ABSTRACT

Title of Document:	BENEATH THE DISTRICT AVERAGES: INTRADISTRICT DIFFERENCES IN TEACHER COMPENSATION EXPENDITURES
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Previous research indicates that typical district budgeting practices mask large between-school teacher compensation expenditures (TCE) differences, that teacher sorting drives those TCE differences, and that TCE differences drive overall resource inequities. While scarce accurate school-level resource data has hindered intradistrict equity research, extant analyses have shown substantial TCE differences disadvantage schools with more non-white, poor and low-performing students. Though compelling, these findings are limited empirically because they examine small numbers of districts and conceptually because they examine average salaries, which cannot control for between-school differences in pupil-teacher ratios or student compensatory needs that could legitimately alter TCE between schools. Empirically, this study expands evidence of intradistrict inequities by measuring TCE variation using universe teacher-salary data for schools and districts in 16 states. Conceptually, this study allows for improved intradistrict TCE equity comparisons through a novel weighting approach that adjusts per-pupil TCE to control for differences in schools' compensatory needs and pupil-teacher ratios. Using detailed data for four states, each district's *de facto* staff-allocation weights are estimated and used to weight schools' student counts to statistically control for different allocations of teachers relative to student compensatory needs. Schools' TCE is indexed by weighted pupil counts to control for legitimate TCE differences associated with compensatory needs. By measuring TCE at the student level while controlling for compensatory needs, this weighted per-pupil TCE approach provides a more precise measure of intradistrict TCE equity than the average salaries used in previous research.

Using descriptive statistics, district-level OLS regressions and hierarchical models on schools within districts, these analyses gauge the scope of TCE inequity and identify the district and school characteristics associated with it. Findings reveal that TCE variation is a widespread district phenomenon, and that districts with greater between-school variation in student poverty, race, and performance have more TCE variation. Within districts, schools with more poor, non-white, and low performing students receive below-average TCE. At the district and school levels, teacher sorting is strongly associated with the distribution of TCE. These findings suggest that intradistrict TCE inequities are widespread and divert targeted compensatory funds. Moreover, intradistrict resource equity deserves increased policy and research attention.

BENEATH THE DISTRICT AVERAGES: INTRADISTRICT DIFFERENCES IN TEACHER COMPENSATION EXPENDITURES

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TABLE OF CONTENTS

List of Tables

List of Figures

Chapter 1: Introduction

Resource equity has long been a central concern in school finance. Since the Supreme Court's 1973 *San Antonio School District v. Rodriguez* decision closed the door to school finance equity challenges at the federal level, the vast majority of research, litigation, and legislation attending to educational equity has focused on resource differences between school districts within states. Historically, public schools have been primarily funded with local property taxes, with additional funding coming from state and federal sources. Since localities' property wealth and ability to pay for public education varies, school finance research has been concerned with the equity or adequacy of educational resources across districts. Interdistrict analyses evaluate district funding based on the principle that the quality of schooling should not be dependent on district wealth (*Serrano v. Priest* 1971; Guthrie et al, 2006). This legal context has kept districts as the primary unit of analysis in the majority of school finance research.

Public education accounting systems have developed in this same legal context to make districts, not schools, the primary units for accounting systems. Districts receive funds from local, state, and federal sources and accounting systems have evolved to meet the accounting requirements associated with those funds. In these finance systems, districts, not schools, are typically the lowest level where expenditures or resources are tracked. District-level data have been widely available for analyses of *inter*district resource differences because districts are the primary unit of school finance accounting (Roza, 2010; Guthrie, 2007). Districts have had little incentive to track expenditures or resources to the school level and as a result school-level resource data have been relatively scarce (Roza, 2010). With the dominant lens of school finance focused on the district level and with limited access to school-level data, *intra*district equity analyses—those focusing on resource differences between schools within a district— have been far less common than interdistrict equity analyses.

Intradistrict finance differs from interdistrict finance because taxation and school funding is determined at the district level. Within districts, schools do not vary in terms of property wealth or tax rates, and thus have an equal claim on district funding relative to the student number and composition. Intradistrict analysis focuses on the distribution of school resources relative to student race, poverty and geographic differences,[1] and not on the interdistrict concerns of property wealth, ability to pay, or adequacy (Berne & Stiefel, 1994).

Studies of both inter- and intradistrict resource equity have employed Berne and Stiefel's (1984, 1994) equity framework which establishes three equity principles that can evaluate resource equity across agencies nested within a higher-level institution (e.g., districts within a state, or schools within districts). The first equity principle is horizontal equity, which requires that similarly situated students receive equivalent resources. A second principle, called vertical equity, is required because not all students are similarly situated. States and districts recognize that some students, such as those living in poverty or those with disabilities, legitimately require more resources. Vertical equity accounts for these differences by requiring that students with legitimate additional educational needs,

[1] Geographic differences are often legitimate reasons for differential allocations between districts or states, however in intradistrict analyses the geographic differences are much smaller and only in exceptional cases would they be considered a legitimate cost difference. More often, geographic differences in intradistrict analyses reflect differences in student residential patterns that do not constitute legitimate educational needs (Barr, 2005).

such as limited English proficiency or disabilities, receive additional resources. Some differences between students, such as race/ethnicity or within-district residential location, are unrelated to legitimate educational needs but have historically been associated with resources. The third equity principle, equality of opportunity (EEO), addresses these illegitimate differences by holding that resources should not be related to characteristics that have no legitimate relation to education. An equitable distribution of resources, either between districts in a state, or between schools within a district, should meet all three of these equity standards. In the long record of interdistrict equity research, scholars have applied these principles, often jointly, to evaluate resource equity between districts. Scholars have employed the same principles in intradistrict research, but the body of research focusing on within-district resource equity is much less extensive than that on between-district resource equity.

In the past 15 years, scholars have increasingly recognized intradistrict equity analysis using school-level data as an important area for research. In 1997, the *Journal of Education Finance* focused an entire issue on the topic. In that issue, Busch and Odden (1997) suggested that school-level analysis could inform a number of issues including the "efficiency and productivity of resource utilization, accountability, equity, adequacy, comparability of data, and longitudinal analysis" (p.228). Since that time, school-level analyses have increased.

Though early intradistrict analyses date to the 1970's (Owen, 1972; Summers & Wolfe, 1976), limited data have slowed the accumulation of empirical studies. Since the mid-1990s, intradistrict analyses have increased with maturing data systems (e.g., Berne & Stiefel, 2004) and laborious data collection (e.g., Roza & Hill, 2004). Several studies have found that intradistrict resource variation is as great as or greater than interdistrict variation (Hertert, 1996; Rubenstein, 1998; Lankford, Loeb & Wyckoff, 2002). This growing body of research has revealed substantial differences between schools in per-pupil funding (Condron & Roscigno, 2003; Owens & Maiden, 1999; Schwartz, 1999), centrally administered programs (Roza, 2010), teacher qualifications (Lankford et al., 2002; Betts, Reuben & Dannenberg, 2000; Pesky & Haycock, 2006), and teacher compensation (Roza & Hill, 2004; Roza, 2010; Education Trust West, 2005). This research includes mixed findings regarding the intradistrict distribution of funding, but consistently shows that schools with more poor, non-White and low-performing students have lesser-qualified and lower-paid teachers (Roza, 2010; Miller & Rubenstein, 2008). An important concomitant finding included in many of these studies is a teacher quantity/quality trade-off in schools with high proportions of disadvantaged students who receive lower-salaried and lower-qualified teachers, but have more teachers per pupil (Rubenstein, 1998). Such tradeoffs are important because they might balance per-pupil resources, in terms of expenditures or quality, despite differences in average teacher salary.

Unlike interdistrict equity analyses, teachers are a primary focus in much of literature on intradistrict equity. Teachers are important not only because they are the most powerful school-related predictor of student achievement (Rice, 2003), but also because they represent the largest component of school spending (Loeb, Miller, & Strunk, 2009) constituting approximately 75% of school operating expenditures (Roza, 2010). Teachers are particularly important for intradistrict resource equity because unlike most other resources, teachers play a direct role in determining which schools they work in.

When higher paid teachers concentrate in particular kinds of schools, they directly influence the distribution of resources between schools. Researchers have identified several sources of within-district resource variation, and principal among these are between-school differences in average teacher compensation expenditures (TCE) (Roza & Hill, 2004; Roza, 2010; Miller & Rubenstein, 2008; Goldhaber, 2008).

Intradistrict differences in TCE are partly due to teacher sorting, which is a function of teacher workplace preferences (Imazeki, 2005; Boyd, Lankford, Loeb, & Wyckoff, 2005b), and are facilitated by an array of commonplace district budgeting and allocation policies. Districts typically use a process called *staff-based budgeting* to allocate resources to schools (Odden & Picus, 2004). Districts allocate staff positions to schools using district formulas that are based on the number of students enrolled and their compensatory needs. The compensation for these positions constitutes the bulk of operating expenditures (Roza, 2010). Teachers preferences to teach in schools with fewer poor, non-White and low-performing students (Hanushek, Kain, & Rivkin, 2004), coupled with district policies such as seniority based transfer privileges and “last in, first out” (LIFO) staff reductions (Sepe & Roza, 2010), concentrate more highly qualified teachers in some schools (Roza, 2010).

Generally, single salary schedules define teacher pay. Under single salary schedules, teacher pay increases with experience and education, such that schools with more highly qualified teachers receive more TCE per teacher. One practice that complicates the evaluation of intradistrict TCE is “district salary averaging” in which school budgets are calculated by multiplying the number of full time equivalent (FTE) teachers by the district-average teacher salary. Based on this practice, most school-level budgets do not reflect the actual salaries going to schools and thus researchers seeking to examine actual salary data have had to limit analyses to the few districts where real salary school-level data are available or laboriously reconstruct school budgets from the ground up (e.g., Miller & Rubenstein, 2008; Roza, 2010). Where scholars have been able to evaluate intradistrict distributions of TCE using real salary data, they have found substantial TCE differences. Such analyses most often examine large urban districts (Argue, Honeyman, & Schlay, 2006; Roza & Hill, 2004; Rubenstein, 1998; Stiefel, et al., 1998), but some have examined wider ranges of districts in a single state (Miller, 2010; Education Trust West, 2005), as well as mid-sized districts (Miller & Rubenstein, 2007). All these studies have shown significant TCE variation between schools. Specifically, these studies show that schools with more non-White, poor and low-performing students often have below-average teacher salaries (Roza, 2010). Between-school TCE differences are substantial, with average school differences constituting roughly five percent of budgets, regularly totaling over $100,000 and in some instances close to $1 million (Roza & Hill, 2004; Education Trust West, 2005; Miller, 2010).

The findings of intradistrict TCE analyses are compelling; however, important empirical and conceptual gaps remain in this nascent literature. First, with most analyses limited to select large districts (e.g., Roza & Hill, 2004), the proportions of districts that have substantial gaps in TCE remain unclear, as do the relationships between-district characteristics and overall TCE variation. Second, most intradistrict studies have focused on the schools at the tails of the district teacher compensation spectrum (e.g., Education Trust West, 2005), revealing compelling findings but providing little evidence on how many schools are affected in districts with substantial TCE variation. Extending the breadth of the analyses on variation in TCE would help fill these gaps. Further, while research has repeatedly shown associations between TCE differentials and student poverty, race/ethnicity, performance, and geography, the research base has been too thin to quantify these relationships with specificity. School-level data on real salaries across many districts would allow for multivariate analyses of these relationships.

Third, intradistrict studies have used inadequate measures of TCE. Most measure TCE using school-level average teacher salaries without controlling for differences in pupil-teacher ratios or the compensatory needs of schools' students. Without such controls, average teacher salaries are difficult to evaluate based on the horizontal, vertical, and EEO equity principles used in school finance research. Pupil-teacher ratios are essential to evaluating equity because of the quantity/quality trade-off found in many intradistrict analyses. Average teacher salaries could differ substantially between schools even while quantity/quality trade-offs make per-pupil teacher compensation equitable. Controlling for students compensatory needs is also essential because districts may legitimately allocate additional teachers to schools with higher populations of disadvantaged students. Compensatory allocations of teachers would drive the pupil-teacher ratios down and per-pupil measures of TCE up in these schools. As a result, comparisons of per-pupil measures of TCE could appear equitable when in fact they are a product of compensatory allocations made on top of inequitable base allocations.

The research on TCE is important because it highlights a potentially substantial school finance equity issue. However, the limits to this research in terms of scope—the number of districts, and the proportion of schools within those districts, that have been evaluated— and measurement—the reliance on average teacher salaries which are ill fit for equity standards— have left substantial empirical and conceptual gaps which have yet to be adequately addressed.

Purpose of the Study

With this dissertation study, I intend to fill some of the empirical and conceptual gaps in the literature on the intradistrict distribution of teacher compensation. In this study, I will extend the empirical evidence on the intradistrict distribution of TCE by examining population data on teachers in 16 states included in the 2006-07 Teacher Compensation Survey (TCS) data from the National Center for Education Statistics (NCES). I will supplement the TCS data with data from NCES's Common Core of Data (CCD), the National Longitudinal School-Level State Assessment Score Database (NLSLSASD), and administrative records from state departments of education. In this study, I will statistically adjust measures of TCE for between-school differences in pupil-teacher ratios and student compensatory needs. These adjustments improve the TCE measures in this study in comparison to average teacher salaries because they allow for clear application of equity principles. By analyzing the distribution of these adjusted measures of TCE, this study will reflect the intradistrict distribution of teachers more accurately than previous research. Further, with data on a large number of districts and schools, I will be able to apply multivariate analyses to determine what district and school characteristics are associated with intradistrict variation in TCE.

Conceptual Framework

The conceptual framework (graphically illustrated in Figure 1) that guides this study is based in the literature on district resource allocation. This framework includes the relationships between school and district characteristics hypothesized to relate to the intradistrict distribution of teacher compensation expenditures (TCE). Conceptually, I define TCE as the total expenditures for instructional staff compensation at a given school.[2] Within schools, TCE is a function of the number of positions allocated to a school by the district (arrow *a*) and the qualifications of the teachers who fill those positions. Largely based on school characteristics, district formulae determine the number of positions allocated to schools, illustrated by arrow *d* influencing arrow *a*. School characteristics include total enrollment, the percentage of students with compensatory needs, and the school level.

Under single salary schedules, teacher qualifications largely determine teacher salaries. Thus, a fundamental relationship in this conceptual model is that between teacher sorting, illustrated by arrow ***b*,** and TCE. Research shows that teacher qualifications vary across schools, and that this variation, or teacher sorting, is driven in part by teacher preferences for schools with fewer low-performing, poor and non-White students. Since, on average, teachers prefer schools with certain characteristics, schools with those characteristics enjoy a greater supply of applicants compared to less-preferred schools. Assuming that school administrators prefer to fill positions with more highly qualified candidates, the schools that are most attractive to teachers will have a hiring advantage in the teacher labor market (Goldhaber, 2008). Over time, this hiring advantage allows more higher-qualified and higher-salaried teachers to concentrate in

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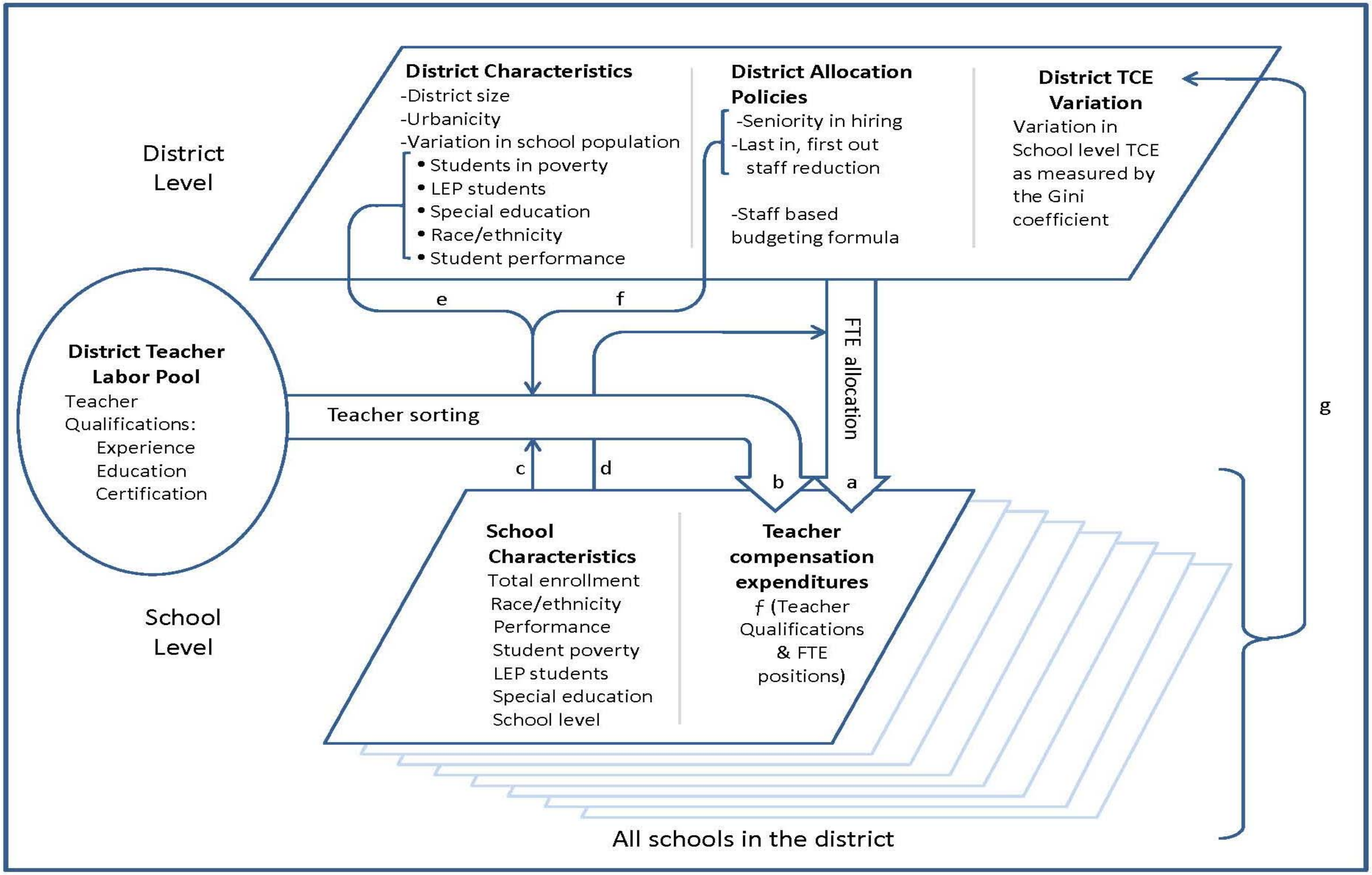
[2] In the analyses for this study, I measure TCE using teacher salaries. Total compensation would include salaries, bonuses and benefits; however, salary is a good proxy for total compensation and is a better measure across districts and states than total compensation, since the proportion of benefits to salary will vary substantially across districts.

preferred schools. In the figure, teachers' preferences for certain school characteristics influence how teachers sort themselves, as depicted by arrow *c* influencing arrow *b*. For example, schools with high proportions of low-performing students may lose higher-qualified teachers to schools with more high-performing students. If lower-qualified and lesser-paid teachers replace these teachers, TCE differentials would grow. The literature on teacher sorting has shown school characteristics that relate to teacher sorting include the proportion of students in poverty, limited English proficient (LEP), non-White, special education, and low-performing students, as well as administrator quality, Title I status, and AYP status (Lankford, et al., 2002; Hanushek, et al., 2004; Boyd, Lankford, Loeb, & Wyckoff, 2005a; 2005b; Clotfelter, Ladd, & Vigdor, 2005; Imazeki, 2005; Scafidi, Sjoquist, & Stinebrickner, 2007).

The district-level hypothesis relates to contextual effects that can affect teacher sorting and thereby affect a given school's variation in TCE from the district TCE average. For instance, larger districts and districts with greater variation in school characteristics have more schools and/or greater differences between schools that provide a context where teachers' preferences increase teacher sorting, as illustrated by arrow *e* influencing arrow *b*. In districts with few schools or few perceivable differences between the schools, teacher preferences and teacher sorting may be less pronounced. Thus, TCE variation may be low. Similarly, district policies such as seniority hiring privileges and "last in, first out" staff reduction practices can potentially exacerbate teacher sorting, as illustrated by arrow *e* influencing arrow *b*. Total variation across districts, as measured by the district Gini coefficient of TCE, will be greater when differences between schools' TCE are greater, as illustrated by arrow *g*.

Figure 1. Conceptual model of the relationships of school and school district characteristics with school TCE and total district TCE variation.



Research Questions

Specifically, this study focuses on three research questions:

1. What proportions of school districts have substantial between-school variation in TCE as measured by the Gini coefficient? What district characteristics are associated with this variation?
2. What proportions of schools are affected by substantial TCE variations? What is the average magnitude of between-school TCE differentials? What school characteristics are associated with greater or lesser TCE?
3. Do legitimate student compensatory needs—such as poverty, special education status, limited English proficiency, and low performance—explain between-school TCE differentials? Does intradistrict variation in teacher qualifications explain away the influences that student compensatory needs have on these differentials?

Data Sources

The primary data for this dissertation come from the 2006-07 Teacher Compensation Survey (TCS), which includes universe data on the salaries of public school teachers in 17 states, and include 1.1 million records on 33% of the nation's teachers (Cornman, Johnson, Zhou, Honneger, & Noel, 2010). I will exclude Arkansas from the analyses because of missing district ids. The remaining 16 states provide measures of salary, demographics experience and education for 973,430 teachers in 29,770 schools (Cornman, et al., 2010). While the TCS is not nationally representative, it includes the population of schools and school district in many states and this NCES survey will substantially expand the empirical evidence on intradistrict TCE variation.

I will supplement the TCS data from three sources: the Common Core of Data (CCD), the National Longitudinal School-Level State Assessment Score Database (NLSLSASD), and data from state departments of education. The CCD is an annual data collection of NCES that includes data on all public schools in the United States. CCD data are provided by state education agencies and include name, location, level, school size, Title I status, urbanicity, racial composition and Free and Reduced Price Lunch participation at the school level.

The National Longitudinal School-Level State Assessment Score Database (NLSLSASD; www.schooldata.org) is collected and housed by the American Institutes for Research (AIR) for the National Center for Education Statistics (NCES). The NLSLSASD includes data from state testing programs across the US and includes state proficiency percentages at the school level for all states participating in the TCS for the 2006-07 school year. I will link the NLSLSASD to the TCS to include measures of school proficiency for multivariate analyses. I will further supplement TCS data with data provided by state education agencies to provide measures to estimate district allocation weights and other measures useful in examining the distribution of TCE. School-level data on the percentages of students qualified as special education or limited English proficient are not widely available. After requesting these data from all TCE participating states, I was able to obtain data for four: Colorado, Florida, Minnesota and Texas. I will focus the analyses in this dissertation on these four states because they are the states for which I have data sufficient for complete analyses.

Analytic Approach

As elaborated below in chapter three, I propose to adapt techniques used by Miles and Roza (2002), and Toutkoushian and Michael (2007) to calculate average district teacher allocation relationships. In this study, I will calculate the average relationships between school characteristics and the number of full-time equivalent teaching positions allocated to schools based on data from the population of schools in each district. I use these calculated district allocation relationships to create "*de facto* allocation weights" which I then use to weight the number of students in each school. The resulting per-pupil measures of TCE are adjusted for between-school differences in student compensatory needs. I use these district-specific weights to remove variance in schools' student populations' compensatory needs between schools within districts. By controlling for these differences in compensatory needs I can use these new measures to directly compare schools using horizontal and EEO equity standards. Since I use the *de facto* weights to control for district-specific "legitimate" vertical equity resource adjustments, any remaining between-school differences in the adjusted per-pupil TCE measures cannot be attributable to legitimate educational differences and will thus constitute horizontal inequities.

At the district level, significant variation in adjusted per-pupil TCE represents inequitable district TCE allocation. I propose to calculate Gini coefficients for adjusted per-pupil TCE for every district to gauge the magnitude and frequency of district TCE variation. At the school level, any systematic relationship between adjusted per-pupil TCE and school characteristics would constitute violations of the EEO equity standard.

Through statistically controlling for the district-average legitimate vertical allocations, this approach allows me to include both illegitimate characteristics such as student race/ethnicity and legitimate vertical characteristics, such as student poverty, in an EEO evaluation. The adjustments to per-pupil TCE remove legitimate differences due to vertical characteristics (e.g., student compensatory needs). Thus, any remaining systematic relationships between school characteristics and adjusted per-pupil TCE violate the EEO standard, even if they favor schools with higher proportions of students with compensatory needs. I will use descriptive statistics to gauge the magnitude and scope of school-level differences in adjusted per-pupil TCE. Further, I will use hierarchical linear models (HLM) with schools nested within districts to explore associations between school and district characteristics and school-level differences in adjusted per-pupil TCE.

