>
<td>Student Lag Z-score</td>
<td>0.54 ***</td>
<td>0.53 ***</td>
</tr>
<tr>
<td>Female</td>
<td>0.05 ***</td>
<td>0.02 **</td>
</tr>
<tr>
<td>Missing Gender</td>
<td>(omitted)</td>
<td>(omitted)</td>
</tr>
<tr>
<td>FRP Recipient</td>
<td>-0.19 ***</td>
<td>-0.09 ***</td>
</tr>
<tr>
<td>Missing FRP</td>
<td>(omitted)</td>
<td>(omitted)</td>
</tr>
<tr>
<td>African American</td>
<td>-0.19 ***</td>
<td>-0.11 ***</td>
</tr>
<tr>
<td>Hispanic</td>
<td>-0.02</td>
<td>-0.01</td>
</tr>
<tr>
<td>Asian</td>
<td>0.07</td>
<td>0.14 ***</td>
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<tr>
<td>Native American</td>
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<td>0.01</td>
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<td>0.02</td>
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<tr>
<td>Missing Ethnicity</td>
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<td>-0.02</td>
</tr>
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<td></td>
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<td>(omitted)</td>
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<tr>
<td>Teacher Years of Experience</td>
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<td>0.0004</td>
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<td>0.00001</td>
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<tr>
<td>Classroom Size</td>
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<td>-0.001</td>
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<tr>
<td>Peer Mean (Z-score)</td>
<td>0.31 ***</td>
<td>0.43 ***</td>
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<tr>
<td>Peer Std. Dev. (Z-score)</td>
<td>0.23 ***</td>
<td>0.03</td>
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<tr>
<td>Peer Skewness (Z-score)</td>
<td>-0.17 ***</td>
<td>-0.13 ***</td>
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<td>N (Groups)</td>
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<td>&lt;0.001</td>
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### Suburb Locale

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<tbody>
<tr>
<td><strong>Student Characteristics:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student Lag Z-score</td>
<td>0.51 ***</td>
<td>0.52 ***</td>
</tr>
<tr>
<td>Female</td>
<td>(omitted)</td>
<td>(omitted)</td>
</tr>
<tr>
<td>Missing Gender</td>
<td>(omitted)</td>
<td>(omitted)</td>
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<tr>
<td>FRP Recipient</td>
<td>-36.91 **</td>
<td>-4.94 ***</td>
</tr>
<tr>
<td>Missing FRP</td>
<td>(omitted)</td>
<td>(omitted)</td>
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<tr>
<td>African American 🔧</td>
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</tr>
<tr>
<td>Hispanic 🔧</td>
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<td>(omitted)</td>
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<td>Asian 🔧</td>
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<tr>
<td>Native American 🔧</td>
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<td>(omitted)</td>
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<tr>
<td>Other Non-White 🔧</td>
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<td>(omitted)</td>
</tr>
<tr>
<td>Missing Ethnicity</td>
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<td>(omitted)</td>
</tr>
<tr>
<td><strong>Teacher Characteristics:</strong></td>
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<td></td>
</tr>
<tr>
<td>Teacher Education Level</td>
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<td>(omitted)</td>
</tr>
<tr>
<td>Teacher Years of Experience</td>
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<td>-0.01</td>
</tr>
<tr>
<td>Teacher Years of Experience²</td>
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<td>-0.001</td>
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<tr>
<td><strong>Peer Characteristics:</strong></td>
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</tr>
<tr>
<td>Classroom Size</td>
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<td></td>
</tr>
<tr>
<td>Peer Mean (Z-score)</td>
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<td>0.43 ***</td>
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<tr>
<td>Peer Std. Dev. (Z-score)</td>
<td>0.32</td>
<td>-0.13</td>
</tr>
<tr>
<td>Peer Skewness (Z-score)</td>
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<td>-0.15 ***</td>
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<tr>
<td>N (Groups)</td>
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</tr>
<tr>
<td>F Statistic</td>
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<td>&lt;0.001</td>
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</table>