Significance of the Study

Existing research on intradistrict resource variation has revealed important between-school disparities in total resources and in the quality, qualifications, and compensation of teachers. As accurate school-level data become increasingly available, new and more detailed research on intradistrict resource equity will inform policies on district resource allocation, federal Title I policy, and state compensatory programs as well. This study will expand the current empirical evidence on the intradistrict distribution of TCE by looking across hundreds of districts to identify the nature and scope of this variation.

This research will add conceptually to the research on intradistrict TCE differences by using a novel measure of intradistrict teacher compensation that examines

TCE per pupil after adjusting for school differences in compensatory needs. Taking advantage of the detail in the combined TCS and supplementary state data, this novel measure is a better basis for making equity comparisons than measures used in previous research. Additionally, this analysis will shed light on the teacher quantity/quality tradeoffs that are often discussed in previous literature, but never explored in depth. These analyses will be able to describe how often such teacher tradeoffs are apparent and whether or not they are the product of compensatory allocations.

The findings of this research may also contribute to understanding differentiated teacher pay programs. This study will not be able to evaluate the effectiveness or feasibility of such programs, but will examine the costs borne by schools below the district TCE per-pupil average— in terms of foregone teacher compensation expenditures— to fund above-average TCE in other district schools. Describing these costs can provide important contextual information for policies that differentiate pay to alter the distribution of teachers within districts.

This research will also add substantial new evidence to inform Title I comparability legislation. Discussed in greater length below, Title I requires that districts use Title I funds to "supplement, not supplant" an equitable base allocation of resources. More simply, Title I funds are intended to provide *additional* resources for students in poverty, and the "supplement, not supplant" requirement is intended to insure Title I resources are not used to balance inequitable base funding. However, currently intradistrict salary differences can be hidden by calculating school budgets based on district average salaries. This provision has been criticized and legislation aimed at ending this "comparability loophole" (Roza, 2008) was introduced in 2011 (http://bennet.senate.gov/newsroom/press/release/?id=8a0d02b5-17b8-4c00-bca9-29f407c1890). Since the very differences in teacher compensation that are the topic of this dissertation are the bases for these proposed changes to Title I comparability legislation, this new evidence will inform that policy and legislative discussion.

Most importantly, if the variation between schools using these novel measures of TCE is as significant as previous research suggests (e.g., Roza & Hill, 2004; Miller, 2010), the between-school differences in TCE described in this dissertation will amount to more than just differences in TCE. Sizable differences found in *ex post* analysis of TCE are not likely to be balanced by non-teacher resources and are thus likely indicators of overall resource inequities that shortchange schools with the neediest students. This study will broaden and deepen the understanding of intradistrict resource equity, in terms of teacher compensation specifically and overall resources as well, and will add to the literature on school-level equity in education.

The remainder of this dissertation consists of four chapters. In the next (second) chapter, I review literature that provides a context and foundation for this study. In the third chapter, I review the data and methodology for the dissertation study. In the fourth chapter, I present the results of these analyses. I discuss these results in the final chapter.

Chapter 2: Literature Review

The research presented in this literature review provides a context for this equity analysis of intradistrict teacher compensation spending. This chapter consists of four sections. The first section presents the equity framework that I will employ in this study. The second section describes typical district resource allocation practices and how those practices allow resources to vary across schools. This section also focuses on how teacher sorting affects intradistrict resource distributions, on the district policies that allow teacher sorting to advantage some schools, and the district policies and practices that keep such advantages hidden from view. The third section reviews the literature on intradistrict resource equity. This section begins by briefly reviewing research on the intradistrict distribution of non-teacher resources, which provides an important context for the research focused on the intradistrict distribution of teachers. The second half of this section contains a more specific review of research focused on three facets of the intradistrict distribution of teachers: teacher qualifications, teacher quality, and teacher compensation. The last part of the third section identifies several gaps in the research on the intradistrict distribution of teachers, with particular attention on the distribution of teacher compensation expenditures, and an examination of newly available data sources that I will use to fill those gaps. The fourth section summarizes the findings in the literature.

Equity Framework

Intradistrict disparities in the distribution of teacher resources across schools have potential implications for equity. Schools differ in their legitimate resource needs, and equity requires that resource distributions account for these differences. Because absolute between-school disparities in teacher resources are not necessarily inequities, evaluating resource equity requires judgments about the fairness of a distribution of resources. Such equity judgments require a framework that establishes clear standards for equity and defensible means of measuring a distribution against those standards. I present my equity framework for this study in two parts. In the first part, I review Berne and Stiefel's (1984, 1999) equity framework and the three equity standards defined in it, and discuss how I propose to apply the framework in an intradistrict analysis. In the second part, I discuss the approach I will use to measure equity in the distribution of teachers.

Berne and Stiefel (1984) defined a popular framework to evaluate school equity in their book *The Measurement of School Finance*. The authors developed the framework around four key questions: (1) Who is the basis for equity claims? (2) What resource objects should be equitably distributed? (3)What principal serves as the basis for equity? and (4) How shall equity be measured? In turn below, I review how scholars have answered these four questions in previous work on education resource equity.

Who is the basis for equity claims? Berne and Stiefel (1999) emphasize the roles of taxpayers and students as the foci of equity evaluations. Taxpayers are typically the focus in questions of state and district tax revenue and funding systems and have been a legitimate center of decades of school finance work aimed at improving fiscal equity across districts or providing students with the resources for an adequate education (Warner-King & Smith-Casem, 2005). Districts fund schools within the same district. Thus, within districts, schools share the same revenue sources and funding system. Since the funding system does not differ between schools as it does between districts, the focus on the taxpayer does not apply in intradistrict analyses as it does in interdistrict analyses. Students are the equity focus in this study.

Typically, children are the primary concern when discussing resource distributions based on the concerns that students have fair access to educational resources, and that they have access to the resources necessary for them to reach minimum levels of achievement or performance (Berne & Stiefel, 1999, p.10). However, in the current post-NCLB, high-stakes accountability environment, schools would also be a valid center for resource equity concerns. Specifically, since schools and schools' staffs are the locus of most accountability mechanisms and are held to similar standards (in terms of meeting AYP under NCLB, for instance), schools have a legitimate claim to equitable resources (Warner-King & Smith-Casem, 2005). Analytically, equity analyses that use the school as the primary unit of analysis (as this research proposes to do) can address resource equity for both students and schools. Although recent research has shown the school level is not necessarily the lowest level required to evaluate resource equity fully for students (Houck, 2006), the unit of analysis for this study is the school, and students and schools are the basis for equity claims.

What resource objects should be equitably distributed? Equity analyses often use dollar measures to capture resource object distributions because dollar measures can capture the entire range of resources. By comparison, evaluating teachers as resource objects is complex because, unlike dollars, teachers vary along an array of important dimensions (e.g., in terms of quality and qualifications), some of which do not directly related to their compensation. For reasons briefly reviewed above, and reviewed in more detail in section two of this chapter, the majority of dollar measures of resources that school districts report at the school level do not accurately reflect the actual amount of dollars that go to schools. In fact, researchers have found that teacher compensation substantially drives intradistrict resources differences, but that because school budgets are calculated using district average salaries, school budgets mask these between-school resource differences (Roza & Hill, 2004). Since the dollar measures used in school budgets do not accurately reflect the resources that go to schools, researchers require alternative measures that do reflect between-school differences to evaluate resource equity accurately.

In this dissertation study, I use administrative records of actual TCE at the school level to examine intradistrict resource equity. Administrative records accurately reflect differences in TCE across schools and enable me to analyze equity of TCE. However, these data do not include the entirety of school resources and therefore cannot serve as the basis for overall equity conclusions. Districts may allocate other school resources that balance unequal TCE distributions, thereby achieving overall resource equity in the face of apparent TCE inequity. This could be a clear limitation for this study. However, as I discuss in detail in section two of this chapter, there are reasons to doubt that districts make such balancing allocations to achieve overall resource equity. In fact, as the research reviewed in section three of this chapter shows, TCE differences between schools drive overall resource differences (e.g., Roza, 2010).Without accurate dollar measures that capture the actual resources going to schools, the distribution of TCE is a resource object worth analyzing.

What principal serves as the basis for equity? Berne and Stiefel include three equity principles in their framework: horizontal equity, vertical equity, and equality of educational opportunity (EEO). Horizontal equity requires that students who are similarly situated receive equal resources. In district-level horizontal equity analyses, researchers compare general or base funding per pupil (separated from compensatory or categorical funding), across similarly situated units to identify resource variation and measure its extent without regard to specific school or student body characteristics (Iatarola & Stiefel, 2003).

Vertical equity requires that students receive compensatory resources according to legitimate educational needs.[3] Within districts, legitimate student educational needs for compensatory funding typically include poverty, learning disabilities or giftedness, and limited English proficiency (Berne & Stiefel, 1999; Miles & Roza, 2002). Policymakers weight student needs when they target certain amounts of categorical compensatory funds (Miles & Roza, 2002). Vertical equity analyses of funding typically measure the distribution of base and compensatory funding against the average amount of compensatory need in districts or schools to determine if resources are distributed to meet differential student needs.

EEO holds that there should be no relationship between the distribution of resources and student characteristics not legitimately associated with educational needs (Berne & Stiefel 1999). EEO analyses examine the relationships between resources and student characteristics such as race or geographic location. For example, student race is

[3] There are multiple considerations for legitimate vertical equity differences, including the ability to benefit from additional resources, in the case of students, and the ability to pay, in terms of taxpayers (from a school finance, not a public finance perspective. See Berne & Stiefel, 1999, pp. 10-11).

not a legitimate educational need. Thus, under an EEO standard, resources should not systematically relate to the racial constitution of a district or school.

In the 1999 update of their framework, Berne and Stiefel (1999) added adequacy to their framework. Adequacy refers to a minimum level of resources sufficient to achieve educational goals reflected in accountability requirements. Although adequacy has become a primary focus of interdistrict finance research, the shift away from equity does not preclude considerations of resource equity. Within an adequacy framework, the equity of resource distributions above the adequacy floor still deserves consideration. Whether the resources available to districts are sufficient to meet basic education requirements is an adequacy concern and districts have the freedom to raise more revenue for education without harming students in other districts. For instance, if a locality approves higher tax rates to provide additional resources, there is no effect on students in other districts. Within districts, schools have the same funding source and, controlling for vertical equity differences between schools, they are entitled to an equal share of the finite pool of district resources. If all schools in a district have adequate resources, but some schools receive a smaller share of resources, again controlling for vertical equity differences, the district may meet the adequacy standard while failing to meet the horizontal equity standard. In addition, if the average resources across schools in a district are adequate, but the intradistrict distribution of resources is inequitable, schools that receive an inequitably lower share of district resources may have both inadequate and inequitable resources. Therefore, not in spite of, but apart from the adequacy of resources, resources equity continues to have a place in school finance and is central for intradistrict analyses (Toutkoushian & Michael, 2007).

How shall equity be measured? In this study, I use all three equity concepts to evaluate intradistrict resource equity. The first research question deals with horizontal equity. However, since schools have legitimate differences in compensatory needs (e.g., students with disabilities or limited English proficiency), unadjusted measures of teacher compensation are not a sufficient basis for horizontal equity comparisons. I apply the logic of vertical equity to adjust resource measures so that I can make horizontal equity comparisons between similarly situated schools. The simplest example of differences in need is numbers of students. A school with twice as many students as another would legitimately qualify for more resources. Thus adjusting the total measures of schools resources by the number of students (e.g., using per-pupil resource measures) is clearly an appropriate means to compare resources across similarly situated units. Adjustments that are more complicated are necessary to arrive at resource measures that are comparable, or similarly situated, betweens schools with varied proportions of students with legitimate educational needs, such as learning disabilities, or limited English proficiency. As described in detail in chapter three, this study will adapt techniques used in previous intradistrict studies (Roza & Miles, 2007; Toutkoushian & Michael, 2007) to adjust school resource measures and make comparisons of horizontal equity. Using the logic of vertical equity to adjust resource measures, this study will use the horizontal equity standard to evaluate district resource distributions.

I propose to use the Gini coefficient of the adjusted measures of TCE to evaluate the equity of TCE distributions at the district level. Described in more detail in chapter three, the Gini coefficient is a measure of resource inequality that ranges between zero (perfect equality) and one (perfect inequality). Many school finance analyses have used the Gini to evaluate horizontal resource equity (e.g., Hertert, 1999, Rubenstein, Ballal, Steifel & Schwartz, 2008), and most often a Gini of 0.05 is used as a benchmark for equality (Odden & Picus, 2004).

By examining schools nested within districts using the adjusted TCE measures, I propose to use the EEO standard to evaluate whether illegitimate student or school characteristics (e.g., student race, or poverty) are associated with greater or lesser resources. Specifically, I will measure schools dis/advantages in TCE as the schools' adjusted TCE differential from their district's adjusted TCE average. Since I control for legitimate resource inequalities using the vertical adjustments described above, any remaining systematic relationships between school characteristics and total resources would be violations of the EEO standard.

Framework summary. Berne and Stiefel's equity framework provides an excellent structure for these analyses. In this study, the equity concern is for schools and the students who attend them. Though it is an imperfect measure for evaluating overall resource equity, TCE is a resource object that districts should distribute equitably, and that can serve as an indicator of total resource inequity. I propose to employ all three of Berne and Stiefel's equity concepts to evaluate intradistrict distributions of TCE. I will adjust measures of TCE for vertical equity adjustments that districts make when allocating teachers to schools in order to evaluate the horizontal equity of TCE within districts and the EEO of TCE across the schools in those districts.

Understanding how districts allocate resources in general, and teachers in particular, to schools is fundamental to understanding how TCE varies within districts, why most school-level resource data do not reflect this variation, and why TCE equity is worth examining. The following section of this literature review examines how districts typically allocate resources to schools. This section provides context for my review of the literature on the intradistrict distribution of teachers and for the methods I use to evaluate intradistrict TCE equity.

District Resource Allocation

District resource allocation processes, specifically those related to teachers, are fundamental to evaluating the equity of school-based distributions. This section of the literature review has five subsections that provide context for this study because it explains typical district roles in resource allocation and typical district data systems. The first subsection provides an overview of how revenues flow into districts and how districts use those revenues to provide resources to schools, with particular attention to the provision of teachers. The second subsection reviews several sources of intradistrict resource variation that often thwart the equity intentions of district allocation systems. The third subsection looks in detail at teacher sorting as a source of intradistrict variation, which is a central element of this study. The fourth subsection reviews how commonplace district practices and data systems often mask intradistrict resource differences. The fifth subsection examines the plausibility that districts allocate non-teacher resources to balance between-school differences in the allocation of teachers. The literature review concludes with a summary of district resource allocation.

Typical district resource allocation. School districts have a central role in school finance. Districts receive funds from a combination of local, state and federal sources and use those funds to centrally provide resources for use in schools. Historically, school districts received funds primarily through local property taxes. Since tax bases and rates varied substantially between localities, the ability to raise local revenues to pay for education also varied. States have addressed these local tax revenue differences through state aid formulas that allocate funds to districts. The goal of the formulas has been to achieve financial equalization between districts or to ensure that students in all districts receive resources sufficient for an adequate education (Odden & Picus, 2004). States have provided additional aid targeted to meet school needs through a variety of means, including per-student allocations, competitive grants, flat grants, targeted compensatory funds, cost sharing or reimbursement, staff-allocations, and funds for specific services (Roza, Guin, & Davis, 2007). The specifics of state aid varied substantially from state to state.

Similar variance was present in federal aid allocations. Historically, the federal government awarded funds to districts for specific programs to serve student populations with additional educational needs (e.g., students in poverty or with disabilities) based on student population driven formulae. These federal allocation attempted to promote equitable (on vertical equity grounds) and sufficient levels of funding. Over the years, federal and state agencies have funneled aid to districts through a multitude of programs with program-specific accounting requirements (Miller & Rubenstein, 2010). Consequential to these various accounting requirements was using the district as primary accounting unit and resulting data that reflected district-level resource measures, such as total expenditures per pupil (Roza, 2010; Guthrie, 2007). Though incentives to track resources and expenditures to schools are currently mounting, historically districts have not had reason or capacity to track funding to the school level. In large part this is because most districts do not actually "fund" schools, they "resource" schools (Roza, Miller, & Hill, 2005). Rather than provide funds for schools to procure goods and services, districts "resource" schools by centrally acquiring, accounting for and providing schools with staff, services, and supplies. In fact, districts account for the inventory of school-level resources rather than the actual expenditures for the resources. Consequentially, measures of school-level funding have often inaccurately reflected school resources (Roza, 2010).

Most districts allocate staff to schools through a process called *staff based budgeting* in which districts allocate full time equivalent (FTE) positions, not dollars, to schools according to district formulae (Odden & Picus, 2004; Rubenstein, et al., 2007). Districts allocate a base of non-instructional staff, such as a principal and a minimum number of administrative staff, to every school. Districts use staff-based budgeting formulae to determine the number of teaching positions at a school based on the number and the type of students attending. Districts weight students with compensatory educational needs (e.g., special education or LEP students) more heavily than students without such needs in district allocation formulas so that districts will allocate appropriate additional resources to schools with legitimate additional educational needs. Further, districts assign additional administrative and guidance staff based on formulas similar to those that determine teaching positions (Roza & Miles, 2002).

Federal and state categorical programs provide districts with additional resources to meet students' compensatory educational needs. Categorical aid carries spending constraints. For instance, the federal government constrains Title I funding through a comparability requirement that requires districts to use Title I funds to "supplement and not supplant" state and local funds. In other words, districts should add Title I funds to already equitably distributed state and local general funding, not replace the state and local funding. Districts can use categorical funds to provide additional teaching and instructional aide positions to schools, to fund central district staff or programs, or to provide non-staff resources to schools (Odden & Picus, 2004). After meeting the minimum funding constraints, districts have substantial leeway in how they target categorical funds (McClure, Wiener, Roza, & Hill, 2008). For instance, one district might target Title I funds to high-poverty elementary schools, while another might evenly distribute funds across all schools according to the proportion of students in poverty. The resources districts purchase with Title I and other categorical funds also vary. A recent GAO study suggested that many districts spend the vast majority of their Title I dollars to supply additional teaching staff to schools (GAO, 2011).

Categorical aid programs and commonplace district allocation mechanisms are intended to allocate resources to district schools equitably. School based budgeting in particular is designed to equitably allocate teaching positions to schools according to student need. However, despite the intent of their designs, these mechanisms still allow substantial intradistrict resource differences to develop (Guthrie, 1997, 2007). Researchers have identified several sources of "unintentional" intradistrict resource variation, by which I mean variations that function outside the designs of district allocation systems. These sources of resource variation not only work apart from, but often in spite of between-school differences in legitimate educational needs. In the following section I overview these unintentional sources of intradistrict resource variation.

Sources of intradistrict resource variation. Resources allocations vary across schools intentionally and unintentionally. Districts vary resources intentionally when they allocate additional resources to meet particular program requirements or to meet student compensatory needs. This subsection focuses on unintentional sources of intradistrict resource variation that allow resources to concentrate in some schools despite the intentions of district allocation mechanisms. Researchers have identified at least three primary sources of unintentional intradistrict resource variation: uneven school use of centralized district staff and services, extra-formulaic allocations of teaching positions, and heterogeneous distributions of teachers across schools (Roza, 2010).

The first of these sources of variation involve centralized services and district-based staff. School budgets reflect only a portion of the actual operating expenditures at a school (estimated between 40 and 60 percent) (Roza & Hill, 2007; Cohen & Miller, 2011; Miller, Roza & Schwartz, 2004). Centralized services constitute a large portion of the remainder. The incomplete attribution of centralized expenditures to the school level is important because districts intend for centralized staff to serve schools equitably based on schools' needs. However, the proportion of staff time and amount of services received at different schools can vary widely for reasons unrelated to school needs. Districts rarely track the use of centrally controlled staff at the school level (Miller & Rubenstein, 2008), but anecdotal evidence suggests substantial differential expenditures across schools. Studies have shown that districts unevenly distribute the assignment of centralized district staff members across the schools within a district (Roza & Hill, 2007; Roza, 2005; Roza & Miles, 2002). For example, Roza and Hill (2007) found a school psychologist assigned to many district schools who, based largely on her own preferences, primarily served a small number of the schools in the district and never served others. Similarly, in another district Roza and Hill found substantial differences such that one district school received more than $3000 per pupil in central services compared to $400 per pupil in another. Again, the authors attributed these differences in centralized services to staff preferences, instead of intentional allocations. The variation in the deployment of these centrally held resources can be substantial and can exacerbate resource allocation inequities that already exist.

A second source of unintentional resource variation is extra-formulaic staff allocations. Extra-formulaic staff allocations can run counter to the allocation design embedded in district formulae and may have a substantial impact on the share of per-pupil resources in schools. In theory, districts allocate extra staff to schools with particular programming needs based on district formulae. However, in practice, districts also allocate extra-formulaic staff for illegitimate reasons, such as in response to vocal students and parents, savvy principals, or school officials that have political influence in district offices (Miles & Roza, 2006). The effect of each extra-formulaic FTE at a school is a substantial reduction in the pupil-teacher ratio and an increase in per-pupil resources. In some districts, extra-formulaic allocations result in between-school differences in pupil-teacher ratios equivalent to more than $5,000 in per-pupil spending (Roza & Hill, 2007). Once a district commits these resources to a school, they tend to remain, even if the original reason for the allocations no longer exists, and thereby perpetuate resource variations (Roza, 2005; Miles, Ware & Roza, 2003).

The most significant source of illegitimate intradistrict resource variation, and central to this study, is the heterogeneous distribution of teachers across district schools, or more simply, teachers sorting across schools. District policies that govern school hiring practices and the matching of teachers to schools allow teacher workplace preferences and school administrators preferences for higher qualified teachers to influence the distribution of teachers across district schools. Teacher preferences can result in a predictably skewed distribution such that teachers with above-average qualifications and salaries concentrate in more “attractive” district schools, leaving less “attractive” schools with lesser-qualified and lower-salaried teachers (Roza & Hill, 2004; Clotfelter, Ladd, Wheeler, & Vigdor, 2006). While I review the findings of research on the distribution of teachers in detail in sections two and three below, I review here the mechanics of district policies, including staff-based budgeting (described above), single-salary schedules, seniority transfer privileges, and LIFO staff reduction. These district policies facilitate teacher sorting and lead to intradistrict resource variations (Rubenstein, et al., 2007; Roza, 2005).

The mechanics of teacher sorting. The vast majority of school districts in the U.S. public school system use single salary schedules that typically base teacher pay on certification, experience and education (Stronge, Gareis & Little, 2006). Districts allocate teaching positions to schools. The schools are then able to recruit and hire the most qualified (and more expensive) teachers to fill the open positions with no fiscal impact at the school level. Within districts, there is no between-school difference in salary; hence, teachers are attracted to schools for non-pecuniary reasons. Non-pecuniary teacher preferences can vary across district schools (Clotfelter, et al., 2006; Hanushek, Kain & Rivkin, 2004). These preferences are numerous and include class size, school leadership, school climate, location, composition of the student body, the availability of resources and student behavior (Rice, Rollke, Sparks & Kolbe, 2009).

Researchers have documented numerous non-pecuniary teacher preferences for school placements. Teachers often prefer schools with higher proportions of non-poor and higher-achieving students. White teachers show some preference for low-minority schools. Teachers working in schools with more disadvantaged students (high-need schools[4]) are more likely to leave their school district or to transfer within the district to schools with fewer disadvantaged students (Lankford, et al., 2002; Hanushek, et al., 2004; Boyd, Lankford, Loeb, & Wyckoff, 2005a; 2005b; Clotfelter, Ladd, & Vigdor, 2005; Imazeki, 2005; Scafidi, Sjoquist, & Stinebrickner, 2007; Feng, 2010; Clotfelter, Ladd, Vigdor, & Diaz, 2004; Feng, Figlio, & Sass, 2010). There are many reasons for teachers' preferences. For example, evidence indicates that teachers in higher-poverty schools experience more negative student behavior issues, have access to fewer resources, and experience less teacher support than those in lower-poverty schools (Smerdon 1999). Accountability pressures and the stigma attached to schools designated as "low performing" can exacerbate the problems that schools serving low-achieving student populations face in retaining high-quality teachers (Feng, Figlio, & Sass, 2010). Further, school leadership has proven to be one of the strongest influences on teacher retention (Boyd, Grossman, Ing, Lankford, Loeb & Wyckoff, 2009), but principal sorting is influenced by the same non-pecuniary aspects of schools that sort teachers. Principal sorting may strengthen teacher sorting patterns (Clotfelter, et al, 2007; Loeb, Kalogrides

[4]The term "high-need school" refers to schools with higher proportions of poor minority and low performing students, and "low-need schools" refers to schools with lower proportions of the same.

& Horng, 2010) Simply put, teacher preferences moderate school staffing such that some district schools are much more attractive to teachers than others (Roza, 2010).

The staffing advantages that "attractive" district schools enjoy are often disadvantages for other district schools. Research on teacher transfers shows that when teachers move between schools within a district they tend to "trade up" to schools with fewer poor and minority students, and higher school achievement than the schools they leave (Clotfelter, et al., 2007, Lankford, et al., 2002; Hanushek, et al., 2004). Further, the schools least preferred by teachers often have the most open positions and the most difficulty hiring. For instance, schools in more urban locales suffer from greater attrition rates than suburban and rural schools (Guarino, Santibanez, & Daley, 2006) and have more pointed perennial shortages of teachers particularly for mathematics, science, special education and bilingual positions (Imazeki, 2002). Even when urban and suburban schools have a similar number of vacancies, urban schools are much more likely to report these vacancies as difficult or impossible to fill (Imazeki, 2002). For instance, in a study of turnover in a single district, Guin (2004) found positions in high-turnover elementary schools had an average of five applicants per position compared to over 150 for low-turnover schools.

With fewer applicants for existing vacancies, schools with more attributes that run counter to teachers' preferences are more likely to hire less-experienced, lower-qualified and lower-salaried teachers. As teachers gain experience, higher percentages are likely to 'defect' from unattractive schools to schools that are more attractive (Imazeki, 2002). Research has shown as teacher experience increases the likelihood of moves within and across districts decreases, suggesting that inexperienced teachers may secure positions in easier-to-staff schools, gain experience and then move to more attractive district schools (Hanushek, et al., 2004). Teachers with less experience and lower salaries often replace the teachers that "trade up." In many districts, this pattern results in a "revolving door" effect that can perennially disadvantage some schools in terms of the qualifications of the teachers they receive and in terms of the total amount of teacher compensation spending that serves those schools (Hanushek, et al., 2004).

Many scholars site seniority transfer privileges as a significant driver of intradistrict disparities in teacher qualifications and experience (Moe, 2006; Stiefel, Rubenstein & Berne, 2006; Hanushek, et al., 2004). Seniority privileges provide teachers with access to open district positions before districts hire new and lower-salaried teachers and often give teachers with more seniority priority over less-experienced colleagues when filling open district positions (Boyd, et al., 2003; Warner-King & Smith Cassem, 2005). Senior teachers have more experience and higher salaries compared to less-experienced teachers. When seniority allows senior teachers to act on their preferences, "attractive" schools tend to have more-experienced and higher-paid teachers than less-attractive schools.

Periods of significant change in school staffing demand offer opportunities to observe the effects of seniority-based practices. For instance after statewide class-size reduction in California, there were many more open positions across schools, and seniority-based policies allowed qualified teachers to cluster much more quickly in the best schools, leaving less attractive schools understaffed (Clotfelter, Ladd, & Vigdor, 2008; Reichardt, 2000). When demand decreases such that schools must reduce staff, LIFO policies ensure that seniority is the primary determinant of which teachers get pink slips. Widely used LIFO policies generally dictate that reductions in force begin with teachers who have the least experience. In the National Center on Teacher Quality's purposive sample of 100 school districts, all districts factored seniority into layoff decisions and 75% of districts reported use of seniority as the primary factor (NCTQ, 2010). LIFO policies disproportionately harm hard-to-staff schools that have more inexperienced "last in" teachers, while they protect the more-experienced and more-expensive teachers (Sepe & Roza, 2010; NCTQ, 2010).

District allocation formulas are intended to distribute resources to schools fairly, but other common district policies reviewed here counter those intentions and create the potential for between-school resource differences (Guthrie, 2007; Miller & Rubenstein, 2008). Unfortunately, the sources of variation, particularly with respect to the distribution of teachers, often work to shortchange schools with more disadvantaged students (Roza, 2010). Policymakers have not been able to easily identify or address between-school differences due in part to common school budget reporting practices and district data systems that obscure intradistrict differences. I review these district practices and data systems in the following section.

District practices and data systems that mask intradistrict differences. A number of stakeholders have an interest in intradistrict resource equity. Students, parents and the public would rightly be concerned if some schools were systematically disadvantaged. Ideally, district officials would want to be able to identify maldistributions of resources, identify their sources, and redress them. Researchers, too, are interested in gauging resource equity for equity's sake alone, as well as to evaluate the relationships between resources and educational productivity appropriately. Unfortunately, typical district budget reporting and data collection systems make it difficult for the public, district officials, or researchers to assess the intradistrict distribution of resources effectively. Published school budgets should reflect the distribution of district resources, but districts often calculate school budgets using district salary averages that mask between-school variation in teachers' salaries (Roza & Hill, 2004; Roza, 2010). The resultant school budgets inaccurately reflect the resources that serve different schools. Thus, the public has no clear vantage on intradistrict equity. Similarly, researchers who evaluate equity using flawed budgets cannot arrive at sound conclusions about equity. District data systems do contain reams of information about school resources. However, in most districts the data systems are incapable of providing district officials with a clear view of what resources go to which schools (Roza, 2010). The insufficiency of these data systems hampers district officials' capacity to identify and redress resource maldistributions (Miller & Rubenstein, 2008; Roza & Hill, 2004; Roza, 2010). Except for a few intrepid researchers, the opacity of these data systems has made intradistrict resource evaluations impractical if not impossible.

I present the remainder of this section on district reporting practices and data systems in four parts**.** In the first part, I discuss how districts erroneously report school budgets using district salary averaging. Next, I discuss how district data systems have historically been unable to accurately record and report comprehensive resource data at the school level. The third part examines the challenges that these data systems pose for district officials who want to allocate resources equitably. The fourth and final part examines the challenges data systems pose for researchers seeking to evaluate intradistrict equity.

School budget reporting using district salary averages. Most districts calculate and report school budgets using district salary averages (Roza, 2010). Instead of reporting the sum of the actual salaries of school staff, districts multiply the number of FTE staff by the district average salary and report the product in school budgets (Odden & Picus, 2000; Berne & Stiefel, 2000; Roza, 2005, Roza, Guin & Davis, 2007). District salary averaging accurately reflects the district's expenditure, since districts pay all teachers, but erroneously reports school resources. While scholars have challenged this practice, most districts use district salary averaging which systematically underreports intradistrict resource differences (Roza, 2006, 2010).

Widespread use of district salary averaging is reified by language in the federal Title I accountability rules that explicitly allow districts to satisfy the Title I comparability provision using salary averages.[5] The comparability requirement for federal Title I funds requires that Title I funds supplement and not supplant base state and local funds which should be comparable across district schools. The law reads:

> (b) FEDERAL FUNDS TO SUPPLEMENT, NOT SUPPLANT, NON-FEDERAL FUNDS.—
>
> (1) IN GENERAL.—A State educational agency or local educational agency shall use Federal funds received under this part only to supplement the funds that would, in the absence of such Federal funds, be made available from non-Federal sources for the education of pupils participating in programs assisted under this part, and not to supplant such funds…
>
> (c) COMPARABILITY OF SERVICES.—
>
> (1) IN GENERAL.—
>
> (A) COMPARABLE SERVICES.—Except as provided in paragraphs (4) and (5), a local educational agency may receive funds under this part only if State and local funds will be used in schools served under this part to provide services that, taken as a whole, are at least comparable to services in schools that are not receiving funds under this part.

[5] For the full text of the Title I provisions see: www2.ed.gov/policy/elsec/leg/esea02/pg2.html#sec1120

(B) SUBSTANTIALLY COMPARABLE SERVICES.—If the local educational agency is serving all of such agency's schools under this part, such agency may receive funds under this part only if such agency will use State and local funds to provide services State and local funds to provide services that, taken as a whole, are substantially comparable in each school.

However, the Title I regulations that determines how localities must satisfy this comparability allows for the use of district salary averaging and specifically removes between-school salary differences based on teacher experience from the written assurance requirements. The law reads:

(2) WRITTEN ASSURANCE.—

(A) EQUIVALENCE.—A local educational agency shall be considered to have met the requirements of paragraph (1) if such agency has filed with the State educational agency a written assurance that such agency has established and implemented—

(i) a local educational agency-wide salary schedule;

(ii) a policy to ensure equivalence among schools in teachers, administrators, and other staff ; and

(iii) a policy to ensure equivalence among schools in the provision of curriculum materials and instructional supplies.

(B) DETERMINATIONS.—For the purpose of this subsection, in the determination of expenditures per pupil from State and local funds, or instructional salaries per pupil from State and local funds, staff salary differentials for years of employment shall not be included in such determinations.

The allowance of district salary averaging in Title I reporting, known as the "Comparability loophole", supports the local use of district salary averaging in calculating school budgets (Roza, 2010). The federal and local use of district salary averaging results in school budgets that under-report intradistrict resource differences and allows districts to allocate federal Title I funds to schools and students who are outside the original policy intent (Roza, 2010; Center for American Progress, 2008).

Districts' budget reporting practices are not the only impediment to uncovering intradistrict resource differences. District data systems rarely track real expenditures to the school level, thus school-level data poorly reflect the actual resources that go to schools (Guthrie, 2007; Roza, 2010). The following section details the limits of most school-level data systems and the resultant budget reporting practices that hide many intradistrict resource gaps.

District data systems. Concerns over school data systems are not new. In 1994, Berne and Stiefel wrote about the pressing need for quality student- and school-level data for the study of educational productivity, resource equity and resource allocation. They described the then current deficiencies in education agency data-collection systems and outlined a strategy to gather better data. Despite growing calls for school-level data among researchers, state and district data systems have been slow to answer. Guthrie's, 2007 lament of the current state of data availability echoed many of the concerns he voiced twelve years earlier (Guthrie 1997). The limits of school-level data come in to sharp relief when compared to widely available district data. Understanding why sufficient school-level data are typically unavailable helps make sense of the limits to analyses of intradistrict resource distributions, and the lack of available data is in large part a product of a district-centric school finance structure.

The culture surrounding state and district data systems has been one built for compliance rather built for better decision-making (Gazzero, 2008). Districts track revenues to meet the varied legal and accounting requirements associated with the multiple revenue streams they receive (Palaich, Good, & van der Ploeg, 2004; Roza, et al., 2007; Guthrie, 2007). Accounting requirements have been a direct incentive for districts to track revenues by their source (making district-level data on funding readily available) (Miller, Roza, & Schwartz, 2004). Before recent changes at the federal level (discussed below) districts had not had comparably powerful incentives to track resources to the school level (Guthrie, 2007). Since districts are the operational unit for resource allocation, accounting, and budget reporting, funding agencies do not treat schools as accounting centers. Thus, it is relatively easy to know how much is spent on teachers at the district level, but not how those compensation dollars are distributed across schools (Roza, et al., 2006; Miller, et al., 2004).

The availability of school-level data is on the rise. Federal programs and research groups have challenged the culture of compliance (Data Quality Campaign, 2010). Several recent federal policies, including the No Child Left Behind Act (NCLB), Race to the Top grants, and data reporting requirements attached to American Recovery and Reinvestment Act (ARRA) funds are all federal policies that encourage data system modernization and require school-level data reporting. Additionally, watchdog groups like the Data Quality Campaign have raised the profile of education data issues (http://www.dataqualitycampaign.org/). Federal data collection efforts are also pressing states for more detailed school-level data. For instance, the ED's Office of Civil Rights (OCR) biannual data collection now requires states to report disaggregated school data including actual school-level teacher salaries, for nearly all of the nation's schools (Miller, 2010; See also http://ocrdata.ed.gov). Though progress has been uneven, specific states and select districts have led the way in modernized data systems and currently have data systems that allow district officials and researchers unprecedented access to the intradistrict distribution of resources (e.g., Florida). However, on a large scale, states and districts have not yet realized the promise of these data systems, and until school-level data is readily available, policy makers and researcher will continue to face the challenges posed by available data systems.

Do district officials know what goes where in districts? District officials have significantly limited knowledge of resource distributions in their own districts. Complex district allocation and budgeting systems and the systems that record data on the resulting allocations pose significant problems for district leaders who want to ensure equitable allocation of school-level resources. The many compensatory funding streams and the accompanying web of disjointed accounting requirements make it difficult for district officials to maintain a "bird's eye view" of what money is going where. Further, in many districts base resource allocations (allocations made prior to additions from compensatory funding) are made independently of categorical allocations, and allocations from one source are not informed by allocations of the other (Miller & Rubenstein, 2008). Simply put, district finance is so complex that officials do not allocate supplementary resources in a way that is both systematic and comprehensive (Miller & Rubenstein, 2008; Roza, 2010). District officials' inability to know the full school-level resource picture inhibits their ability to ensure equity in initial resource distributions. Further, it makes it difficult for officials to identify under-resourced schools and then allocate additional resources to redress inequities.

District finance systems make it difficult for district officials to redress the intradistrict resource variation outlined above; however, some evidence suggests a deeper problem, that district officials may not understand that a resource allocation problem exists that requires redress. For instance, while some research has shown that teacher sorting drives intradistrict resource differences, other research suggests that district officials underestimate the impact of teacher sorting, and that they do not consider between-school differences in teacher qualifications when allocating teaching positions (Miller & Rubenstein, 2008; Roza & Hill, 2004). Two studies that interviewed district personnel about teacher-allocation practices, found that though each districts used single salary schedules and district salary averaging, all respondents indicated that they believed any differences in teacher qualifications and compensation between schools would be a wash (Roza & Hill, 2004; Miller & Rubenstein, 2008). In one of these studies, again without exception, those interviewed reported that they did not consider the distribution of teacher salary and qualifications during the resource allocation process (Miller & Rubenstein, 2008). Contrary to district officials' perceptions, both studies revealed that teacher sorting resulted in substantial between-school differences in teacher qualifications and teacher salaries in these districts.

Can researchers discover what goes where in districts? District data systems pose similar problems for researchers who try to evaluate the distribution of school-level resources retrospectively. Two major problems in these systems are that they do not reflect the full amount of resources going to schools and the school-level resource data are often inaccurate. Both of these challenges obstruct researchers' holistic view of what resources go where within districts.

As researchers have used them in interdistrict analyses, measures of per-pupil funding are potentially excellent resource measures at the school level. However, since districts do not typically track resources to schools, the reported school-level per-pupil funding measures only reflect a portion of the resources that actually go to the school. For instance, the Cross City Campaign for Urban School Reform found that in ten large districts the percentage of total district operating expenditures reported at the school level varied from 38 to 99 percent, with seven districts reporting 80 percent or less (CCCUSR, 2001). Working with incomplete resource data keeps researchers from accurately evaluating intradistrict resource equity or resource effectiveness (Miller, Roza, & Swartz, 2004). A second issue that researchers face when using school-level per-pupil funding measures are inaccuracies due to salary averaging. As previously discussed, district use of averages understates potential between-school differences in teacher salaries, which are the largest portion of school operating procedures. The result of these two problems is that school per-pupil funding data are usually incomplete and often conceal important between-school resource differences. Measures of per-pupil funding are a good way to evaluate resource distributions because they capture the entire value of the mix of resources in schools and allow for clear comparisons (Berne & Stiefel, 1999). However, since available school-level funding measures are problematic researchers have looked at the distribution of specific resources across schools. Chief among these resources are teachers, again due to their importance and expense (Roza, 2006, 2010). Unfortunately, data systems pose some problems for assessing the distribution of teachers as well.

Districts record data on funding, positions, qualifications, student records and teacher compensation. These data systems are not typically interoperable, meaning fragmented data systems make it difficult to connect multiple databases to supply researchers with data that is both comprehensive and accurate (Palaich, et al., 2004; Collins & Fruth, 2007; Goertz 1998, Guthrie, 2007; Gazzerro, 2008). For example, when officials in Maine assessed their states data system they found education information was located in 133 different isolated databases (Aarons, 2009). Faced with limited resources and with no incentive to undertake the significant task of redesigning unified data systems, districts have long been unable to make basic connections between data (Palaich, et al., 2004). Another challenge for researchers has been the inability to connect resources to their funding sources. In part, compensatory funds may pay for district-allocated positions with the remainder of the expenditure coverage coming from unrestricted operating funds (Roza, et al., 2007). Thus directly identifying which positions, or the proportion of positions, that were allocated by source is not easily done (Roza, Guin, & Davis, 2007; Roza, 2010; Miller & Rubenstein, 2008).

Since school-level measures of funding are incomplete and inaccurate, several analyses have examined equity by looking more narrowly at teacher compensation (e.g., Roza & Hill, 2004). Analyses of teacher compensation can yield valuable information on intradistrict resource equity because it is the largest portion of school operational expenditures (by some estimates 80% of a schools operating budget (Roza & Hill, 2004)) and because research has shown that variation in teacher compensation can drive between-school resource differences (Roza, 2005, 2010). However, equity conclusions based on *ex post* analyses of teacher compensation data alone implicitly assume that districts do not allocate other non-teacher resources to compensate for differences in teacher compensation. Any *ex post* analysis of per-pupil teacher compensation would capture the additional per-pupil teacher compensation coming from the allocation of additional staff positions, so this assumption would be limited to equity through non-teacher resources. Such an assumption is impossible to verify on a large scale, however the literature on district allocations provide reason to believe that districts do not compensate for differences in teacher compensation with non-teacher resources.

No mechanism balances TCE differences with non-teacher resources. There are two reasons to doubt that districts have mechanisms that compensate for TCE differences with supplemental allocations of non-teacher resources: their dubious feasibility as a remedy and the lack of evidence that such mechanisms are in use. First, since the expense of non-teacher resources is comparatively small, supplementing significant differences in teacher compensation would be impractical (Roza & Hill, 2004, Roza, 2005; Goldhaber, 2008). Empirical analyses of TCE differences have revealed average differentials between high- and low-poverty schools can be substantial; indeed, in some instances they constitute roughly 5% of total school budgets. At the extremes, the total between-school differences approach one million dollars per year (Miles & Roza, 2002; Roza & Hill, 2004; Education Trust West, 2005).

The principal means of balancing substantial differences would likely be to allocate more teachers, because most other educational resources are less expensive than teachers are and less important to the educative process. A reasonable response to balancing these differences would be to add another FTE teacher position, assuming additional investments in materials and technology in amounts sufficient to balance salary differences would likely be less educationally productive than additional teachers. For example, assume the average difference in TCE within a district is $72,500.[6] Arguably, non-teacher resources could balance the mean difference of $72,500, but in this district, the maximum school loss due solely to TCE differentials was over $260,000, an amount

[6] This figure is taken Miles & Roza, (2002) and is the lesser of the two district figures compared to $107,000 in a second district and the extreme in the second district was nearly $1,000,000.

that nothing short of additional staff would practically remedy. However, any *ex post* TCE analysis would capture any compensatory allocations of staff, as the differential in this example does. It is hard to imagine that non-teacher resources, even if allocated to balance TCE differences, would be a prudent, practical or probable remedy to compensate for differences at these dollar amounts.

One possible non-teacher resource that could practically balance these differentials is teacher's aides. While teachers' aides earn significantly less than teachers do, their compensation is large enough that district officials could allocate aides to balance differences in TCE spending. Researchers have shown that aides are not associated with increased student achievement, as increased teacher quality and reduced class-sizes are (Gerner, Finn, Achilles, & Boyd-Zecharias, 2001; Grissmer, Flanagan, Kawata, & Williamson, 2000), and some research suggests that spending dollars on teachers instead of aides is cost effective for increasing student achievement (Normore & Ilon, 2006). Despite evidence on the effectiveness of teachers' aides, they could balance differentials in TCE spending across schools, however this possibility is not very likely given the research on district allocation processes which show that districts typically allocate aides on a per-pupil basis using general funds or for specific student needs using compensatory funding (Rubenstein & Miller, 2008; Guthrie, 2007; GAO, 2011).

Beyond the probabilities of balancing compensation differences through non-teacher resources, there is no evidence of district allocation mechanisms that use non-teacher resources, including teachers' aides, to balance TCE differences exists (Roza, 2010). If districts compensated for between-school teacher differences, research on district allocation should reflect that district leaders understand that there are gaps in TCE and that there is an identifiable means to fill those gaps. Not only is there a lack of evidence of such a mechanism in research on district allocations (e.g., Miller & Rubenstein, 2008), but interviews with district officials have revealed that many doubt teacher differences amount to substantial inequities (Miller & Rubenstein, 2008). There are substantial resources going to several existing policies mechanisms aimed at addressing between-school teacher differences. For example, some states, districts, and federal programs provide bonuses or salary increases to draw teachers to hard-to-staff schools (Clotfelter, Glennie, Ladd, & Vigdor, 2008; Roza & Hill, 2004). While these policies are on the rise, they are only in place in a minority of districts. Importantly, *ex post* analyses of teacher pay would capture the additions such policies make to teacher pay. Districts would have to balance remaining differences in teacher compensation with non-teacher resources to achieve equity in per-pupil expenditures. The important point is that some policies are aimed at changing the distribution of teachers to improve equity when the contextual problem is rooted in the distribution of teachers, but that no such non-teacher based allocation mechanism is mentioned in the research on district allocations (Roza, 2010; Roza & Hill, 2004; Roza, 2005; Miller & Rubenstein, 2008). Without such a mechanism, it is reasonable to assume that substantial between-school differences in per-pupil teacher indicate inequities in overall resources (Goldhaber, 2008). Indeed these assumptions are implicit in many intradistrict teacher compensation studies (Roza, 2010; Roza & Hill, 2004; Education Trust West, 2005).

Summary of district resource allocation. Predominant school district resource allocation practices and policies are based on formulae that have a stated intent to provide resources to schools equitably based on legitimate between-school differences in educational needs. However, these allocation policies and practices are not foolproof, and research has shown these systems contain numerous sources of variation that thwart their design. In practice, districts allocate resources based on the preferences of district staff, parents, administrators and teachers, not according to legitimate educational needs. District accounting and data systems make it difficult to detect this variation, particularly in terms of TCE. The difficulties of these data systems not only pose challenges for researchers attempting to assess intradistrict equity, but also make it difficult for district staff to systematically and comprehensively allocate resources and staff according to legitimate school needs. Given that TCE is the primary school-level expense, that TCE differences drive intradistrict resource differences, and that there is no evidence of a mechanism to balance TCE differences with non-teacher resources, evaluating the intradistrict distribution of teachers and teacher compensation provides an important vantage for evaluating school equity in general.

In this section of the literature review, I have fully discussed the mechanics of district resource allocation, but have only tangentially addressed the findings of the research on the intradistrict distributions of resources these mechanism produce. In the following section, I review the findings of research that examines those distributions, and use that literature to contextualize this dissertation study.

The Intradistrict Distribution of Teachers

This section has five parts. The first part reviews research that has examined the intradistrict equity of broad resource objects, such as funding figures or arrays of multiple resources. While this research does not focus on teachers—the central focus of this study— it provides context for the research on the intradistrict distribution of teachers.

The remaining four parts focus on specific aspects of the distribution of teachers within districts. The second part of this section examines research on the intradistrict distribution of teachers focusing on teacher qualifications, both the qualifications directly related to teacher compensation and those less directly related to compensation but more closely associated with teacher effectiveness. The third part focuses on research that assesses the distribution of teacher effectiveness by looking at measures of teachers' value added. The fourth part looks at research on the intradistrict distribution of TCE. Since the distribution of TCE is central to this dissertation, and the limitations to extant research on TCE are fundamental to the methodology I present in the following chapter, I discuss the limitations to the extant research on TCE separately in the fifth part of this section.

Research on the intradistrict distribution of educational resources. For 40 years, scholars have assessed equity in school finance primarily between states and districts, primarily because available data systems support analyses at the state and district levels. Since the mid 1990s, the body of research on intradistrict equity and calls for improved school-level data began to increase. Berne and Stiefel's 1994 study applied their own equity framework to intradistrict equity and argued that the "dominance of the district as the unit of analysis in school finance equity" might change due to three factors. They argued that there was a growing "belief that the most critical educational activities are those closest to the student." That there was an increasing and "developing interest in studying the relationship between inputs, processes and outcomes, which were assumed to more effectively studies at the school level," and that data systems in the near future would make "the collection and review of school-level data both possible and palatable (p.405)." Berne and Stiefel's third observation has proven prescient and the frequency of intradistrict resource analyses has steadily increased.