* may not be accurate predictor because of small n
### Town Locale

<table>
<thead>
<tr>
<th>Student Characteristics:</th>
<th>Elementary School</th>
<th>Middle School</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student Lag Z-score</td>
<td>0.49 ***</td>
<td>0.54 ***</td>
</tr>
<tr>
<td>Female</td>
<td>0.11 **</td>
<td>0.07 **</td>
</tr>
<tr>
<td>Missing Gender</td>
<td>-0.05</td>
<td>-0.35 **</td>
</tr>
<tr>
<td>FRP Recipient</td>
<td>-0.18 ***</td>
<td>-0.09 ***</td>
</tr>
<tr>
<td>Missing FRP</td>
<td>(omitted)</td>
<td>(omitted)</td>
</tr>
<tr>
<td>African American †</td>
<td>2.65</td>
<td>4.63 *</td>
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<tr>
<td>Hispanic †</td>
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<td>4.51</td>
</tr>
<tr>
<td>Asian †</td>
<td>37.40 **</td>
<td>-70.50 **</td>
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<td>Native American †</td>
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<td>63.33 ***</td>
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<td>Other Non-White †</td>
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<tr>
<td>Missing Ethnicity</td>
<td>(omitted)</td>
<td>(omitted)</td>
</tr>
</tbody>
</table>

**Teacher Characteristics:**

| Teacher Education Level | (omitted) | (omitted) |
| Teacher Years of Experience | -0.04 | 0.04 ** |
| Teacher Years of Experience² | 0.001 | -0.001 |

**Peer Characteristics:**

| Classroom Size | 0.01 | 0.001 |
| Peer Mean (Z-score) | 0.12 * | 0.45 *** |
| Peer Std. Dev. (Z-score) | 0.28 ** | -0.03 |
| Peer Skewness (Z-score) | -0.31 *** | -0.20 *** |

| N (Groups) | 48 | 34 |
| F Statistic | <0.001 | <0.001 |

† may not be accurate predictor because of small n
### Rural Locale

<table>
<thead>
<tr>
<th>Student Characteristics:</th>
<th>Elementary School</th>
<th>Middle School</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student Lag Z-score</td>
<td>0.48 ***</td>
<td>0.55 ***</td>
</tr>
<tr>
<td>Female</td>
<td>0.08 ***</td>
<td>0.01</td>
</tr>
<tr>
<td>Missing Gender</td>
<td>(omitted)</td>
<td>(omitted)</td>
</tr>
<tr>
<td>FRP Recipient</td>
<td>-0.18 ***</td>
<td>-0.11 ***</td>
</tr>
<tr>
<td>Missing FRP</td>
<td>(omitted)</td>
<td>(omitted)</td>
</tr>
<tr>
<td>African American(^1)</td>
<td>-0.07</td>
<td>0.03</td>
</tr>
<tr>
<td>Hispanic(^1)</td>
<td>-0.19</td>
<td>0.17</td>
</tr>
<tr>
<td>Asian(^1)</td>
<td>0.16</td>
<td>0.15</td>
</tr>
<tr>
<td>Native American(^1)</td>
<td>-0.45</td>
<td>-1.36</td>
</tr>
<tr>
<td>Other Non-White(^1)</td>
<td>0.31 (omitted)</td>
<td>(omitted)</td>
</tr>
<tr>
<td>Missing Ethnicity</td>
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<td>(omitted)</td>
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### Teacher Characteristics:

<table>
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<tr>
<th>Teacher Education Level</th>
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<th>(omitted)</th>
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<tbody>
<tr>
<td>Teacher Years of Experience</td>
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<td>0.001</td>
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<tr>
<td>Teacher Years of Experience(^2)</td>
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### Peer Characteristics:

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<th>0.002</th>
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<td>0.40 ***</td>
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<tr>
<td>Peer Std. Dev. (Z-score)</td>
<td>-0.15 ***</td>
<td>-0.13 ***</td>
</tr>
<tr>
<td>Peer Skewness (Z-score)</td>
<td>-0.32 ***</td>
<td>-0.17 ***</td>
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<table>
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<tr>
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<td>&lt;0.001</td>
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\(^1\) may not be accurate predictor because of small n
Appendix F Regression Analyses Predicting Student Achievement by Locale Using Classroom High- and Low-Performers

Urban Locale

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<tr>
<th>Student Characteristics:</th>
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<td>0.51 ***</td>
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<td>0.01</td>
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<tr>
<td>Missing Gender</td>
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<td>(omitted)</td>
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<td>FRP Recipient</td>
<td>-0.14 ***</td>
<td>-0.08 ***</td>
</tr>
<tr>
<td>Missing FRP</td>
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<td>(omitted)</td>
</tr>
<tr>
<td>African American</td>
<td>-0.13 ***</td>
<td>-0.11 ***</td>
</tr>
<tr>
<td>Hispanic</td>
<td>0.04</td>
<td>0.03</td>
</tr>
<tr>
<td>Asian</td>
<td>0.06</td>
<td>0.12 ***</td>
</tr>
<tr>
<td>Native American</td>
<td>0.10</td>
<td>0.03</td>
</tr>
<tr>
<td>Other Non-White</td>
<td>-0.10 *</td>
<td>0.02</td>
</tr>
<tr>
<td>Missing Ethnicity</td>
<td>-0.10 ***</td>
<td>-0.01</td>
</tr>
</tbody>
</table>

Teacher Characteristics:

| Teacher Education Level                  | 0.01 **           | -0.005        |
| Teacher Years of Experience             | -0.01 *           | -0.004 ***    |
| Teacher Years of Experience^2           | 0.0001            | 0.0001 **     |

Peer Characteristics:

| Classroom Size                           | -0.003 **         | 0.001         |
| Percentage of High-Ability Peers in Classroom | 0.86 ***     | 0.67 ***      |
| Percentage of Low-Ability Peers in Classroom | -0.66 ***   | -1.05 ***     |

N                                      | 9380              | 29315         |
R-Squared                                | 0.58              | 0.64          |
## Suburb Locale

<table>
<thead>
<tr>
<th></th>
<th>Elementary School</th>
<th>Middle School</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Student Characteristics:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student Lag Z-score</td>
<td>0.52 ***</td>
<td>0.50 ***</td>
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<tr>
<td>Female</td>
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<td>(omitted)</td>
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<tr>
<td>Missing Gender</td>
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<td>(omitted)</td>
</tr>
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<td>FRP Recipient</td>
<td>-0.76</td>
<td>-14.13 ***</td>
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<td>(omitted)</td>
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<tr>
<td>Missing Ethnicity</td>
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<tr>
<td><strong>Teacher Characteristics:</strong></td>
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<td></td>
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<td>0.0002</td>
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<tr>
<td>Percentage of High-Ability Peers in Classroom</td>
<td>1.42 ***</td>
<td>0.75 ***</td>
</tr>
<tr>
<td>Percentage of Low-Ability Peers in Classroom</td>
<td>-1.36 ***</td>
<td>-1.08 ***</td>
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<tr>
<td>N</td>
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<tr>
<td>R-Squared</td>
<td>0.51</td>
<td>0.66</td>
</tr>
</tbody>
</table>