Early intradistrict research dates to the 1970's (Owen 1972; Summers & Wolfe, 1976) and in the mid 1990's intradistrict analyses increased pointedly. The *Journal of Education Finance* committed an entire 1997 issue to intradistrict data and equity analyses, increasing the profile of the intradistrict equity problem. Intradistrict equity analyses increased with early advances in data systems (e.g., Berne & Stiefel, 2004) or laborious data collection (e.g., Roza & Hill, 2004). The following section reviews central studies on intradistrict resource distributions. Considering the variation in the design, samples, and approaches, these studies have remarkably consistent findings succinctly summarized in an article by Stiefel, Rubenstein, and Schwartz who wrote:

> "First, though evidence directly comparing school-level and district-level disparities is limited, the resource disparities found across schools within districts are often large and, in some cases, may be larger than the more widely-recognized disparities across districts. Second, these disparities are generally perversely related to school and student characteristics; schools with greater student needs often find themselves disadvantaged relative to other schools in the same district, particularly in terms of the quality of teacher resources. Third, these patterns are not caused by the intentional targeting of resources to lower-need schools…. these resource disparities are frequently the result of intradistrict funding formulas that allocate positions, rather than dollars, to schools, and teacher sorting patterns that allow higher paid teachers to systematically opt into lower need schools without financial ramifications for the schools to which they transfer (2004, p.11)."

The majority of intradistrict equity research has examined large and urban districts based on the logic that larger districts have more schools and substantial student diversity across schools and are more likely to both have resource variation and sufficient data to examine the variation statistically (Miller & Rubenstein, 2008). Looking measures of per-pupil funding, teacher qualifications and teacher salaries, these studies consistently found as much or more resource variation between schools within districts than the variation between districts (Burke 1999; Rubenstein 1998; Owens & Maiden 1999). Most studies found relationships between per-pupil funding measures and school characteristics such as student race and poverty level (e.g., Stiefel, Rubenstein & Schwartz, 2004). Many of these studies examine the distribution of teachers by a variety of measures, alongside measures of funding (e.g., Iatarola & Stiefel, 2003). Consistently these studies find that teachers' qualifications and salary vary across schools, and that schools with more low-performing, poor and non-White students tend to have the least qualified and lowest paid teachers (Lankford, et al., 2002). While this dissertation focuses on the intradistrict distribution of teacher compensation spending, the research on the distribution of other resources reviewed in this section contextualizes the more specific issues the distribution of teachers and teacher compensation.

School-level resource differences both within and across districts. Several studies have approached school-level equity by examining how much variation in school resources, variously defined, lay within districts, across districts, and in some cases between states. These studies establish that as much or more of the variation in school funding, as well as measures of teacher resources, lies within districts as it does between them. For instance, Burke (1999) examined school-level horizontal equity using a national dataset. Burke calculated Gini coefficients, a statistic that measures the equity in a distribution,[7] to measure variation in per-pupil funding and decomposed the Gini coefficient into between state, between-district and intradistrict variance components.

[7] The Gini coefficient is discussed in more detail in section 3.

Burke found most of the variation in expenditures and teacher student ratios within districts as opposed to across them. Comparatively little of the between-school variation was found between states or districts.

Owens and Maiden (1999) examined base and total per-pupil expenditures across elementary schools in Florida, again without respect to district boundaries. As Burke (1999) did, they found more variation between schools within districts and significant inequities. Using regression Owens and Maiden found that schools with more black and poor students received less base expenditures than other schools. After adding compensatory funds, Owens and Maiden found that districts (or the state) had reduced but not eliminated the inequities. Owens and Maiden interpreted their results as potential evidence that Title I funds are allocated without comparability and that compensatory programs may lessen resource gaps, but not completely. Importantly, Owens and Maiden replicated their analyses at the district level and found that none of their findings remained. This comparative finding underscores the importance of analyzing school-level resource measures.

Looking both between and within districts in a sample of California districts, Hertert (1996) examined the horizontal and vertical equity of base expenditures, independent of categorical funds. Using a variety of indexes (including the range, restricted range, federal range ratio, the coefficient of variation, the Gini coefficient and the McLoone index; these measures are explained in more detail in chapter 3) to assess horizontal equity, and used multiple regression to assess vertical equity. Hertert did not find that student race had a strong relationship with expenditures, and attributed this lack of association to changes in the statewide school finance policies that equalize district funding. Hertert found the majority of variation in school expenditures lay between schools within districts, and that differences in school level (e.g., elementary, middle and high school) explained much of the variation.

These studies by Burke (1999), Owens and Maiden (1999), and Hertert (1996) identify funding inequities across schools. More importantly for this study, all three find that resource variation within districts is as great as or greater than the variation between districts. Given the attention that interdistrict resource equity has garnered in the past, these findings suggest that intradistrict equity deserves more scrutiny than it has received. In particular, Owens and Maiden's study demonstrates the importance of using the school as the unit of analyses, as many of their findings were not apparent at the district level. These studies suggest that much of the inequity in school resource has flown "under the radar" of school equity research that predominantly uses districts as the unit of analysis, and underscores the importance of the intradistrict equity research reviewed below.

Studies of intradistrict funding measures. Several studies have focused on intradistrict equity in large cities without cross-district comparisons. In an early example, Owens examined intradistrict equity in nine cities using the Coleman sample (1972). Owens calculated elasticities between student race and income and resource levels at the schools and used regression to analyze six dependent variables, including real teacher salary expenditures per pupil, average teacher salary, teacher experience, teachers' verbal ability, the proportion of White teachers, and facility quality. Consistently, Owens found that schools in neighborhoods with fewer non-White students and those with lower incomes received fewer resources. Teacher salary had the strongest relationship with student race and poverty. Writing 32 years before Stiefel, Rubenstein, and Schwartz

(2004), Owens also attributed the school differences he found to the teacher-allocation system, writing,

> "The immediate cause of the economic and racial biases in the allocation of teaching resources appears to lie in the teacher assignment system: the single city-wide salary schedule, the allocation of attractive teaching posts to the most experienced teachers, and, in some cities, the informal pressures that are exerted to keep black teachers in black schools" (1972, p.38)

Decades later, subsequent intradistrict studies echo Owens's findings and causal attribution.

In another early study, Summers and Wolfe (1976) examined vertical equity in Philadelphia using two years of school-level data. Their regression analyses showed that schools with more black and poor students received greater amounts of compensatory funding, and that schools with more black students had lower pupil-teacher ratios. However, these same schools had teachers with less experience, lower licensure exam scores and salaries, principals with less experience, and more teacher turnover. The relationships they found between school resources and student race and poverty remained after alternatively controlling for both race and poverty. Summers and Wolfe were the first to identify the "quantity/quality" tradeoffs in the distribution of teachers, tradeoffs found in subsequent research and drive the methodology for this study.

Berne and Stiefel (1994) adapted their equity framework to intradistrict analyses using data on 800 New York City schools in 32 sub-districts. They examined vertical equity using regression analyses with multiple dependent variables including general education budgets and expenditures per pupil, budgeted and average teacher salaries per pupil, and teacher student ratios. They did not have school-level salary data but used subdistrict averages, so the researchers based their conclusions on data more detailed than the typical district salary averages, but still less than actual school salaries. Berne and Stiefel (1994) found mixed results in elementary schools where student poverty was negatively associated with funding and teacher salaries, but positively associated with pupil-teacher ratios. These findings suggest there some trade-off between the number of teachers and their salary (driven by experience). High-poverty schools had an average student to teacher ratio of 15.49 compared to 17.59 in low-poverty schools. Curiously, the findings on funding were opposite for middle schools, though again teacher salaries were lower in high-poverty schools. Berne and Stiefel (1994) concluded that these differences were due to differing allocations of teaching positions where districts compensated middle schools[8] for the lower salaries with additional positions but did not compensate elementary schools. This early foundational study established two important precedents for this study that are borne out in much of the later literature. First, teacher experience and pay differ systematically within many districts, and second, the primary option districts have to compensate for these differentials is allocating additional staff.

In another study using more detailed school-level data, Rubenstein (1998) examined Chicago schools data on multiple funding measures, beginning with base funding per pupil and then by adding compensatory funding streams, and again found evidence of quantity/quality trade-offs. Rubenstein's horizontal equity evaluation found lesser general (base) funding went to high-poverty schools. His vertical equity analysis showed compensatory funding streams increased high-poverty school funding above the

[8] No intent on the part of district staff responsible for teacher allocations was established.

district average, but only did so when the district (or state) added funding to compensate for the inequitable bases. Rubenstein also found a teacher trade-off where schools with more poor students had more teachers per pupil, but had lower-salaried and less-experienced teachers. Again, Rubenstein observed this teacher quantity/quality trade-off, but neither established any associated intent in district allocations, nor investigated the nature of these trade-offs in depth.

In, 2003, Iatarola and Stiefel used detailed school-level data from 1997-98 New York City schools to examine intradistrict variation in several dependent variables that captured differences in funding, teachers and student outcomes across schools. Iatarola and Stiefel's (2003) study is important in three ways. First, they provide a holistic evaluation of intradistrict equity by applying Berne and Stiefel's framework to multiple resource distributions at the same time. Second, their models included a comprehensive set of controls for student characteristics associated with legitimate student needs including student poverty, LEP status, mobility, and special education status. Their use of these controls allow for vertical comparisons between schools by explicitly examining differences in school's compensatory needs. Third, their study was one of the first to look at multiple dimensions of teachers simultaneously to try to gauge teachers by per-pupil number, salary expenditures, and qualifications in a unitary analysis. Iatarola and Stiefel measured funding using general revenues and total revenues, as well as pupil-teacher ratios, teacher salaries and the percentage of teachers who were certified. These teacher-related measures captured multiple dimensions of the distribution of teachers specifically gauging pupil-teacher ratios, salary expenditures, and a single proxy for teacher quality.

Iatarola and Stiefel (2003) explicitly applied Berne and Stiefel's framework evaluating horizontal equity in base funding, as well as measures of teachers and outcomes using the coefficient of variation. They evaluated vertical equity of total funding and other measures with regressions that included legitimate student needs and evaluated equality of opportunity in terms of student race and geographic location. Their regression results showed a negative relationship between student poverty and base funding and no relationship between poverty and total funding in elementary or middle schools. This pattern of results suggests that base funding was inequitable and that compensatory funds supplanted, rather than supplemented, base funding. As Rubenstein (1998) found in Chicago the authors found schools with more minority and high-poverty students received more teachers-per-pupil, but had lower salaries and lower certification percentages. Again, the authors attributed the teacher salary and qualifications differences to teacher assignment and transfer policies, and attributed differences in pupil-teacher ratios to the "system allocate[ing] more teacher resources to schools with needier students" (2003, p.77). However, the nature of these trade-offs was not thoroughly discussed.

Condron and Roscigno's (2003) study is particularly important because they attempt to close the circle between intradistrict resources and education production. The authors used regression analysis on data from one large Ohio district to estimate the effect of school funding and composition on achievement measures in five subjects. They included a numerous control variables, including students' prior achievement, and independently evaluated base funding measures and federal Title I funding. Condron and Roscigno found base funding related to student race and income measures and found positive associations between funding and many achievement measures. That they found the potential for resources to influence student achievement adds to the importance of examining intradistrict resource variation.

Stiefel, Rubenstein and Schwarz (2004) used regression to evaluate intradistrict school funding, teacher salaries and qualifications in New York, Cleveland and Columbus, Ohio. Like Iatarola and Stiefel (2003), their analyses controlled for special education and LEP students but also included performance and a measure of school size. In New York, greater amounts of funding went to schools with more poor and special education students, but these schools had lower-salaried teachers, and fewer teachers with graduate degrees. All three cities showed trade-offs with poverty associated with increased funding but lower teacher qualifications and salaries.

Summary of research on general intradistrict finance. The literature on intradistrict differences in funding informs this study with several common findings. First, resource differences between schools within districts are as substantial as differences between states and districts, and research using district-level data fail to capture the full range of resource variation. Second, base funding often favors low-need schools. Third, categorical funds often supplant rather than supplement base funding as they are intended. Fourth, these differences between schools are frequently attributed to intradistrict teacher sorting. Trade-offs between the quantity and quality (in terms of salary and qualifications) of teachers complicate between-school teacher related differences. Though observed often, researchers have not thoroughly investigated the nature of these trade-offs, and these trade-offs are central to the methodology for my study. In most districts, resource distributions cannot be evaluated using funding measures, because these measures are inaccurate when based on district salary averages (e.g., Owens & Maiden, 2003, or Iatarola & Stiefel, 2003) and because overall funding measures do not capture quantity/quality differences in teachers.

Teachers' centrality in the above research on general intradistrict equity is plain. Given the challenges in evaluating intradistrict resource equity generally, several researchers have focused on teachers within districts. In the following section, I review research specifically focused on the intradistrict distribution of teachers.

Dimensions of the intradistrict distribution of teachers. The literature focused on the intradistrict distribution of teachers consistently echoes two findings from the overall intradistrict resource equity. First, the distribution of teachers often disadvantages higher-need schools in terms of qualifications, effectiveness, and salaries. Second, scholars primarily attribute these differences to district allocation policies that predictably allow teacher sorting across schools.

Generally, scholars have assessed the distribution of teachers along three primary dimensions: teacher qualifications, teacher quality, and TCE. Researchers have most frequently examined the distribution of teachers by their qualifications, some of which drive teacher compensation and others of which are more strongly associated with teacher quality (e.g., Lankford, et al., 2003). Researchers have also evaluated the distribution of teacher quality or effectiveness using value-added measures (e.g., Sass, Hannaway, Xu, Figlio & Feng, 2011). Methods for estimating teachers' value-added are still developing and with limited data for such analyses, investigations of the intradistrict distribution of teachers' value-added are uncommon. However, the research on the distribution of teachers' value added is important because value added measures reflect teacher quality better than teacher qualifications do. Finally, scholars have assessed the distribution of teachers by examining TCE (e.g., Roza & Hill, 2004; Education Trust West, 2005).

Several of the studies I review below include references to teacher quality/quantity tradeoffs. These tradeoffs are more relevant to the distribution of TCE than to teacher qualifications and quality. However, I take care to note when studies reference these tradeoffs because accounting for them is essential to evaluating the equity of TCE and to the methodology for this dissertation. In my discussion of the literature specifically focused on the distribution of TCE and in chapter 3, I will elaborate on the importance of these tradeoffs for assessing equity in TCE and for the methodology of this study.

This study focuses on the distribution of TCE, but the research findings on the distribution of teachers along all three dimensions warrants a holistic review because the distributions of teacher compensation, quality and qualifications are interrelated. TCE differences are important in their own right, but are more important if schools with above-average teacher compensation concurrently have teachers that are more effective. I review research on the differences in teacher compensation as a section separate from the first two because it is the integral component of intradistrict variation for this study.

In the remainder of this section, I review research on teacher qualifications and teacher, quality, in turn by examining the conceptual approaches, measures, and equity standards researchers have applied to each dimension; by a summary of the associated research findings; and by a discussion of what the findings add to the holistic understanding of the intradistrict distribution of teachers.

The intradistrict distribution of teachers by qualifications. Teacher qualifications are measurable indicators that researchers have used as proxies for teacher quality (e.g., Lankford et al., 2002; Presley, White & Gong, 2005) and teacher compensation at the school level (Education Trust West, 2005; Condron & Roscigno, 2003). In most districts, teachers' experience, education, and certification determine their pay. Though recent research suggests that specific measures of salary-determinant qualifications –namely experience and in-field certification, particularly in combination– are credible predictors of student achievement (Clotfelter, et al., 2007; Boyd, et al., 2008), salary dependent teacher qualifications are generally considered to weakly indicate teacher quality (Hanushek, 1997; Rice, 2003). Therefore, researchers have examined other teacher qualifications that are more strongly associated with teacher quality (Lankford, et al., 2002; Clotfelter, Ladd, Vigdor & Wheeler, 2006).

Studies have shown that teacher test scores on general aptitude tests (e.g., SAT, and ACT) or licensure examinations, teachers' college selectivity and GPA, and National Board Certification to be better indicators of teacher quality than experience, certification and education (Lankford, et al., 2002; Clotfelter, et al., 2006; Ballou & Podgursky, 1997). Since many teacher attributes are correlated within schools, some researchers have made composite factors of teacher characteristics to evaluate the distribution of teacher quality (Presley, White, & Gong, 2005; Lankford, et al., 2002, DeAngelis, Presley & White, 2005). Scholars have used other measures, such as the proportion of teachers who teach subjects out of their certification field, to look at how well teachers are matched to their positions across schools (Ingersoll, 2002).

Scholars have assessed the equity of the distribution of both salary-determinant and non-salary-determinant teacher qualifications using horizontal, vertical and equal opportunity standards. Horizontal equity is a natural equity standard because all students are "equal" with respect to teacher qualifications (e.g., Lankford et al., 2002; Betts et al., 2000). For example, while districts legitimately allocate more FTE positions to schools with more special education students, there is no reason they would expect teachers that are more experienced or teachers with higher licensure scores compared to other schools. A number of analyses have assessed the vertical equity of teacher qualifications as part of analyses primarily aimed at funding equity (e.g., Iatarola & Stiefel, 2003; Stiefel, et al., 1998; Berne & Stiefel, 1994).[9] For instance, researchers have used multiple regression analyses to examine pupil-teacher ratios, average teacher salary, teacher experience, and teacher certification in addition to funding measures to determine if schools with greater compensatory needs receive more resources (Iatarola & Stiefel, 2003). However, the reasons these qualifications are apt for horizontal equity analyses– that there are no legitimate reasons for qualifications to vary across schools systematically – make them ill fit for vertical equity analyses.[10] EEO is a more apt equity standard for teacher qualifications because any relationship between teacher qualifications and student or school characteristics has no legitimate basis. When teacher qualifications systematically

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[9]A number of teacher sorting analyses include measures of variation in teacher resources that parallel the vertical equity analyses discussed here, but do so without explicitly naming any equity standard. I discuss these in the section on EEO because there is no explicit equity standard, and because I believe these measures constitute an equal opportunity analysis due to a lack of legitimate reasons for compensatory teacher resources.

[10] For instance, in one such study, Iatarola and Stiefel invoke the concept of vertical equity regarding funding, but describe the pattern of results regarding teacher resources without referencing any equity concept directly (2003). This omission may be happenstance, or may reflect the problematic nature of using vertical equity to assess teacher resources.

vary across schools, they violate the EEO standard. Researchers have evaluated the EEO of teacher qualifications using descriptive statistics and using regression analyses that describe the relationship between qualifications and student race, poverty, LEP, special education and immigrant status (e.g., Lankford et al., 2002; Iatarola & Stiefel, 2003).

In the remainder of this section, I review research on the distribution of teacher qualifications in three parts. First, I overview research focused on salary-determinant qualifications. Second, I review research that looks at a broader set of non-salary-determinant qualifications, usually alongside salary-determinant qualifications. Third, I review studies where scholars have created composite measures of teacher qualifications at the school level.

The distribution of salary-determinant teacher qualifications. Studies examining the intradistrict distribution of teachers in large and midsized school districts consistently find substantial variation in a range of teacher qualifications, and yielded consistent conclusions. Generally, high-need schools have higher proportions of uncertified, lower-salaried, less-experiences, and less-educated teachers (Owens, 1972, Summers & Wolfe, 1976, Rubenstein, 1998; Schwartz & Stiefel, 2003; Lankford, et al., 2002; Clotfelter, Ladd & Vigdor, 2005, 2006).

An illustrative large-scale study of salary-determinant teacher qualifications is Betts, Rueben and Dannenberg's (2000) examination of 1997-98 data on California schools. This study focuses narrowly on salary-determinant qualifications across a large number of districts. The authors focused on the distribution of salary-determinant teacher qualifications as well as class size, teacher preparation and curriculum by schools' average student socio-economic status, LEP status, race and performance. The authors found low variation in class size[11] but substantial variation in salary-determinant teacher qualifications by student poverty and performance. The authors also found the distributions of specific teacher credentials were dependent, indicating there are "have" and "have not" schools in California. Students in the "have not" schools were disproportionately low performing, non-White and poor. Though some evidence of teacher quantity/qualification trade-offs were found in a weak correlation between class size and teacher education, the variation in class size was small suggesting trade-offs were minimal. Though the student performance data were not ideal for connecting teacher resources and performance, the authors found small relationships between experience and performance after controlling for the more powerful effects of student SES. Betts and colleagues summarized their findings writing,

> "Our exploration of resource allocations shows very small variations in class size among schools. In sharp contrast, we find large variations in the characteristics of teachers, especially in teacher education and experience. The percentage of teachers who are not fully certified also varies in important ways across schools. These variations in teacher characteristics are systematically related to differences in student socioeconomic status. In general, schools with more-disadvantaged students tend to employ teachers with lower levels of experience, certification, and education." (2000, p. 205).

Many studies before and since have similar findings, in terms of salary-determinant qualifications and many other qualifications not directly related to teacher salaries.

The distribution of a broad array of teacher qualifications. Most studies of the intradistrict distribution of teacher qualifications examine salary-determinant

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[11] The low variation is in large part attributed to constraints from a class size reduction initiative in California.

qualifications alongside a broader scope of qualifications that have proven to be indicators of teacher quality. These non-salary determinant qualifications have included various types of teacher test scores, certification in the subject taught, undergraduate selectivity, and National Board Certification (Barr, 2005; Goldhaber, Choi, & Cramer, 2004; Ingersoll, 2002; Lankford, et al., 2002; Stiefel, et al., 1998; Clotfelter, et al., 2005, 2006; Pesky & Haycock, 2006; Clark & Teonjes, 1996). As with salary-determinant qualifications, the distribution of other qualifications disadvantage higher-need schools. Further, the variation among qualifications is correlated, such that if a school is bereft in one teacher qualification, they are likely bereft of others (Lankford, et al., 2002; Betts, et al., 2000). Most longitudinal analyses of the intradistrict distribution of teacher qualifications have found that variation is not decreasing, but is either stable (Lankford, et al., 2002) or increasing (Clotfelter, et al., 2006; Boyd, et al., 2005b).

In one of the most comprehensive of such studies, Lankford, Loeb and Wyckoff (2002) analyzed detailed New York State data on numerous teacher qualifications, including novice teachers, those with advanced degrees, certification, NY state teacher exam performance, undergraduate selectivity, and salaries. Lankford et al. found that, “By almost any measure, the qualifications of New York's teachers are unevenly distributed across schools” (Lankford, et al., 2002, p.41). Second, they found correlations among school-level average teacher qualifications, such that schools with higher measures in one teacher qualification are likely to have higher measures on others. Third, they found that the majority of variation in most teacher qualifications lay between schools within districts.[12] Student characteristics were related to teacher qualifications such that students in urban and/or higher-need schools had teachers with below-average qualifications. For instance, non-White students were fifty percent more likely to have a teacher with no previous teaching experience and 400 percent as likely to have a teacher not certified in any assignment. Further, the Lankford et al. study provides evidence that suggests teacher mobility contributes to the between-school differences in teacher qualifications, and that teacher salaries vary along the same lines as non-salary determinant teacher qualifications. Looking at the same data longitudinally, the authors found the differences apparent in 1999-2000 had been stable since 1985.

In 2008, Boyd, Lankford, Loeb, Rockoff and Wyckoff followed up on this 2002 research by evaluating the distribution on teacher qualifications using New York City data from 2000-2005. New York City was an important district for study because in their 2002 study Lankford, Loeb and Wyckoff showed that the qualifications of New York City teachers were more disparately distributed that all the other New York state districts. The authors examined teacher experience, demographics, undergraduate selectivity, test scores, and pathways to teaching (whether teachers completed a college recommended certification program or an alternative certification program) across schools by student poverty. Again, the authors found that in 2002 teachers' qualifications were inequitable across schools by poverty and that qualifications were correlated at the school level. However, they find a narrowing of these teacher qualification gaps by 2005, particularly in elementary schools. Boyd et al. attribute this narrowing to policy changes that removed

[12] The intradistrict variation was an even greater proportion of overall variation after removing New York City.

temporary licenses for uncertified teachers (which reduced the number of uncertified teachers in New York City) and the development of alternative certification routes for teachers. The authors also found achievement gaps diminished between low and high-poverty schools. As discussed below, the authors also found that teacher qualifications were related to teachers' value-added. Boyd et al.'s follow up study is informative because it again suggests a positive association between qualifications and quality in schools and because it suggests that policy changes that affect the distribution of teachers may improve student outcomes.

Clotfelter, Ladd and Vigdor (2007) used ten years of North Carolina data that linked students' test scores to teachers to investigate the relationships between teacher qualifications and student achievement. Their study not only catalogues the distribution of multiple qualifications in a large state, but also estimates the impact of qualifications differences with value-added measures. Further, the study compares the effects of higher qualifications and class size differences, which has implications for the net impact of qualification quality trade-offs. Controlling for multiple student measures, the authors examined the associations between average student test scores and class sizes, teachers' licensure and license test scores, teachers' undergraduate institutions, graduate degrees, National Board Certification and years of experience. Concurrently, they measure the impacts of class size on student achievement. The authors found that experience (primarily in the first few years), and teacher licensure were the largest indicators of differences in student scores. The other teacher measures were also positively related to student achievement, except for graduate education. As an illustration, estimated differences in cumulative teacher credentials had differential effects on mathematics achievement between 0.15 and 0.21 standard deviations, compared to 0.08 and 0.12 standard deviations in reading. The effects for lower class sizes were smaller with decreases of five students associated with less than 0.03 standard deviations increases in both mathematics and reading. The authors' findings are consistent with other research on teacher credentials (Rockoff, 2004; Clotfelter, et al., 2006), and indicate that the distribution of teacher credentials matter for student achievement, and thus support a link between teacher qualifications and teacher quality. Further, in comparing the impact of teacher credentials and class size differences, this research suggests that the trade-offs evident between schools may be uneven in terms of instructional productivity.