\(^1\) may not be accurate predictor because of small n
Town Locale

<table>
<thead>
<tr>
<th></th>
<th>Elementary School</th>
<th>Middle School</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Student Characteristics:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student Lag Z-score</td>
<td>0.50 ***</td>
<td>0.51 ***</td>
</tr>
<tr>
<td>Female</td>
<td>0.12 **</td>
<td>0.09 ***</td>
</tr>
<tr>
<td>Missing Gender</td>
<td>0.08 ***</td>
<td>-0.32 ***</td>
</tr>
<tr>
<td>FRP Recipient</td>
<td>-0.17 ***</td>
<td>-0.08 ***</td>
</tr>
<tr>
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<td>(omitted)</td>
</tr>
<tr>
<td>African American (^1)</td>
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<td>0.48</td>
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<td>Asian (^1)</td>
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<td>29.75 **</td>
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<td>Other Non-White (^1)</td>
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<td>(omitted)</td>
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<tr>
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<td>(omitted)</td>
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<tr>
<td><strong>Teacher Characteristics:</strong></td>
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<tr>
<td>Teacher Education Level</td>
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<td>0.01</td>
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<tr>
<td>Teacher Years of Experience</td>
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<td>-0.002</td>
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<td>Teacher Years of Experience(^2)</td>
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<tr>
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</tr>
<tr>
<td>Classroom Size</td>
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<td>1.16 ***</td>
<td>0.84 ***</td>
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<tr>
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<td>-0.90 ***</td>
<td>-1.08 ***</td>
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<tr>
<td>N</td>
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<td>4307</td>
</tr>
<tr>
<td>R-Squared</td>
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<td>0.58</td>
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\(^1\) may not be accurate predictor because of small n
## Rural Locale

<table>
<thead>
<tr>
<th>Student Characteristics:</th>
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<th>Middle School</th>
</tr>
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<tbody>
<tr>
<td>Student Lag Z-score</td>
<td>0.48 ***</td>
<td>0.52 ***</td>
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<tr>
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<td>0.10 ***</td>
<td>0.01</td>
</tr>
<tr>
<td>Missing Gender</td>
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<td>-0.01</td>
</tr>
<tr>
<td>FRP Recipient</td>
<td>-0.14 ***</td>
<td>-0.11 ***</td>
</tr>
<tr>
<td>Missing FRP (omitted)</td>
<td></td>
<td>(omitted)</td>
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<td>African American</td>
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<td>0.04</td>
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<tr>
<td>Hispanic</td>
<td>1.26</td>
<td>0.10</td>
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<td>(omitted)</td>
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<td>0.01 **</td>
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<td>-0.002</td>
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<tbody>
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<td>1.09 ***</td>
<td>0.98 ***</td>
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<tr>
<td>Percentage of Low-Ability Peers in Classroom</td>
<td>-1.24 ***</td>
<td>-1.09 ***</td>
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<th>N</th>
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<tr>
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$^*$ may not be a predictor because of small n
## Appendix G Regression Analyses Predicting Student Achievement by Locale Using Classroom High- and Low-Performers and Teacher Fixed Effects

### Urban Locale

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<th></th>
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</tr>
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<tbody>
<tr>
<td><strong>Student Characteristics:</strong></td>
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<td></td>
</tr>
<tr>
<td>Student Lag Z-score</td>
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<td>0.52 ***</td>
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<tr>
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<td>0.01 *</td>
</tr>
<tr>
<td>Missing Gender (omitted)</td>
<td></td>
<td>(omitted)</td>
</tr>
<tr>
<td>FRP Recipient</td>
<td>-0.19 ***</td>
<td>-0.09 ***</td>
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<tr>
<td>Missing FRP (omitted)</td>
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<td>(omitted)</td>
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<tr>
<td>African American</td>
<td>-0.20 ***</td>
<td>-0.11 ***</td>
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<tr>
<td>Hispanic</td>
<td>-0.02</td>
<td>0.004</td>
</tr>
<tr>
<td>Asian</td>
<td>0.08 *</td>
<td>0.13 ***</td>
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<tr>
<td>Native American</td>
<td>0.05</td>
<td>0.03</td>
</tr>
<tr>
<td>Other Non-White</td>
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<td>0.02</td>
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<tr>
<td>Missing Ethnicity</td>
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<td>-0.02</td>
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<tr>
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<tr>
<td>Teacher Years of Experience(^2)</td>
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<td>0.0003</td>
</tr>
<tr>
<td><strong>Peer Characteristics:</strong></td>
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<tr>
<td>Classroom Size</td>
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<td>-0.0004</td>
</tr>
<tr>
<td>Percentage of High-Ability Peers in Classroom</td>
<td>0.81 ***</td>
<td>0.69 ***</td>
</tr>
<tr>
<td>Percentage of Low-Ability Peers in Classroom</td>
<td>-0.66 ***</td>
<td>-0.93 ***</td>
</tr>
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<td>&lt;0.001</td>
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## Suburb Locale