Composite measures of teacher qualifications. Several studies have shown correlations between teacher qualifications at the school level, echoing Betts et al.'s observations of "have" and "have not" schools. For instance, Clotfelter , Ladd, Wheeler, and Vigdor compared North Carolina schools' teacher qualifications by student poverty and found the patterns in teacher experience, licensure, test scores, undergraduate institution quality and National Board Certification that were "strikingly consistent" (2007, p13). In every case, teachers in low-poverty schools had higher qualifications than those in high-poverty schools and in many cases, these differences were large. Correlations between teacher qualifications have been strong enough that several studies have created and evaluated composite measures of teacher qualifications (Presley, White, & Gong, 2005; Lankford, et al., 2002, DeAngelis, Presley & White, 2005). For instance, Lankford et al. created a composite of overall teacher quality constructed from school percentages of teachers with no experience, not certified in any assignment, New York State test failure, and the percentage of teachers from the most selective and least competitive colleges (2002). Essentially replicating Lankford et al.'s New York analysis in Illinois, DeAngelis, Presley and White created a composite using the school percentage of teachers with degrees from competitive colleges, those with less than four years experience, percent with emergency certification, test failure, and teachers' ACT composite score (2005). In both studies, the composite qualification measures explain about half of the variation in teacher qualifications, and the authors showed that teachers are more highly qualified in lower-need schools. Both studies decomposed the variation in composite teacher quality measures across regions, districts within regions, and schools within districts, and in both more than 60 percent of the variation in the composite measures lay between schools within districts.

The evidence from the research reviewed in this section clearly shows that the intradistrict distribution of teacher qualifications often violates the EEO standard. Lower-need schools consistently have teachers with higher qualifications than do higher-need schools. Further, the distributions of qualifications are correlated, such that many schools are winners or losers in terms of overall teacher qualifications. In large part, researchers are interested in the distribution of teacher qualifications because qualifications serve as indicators of teacher quality. However, since qualifications are proxies for teacher quality researchers have used more direct approaches to assessing the distribution of teacher quality, principally using value added measures. I review these studies in the following section.

The intradistrict distribution of teachers by teacher quality. Perhaps the most direct approach to measuring teacher quality directly is through value-added measures. Value-added measures are statistically estimated teacher effects on student achievement after controlling for a variety of other measures. Teachers' value-added varies substantially with potentially large associated effects on student achievement (Hanushek, 1997, Sanders & Horn, 1998). In a seminal value-added analysis Sander and Horn concluded that ‘‘the effectiveness of the teacher is the major determinant of student academic progress’’ (Sanders & Horn, 1998, p. 247). Though Sanders and Horn's analysis has received some critiques, most agree that teachers are the most important school resource for improving student achievement (Rice, 2003).

Districts do not allocate teachers based on quality so there is no legitimate educational reason that teacher quality should vary by student needs. Therefore, any systematic associations between teacher quality and student or school characteristics would violate horizontal equity and equality of opportunity. Since teacher quality is not allocated in relation to compensatory need the vertical equity standard does not readily apply. Measures of teacher quality are relative measures and do not have an absolute or standard value, nor can they be indexed by pupil-teacher teacher ratios for a "quality per pupil" metric. However, researchers have examined the relative importance of teacher quality and pupil-teacher ratios and the results suggest that teacher quality may have more influence on student achievement (Clotfelter, et al., 2007).

Value-added measures are statistically complex, require uncommonly large and detailed data sets, cannot be applied to new teachers or teachers with untested students (e.g., Hanushek, 2011), are potentially unstable across time (Sass, 2008) and are difficult to compare across districts (Lankford, et al., 2002). Despite these difficulties, some recent studies have addressed the intradistrict distribution of teacher quality. These studies implicitly evaluate equity on an EEO basis by comparing the quality by school poverty.

Though these studies find teacher quality is typically higher in low-poverty schools, the distribution of quality is complex.

Sass, Hannaway, Xu, Figlio and Feng (2011) examined North Carolina and Florida data and found that teacher quality is generally higher in low-poverty schools, though differences are small in magnitude and inconsistent. Though this is evidence that there are differences in teacher quality by poverty the authors assert their results "cast doubt on the conventional wisdom that teacher quality in high-poverty schools is uniformly worse than in lower-poverty schools" (2010, p.14). They found the differences in teacher quality are primarily in the bottom of the teacher quality distribution, meaning that high- and middling-quality teachers are comparable across schools, but the low-performing teachers in high-poverty schools are significantly worse than the low-performing teachers in low-poverty schools. The authors attribute most of these differences to a varying relationship between experience and quality in low and high-poverty schools. Simply put, experience engenders higher teacher quality in low-poverty schools faster than it does in high-poverty schools.

In another study, Feng and Sass examined teacher sorting by teacher quality in Florida schools (2011). Consistent with other literature, they found that teachers tend to move to schools with fewer black, low-income and low-performing students. However, holding the teacher's own quality constant, Feng and Sass find that teachers appear to be attracted to and to stay in schools whose average teacher quality matches their own. Regarding retention, they find that schools in the top quartile of teacher quality attract more high-quality teachers compared to schools in the bottom quartile. Further, schools in the bottom quartile of teacher quality attract more bottom quartile teachers. Regarding attrition, they find that teachers in general remain in positions in high-performing schools longer than in low-performing schools. Further, they find low-quality teachers are more likely to leave all kinds of schools faster than average-quality teachers are, and that high-quality teachers leave at higher rates in lower- than in higher-performing schools. "The net result is that the "rich get richer" and the movement of teachers across schools tends to exacerbate differences in teacher quality" (2011, p18).

Though they did not examine the distribution of teacher quality directly, Boyd et al. (2008) examined the shifting distribution of teacher qualifications in New York City from 2000-2005. They found teacher qualifications inequitably distributed across schools by poverty. Further, they found teachers with the lowest value-added scores had very little experience, were uncertified, and had histories of poor test performance. Boyd, et al.'s analysis suggests there is a bridge between differences in school-average teacher quality and qualifications.

It is important to consider how closely linked the school-level distributions of teacher quality, qualifications are. TCE is directly related to salary-determinant qualifications. While Boyd et al.'s (2008) research suggests a positive relationship between salary-determinant qualifications and teacher quality, the relationships not strong. However, the linkages between quality and qualifications are greater for non-salary determinant qualifications than they are for salary-determinant qualifications. Thus, the link between TCE and teacher quality is probably positive, indirect and weak, but difficult to establish clearly with current evidence (Roza, 2010; Rivkin, Hanushek & Kain, 2005; Rice, 2003).

Acknowledging this weak association at the teacher-level, scholars have offered reasons to expect stronger associations between teacher quality and TCE at the school level. For example, Roza and Hill (2004) argue that schools with above-average salaries are more attractive to teachers and since evidence shows these schools have greater numbers of applicants for open positions they are more likely to attract higher-quality teachers (Guin, 2004; Roza, 2005). On the opposite end of the spectrum, schools that are "revolving doors" often have disproportionate proportions of novice teachers who are less effective and paid the least (Imazeki, 2002; Roza, 2005). These schools are likely to have lower average schools salaries, more teachers who are less effective, and have a lower school-wide capacity for instruction due to the instability of the staff (Roza, 2005). Further, several studies suggest that a greater per-pupil quantity of lower-qualified teachers, often found in high-need schools, is not as beneficial to students as higher-quality teachers are (Nye, et.al., 2004; Clotfelter, 2007). These linkages are loose and inconclusive, but they fall in line with the "rich get richer" hypothesis, and suggest that schools with above-average teacher qualifications and salaries may also have above-average teacher quality, and there is little if any evidence that there would be an associated teacher quality deficit.

The findings of research on teacher quality are complex and inconclusive, but they suggest that higher-need schools receive lower-quality teachers. This general finding is important for this study because it suggests that the distribution of teacher quality is distributed across schools in ways that advantage lower-need schools and disadvantage high-need schools. Similar to the literature on teacher qualifications, of the research on teachers' value added suggests a "rich-get-richer" effect. Further, scholars have argued that the weak connections between salary-determinant qualifications (which drive TCE differences) and teacher quality would be stronger at the school level compared to connection at the teacher level.

Summary of the research on intradistrict distributions of teacher qualifications and quality. Intradistrict distributions of teacher qualifications and quality show significant overlap in that the same types of schools with below-average teacher qualifications have below-average teacher quality. This research provides important context for the research focused on the intradistrict distribution of TCE because the distribution of TCE advantages and disadvantages the same kinds of schools. The likely scenario of compound advantages makes the examination of TCE more important than if these distributions were independent. Unfortunately, this "rich get richer" effect is not limited to qualifications and quality. The research on the distribution of TCE, which I review in the next section, indicates that the same schools that receive less-qualified and lower-quality teachers are often shortchanged in terms of TCE.

The intradistrict distribution of teachers by compensation expenditures. The conceptual approach to evaluating the intradistrict distribution of TCE differs from the approaches for teacher qualifications and quality because the former focuses on input equity in dollar terms while the latter primarily focus on the productive capacity of schools. The distribution of TCE is like a zero-sum game where the total of district TCE is divided among schools. With a finite set of district resources, each school's share of resources should be equal, conditional on the legitimate educational needs of students (e.g., LEP or disabilities) or schools (e.g., special district allocations for special programs such as magnet schools). However, unless other non-teacher resources balance differences in TCE, schools with below-average TCE are the losers in the zero-sum game, and schools with above-average TCE are the winners. Researchers have looked at the intradistrict distribution of TCE to determine what kinds of schools are most often losers and what kinds are most often winners (Roza, 2010; Roza & Hill, 2004; Education Trust West, 2005; Reagan, 2010; Cohen and Miller, 2011)

TCE differences between schools are denominated in dollars, which are fungible and of equivalent value within school districts. Because other resources also have a dollar metric, the magnitude of between-school TCE differences is easily measured. Differences in qualifications or quality are neither easily measured nor fungible, making it difficult to redress between-school differences. For instance, balancing differences in teacher qualifications is difficult when the relative value of those qualifications is uncertain. In addition, even if differences in teacher quality were measurable, redressing differences with other resources would be similarly difficult.

When between-school differences in actual TCE are estimated, the value of schools' gains and losses are much clearer than are the value of differences in teacher quality or qualifications. For example, a schools loss in TCE is the dollars they would otherwise receive, if not for TCE differentials (Miller, 2010; Roza, 2010). Schools could use the money lost to TCE differentials for non-teacher resources, more teachers, or as incentives to improve the quality of teachers in the school. The bottom line is that in districts some schools are not receiving the resources they are entitled to because districts ignore measurable and addressable teacher salary differentials.

I organize the remainder of this subsection on the intradistrict distribution of TCE into three parts. In the first part I discuss in detail the measures that researchers have used to gauge TCE; I devote a separate subsection to the measures and equity standards in this section on TCE because the limitations of these measures play a significant role in the methodology for this dissertation. In the second part, I review research on the intradistrict distribution of TCE by looking at studies that have included findings on the distribution of TCE, studies focused in detail on the distribution of TCE in a few districts, and studies that have looked at the distribution of TCE in less detail but in a larger number of districts. In the third and final part, I examine the limitations to and gaps in extant research on the intradistrict distribution of TCE.

Measures of TCE. Researchers have measured TCE in two principal ways. Most often TCE is compared across schools by looking at average teacher salaries (TCE_{FTE} – the total school TCE divided by the total number of FTEs) (Roza & Hill, 2004; Iatarola & Stiefel, 2003; Lankford et al., 2002). Most analyses focused on the intradistrict distribution of TCE discuss differences in average teacher salaries (Roza & Hill, 2005; Roza, 2005; Education Trust West, 2005; Miller, 2010). Though not stated explicitly, these studies probably use average salaries because doing so permits a direct focus on the effects of policies such as district salary averaging that have long hidden between-school TCE differences. Fewer studies have used per-pupil measures of TCE (TCE_{PP} - the sum of total TCE at the school divided by the number of pupils) (Education Trust, 2008; Argue, Honeyman & Schlay, 2006; Roza, 2005).

Evaluating average teacher salaries by horizontal equity and EEO standards is straightforward because in most districts there are no legitimate reasons why average teacher salaries (TCE_{FTE}) within the same district should systematically differ between schools using any equity standard.[13] Districts often use compensatory funds to provide more teachers for schools with compensatory needs, but these additional teachers need not affect TCE_{FTE}. Further, since these extra teachers are part of compensatory funding they should not necessarily be included in a horizontal evaluation. One exception would be districts that use salary bonuses as incentives to retain teachers in hard-to-staff schools. Higher average salaries would be expected in the targeted schools unless base pay (minus bonuses) was used for these salary averages.[14] Programs such as the federal Teacher Incentive Funds grants are making such targeted retention incentives more common, but such programs are the exception rather than the rule (Stronge, Gareis & Little, 2006). Most districts do not have targeted retention programs, and in these districts, there are no legitimate reasons for TCE_{FTE} to vary across schools, and thus no basis for a vertical equity analysis using average teacher salary. Any substantial variation in TCE_{FTE} would indicate horizontal inequalities (different from inequities, discussed below), and any relationship between a school characteristics and average salaries would indicate EEO violations.

Average teacher salaries are informative as they accurately signal teacher sorting, but they are insufficient bases for equity conclusions for several reasons. First, evaluating equity by any measure of teacher compensation alone assumes that other, non-teacher resources are not allocated to achieve resource equity. If district officials understand that the variation in teacher salaries divert resources from needy schools, they may allocate

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[13] This assumes that there is no extra pay for special education teacher, or other student specific positions.

[14] The TCS data in the analyses for this dissertation use base pay, which does not include bonuses.

other non-teacher resources to fill those gaps. A second reason is that differences in pupil-teacher ratios may counterbalance differences in teacher salary. Differences that are apparent in school-average teacher salaries may change substantially when examining per-pupil TCE, especially if there are significantly more teachers per pupil in schools with below-average teacher salaries (Education Trust, 2008). The quantity/quality teacher tradeoffs mentioned in many studies reviewed above underscore the importance of controlling for pupil-teacher ratios when comparing school salary averages (Rubenstein, Stiefel & Schwartz, 2007; Stiefel, et al., 2004; Stiefel, et al., 1998, Rubenstein, 1998; Summers & Wolfe, 1976; Owen, 1972).

Establishing the true nature of these trade-offs is difficult because it is often unclear whether the additional teachers are attributable to 1) variable concentrations of students with compensatory needs or 2) to what I call "corrective allocations" which are district allocation strategies that attempt to balance teacher quality or expenditure differences with additional positions. To appropriately evaluate pupil-teacher ratios across schools and accurately identify true quantity/quality trade-offs, analyses would have to evaluate horizontal equity of pupil-teacher ratios separately using only base allocations of teaching positions. Vertical equity evaluations might examine total pupil-teacher ratios while controlling for between-school differences in compensatory student needs. Unfortunately, most district data systems make it difficult to decompose schools' FTE allocations into base and compensatory components (Roza, 2005, 2006; Miller & Rubenstein, 2008), and researchers have not previously been able to separate compensatory and "corrective allocations." As a result, these quantity/quality trade-offs are often observed in the studies in this literature review, but not explored or well explained (e.g., Rubenstein, Stiefel & Schwartz, 2007; Rubenstein, 1998; Summers & Wolfe, 1976).

Equity evaluations of TCE that use per-pupil measures are still limited by the possibility of equity through non-teacher resources, they do control for trade-offs between quantity and compensation. Higher TCE per pupil in schools with greater compensatory needs would indicate vertical equity. The quantity/quality trade-off so often mentioned in the literature reviewed above can only be evaluated with a per-pupil measure of TCE, and not by school-average salaries, which most intradistrict TCE studies have examined. These school-average salary measures used in most intradistrict TCE studies makes drawing equity conclusions difficult (Roza & Hill, 2004; Roza, 2010; Education Trust West, 2005, 2006; Miller, 2010; Cohen & Miller, 2011).

Research on the intradistrict distribution of TCE. Despite measurement issues, studies focused on intradistrict TCE have consistently shown that the distribution of TCE benefits the same kinds of lower-need schools that often have above-average teacher quality and qualifications. I review this research into three categories. The first category includes studies that examine measures of TCE, but focuses on the intradistrict distribution of teachers more generally. The second category includes studies that have used uncommonly detailed data on a small number of districts to examine the distribution of TCE. The third category includes studies that examine less detailed data on a large number of districts to examine the magnitude and the scope of inequitable distributions of TCE. I review the research in each of these categories in turn below, and conclude with a summary of the research on the intradistrict distribution of TCE.

Intradistrict studies that include measures of TCE. Many of the studies reviewed above examined both teacher qualifications and measures of TCE, most often in terms of average teacher salary (Burke, 1999; Education Trust West, 2005; Stiefel, et al., 1998; Stiefel, et al., 2004; Lankford, et al., 2002; Owen, 1972; Summers & Wolfe, 1976; Roza & Miles, 2002; Rubenstein, 1998; Iatarola & Stiefel, 2003). These studies examine average teacher salaries using descriptive statistics such as means, interquartile and federal range ratios (e.g., Betts et al., 2000) and regression analyses (e.g., Iatarola & Stiefel, 2003). Studies that use regression have analyzed average teacher salaries without controls for pupil-teacher ratios, essentially showing salary differences (e.g., Iatarola and Stiefel, 2003). In many, but not all of these studies, researchers have found lower pupil-teacher ratios in schools that have teachers with higher salaries and greater qualifications (Rubenstein, Stiefel & Schwartz, 2007; Stiefel, et al., 1998, 2004; Rubenstein, 1998; Summers & Wolfe, 1976; Owen, 1972). These authors suggest that these trade-offs may offset inequities in TCE_{FTE}, but these suggestions are not the focus of these analyses and never fully explored.

Studies focused on the intradistrict distribution of TCE in select large districts. In recent years, several studies have taken direct aim at gauging the impact that the unequal distribution of teachers has on school budgets. These studies analyze TCE in a few districts with more detail than do the studies above that include but do not focus on TCE measures, or compared to studies in the next section that analyze the distribution of TCE in a larger number of districts. Such focused and detailed studies are few, as are the number of districts studied, but their findings are consistent and compelling.

In, 2004, Roza and Hill wrote a seminal article on intradistrict differences in teacher salary. Unable to rely on published district data, the authors reconstructed school budgets "from the ground up" (p.203) for four large urban districts in order to include real salary variation in school funding measures. In this article, Roza and Hill highlighted the inequities hidden by the use of district salary averaging, and their analyses focused on showing the magnitude of the school budget differences hidden by this practice. Importantly, they present the differences between the published budgets and what the budget totals would have been using actual teacher salaries instead of district averages. In these districts, the average school-budget differences hidden by salary averaging were substantial, ranging from 4.9 to 6.5% of published school budgets. In terms of per-pupil spending, the differences ranged from $145 to $246, which translated into average school disparities of between $72,500 and $120,000. These averages were far less than the maximum differences found in these districts, which ranged from $949 to $2800 per pupil. At the extremes, these per-pupil differences sum to huge amounts, with gains from $230,000, to $550,000 annually, and losses from $263,000 to $960,000.

Roza and Hill found systematic salary differences. In all four districts, high-poverty, and to a greater degree, low-performing schools had lower salaries, despite district formulas and federal funds that targeted funds to high-poverty schools. The authors show that teacher sorting affects compensatory funds as well as the distribution of general funds. They showed that Title I funds provide additional staff for high-poverty schools and, that these staff are accounted for with district average salaries. However, because high-poverty schools have below-average salaries, Roza and Hill argue that the difference between the average and real salaries of these teachers effectively fund the above-average teacher salaries in low-poverty schools. Further, they showed that a program in Baltimore City schools that provided salary bonuses to retain fully certified teachers in low-performing schools fell far short of equalizing the differences in TCE.

While their findings highlight the importance of the distribution of teacher salary, Roza and Hill's measurement focus on the differences made by salary averaging are problematic for drawing equity conclusions. For instance, in a hypothetical school with twenty teachers and an average salary \$2,000 below the district average, the "gain or loss" made by salary averaging would equal \$40,000. Roza and Hill present these differences in total, per-pupil, and as a percentage of total published school budget (2004, p. 209). The first problem with only focusing on the "gains or losses" is that the authors failed index these differences by pupil-teacher ratios, which leaves no vantage point for evaluating equity between schools, because the authors never present the absolute amounts of resources per pupil. For instance, if these districts used the "quantity/ quality" trade-off mentioned above, Roza and Hill's analysis would capture differences in the school budgets made by differences in "quality" (in terms of TCE_{FTE}), but not in "quantity", because there was no control for the number of teachers relative to students. In districts where high-need schools received more, but lower-salaried teachers, Roza & Hill's examination of TCE_{FTE} is blind to the additional per-pupil spending associated with additional allocated positions. Further, using their calculations of schools' "gains and losses" —by multiplying the number of FTE times the salary differential—overstates the losses in schools with lower salaries because they have more teachers. With more teachers below the district average, there are more losses to sum in high-need schools, and thus the salary differences would appear larger in these schools when districts provide more teachers, and thereby more TCE, to these schools to promote equity. Roza and Hill's calculations follow this pattern where average school "losses" are larger than average "gains".

In another study of five large city districts, Roza (2005) used a similar focus on "gains or losses" due to salary averaging. Again calculating school-level budgets with actual salary data, Roza first examined base levels of funding by subtracting categorical funding from total school budgets. In four of the five districts she examined, Roza found that the base allocation of funds favored high-performing, low-need schools.[15] Roza then determined how much of the spending gap in these schools is due to variation in teacher salaries. Again calculating school "gains or losses" due to salary averaging, Roza found salary differences account for most of these gaps. For example, in Denver salaries accounted for 82% of the gap between high- and low-poverty schools (2005, p. 14). However, after adding categorical funds to the base level of resources, three of the five districts provided more resources to schools in the lowest poverty quartile.

While Roza's findings show that salary gaps did favor low-poverty schools, in some cases high-poverty schools received more total resources even after accounting for differences in actual salaries. However, the base amount of resources that are intended to be equal before adding categorical resources, were inequitable more often than not, and by substantial margins. Roza argued that vertical resources adjustments are insufficient to achieve resource parity because of the unequal base funding. Roza further argued that even in districts that have higher average total spending in high-poverty schools, salary

[15] The sole exception, Dallas, was attributed to court decrees that dictated base allocations favor high-need schools.

differences undermine the original intent of the compensatory allocations. Other research has shown that compensatory funds often balance overall funding between schools, but that they are layered on top of horizontally inequitable base allocations (Scafaldi, 2004; Miller & Rubenstein, 2008; Roza, 2005; Roza & Miles, 2004; Rubenstein 1998; Roza, Guin, & Davis, 2007). Roza's research provides reason to believe teacher salary variation either drives or exacerbates these unequal bases.

Analyzing TCE_{FTE} and TCE_{PP} in Philadelphia schools from 2001 to 2005, Argue, Honeyman, and Schlay (2006) found substantial differences in teacher salary and qualifications across schools by poverty. The related experience and salary gaps between low- and high-poverty schools were substantial, averaging eight years of experience and around $8000 ($TCE_{FTE}$). Argue, Honeyman, and Schlay computed TCE_{FTE} gaps in the same way that Roza and Hill did in their 2004 study, however they also report TCE_{PP}. Though class-size differences between high- and low-poverty schools were slight, differences in TCE_{PP} were substantial. Differences in per-pupil spending between high-poverty and low-poverty schools were $270 in 2001, and grew to almost $700 in 2005. The average difference in the total instructional budgets between high- and low-poverty school budgets during this period was over $240,000. Argue, et al. concluded that salary differences between schools amounted to considerable inequities. While these findings from Philadelphia cannot directly confirm that Roza and Hill's analytic approach of calculating the "salary gaps" accurately reflect inequities, they suggest "salary gaps" may reflect inequities even after controlling for quantity-quality trade-offs.

These studies by Roza and Hill (2004), Roza (2005), and Argue, Honeyman, and Schlay (2006) highlight the problem of highly varied distributions of TCE in a few districts. However, they provide little information about the scope of the problem they address or about the magnitude of TCE differences across districts. The extant literature on intradistrict TCE does not indicate the scope of this problem, but larger scale studies reviewed in the next section have begun to clarify the scope of the problem of TCE variation.

Studies focused on the intradistrict distribution of TCE in many districts. Several research and policy reports have analyzed salary differences in less detail, but in a larger number of districts in a single state. These studies provide some sense of what proportion of districts may have substantial imbalances in the distribution of TCE. Education Trust West (2005) examined TCE in California's 50 largest school districts. Without accurate school-level salary data, they estimated teacher salaries based on salary-determinant teacher qualifications and district salary schedules. Confirmatory analyses using actual salary data in two large districts confirmed the validity of their estimation approach. Using these estimates, they found consistent and large differentials between schools in the top and bottom quartiles of minority composition and student poverty. While eight districts had higher salaries in higher-need schools, the vast majority showed large salary gaps favoring higher-need schools. On average, salary gaps between high- and low-poverty schools averaged over $3,000 per teacher, amounting to over $100,000 losses in typical high-poverty school budgets. In some examples these differences amount to $450,000, enough to "hire nine additional teachers with five years of experience each" (Education Trust West, 2005, p.12). The authors did not report per-pupil TCE differences; however, the report states that pupil-teacher ratios were examined and showed little variation.

Education Trust completed two similar analyses in Texas and Ohio and found results similar to those in the California study. Looking at the 50 largest Texas districts, they found approximately $1000 TCE_{FTE} gaps between the highest- and lowest-poverty elementary and high schools (2006). This analysis was presented in a research brief, not an in depth report, and the salary gaps they present are not the average gaps, but the gaps between the highest-poverty school and the lowest-poverty school in these districts. While these results may be accurate, they highlight a problem by only focusing on two schools at the extremes of poverty in each district and provide little clear information about the breath of the salary gaps in Texas schools. Further, the report does not discuss pupil-teacher ratios differences in these schools.

Looking at elementary schools in the 14 largest Ohio school districts, Education Trust (2008) again found substantial TCE_{FTE} differences between the highest- and lowest-poverty schools. In 11 of the 14 districts, the highest-poverty schools had lower TCE_{FTE} compared to the lowest-poverty schools, with differences ranging from $204 to $7,176. Unlike the report on Texas districts, the Ohio report examined pupil-teacher ratios and TCE_{PP} and found more teachers per pupil in the lowest-poverty schools in 9 of the 14 districts studied. The differences in pupil-teacher ratios in these schools were small (less than five students per teacher) in all but two districts. However, the analysis of TCE_{PP} showed that in 10 of 14 districts the highest-poverty schools had higher TCE_{PP}. The authors note that though the majority of districts spend more teacher salary dollars per pupil in the poorest schools, the differentials are small compared to the amount of compensatory resources intended to go to these schools. As was the case with their report on Texas districts, the Ohio Education trust report again focused on the extremities of school poverty in these districts leaving little indication of the scope of the problem for the districts' remaining schools. Neither report gauges the number of schools or students affected by salary gaps in these districts.

Two research reports released by the Center for American Progress use a hierarchical linear modeling (HLM) framework to analyze average teacher salaries across schools within districts. An important advantage of these two reports is that they analyze a large number of schools in multiple districts and can therefore estimate the average district differences in teacher salary. One of these examined actual salaries for a representative sample of California districts to evaluate the association between poverty and average teacher salaries (Miller, 2010). The report took advantage of data from California School Report Cards which state law recently required include real school salary averages. Relying primarily on data from California School Report Cards, this report analyzed actual school-level salary expenditures using an HLM framework that nested schools within districts. The report decomposed the variation in teacher salaries between and within districts and found more than 70% of the variation was between schools within districts. The models revealed that a 10% increase in student poverty, as measured by reduced price meals eligibility, was associated with an average increase in teacher salaries of $411. For schools with the average number of teachers for California schools that differ in student poverty by 50%, the average estimated difference made by salary differences totaled more than $75,000, holding all else constant. This difference is roughly equivalent to the salary and benefits of an additional teacher with average qualifications for California. While the primary model in this study did not control for pupil-teacher ratios, the author states that robustness checks on the model included a measure of pupil-teacher ratios did not substantially alter the results. In this report, the authors did not present the results of the robustness check.

In a similar analysis on all districts in Florida, the Center for American Progress found just over half of the variation in average salaries was within districts (Cohen & Miller, 2011). Again using HLM analyses, the analyses of Florida found that a 10% increase in student poverty was associated with a decrease of $213 in average teacher salary, roughly half as large as the relationship found in the California study (Miller, 2010). Though the model did include a measure of schools size (specifically, the natural log of student enrollment) it did not include pupil-teacher ratios. With no control for pupil-teacher ratios, this analysis only examined average teacher salaries and failed to examine the quantity/quality trade-off in Florida schools.

Summary of research focused on the intradistrict distribution of TCE. The research focused on intradistrict differences in TCE has consistently found that similarly to the research on teacher qualifications, teacher salaries are higher in lower-need schools. The research on TCE goes a step beyond the research on teacher qualifications by quantifying the magnitude of these differences in dollars terms, which have proven substantial in a number of districts and states. While these studies effectively highlight an equity problem, they fall short of fully gauging equity of TCE. Further, the scope of available empirical evidence is thin. In the following section I discuss the limitations of this research in detail in a separate section below in order to highlight several issues that my methodology is designed to address.

Limitations to the research on the intradistrict distribution of TCE. While the research focused on the intradistrict distribution of TCE highlights an important equity issue, two significant limitations remain. First, most of this research looks at average salaries, which are insufficient evidentiary bases for equity conclusions. Second, the number of districts assessed limits the scope of the research on TCE differences as does the proportion of district schools that are included in the analyses. I explore these two limitations below in turn.

Limits to making equity conclusions. Given that TCE is one component of the mix of resources allocated to schools, analyses of intradistrict teacher-salary differences can make valid equity claims only after controlling for two primary means by which districts could balance TCE differences to achieve equity. The first means would be to allocate more teachers to schools with below-average salaries, thereby reducing pupil-teacher ratios and increasing TCE per pupil in those schools. The second means would be to allocate non-teacher resources to schools with below-average salaries. The failure of existing research to control for additional allocations of teachers is a conceptual shortcoming, while the failure to explicitly deal with additional allocations of non-teacher resources is a limitation of the data available.

First, by focusing on measures of school-average salaries while either ignoring or inadequately addressing per-pupil measures of TCE, these studies consistently fail to deal with the often-mentioned teacher quantity/quality trade-off. These studies establish clearly that high-need schools often have below-average teacher salaries, but they usually fail to establish whether additional teachers in these high-need schools make per-pupil TCE equitable within districts. The single study reviewed above (Education Trust, 2008) that directly addresses the differences between average salaries and per-pupil TCE is illustrative.

Education Trust's Ohio analysis found average salary gaps favoring lower-poverty schools in 11 of 14 districts. The report characterized the between-school differences in student teacher ratios as small in most districts; however, adjusting for these ratios essentially reversed their findings on average salary differences. Ten of the 14 Ohio districts studied had higher TCE_{PP} in the highest poverty schools. While many of these studies either ignore or gloss over between-school differences in teacher student ratios, these findings from Ohio suggest that even "small" differences in teacher student ratios have substantial impacts on the equity of TCE.

Analyzing per-pupil TCE measures is only a first step in effectively evaluating equity in TCE. A second hurdle for evaluating horizontal and vertical equity is determining what portions of TCE are base allocations and what portions are associated with compensatory needs. Decomposing total TCE into base and compensatory funding is difficult or impossible when analyzing single districts, and all the more difficult when examining multiple districts (Roza, 2007 &, 2010; Miller & Rubenstein, 2008). Research has repeatedly shown that compensatory funding is often layered on top of inequitable base allocations, and research suggest that differences in teacher salary averages are a primary driver of inequitable base allocations. Without the ability to separate base and compensatory allocations of teachers, or some other means of controlling for compensatory allocations of teaching positions, analyses could reveal equal TCE per pupil between schools, yet still be unable to say whether the distribution of TCE is equitable relative to student compensatory needs.

The second limitation for equity conclusions in this research is that districts may make "corrective allocations", sending non-teacher resources to schools to achieve equity in per-pupil instructional expenditures. The primary reason that analyses do not control for these alternative resources is the available data's limited depth. Real school-level salary data have been uncommon, and most of the research on intradistrict teacher salary spending has been in response to this lack of accurate salary data and the resource gaps that remain hidden without it. If accurate per-pupil spending data that included both real teacher salary data and other non-teacher resource allocations at the school level were available, there would be no need for these studies in the first place. While data limits preclude explicit control for differences in non-teacher resources vis-à-vis teacher salary differences, there are several reasons to believe that districts do not typically alternative resources to balance school differences in TCE in most districts. However, until available data capture school-level real salaries and all other non-teacher resources, TCE equity conclusions must assume that other resources are not systematically allocated to balance differences in TCE and thereby achieve equity.

Limits to the scope of TCE research. While the limited depth of available data has constrained the school-level resources that analysts can control for, the limited breadth of available data has constrained the scope of research on intradistrict TCE. The evidentiary base is insufficient to describe the scope of the problem of intradistrict TCE differences across districts, and the predominant analytic approaches limit the ability to describe the scope of this problem across schools within districts. Many of the intradistrict TCE analyses have focused on a small number of districts for which detailed data are available (Roza & Hill, 2004; Argue, Honeyman & Schlay, 2006), while others use data on a larger number of districts within a single state (Education Trust West, 2005; Miller, 2010; Cohen & Miller, 2011). Except for the two analyses done by the Center for American

Progress (Miller, 2010; Cohen & Miller, 2011), these analyses have been limited to large urban districts. Researchers focused on large, urban districts because such districts have enough schools and enough diversity between schools, to exhibit variation in TCE (Roza, 2010). Research in mid-sized districts has shown the antecedents of TCE differentials are not limited to large districts alone (Miller & Rubenstein, 2008; Lankford et al., 2002). However, the focus on large urban districts has left little descriptive evidence on what proportion of districts exhibit substantial TCE variation. Even in the two HLM analyses with broader scopes (Miller, 2010; Cohen & Miller, 2011) the distribution of TCE variation across districts is not well described.

The lack of evidence on the portion of districts' schools affected by TCE variation is a result of researchers' analytic approaches. Most researchers have reported TCE differences only between schools at the ends of the spectrum of poverty or race/ethnicity (e.g., Roza & Hill, 2004; Education Trust West, 2005, 2008). By focusing on the extremes these studies effectively highlight a policy problem, but they neither indicate the proportion of schools affected by TCE variation, nor the degree of these impacts on schools.

The data limitations that have hindered the description of TCE variation have similarly hindered analyses of the association between TCE variation and district and school characteristics. With school-level data usually limited to a small number of districts, multivariate analyses that might investigate the association between district characteristics and TCE variation are impossible. Data on the district characteristics most likely related to TCE variation, such as allocation, transfer, and budgeting policies, would be difficult to gather by any means (Roza, 2010; Miller & Rubenstein, 2008). However, without a large sample of districts, scholars have been unable to test relationships between TCE variation and even the simplest of district characteristics, such as size and variation in the student composition of district schools. In two studies that use an HLM framework, in which these relationships could have been investigated, the authors do not do so (Reagan, 2010, Cohen & Miller, 2011). There is little empirical evidence on what kinds of district policies and characteristics are associated with TCE variation.

For similar reasons, scholars have not been able to assess thoroughly the relationships between school characteristics and schools' gains or losses due to TCE. All of the TCE studies reviewed here present simple bivariate relationships between teacher salaries and school characteristics. However, few have even attempted multivariate analyses of these relationships. Further, in the two HLM analyses, the multivariate framework for analysis has not been used to advantage. The authors of the HLM analyses use them to establish that there are differences in teacher average salaries by student poverty controlling for other characteristics, but they do not detail the implications of other measures in the model. Primary among these neglected controls are pupil-teacher ratios at schools, which would better inform equity claims. Compared to the detailed analyses that have examined the distribution of teacher qualifications across schools (e.g., Iatarola & Stiefel, 2003), the HLM models examining teacher salary within districts are under-parameterized, including only measures of student poverty, school level, district level (elementary or high school), and a wage index. Adding school and district measures to such analyses would substantially add to the understanding of the intradistrict distribution of TCE.

In summary, the available data has limited the scope of the empirical evidence on intradistrict TCE, and the conceptual and measurement approaches have limited equity comparisons of TCE. Fortunately, the availability of detailed school-level data is on the rise and may provide new opportunities to expand the empirical base and conceptual approaches to explore intradistrict TCE, which will add to the understanding of intradistrict equity generally.

Chapter Summary.

The literature reviewed in this chapter establishes the context for the analysis of intradistrict TCE in this dissertation. The first section of this chapter shows that the same equity framework and standards that have been applied to interdistrict school-finance, have been adapted for application to intradistrict analyses using numerous resource measures, often using inclusive funding measures. The literature on intradistrict funding differences shows that substantial portions of total resource variation lie between schools within districts and that school-level data are necessary to capture the full range of resource variation. This research has found that in many districts schools low-need schools receive a greater per-pupil share of general funding and that compensatory funds often supplant, rather than supplement general funds. This literature has also shown that the distribution of teachers is a significant driver, if not *the* significant driver, of total intradistrict resource differences. Further, teacher sorting and teacher quantity/quality tradeoffs are key factors in the variation in teachers across district schools.

The second section presents commonplace school district resource allocation practices and policies that are intended to provide resources to schools equitably with respect to legitimate educational differences between schools (Guthrie, 2007). However, research has shown numerous sources of variation in these systems that thwart their design such that resources are often allocated not according to legitimate educational needs, but based on the preferences of district staff, parents, administrators and teachers. District accounting and data systems make it difficult to detect this variation, posing challenges for researchers attempting to assess intradistrict equity and for district staff attempting to allocate resources and staff. Given the lack of evidence of an allocation mechanism that works to balance TCE differences with non-teacher resources, that the proportion of school-level expenditures that go to TCE, and that TCE differences drive overall intradistrict resource differences, evaluating the intradistrict distribution of TCE is an important vantage for evaluating resource equity in general.

The third section of this review covers research focused on the intradistrict distribution of teachers, which has examined how human resource systems allow teachers to concentrate in schools in terms of their quality, qualifications and compensation. In many districts, these studies show substantial intradistrict variation in these teacher attributes, and further, that these distributions of teacher characteristics are not independent of one another. The research suggests that with respect to teacher quality, qualifications, and compensation, many schools are divided between the "haves", whose teacher quality, qualifications and compensation are above the district average, and the "have-nots", whose teachers fall beneath district averages.

While research specifically focused on intradistrict differences in TCE is not expansive, the available studies consistently show that many districts shortchange high-need schools in terms of TCE. These studies have highlighted an important equity issue, but additional research is needed to determine the scope of inequitable distributions of

TCE among districts and schools and the district and school characteristics associated with TCE variation. The following chapter outlines a methodological approach that leverages newly available data to create a novel measure of TCE variation that may better capture the equity implications of TCE differences on a scale unprecedented in previous intradistrict studies.

Chapter 3: Methodology

This chapter contains three sections, beginning with a description of the data sources, and the data collection procedures of the primary data source for this study—the 2006-07 Teacher Compensation Survey (TCS). After I overview of the data sources, I explain my empirical framework for this study and describe the variables included in this analysis. In the third section, I review the statistical analyses for this study.

Description of Data Sources

The TCS, 2006-07 is the primary data source for this dissertation. I will supplement the TCS using additional data from the Common Core of Data, 2006-07 (CCD), the National Longitudinal School-Level State Assessment Score Database (NLSLSASD), administrative records from departments of education in states that participated in the TCS, and data from the American Community Survey (ACS)

Teacher Compensation Survey (TCS), 2006-07. The TCS, 2006-07 is a pilot restricted-use dataset that collects universe teacher-level data for public schools in participating states, and is part of NCES's CCD survey program. Participating states include Arizona, Arkansas, Colorado, Florida, Idaho, Iowa, Kansas, Kentucky, Louisiana, Maine, Minnesota, Mississippi, Missouri, Nebraska, Oklahoma, South Carolina, and Texas. The TCS includes 1.1 million records on nearly 1 million full-time-equivalent (FTE) teachers. Unlike many NCES surveys, TCS is not nationally representative and is not a sampled survey, and thus only supports direct inferences about the states included in these data. However, the TCS includes teacher-level compensation data of greater breadth than any other dataset, and it represents more than one third of the 3.2 million public school teachers who worked in the 2006-07 school year (Cornman, Johnson, Zhou, Honegger, & Noel, 2010). The TCS includes data on public school teachers' compensation, demographics, and salary-determinant qualifications. The TCS does not contain individually identifiable teacher data, but it is a restricted-use dataset that requires a license from NCES.

The TCS is well suited for a large-scale analysis of the intradistrict distribution of TCE because it is a universe survey, including compensation data for all teachers in all schools in participating states. The TCS includes measures of teachers' base and total salaries. In states that provided benefits data, the TCS includes the amount of total benefit compensation, and disaggregates total benefits into retirement, health, and other benefits. The TCS provides data on salary-determinant teacher qualifications (licensure, graduate education, and experience) in addition to compensation data, allowing for concomitant analyses of the distribution of teacher qualifications and compensation. With actual teacher-level salary data, the TCS allows real school-level salary averages to be calculated rather than estimated, and with data for every school in each district, the full distribution of TCE across schools can be analyzed. Such comprehensive data are a definite advantage over datasets that include only a sample of district schools (e.g., Miller, 2010), and no weighting is necessary because TCS has population data.

TCS, 2006-07 is the second administration of the TCS by NCES. The TCS is collected from voluntarily participating states through an online reporting system developed by the U.S. Census Bureau. NCES provided state officials with secure access to the data collection systems, as well as directions for submitting single-state data files. NCES also standardize data reporting with item definitions, record layouts, and data plans for state officials. After submission, NCES edited state files according to NCES statistical standards. NCES collected data for the 2006-07 TCS between March 2008 and January 2009 (Holland, Zhou, & Noel, 2010).

Not all states provided all the data requested for the TCS. Although 16 of the 17 participating states included data on all teachers, Arkansas could not supply data for its largest district, Little Rock. Neither was Arkansas able to provide district IDs for its schools. Without districts IDs, no intradistrict analyses of Arkansas schools are possible and so Arkansas will not be included in the analytic dataset.

NCES sent questionnaires to state department of education officials who then prepared the data files for submission to the TCS. These questionnaires were not surveys but only contained questions designed to clarify the administrative data that states submitted. For instance, to ensure that teachers' years of experience were reported similarly in all states, the questionnaires ask two questions about the states means of counting years of experience. The questionnaire asks for no information on teachers, schools, or districts, but only about data definitions and disclosure rules. The "Data Plan Questions" questionnaire and states answers are available in the TCS documentation (Holland, Zhou, & Noel, 2010).

Supplementary data. I will supplement TCS data with the Common Core of Data (NCES), supplemental data files obtained from the Colorado, Florida, Minnesota and Texas state departments of education, the NLSLSASD, and the American Community Survey. I overview these supplementary data sources in turn below.

Common Core of Data (CCD). The TCS is part of NCES's CCD survey program and includes NCES and state school identification numbers suitable for merging with supplementary data from other NCES and state databases. The CCD is a universe listing of all public and private schools in the US and includes data on school location, school type, Title I status, grade span, student membership totals, student race, and poverty. This dissertation study requires school-level data on students' educational needs. The CCD provides several key measures for this study, including student membership totals required to compute school-level pupil teacher ratios, and school measures that are associated with district allocation formulae. The school characteristics that are commonly associated with the allocation of teaching positions are Title I status, the proportions of students in a school who are classified as poor (defined as the percentage qualified for free and reduced price meals (FARM)), limited English proficiency (LEP[16]), or special education students. The CCD provides schools' Title I status and the percentage of FARM eligible students, for all schools in the TCS, as well as school-level race/ethnicity data for use in equity analyses. The CCD does not provide school-level data on the percentage of LEP or special education students, or on measures of student achievement. School-level LEP, special education, and academic performance measures are required for the full analyses in this dissertation. The sources for these important data elements are detailed next.

Supplementary State Data. Supplementing the TCS with school-level percentages of students classified as LEP or special education required data from state departments of education. The availability of state data varies considerably across states. Only three states that participated in the TCS, Texas, Florida, and Minnesota have 2006-07 data

[16] States differ in the titles they use to designate students who have limited proficiency in English. In this study, I use the term "limited English proficiency" (LEP) for the varied state designations by which compensatory resources are assigned.

posted on the internet that include school-level special education data. School-level LEP percentages are available on the web for these three states and five other TCS participating states (Arizona, Florida, Iowa, Kentucky, and Louisiana).

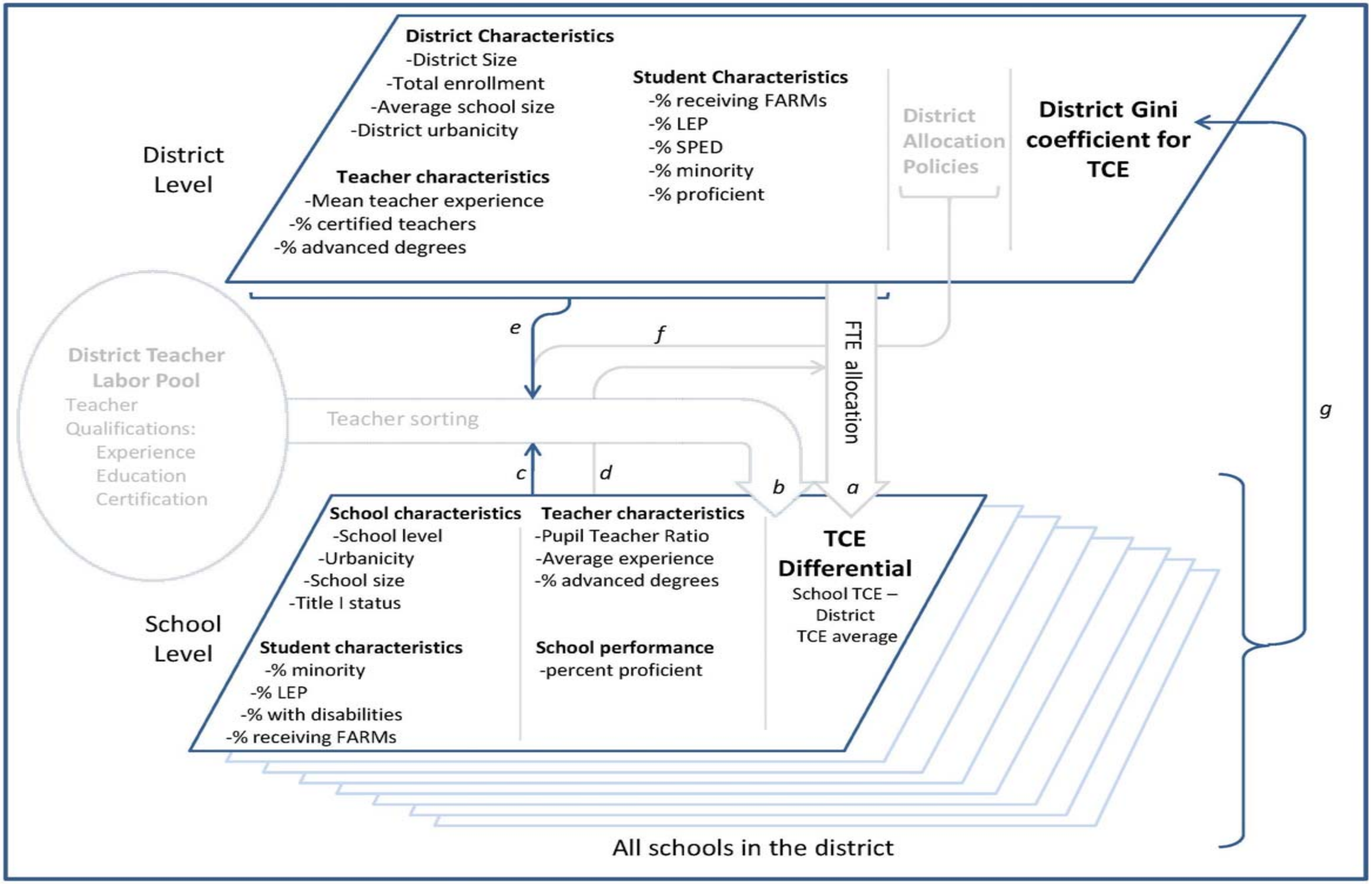
Publicly available state data are sufficient for a complete analysis in three states: Texas, Florida and Minnesota. The data from Texas and Minnesota contain school-level counts of students classified as special education and LEP students. I had to estimate school-level data for some Florida schools based on school-level F-CAT assessment data. Florida students in grades 1, 2 and 12 are not tested and counts or percentages for these students were not available. To estimate this data for schools that included students from these grades I calculated school percentages of special education and LEP students in grades for which the assessment data was available. I then multiplied these percentages by the total number of students in the schools found on the CCD. The resulting estimated counts of students with special education or LEP designations were used to derive *de facto* district allocation weights and in the multivariate analyses. The students in grades 1, 2, and 12 for whom there are not exact counts were a small portion of the total students in these schools and these estimated counts are a reasonable approach to include the Florida schools in the analysis. However, to the degree these counts are inaccurate there will be some bias in the results which is a necessary limitation for this study.