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<tbody>
<tr>
<td>Student Lag Z-score</td>
<td>0.53 ***</td>
<td>0.51 ***</td>
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<tr>
<td>Female</td>
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<tr>
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<td>FRP Recipient</td>
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<td>Native American</td>
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<td>Other Non-White</td>
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<td>(omitted)</td>
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<tr>
<td>Missing Ethnicity</td>
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### Teacher Characteristics:

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<th>Elementary School</th>
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<tr>
<td>Teacher Education Level</td>
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<tr>
<td>Teacher Years of Experience</td>
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</tr>
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<td>-0.001</td>
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### Peer Characteristics:

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<td>Classroom Size</td>
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<td>Percentage of High-Ability Peers in Classroom</td>
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<td>0.77 ***</td>
</tr>
<tr>
<td>Percentage of Low-Ability Peers in Classroom</td>
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<table>
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*Superscript 'may not be accurate predictor because of small n*
## Town Locale

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<td>Female</td>
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<tr>
<td>Missing Gender</td>
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<td>-0.08 ***</td>
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<td><strong>Teacher Characteristics:</strong></td>
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<td>(omitted)</td>
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<td>0.01</td>
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<tr>
<td>Classroom Size</td>
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<td>Percentage of High-Ability Peers in Classroom</td>
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<td>-0.92 ***</td>
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<tr>
<td>N (Groups)</td>
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$^1$ may not be accurate predictor because of small n
### Rural Locale

#### Student Characteristics:
<table>
<thead>
<tr>
<th></th>
<th>Elementary School</th>
<th>Middle School</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student Lag Z-score</td>
<td>0.51 ***</td>
<td>0.55 ***</td>
</tr>
<tr>
<td>Female</td>
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<td>0.01</td>
</tr>
<tr>
<td>Missing Gender</td>
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<td>(omitted)</td>
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<tr>
<td>FRP Recipient</td>
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</table>

#### Teacher Characteristics:
<p>| | | |</p>
<table>
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<th></th>
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<td>Teacher Education Level</td>
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<td>(omitted)</td>
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<tr>
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<td>-0.01</td>
</tr>
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#### Peer Characteristics:
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<tbody>
<tr>
<td>Classroom Size</td>
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<td>Percentage of High-Ability Peers in Classroom</td>
<td>1.25 ***</td>
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</tr>
<tr>
<td>Percentage of Low-Ability Peers in Classroom</td>
<td>-0.83 ***</td>
<td>-0.93 ***</td>
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</table>

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^1 may not be accurate predictor because of small n
REFERENCES


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VITA

TOSHA KURZYNSEK FRALEY

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  - University of Kentucky, Lexington, Kentucky  May 2013

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  - Minor: Chemistry  May 2006

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  - Research Assistant on a National Science Foundation Grant
    Fall 2010 – Fall 2012

CURRENT RESEARCH AND WORKING PAPERS

“Peer Effects in Rural America.” 2011.

“Theoretical Examination of Rural and Urban Schools.” 2011.


RESEARCH PRESENTATIONS

University of Kentucky Martin School, Lexington, Kentucky  June 2012
  - “Rural and Urban School Peer Effects”

University of Kentucky Martin School, Lexington, Kentucky  August 2010 - June 2012
  - National Science Foundation Grant Presentations

University of Kentucky Martin School, Lexington, Kentucky  December 2011
  - “Peer Effects in Rural America”
  - “Theoretical Examination of Rural and Urban Schools”
  - “Solid Waste Policies and its Impact on Waste Management Budgets”