I submitted data requests for all the remaining states in the TCS. Of these, only the Colorado Department of Education has provided all the data I have requested. Complete data for the analyses described in this chapter were available for the following states: Colorado, Florida, Minnesota, and Texas. Presenting the full set of analyses for all the states in the TCS would be overwhelming so I completed the full set of analyses for these four states.

National Longitudinal School-Level State Assessment Score Database. The National Longitudinal School-Level State Assessment Score Database (NLSLSASD) is collected and housed by the American Institutes for Research (AIR) for the National Center for Education Statistics (NCES). The NLSLSASD includes data from state testing programs across the US and includes state proficiency percentages at the school level for all states participating in the TCS for the 2006-07 school year. The NLSLSASD data include school-level percentages of students in state defined proficiency categories based on state testing programs. State tests differ in the subjects assessed, their difficulty, in the number of proficiency categories, and in the benchmarks states set for various proficiency levels. However, the data provided are suitable for comparing schools within districts and districts within states and thus provide an adequate measure for comparing intradistrict performance. I use these data to create standardized measures of school performance by averaging schools' percentage of student categorized as proficient in state mathematics and reading/English-language arts tests and then standardizing these average proficiency percentages within states. The resulting measures have a mean of zero and a standard deviation of one for each state and are suitable for the comparisons of districts within states and schools within districts that I make in this dissertation.

The American Community Survey. The American Community Survey (ACS) is and annual data collection of the Census Bureau that provides a wide variety of data previously gathered on the long form of the decennial census. The ACS is the least central source of data for my analyses, but it provides a number of measures to

Figure 2. Empirical framework for relationships between district and school characteristics, school TCE differentials and district total TCE variation



characterize the district labor markets in this study. Though I performed exploratory analyses with multiple ACS measures, the only measure included in the final models presented in this dissertation is district unemployment rates for the 2006-07 school year.

Empirical Framework

Based on the conceptual framework presented in the first chapter, I applied the combined dataset to the conceptual framework presented in Figure 1 above. The empirical framework illustrates the measures I used to examine total district variation in TCE and school TCE gaps. Below I describe the measures used as dependent and independent variables in these analyses. Table 2 contains a full description of the variables used in the district and multilevel models.

Dependent variables. This study has three primary TCE measures dependent variables measured in two different ways to gauge equity in teacher compensation at the school level and at the district level. These measures (described in more detail below) are average teacher salary, per-pupil teacher salary, and a weighted measure of per-pupil teacher salary. At the school level, all three dependent variables calculate each school's TCE measure relative to the TCE received by other schools in the district. I calculate school differentials for each outcome measure as the difference between the measure of TCE and the district average of the same measure. At the district level, I measure variation in each dependent variable by the district Gini coefficient.

Two of the measures of TCE are straightforward. Average teacher salaries are simply the average salary for full-time teachers in each school. Salary per pupil is a measure of the total salaries at each school divided by the number of students in the schools. The third measure is a weighted salary per pupil measure based on adjusted student counts in each school. This weighting scheme, discussed in detail in chapter 3, adjusts student counts based on the average number of teachers its district allocates for a variety of compensatory needs. I designed this adjusted measure, which I detail below, to overcome two significant limitations of TCE measures used in previous intradistrict analyses.

Previous examinations of TCE have most often-examined schools' average teacher salaries (TCE per full-time employee, referred to as TCE_{FTE}). TCE_{FTE} is an informative measure because it clearly reflects teacher sorting (in terms of salary-dependent qualifications) across schools, however it cannot account for allocation trade-offs between teacher qualifications and teacher quantities. This dissertation examines TCE_{PP} which can capture these trade-offs in dollar per-pupil terms. The second limitation to TCE_{FTE} is also a limitation to TCE_{PP}, because neither measure controls for between-school differences in student compensatory needs (e.g., special education) that may legitimately reduce pupil-teacher ratios. To control for these differences, I adjust the number of pupils in each school by *de facto* district allocation weights, which are described below.

Derived *de facto* district teacher-allocation weights. Districts have their own formulas and systems by which they allocate teachers to schools. Each district weights student needs differently. Data on the formula weights for each compensatory need in every district would allow me to estimate how closely school staff allocations follow districts' formulas, and I would be able to use deviations from the formula-predicted staffing to evaluate TCE equity across district schools. Unfortunately, the formula's allocation weights are not available for all the districts included in these analyses.

Fortunately, the weights can be estimated using regression analyses (in districts that have a sufficient number of schools to yield reliable estimates).

Previous research has used similar approaches, which use weights to remove resource variation that is attributable to legitimate compensatory needs, to validly compare illegitimate resource variation across schools or districts. Miles and Roza (2002) and Roza, Guin, Gross and DeBurgomaster (2007) use estimated weights for student need types (such as free or reduced-price lunch eligibility and bilingual, vocational, or gifted education) to compare categorical and non-categorical expenditures between and across large Texas districts. Using non-categorical expenditures (per pupil), the authors create a ratio by dividing expenditures in a given school by the district average. Since these ratios compare school spending to the average spending of their district, variation in the ratio is intradistrict variation by definition. Similarly, for categorical expenditures, the researchers average categorical per-pupil expenditures at each school to the district level, and then convert deviations from the average into a ratio they call the *Weighted Student Index*. The authors are unclear as to exactly how they calculated different categorical expenditures to deal with the non-exclusivity of these categories.

Toutkoushian and Michael (2007) use a similar approach, again looking at expenditure data for Indiana in 2004 and 2005, but using districts instead of schools as the unit of analysis. Toutkoushian and Michael's purpose was to compare vertical equity adjustments in districts to the state finance formulas used in Indiana. They use regression to calculate the weights for multiple categories that might affect the per-pupil revenues directed to school districts. The advantage of using multiple regression is that each category is estimated controlling for the amount of revenues directed to school districts for the other categories. Toutkoushian and Michael use the residuals from these equations to calculate how much district revenues deviate from the state formula. The power of this approach is that they can assess the direction and magnitude of vertical equity adjustments, and thereby detect whether districts receive too little or too much revenue for a given categorical need. The ability to establish the magnitude of these deviations is a great advantage over approaches that can establish the directionality of funding, but cannot compare the amount of those funds to a standard. Toutkoushian and Michael's multivariate approach to adjusting for compensatory needs is also advantageous for horizontal equity comparisons, because the deviations from their regressions (measured by regression residuals) represent deviation from the state average after controlling for compensatory needs.

I synthesize these approaches and use multiple regression to estimate the average weight each district gives to student compensatory needs, not in allocating revenues or to compare expenditures, but in allocating FTE teaching positions. Then, using these *de facto* weights I compare the total number of FTE teaching positions each school receives to what they should receive if all teachers were allocated exactly according to district averages. Deviations from the district averages are by definition intradistrict deviations in teacher allocation, as was the case with the expenditure ratios calculated in Miles and Roza (2002) and Roza et al. (2007).

I use the term "*de facto*" to describe the weights because they do not estimate the formula weights for each district, but the actual average weight associated with compensatory student needs in each district. Having universe data on schools in these districts allows me to use multiple regression to estimate the average association between

FTE allocations and a number of potentially related school characteristics. Therefore, for each district, the resulting regression coefficients are actual average relationships, and not estimates of the associations based on a sample of schools. Because these weights are not estimated from a sample of schools, the sample sizes requirements associated with using regressions to produce inferential statistics are not required for my analyses. Instead, I apply regression equations to universe data to calculate the average allocation weights for multiple compensatory needs in each district for which I have data.

To estimate the *de facto* district teacher-allocation weights, I apply the following regression formula (3.01) for each district:

Formula 3.01

$$FTE = \beta_1(N_{All\_students}) + \beta_2(N_{SPED}) + \beta_3(N_{LEP}) + \beta_4(N_{FARM}) + \beta_5(\text{High School}) + e$$

Where FTE is equal to the number of full time equivalent positions at a school and $N_{All\_students}$ is the number of all students enrolled, regardless of their inclusion in the other compensatory categories. N_{SPED}, N_{LEP} and N_{FARM} are school student counts of students classified as learning disabled, limited English proficient (LEP), or free and reduced priced meals eligible (FARM), respectively.[17] To ensure stable estimates, I center all these measures on the district mean.[18] I constrain the coefficients for special

[17] To be clear, the N_{SPED}, N_{LEP} and N_{FARM} categories are not exclusive and may be counted once in $N_{All\_students}$ and possibly again for each compensatory category. Since the regression controls for the allocation according to each characteristic, holding the others constant, the estimates are category-specific and additive.

[18] That is, the district elementary school average number of students in SPED, LEP or FARM is subtracted from each school total. Centering does not affect the interpretation of the coefficients but does ensure that estimates are based on the range of schools present in the district. For instance, in a regression equation with un-centered predictors, the estimates would be based on a school with zero percent SPED, LEP and FARM. In many districts no such school exists and the derived weights from such a model can be biased. Centering the predictors results in better estimates for the district allocation weights.

education, LEP and FARM students to be positive based on the assumption that no district would reduce the number of teachers for these student compensatory needs. High_sch is a binary indicator for high schools (elementary schools are the default school level in the equation). The betas (β) are the coefficients associated with the adjacent parameters. There is no intercept in the model because the number of FTEs in a school is based on the number of students attending and an intercept would result in insensible allocation weights. I index the coefficients β_2 through β_6 by the weight for $N_{All\_students}$ (β_1) to calculate the allocation weight for each student type using formula 3.2 below (e.g., SPED weight= $(\beta_2 + \beta_1) / \beta_1$). The resulting weights equal the district average teacher FTE position allocation weight associated with each type of legitimate compensatory student need and with the school level.

Formula 3.02 Compensatory allocation weight =

$$(\beta_{compensatory\_category} + \beta_{All\_students}) / \beta_{All\_students}$$

Using the *de facto* weights produced in the regression equations I calculate the predicted number of FTE teachers each school would have received in a perfectly equitable distribution. I calculate this number of teachers by multiplying appropriate measures for the school (the numbers for each kind of student and the school level) by the estimated coefficients (see Formula 3.02). Additionally, I can use the coefficients to adjust the number of students in each need category by the associated allocation factor. For instance, in a hypothetical district[19] where β_1= 0.055, the pupil-teacher allocation for all students is roughly one teacher for every 18 students (18.21=1/0.055). If the

[19] The coefficients used in this example are from estimates of allocation weights for about 200 Texas districts.

Table 1. Hypothetical example of district derived teacher-allocation weights by student need and adjusted school enrollment counts.

	District averages				School enrollment	
	Beta	Weight	District average teacher allocation		Number of students by need category	Adjusted number of students by need category
All students	0.050	1.000	20.137		250	250
Special education	0.064	2.282	8.823		40	51
LEP	0.007	1.146	17.578		60	9
FARMS	0.015	1.300	15.484		125	38
High school	-0.001	0.974	20.677		0	0
				Total	250	348
School total TCE			\$810,000			
Average Salary			\$45,000			
Number of teachers			18			
Number of students			250			
Adjusted number of students			348			
Pupil-teacher ratio (250/18)			13.9			
TCE_{PP}			\$3,240.00			
TCE_{PPW}			\$2,330.35			
Difference (TCE_{PP}-TCE_{PPW})			\$909.65			

Note: District weights are the average weights derived from ~300 school districts. Schools' student numbers and TCE numbers are hypothetical. No actual school data is used in this table.

coefficient for special education students is 0.067 the average allocation of teachers for special education students is 2.2 times the base weight [(SPEDweight=(β_2+ β_1) / β_1) and in this case (0.055+0.067)/0.055)=2.2)]. The district-average teacher allocation for special education students would be one teacher for every eight special education students (8.17=1/ (0.055+0.067)). I similarly calculate the weights for other student needs and average district allocations for those needs.

To adjust the number of students at the school by the derived weights, I multiply the school's number of students in each category by the respective coefficients. For the hypothetical example presented in table 1, the total number of students in a school is 250, 40 of whom have special education needs, 60 of whom are LEP, and 125 of whom receive FARMs. Multiplying the number of students in each category of need by the beta weight for the given category equals the number of additional base weighted students that would be needed to receive the additional increment of teachers (e.g., 40 SPED students times the SPED weight minus the base weight (2.228-1.0=1.228) or 40*1.228=49.1 additional base weighted students).[20] I use these adjusted pupil numbers, which I use to remove variation in teacher FTE allocations that would be attributable to the compensatory needs in the regressions specified in formula 3.01, to per-pupil TCE.

Adjusted per-pupil measures of TCE. The adjusted pupil numbers result in substantially different measures of per-pupil TCE. I calculate the adjusted teacher compensation expenditures by dividing the school total of teacher salaries by the weighted number of students. I call this measure *teacher compensation expenditures per-pupil, weighted* (TCE_{PPW}). Using TCE_{PPW}, I can make comparisons across schools that have different pupil-teacher ratios and different proportions of student compensatory needs, both of which may account for the two critical aspects of the quantity/quality trade-off found in previous research.

School-level outcomes: TCE differentials. To measure each schools relative standing in the distribution of TCE within the district, I subtract schools' TCE from the district average TCE. I call these deviations from districts' mean TCE the "TCE differentials", which are the primary dependent variable for the HLM analyses. Schools

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[20] Because some measures are centered in each district, actual calculations use centered numbers of students. For simplicity sake, the conversions here are illustrated using raw numbers.

that receive fewer teachers per pupil (conditional on the average allocation for their district), schools that receive below-average teacher salaries, and schools that receive less of both, will have below-average TCE. For these schools, TCE differentials will be a negative dollar amount equal to what schools would receive in a perfectly equitable district TCE allocation. Schools with below-average pupil-teacher ratios, above-average salaries, or both will have a positive differential. I will use these measures as the dependent variable in a HLM framework to determine what school and district characteristics are associated with TCE differentials. Further, by using a HLM framework I can examine cross-level interactions, which are differential impacts of school characteristics depending on characteristics of the districts they are in, which likely influence TCE differentials.

District-level outcomes: Gini coefficient of TCE. I will measure district variation in my three TCE measures using the district Gini coefficient for each. Scholars frequently use the Gini to examine distributions of wealth, but have used the Gini in many other contexts, including interdistrict school finance analyses (Burke, 1999; Hertert, 1999). The Gini coefficient is a measure of inequality that represents the area between the Lorenz curve and the line of perfect equality in an ordered cumulative distribution where schools are ordered by TCE on the X-axis and by the cumulative TCE on the Y-axis (Odden & Picus, 2004). The Gini coefficient ranges from zero to one, with higher coefficients indicating more inequality. The Gini coefficient is mathematically equal to half of the relative mean difference, which is the average absolute difference[21] in a measure between two observations, divided by the overall mean (in this case the district average TCE).

[21] This average absolute difference is also called the *mean difference* or the *Gini mean difference,* and in this case would be the average TCE difference between schools in a district.

Equations for both are below; where y is schools' TCE in an ordered distribution where school *i* receives the least TCE in the district:

Formula 3.03

$$G = \frac{1}{n}\left(n + 1 - 2\left(\frac{\sum_{i=1}^{n} (n+1-i)y_i}{\sum_{i=1}^{n} y_i}\right)\right)$$

or

Formula 3.04[22] G =RMD/2

Where

Formula 3.05

$$RMD = \frac{1/(n*n-1)\sum_{i=1}^{n}\sum_{j=1}^{n}|y_i - y_j|}{\overline{y}}$$

These district-level Gini coefficients are the dependent variable in regression analyses that estimate the association between district characteristics and variation in TCE across schools. The Gini is an excellent measure of district variation for this study because it includes data from each point on the distribution of TCE and because it has a normal distribution suitable for multivariate analyses. The Gini coefficient also has some unfortunate attributes. One of these is that marginal differences in the Gini are not intuitively meaningful. It must suffice to understand that higher Ginis indicate a district has more TCE variation relative to districts with lower Gini's, and vice versa. Another unfortunate attribute is that the Gini does not have a clear standard or benchmark that defines what amount of variation is equitable and what is not. This challenge of benchmarking the Gini, and the method I choose for this study, deserves some consideration.

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[22] I have included formulas 3.04 and 3.05 because I calculate the Gini coefficient using the RMD and these equations show that the RMD method is equivalent to the more often cited Gini formula (3.03).

Benchmarking the Gini Coefficient. The standard for the Gini coefficient typically used in school finance is 0.05 (Odden & Picus, 2004). The 0.05 standard has been a functional standard in school finance literature that primarily evaluated per-pupil revenue or expenditure data in inter-district or interstate contexts. However useful the 0.05 standard has been for comparisons in this literature, the standard is not particularly meaningful in an absolute sense and may not apply to the interdistrict context or measures of TCE with the same functionality found in the other school finance literature.

Comparing the application of the Gini coefficient in different research contexts may help clarify the difficulties of benchmarking the Gini coefficient for this analysis. The Gini is most widely applied to income inequality, often within national contexts (e.g., Davies et al., 2009). When applied to national income inequality, Gini coefficients range from 0.23 for Sweden to 0.71 for Namibia, with the United States falling in between at 0.45. In contrast, Gini coefficients found in U.S. school finance analyses of per-pupil expenditures are far lower with interstate analyses yielding average Ginis below 0.1 and interdistrict (e.g., Burke 1999), and intradistrict analyses yielding lower Ginis still, from 0.045 to 0.065.

These differences highlight that the Ginis range and mean are dependent on the measure used, and the level of aggregation across groups. For example, income differs from per-pupil expenditures in that income can be zero for a substantial portion of a population and differences between the mean and the top percent by income can be many orders of magnitude. This is not so with U.S. per-pupil expenditures, for which the lowest and highest measures will be marginally different from the mean (perhaps by one or two multiples), and the lowest measures will never be zero. Thus, it is not surprising that income would have larger Gini coefficients than per-pupil expenditures.

Perhaps these different Ginis reflect different amounts of variation, where income is highly inequitable and per-pupil expenditures less so. Calculations and statistics cannot answer this question, because the answer requires defining what equity should be for two very different measures. Arguably, there are good reasons that income should vary much more than per-pupil expenditures, and thus the 0.05 benchmark typically used in school finance for per-pupil expenditures within states would not cross over to evaluate income within countries.

There are analogous differences, though by a smaller degree, between the measures and contexts of intradistrict TCE and the measures and contexts of inter-district per-pupil expenditures, which justify different benchmarks for the Gini coefficient. As variation in per-pupil expenditures is limited compared to income, TCE variation within districts is limited compared to per-pupil expenditures. Within districts, school average salaries are bounded by a single salary schedule and are funded from the same district pool of funding, and the only source of variation should be between-school differences in teacher qualifications. In comparison, interdistrict per-pupil expenditures are not bounded by any similar schedule and are funded from variable pools of funding (e.g., different tax bases). Given these bounds, not only would one expect the intradistrict TCE_{FTE} Ginis to be smaller, one could argue that they should be smaller since there are fewer legitimate sources of variation across schools within districts than there are across districts within states. One would also suspect that per-pupil measures of TCE would have larger Ginis than TCE_{FTE} because there are two sources of variation, differences in teacher qualifications and differences in the allocation of teachers, for these measures. For these reasons, Odden and Picus's often cited 0.05 benchmark for the Gini used in other school finance research does not readily apply to the measures and contexts of this study, as one of the authors of the cited work agrees (personal communication with Larry Picus, April 19, 2012). This indeed is what I find in this study (See Chapter 4).

Establishing an alternative benchmark for this study is necessary, but there are few rules to guide identifying the benchmark.[23] I combine a measure of equity differences that directly relates to the Gini coefficient and a subjective judgment on what could be considered the limit of equity to establish benchmarks for two tiers of inequity: a stricter Gini benchmark of 0.25 and a more generous benchmark of 0.05.

Returning to the mathematical basis for the Gini, recall from equation 3.05 that the relative mean difference (RMD) is the average absolute difference in a measure between two observations in a distribution, divided by the mean of the same. More intuitively, the RMD of TCE is the average intradistrict difference between schools as a percentage of the district mean TCE measure. For example, if a district's average salary was $45,000, and the average salary difference between schools in that district were $2,250, the RMD would be $2,250/45,000 or 5%. According to equation 3.04, the Gini is simply half the RMD, in this case 0.025. Therefore, I use the RMD to connect Gini levels to a subjective judgment about functional benchmarks.

There are few sources to base a subjective equity benchmark on, but the few that exist are instructive. One suggestion comes from federal legislation. The Fiscal Fairness Act of the 112th Congress (HR 1294 and S.B. 701) addresses Title I funding

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[23] In a personal communication, Larry Picus (April 19, 2012) indicated as much saying that there are no clear grounds for establishing an objective benchmark for the Gini in any context and that I should develop an argument for a benchmark for comparisons, and establish it as a functional, rather than an objective, benchmark.

comparability within districts. The law holds that for Title I funds to be distributed on an equitable level of base district and state funding, Title I schools must receive 97% of the base district and state funding that non-Title I schools receive. A 97% benchmark would require and RMD of .03 and a Gini of 0.015, a narrow threshold for equity. Two suggested benchmarks are found in a ED report on intradistrict Title I comparability (Heuer & Stullich, 2011) which uses three levels for between-school differences in personnel expenditures, +/- 3% described as "about the same",[24] 4-10% and 10%.

While these benchmarks are suggestive, I choose two benchmarks for the Gini, 0.025 and 0.05 based on their associated impact on schools. A Gini of 0.025 is associated with a RMD of 0.05, meaning that the average difference between schools in a district with a Gini of 0.025 would be 5% of the district's school salary average. In more concrete terms, if such a district had an average salary of $45,000 and an average of 44 FTE teachers per school the average difference in funding would be $99,000 or enough to hire two additional teachers at average salary. In a similar district with a Gini of 0.05 and an RMD of 0.1, the difference would be twice that. While these levels are somewhat arbitrary (as any other benchmarks would be), they are functional for these analyses and are clearly associated with a proportion of variation. It should be noted that since the Gini is only useful as a horizontal equity measure they are only applicable to two of my TCE measures, TCE_{FTE} and TCE_{PPW}. Since TCE_{PP} compares schools with differently situated students, it is not valid to make equity inferences based on a Gini measure. Nonetheless, I include parallel results for all three measures because the differences between the results are illuminating.

[24] The 3% cutoff in the ED report was based on the 3% standard in the Fiscal Fairness Act.

The Gini coefficients for TCE_{FTE}, TCE_{PP}, and TCE_{PPW} serve as the dependent variables in parallel analyses of district TCE variation. In the next section, I review the independent variables I will use in these regressions, beginning with the measures applied to school TCE differentials followed by those used in analysis of total district TCE variation.

Independent variables for analyzing school-level TCE differentials. This dissertation will examine the relationship between school TCE differentials and a variety of school and district characteristics using an HLM framework where schools are nested within districts. There is no single primary independent variable in these analyses because the literature on intradistrict variation includes numerous hypothesized relationships between TCE variation and school and district characteristics. Most of the school-level independent variables included in this study fall into the categories of school type, and school compositions measures of student and teacher. District characteristics that may be associated with TCE differentials fall into three categories: district-wide characteristics, aggregated school compositional characteristics, and measures of the variability of school compositional characteristics. In the empirical framework illustrated in Figure 2, I have illustrated the association of district measures with TCE differentials with arrow *e* affecting arrow *b*. Similarly, arrow *c* affecting arrow *b* represents the association between school-level independent variables and TCE differentials. I detail the school- and district-level independent variables in turn below.

School-level independent variables. School variables for these analyses include binary indicators for school level (e.g., elementary), and categorical measures of school size, urbanicity, and Title I status. Based in the literature on intradistrict resource distributions and teacher sorting (e.g., Imazeki, 2004), schools' urbanicity is the most likely "school type" measure to be associated with TCE differentials. The literature on teacher sorting (e.g., Lankford et al., 2002) suggests that student compositional variables will be associated with TCE differentials, especially the percentage of minority, poor, and low-performing students. To measure school minority and poverty, I standardize the percentage of minority students and the percentage receiving free or reduced priced meals. To measure school academic performance I average school percentages of students scoring proficient on state tests of mathematics and reading/ELA, and then standardize these percentages within states.

I purposively add teacher composition variables to analyses of TCE in order to detect whether the distribution of teachers, in terms of FTE positions per pupil and in terms of qualifications, explain differences in TCE. I will enter variables into models by blocks, first establishing a primary model and then exploring changes in these results with secondary models. I will only use salary related teacher characteristics in secondary analyses to determine if these measures explain away differences in TCE. For instance, if primary results show TCE differentials between schools, and secondary analyses that include teacher-salary related characteristics explain away these differentials, it would follow that TCE differentials relate to the distribution of teacher qualifications rather than differences in the allocation of FTE teacher positions.

District-level independent variables. District characteristics used to analyze TCE differentials include district-wide characteristics, average school compositional characteristics and measures of the variability of compositional characteristics across district schools. District type variables include categorical measures of district size in

Table 2. Definition of variables used in this study.

Level	Variable Name	Description
Dependent Variables		
TCE measures	Average teacher salary (TCE_{FTE})	TCE divided by the number of FTE teachers at a school.
	Teacher Compensation Expenditures per pupil (TCE_{PP})	TCE divided by the number of students in each school.
	Teacher Compensation Expenditures per pupil, weighted (TCE_{PPW})	TCE divided by the weighted number of students in each school.
School Level	TCE_{FTE} Differential	School TCE_{FTE} minus the district average TCE_{FTE}
	TCEPP Differential	School TCE_{PP} minus the district average TCE_{PP}
	TCE_{PPW} Differential	School TCE_{PPW} minus the district average TCE_{PPW}
District Level	Gini Coefficient for TCE_{FTE}	District Gini coefficient for TCE_{FTE}
	Gini Coefficient for TCE_{PP}	District Gini coefficient for TCE_{PP}
	Gini Coefficient for TCE_{PPW}	District Gini coefficient for TCE_{PPW}
Independent Variables		
School Level	Elementary school	Binary indicator for elementary schools
	Middle school	Binary indicator for middle schools
	High school	Binary indicator for high schools
	Urban school	Binary indicator for urban school
	Suburban school	Binary indicator for suburban school
	Town/rural school	Binary indicator for town or rural school
	Total enrollment	Standardized School student count
	Pupil-teacher ratio	Pupil-teacher Ratio
	Percent minority students	School percentage non-White students
	Percent LEP students (LEP)	School percentage LEP students
	Percent special education students	School percentage students with disabilities
	Percent poverty (FARMS)	School percentage students eligible for free and reduced price meals
	Title I eligible school	Binary Title I eligible school indicator
	School proficiency	Standardized average percentage of students scoring proficient on state mathematics and reading exams (standardized within states)
	Teacher experience	Average teacher experience
	Percent of teacher with advanced degrees	Percentage of teachers with a an advance degree (MA or PhD)
	School total FTE	School total FTE positions

District Level	Number of schools in the district	Number of schools in the district
	Urban district	Binary indicator for urban district
	Suburban district	Binary indicator for suburban district
	Town/rural district	Binary indicator for town or rural district
	District average pupil-teacher ratio	Average Pupil-teacher Ratio
	Percent Title I schools	District Title I school percentage
	District average student poverty percentage	District average for the school percentage students eligible for free and reduced price meals
	CV school poverty	CV for district average student poverty percentage
	District average minority percentage	District average for school- percentage non-White students (CCD)
	CV minority percentage	CV for district average minority percentage
	District average percentage LEP students	District's school average percentage LEP students
	District average percentage special education students	District's school average school percentage students with disabilities
	CV special education	CV school percentage students with disabilities
	District average school proficiency	Districts' school average student proficiency
	CV proficiency	CV of district average school proficiency

terms of the number of schools and the modal urbanicity. I will aggregate many of the school-level student and teacher compositional variables to the district level, such as measures of student performance and minority, and FARMS percentages. Aggregated teacher measures will include average teacher experience and percentage of teachers with advanced degrees.

While district compositional measures of student and teachers characteristics are important for these analyses, the amount of dispersion in these measures may be more strongly related to total district TCE variation. The more between-school variation there is on these measures, the more likely that teacher preferences for “attractive” schools will be strong and sorting more pronounced. More pronounced sorting and disparate concentrations of teacher qualifications across schools should be associated with greater differences in TCE. To capture the dispersion in the various schools characteristics I calculate coefficients of variation (CV's) for the compositional characteristics, and include the standardized CV's in the district-level model.

Independent variables for analyzing total district TCE variation. The analyses of total district variation, as measured by the Gini coefficients, include many of the same measures that I use in the HLM analyses. The same district type characteristics and measures of variation in school compositional characteristics will be used, including district averages and coefficients of variation for school percentages of minority, FARM, and academically proficient students. I illustrate the indirect associations between these measures and total district TCE_{PPW} variation with the flow of arrows *e* to *b,* which affect the amount of variation across schools, which is in turn captured by arrow *g* in the empirical framework. Finally, I will use measures of the variation in pupil-teacher ratios and teacher salary-determinant qualifications in secondary analyses to determine how much of the variation in TCE is attributable to the distributions of these factors.

Analytic Data. The TCS, 2006-07, is a universe survey including data on all schools in 16 states. Arkansas is missing data for Little Rock and further, Arkansas does not have district id numbers so these data are not usable for an intradistrict analysis. The remaining 16 states are Arizona, Colorado, Florida, Idaho, Iowa, Kansas, Kentucky, Louisiana, Maine, Minnesota, Mississippi, Missouri, Nebraska, Oklahoma, South Carolina, and Texas. Very small districts are not practical for inclusion in these analyses because with only a few schools there is little opportunity for variation across schools. Further, because small districts often include one school at each level— one elementary,

Table 3. States, districts, and schools included in the TCS, 2006-07 by total number, total number of minimum size, and percentage of minimum size: CCD, 2006-07.

	Total state schools*	Total state districts	State schools in minimum sized districts	State districts of minimum size	Percentage of state schools in minimum sized districts	Percentage districts of minimum size
Arizona	1,265	186	861	47	68%	25%
Colorado	*1,362*	*158*	*1,008*	*36*	*74%*	*23%*
Florida	*2,371*	*71*	*2,276*	*49*	*96%*	*69%*
Idaho	513	106	271	21	53%	20%
Iowa	1,310	357	392	29	30%	8%
Kansas	1,207	278	508	32	42%	12%
Kentucky	1,157	175	680	51	59%	29%
Louisiana	1,122	70	1,051	52	94%	74%
Maine	563	195	148	18	26%	9%
Minnesota	*1,367*	*332*	*549*	*40*	*40%*	*12%*
Mississippi	868	152	432	36	50%	24%
Missouri	1,974	483	880	56	45%	12%
Nebraska	833	236	330	18	40%	8%
Oklahoma	1,588	509	511	27	32%	5%
South Carolina	1,022	85	900	53	88%	62%
Texas	*6,630*	*1008*	*4,268*	*177*	*64%*	*18%*
Total	25,152	4,401	15,065	742	56%	26%
Case Study State	*11,730*	*1,569*	*8,101*	*302*	*69%*	*30%*

* Total state schools do not include charter schools, kindergarten or pre-kindergarten schools, schools specifically designated for the education of students with special education needs, with persistent behavior problems, or students in the penal system.
Note: Data for this drawn from the public use version of the Teacher Compensation Survey, 2006-07 and the Common Core of Data, 2006-07. Minimum district size for deriving allocation weights is 7 schools. Case study states are in italics and have complete data for HLM models.

one middle, and one high school—variation due to school level would not be discernable from that due to any other factor.

Ultimately, the decision rule for inclusion in this analysis hinges on the whether the districts contain enough schools to yield reliable estimates of district teacher-allocation weights. The decision rule includes two requirements. First, the district must include more than six schools, because districts with six or fewer schools result in unreliable estimated *de facto* allocation weights. The second requirement is that the allocation weights must explain 90% of the variation in teacher allocations in the district; that is, the R-squared for the regression that estimates allocation weights must be 0.90 or above. The second requirement is included because where allocation weights do not explain 90% of the variance in teacher allocations across schools there may be anomalies in the data. The majority of districts, 96%, with seven or more schools had an R-squared above that threshold. This decision rule strikes a balance between maximizing the coverage of the analysis and retaining reliable estimates.

Table 3 summarizes the number of schools and districts that will be included in the analysis by the first requirement of the decision rule. The number of districts that are included in the analysis appears rather small in the table below, averaging at 26% of all the districts in the TCS and 30% in the case study states. However, the number of schools included in the analytic dataset is much larger at 56 and 69%, respectively, because the removed districts contain the fewest schools. The coverage of schools in a state ranges from a high of 96% in Florida to a low of 26% in Maine. Taken as a whole, and for the case study states, these data provide ample power for multivariate statistical analyses.

Another point that deserves clarification is the feasibility of using coefficients from regression equations based on a small number of schools. Typical sample size requirements for regressions in an inferential statistical framework do not apply to these analyses because I am not using the resulting coefficients to make inferences. Instead, I use regression as a tool to calculate average relationships between schools characteristics and teacher allocations concomitantly, using the population of schools. Since the data include the population of schools, the coefficients are not "representative" estimates of these relationships, but are the average relationships in these districts.

Analyzing the entire set of available data, while ignoring differences between states, may potentially bias results in an unpredictable way. However conducting these analyses with multiple outcome variables across 16 states would produce more results than can be practically digested. To maintain a balance between the depth and breadth of analyses, I present descriptive results for the dataset as a whole and complete the full multivariate analyses for the four case study states.

Table 4 presents a range of descriptive statistics that compare the TCE and school compositional characteristics across the case study states and in those states, between the total state districts and those included in the analytic sample. The most notable differences between the states is that Minnesota has higher teacher salaries, per-pupil expenditures and per-pupil instructional expenditures, than the other states, while Texas spends less on each.

There are several notable differences between the analytic samples and the total districts in each state. First, the number of districts in the analytic sample is much smaller than the states' totals because the districts with six schools or fewer, of which there are many in Colorado, Minnesota and Texas, are not included in the analytic sample. A large proportion of state schools are retained in the analytic sample because of the larger number of schools per district. The selection of districts for the analytic sample based on size influences a number of the differences between total state districts and those included in the analytic sample, including differences for Title I percentage, urbanicity and enrollments. The differences between the districts in the analytic sample and all the districts in the state are notable, but are not a threat to the validity of these analyses

Table 4. Descriptive statistics for case study states, comparing all districts and those included in the analytic sample.

State characteristics	Colorado		Florida		Minnesota		Texas	
National teacher salary rank	26		28		18		29	
Average Teacher Salary	$45,833		$45,308		$49,634		$44,897	
Average per-pupil expenditures	$9,152		$9,084		$10,048		$8,350	
Average per-pupil instructional expenditures	$5,299		$5,473		$6,474		$4,993	
	Total	Sample	Total	Sample	Total	Sample	Total	Sample
Number of districts	160	40	70	50	330	40	1010	180
Number of schools	1,360	1,010	2370	2280	1,370	550	6630	4270
Average number of schools per district	8.6	28.0	33.4	46.4	4.1	13.7	6.6	24.1
Average enrollment	520	600	910	730	550	730	660	810
Average pupil teacher ratio	16.4	17.2	16.0	17.6	16.4	17.6	14.3	15.3
Average percent free/reduced price lunch	39%	39%	51%	33%	33%	33%	49%	50%
Average percent minority	38%	42%	50%	29%	18%	29%	60%	70%
Average teacher salary	$43,846	$46,804	$44,343	$53,672	$48,797	$53,672	$44,548	$46,090
Average teacher experience	12.8	12.5	11.4	14.3	15.1	14.3	12.6	12.0
Average percentage teachers with advanced degrees	49%	53%	31%	60%	45%	60%	20%	22%
Title I school percentage	38%	33%	72%	44%	50%	44%	72%	68%
Urbanicity distribution								
Urban	30%	40%	23%	34%	14%	34%	36%	53%
Suburban	30%	39%	50%	40%	22%	40%	20%	28%
Town	12%	8%	8%	14%	21%	14%	15%	7%
Rural	28%	14%	19%	12%	44%	12%	30%	11%

because I exclude smaller districts on purpose. Many of these districts have too few schools to separate TCE differences from differences in school levels. Further, the current analyses do not attempt to be representative of all state districts, but only of those of sufficient size. The analytic samples in all four states include a large portion of state schools and together make up a large sample for multivariate analyses.

Statistical Procedures

The statistical procedures I propose for this dissertation consist of five parts. The first set of procedures, detailed above, allow me to estimate *de* facto allocation weights within each district I will analyze. The estimation of these weights is a necessary preliminary step to the remaining four statistical procedures. These four analyses are designed to answer my research questions, though not necessarily in a direct linear fashion. To review, the research questions for this dissertation are:

1. What proportions of school districts have substantial between-school variations in TCE as measured by the Gini coefficient? What district characteristics are associated with this variation?
2. What proportions of schools are affected by substantial TCE variations? What is the average magnitude of between-school TCE differentials? What school characteristics are associated with greater or lesser TCE?
3. Do legitimate student compensatory needs- such as poverty, special education status, limited English proficiency, and low performance explain between-school TCE differentials?

The first set of analyses provides descriptive statistics for multiple measures of TCE that will extend the findings in previous research by controlling for per-pupil teacher allocations and student compensatory needs. These descriptive will also examine the district-level Gini coefficients for TCE_{FTE}, TCE_{PP} ad TCE_{PPW}, which will answer the first part of my first research question, "What proportions of school districts have substantial between-school variations in TCE as measured by the Gini coefficient?" For the district-level analysis of district-level variation, I will use OLS regression to examine district Gini coefficients for multiple measures of TCE; these analyses will address the second part of my first research question, "What district characteristics are associated with [substantial between-school variations in TCE as measured by the Gini coefficient]?" Finally, to address question raised in my second and fourth research questions, I will conduct multilevel analysis of schools nested within districts, with school-level TCE_{PPW} differentials from the district-level TCE_{PPW} average as my dependent variable. I detail each set of analyses in turn below.

Descriptive analyses. To compare my descriptive data to findings from previous literature, I compare school average salary measures across schools by poverty, minority and proficiency quartiles (Roza, 2010; Roza & Hill, 2004; Education Trust West, 2005). Additionally, I extend prior research by examining differences in TCE_{PP} and TCE_{PPW} by the same quartiles. Comparing these three TCE measures using the same evaluative methods used in previous studies provides context for my findings vis-à-vis the findings from prior research. Further, the magnitudes of the differences between TCE measures by these quartiles indicate the importance of controlling for pupil-teacher ratios and student compensatory needs.

Regression analyses of total district variation. Descriptive and regression analyses of district Gini coefficients of TCE_{FTE}, TCE_{PP} and TCE_{PPW} address the third research question regarding what district characteristics are associated with total TCE variation. This study will use the 0.025 and 0.050 thresholds for equity, as discussed above. I will present tables with average Gini coefficients for all three TCE measures for each state, using the two Gini benchmarks. These tables will provide the first empirical evidence on the proportion of districts that have substantial TCE variation.

I will conduct a series of regression analyses to explore what district characteristics are associated with total district TCE variation as measured by the Gini index for TCE_{FTE}, TCE_{PP} and TCE_{PPW}. The Gini Index is simply the Gini coefficient multiplied by 100. Using the Gini index returns more readable results (using fewer decimal places) than the Gini coefficient and return the same relationships. The generalized regression equation is in formula 3.06:

Formula 3.06 $G_i = a + \beta_1 (W_i) + \beta_2 (X_i) + \beta_3 (Y_i) + \beta_4 (Z_i) + e$

where *G* is the outcome measure (the Gini coefficient for the *i*th district), where *a* is the average Gini coefficient holding all other variables in the model to zero. Where W_i, X_i, Y_i, and Z_i are vectors of variables I will enter in stepped or blocked models, and *e* is the error term. I will run stepped models by adding blocks of variables to the regression model in turn. The first block will be a vector of district characteristics I hypothesize to relate to teacher sorting that will serve as my base model (W_i). The first block of district measures includes average schools measures for student compensatory needs such as the standardized percentage of students classified as LEP, special education, and those receiving free and reduced priced meals. Three school compositional measures—student poverty, minority composition, and proficiency— are key independent variables in these analyses. Unfortunately, these measures are highly correlated at the schools and district levels, and entering all three to the model simultaneously could hide important relationships. In order to examine each relationship in turn, I add the two additional measures of the schools' average compositions of minority students and students scoring proficient on state tests in blocks. Minority composition and student proficiency included in the second vector of variables (X_i). Examining these key independent variables in turn reveals important relationships between each and district TCE variation, and interrelationships between these three key measures that would be invisible in a single cumulative model.

Between-school variation in these key school composition measures may be related to the severity of teacher sorting across schools, and thus TCE variation. The third vector of measures (Y_i) includes coefficients of variation (CV) for average school poverty, minority composition and proficiency. Again, I enter each CV on the model using a blocked presentation.

Finally, the distribution of teacher qualifications—specifically the variation in salary related teacher qualifications— are hypothesized to be directly related district TCE variation and the final vector of variables (Z_i), includes such measures. If adding the final vector of variables reduces either the constant (*a)* or the coefficients for variables in the first two vectors, it will suggest that teacher sorting is indeed a significant driver of TCE variation within districts.

Hierarchical linear models of school TCE differentials. To address my second research question, I will investigate the school and district characteristics associated with school-level TCE differentials with a series parallel HLM analyses. I will use parallel models across all three TCE measures for the four case study states that have complete data. My data for these analyses will come from all districts that meet my decision rules for inclusion in the multivariate analyses. The models will appropriately model school

TCE differentials with schools nested in districts.

The within-district (Level 1) model. For the within district (level 1) model, I will enter school and district variables into the HLM to estimate the relationships between TCE and various school and district characteristics. I will add school-level variables to the model to estimate their average relationship to TCE and to determine whether those relationships have random effects across districts. I will enter the school-level variables into the model in five blocks. The first block (see "Block 1" in the equation below) of school-level measures include a standardized measure of school size and binary indicators for elementary schools, Title I schools, urban schools and town or rural schools. The second block of variables includes measures of student compensatory needs for each school, including district-centered[25] standardized percentages of LEP, special education, and FARM eligible students. In the third and fourth blocks, I add the district-centered standardized measure for minority percentage and percent proficient, respectively. In the fifth block, I add a cross-level interaction between school proficiency and the districts' Gini for average school salary (TCE^{FTE}). The final blocks of variables (presented in secondary tables) include two measures of salary-determinant teacher qualifications: teacher experience and education. Continuous variables will be group-mean centered because their effects on TCE differentials are a function of the district context, rather than the grand mean across all districts.

This blocked variable strategy is informative because as blocks of variables are

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[25] "District-centered" indicates that the scores for each school are standardized with a standard deviation of one centered on the schools' district mean of zero. This is the same as "group-centering these standardized measures. Group-centering is sensible because I am trying to model TCE differences within districts that are a function of intradistrict teacher sorting.

added to the model they can explain a portion of the variation in TCE differentials estimated in the base model, and the portion of variance that is explained by these variables indicates the relative importance of each block. Further, when latter blocks of variables are entered into the model, they can reduce the magnitude and significance of the coefficients for variables in earlier blocks. The changes made to block-1 coefficients by adding subsequent measures to the model may provide a basis for inferences that could not be had by entering all the variables into a single model. For instance, assume that block 1 variables reveal significant associations with TCE differentials when entered on the model alone. If those associations are reduced when salary-determinant teacher qualifications are added to the model, I can infer that the sorting of teacher qualifications is related to TCE differentials and that these relationships explain away the differences in TCE that are associated with student body characteristics. In short, such a pattern of results would suggest that student composition drives the distribution of teacher qualifications and that those qualifications drive TCE differentials. The relative power of each measure will be reflected in the amount of school-level variance explained by blocks entered, and in the changes in coefficients for variables in preceding blocks.

HLM can test whether the slopes of school-level measures—that is, the average relationships between these measures and TCE differentials— vary across districts. Random slopes are those that have significant amounts of variation across districts and I can model such variation with district-level measures. For example, the association between the percentage of poor students in schools and TCE differentials may be small in districts with relatively few students in poverty, or in districts where schools have similar proportions of poor students. In districts that have more poor students and greater variation in the school percentage of poor students, the relationship between the school percentage of poor students and TCE differentials may be stronger. Identifying and modeling random slopes can evaluate these cross-level interactions. When fitting the HLM models for each state, I test the school-level measures of student composition and teacher qualifications for random effects. I model slopes that have significant random effects with the same district characteristics used to model variation on the intercept.

I present the total school-level model in formula 3.07 below by blocks:

Formula 3.07

$Y_{ij}=$ $\beta_{0j} + \beta_{1j}$ (School size) + β_{2j} (Elementary School) +β_{3j} (Title I school) + β_{4j} (Urban school) + β_{5j} (Town/Rural school)

Block 2 + β_{6j} (Percent LEP) + β_{7j} (Percent Special Education) β_{8j} (Percent Poverty)

Block 3 + β_{9j} (Percent Minority)

Block 4 + β_{10j} (Percent Proficient) +

Block 6 [26] β_{11j} (Mean Teacher Experience) + β_{12j} (Mean Advance Degree) + r_{ij}

where

Y_{ij} is the predicted TCE differential for school *i* in district *j*; and

β_{0j} is the intercept or mean TCE differential for district *j*; and

β_{1j} - β_{5j} are the coefficients associated with the respective dichotomous or categorical variables in school *j*; and

$\beta_{6j} - \beta_{10j}$ are the coefficients associated with the continuous measures of student body composition and performance; and

$\beta_{11j} - \beta_{12j}$ are the coefficients associated with the continuous measures of salary-determinant teacher qualifications; and

r_i is a random "school effect", that is, the deviation of school *i*'s TCE differential from the predicted TCE differential based on level-1 model. Residual school effects are assumed normally distributed with a mean of zero and variance σ^2.

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[26] Block 5 includes a cross-level interaction between school proficiency and the district Gini for TCE_{FTE}, which is not part of the school-level model.

The between-district (Level 2) model. The district-level model examines the associations between-district characteristics and school-level TCE differentials. I will specify the level-two model in part based on the findings from the district Gini regression models explained above. District measures will include binary measures for urban districts and town or rural districts and a standardized measure of the number of schools in a district. District averages and coefficients of variation for percent LEP, percent special education, percent FARM eligible students, percent minority, and proficiency are included in the model as well as a standardized measure of district unemployment. The model also includes state fixed effects to control for differences between states (Texas, the state with the largest sample, is the reference group.) I will use these district measures to model the mean school TCE differentials. The resulting level-two equation is in formula 3.08 below:

Formula 3.08

$$\beta_{0j} = \gamma_{00} + \gamma_{01}\,(\text{Urban District}) + \gamma_{02}\,(\text{Town/Rural district}) + \gamma_{03}\,(\text{Number of schools}) + \gamma_{04}\,(\text{Special Education \%}) + \gamma_{05}\,(\text{LEP \%}) + \gamma_{06}\,(\text{Poverty \%}) + \gamma_{07}\,(\text{Minority \%}) + \gamma_{08}\,(\text{Mean proficiency}) + \gamma_{09}\,(\text{District mean unemployment}) + \gamma_{10}\,(\text{CV LEP\%}) + \gamma_{11}\,(\text{CV Special Education \%}) + \gamma_{12}\,(\text{CV Poverty \%}) + \gamma_{13}\,(\text{CV Minority \%}) + \gamma_{14}\,(\text{CV Proficiency \%}) + \gamma_{15}\,(\text{Minnesota}) + \gamma_{16}\,(\text{Florida}) + \gamma_{17}\,(\text{Colorado}) + \gamma_{17}\,(\text{Gini TCE}_{FTE}) + \mu_{03}$$

where

γ_{00} is the grand mean TCE differential; and

γ_{01} - γ_{02} are the estimated difference in the average TCE differential in districts where schools modal urbanicity is Urban and Town/Rural, respectively; and

γ_{03} is the estimated difference in the average TCE differential in districts per standard deviation of the number of district schools; and

γ_{04} -γ_{08} is the estimated difference in the average TCE differentials associated with a percent increase in school averages for student composition characteristics; and

γ_{09} is the estimated difference in the average TCE differentials associated with a standard deviation increase in district unemployment; and

$\gamma_{10} - \gamma_{14}$ are the estimated differences in the average TCE differentials associated with a percent increase in the CVs for student composition characteristics; and

$\gamma_{15} - \gamma_{17}$ are the State fixed effects for Minnesota, Florida and Colorado; and

γ_{18} is the estimated difference in the TCE differential associated with a standard deviation increase in the Gini for TCE_{FTE} ; and

μ_{03} is a unique random effect for the district number of schools in district j.

Typically, HLMs have a random effect for the intercept. These models differ from this form because the dependent variable, TCE differentials, are centered on the district mean at zero, and thus have no variation across districts. HLM remains the appropriate framework for these analyses because they are designed to capture variation in the nested structure of schools within districts. Several of the school-level variables have significant random effects, which are left free to vary though they are largely unmodeled. The random effect for districts' number of schools is significant and allowed to vary across all models. The only modeled random slope is the school measure for proficiency. I include a cross-level interaction between total district variation in teacher salaries, as measured by the Gini for TCE_{FTE}, and school proficiency. I add this interaction in the fifth block of the model. For brevity's sake, I do not present all the formulas for each block here.

The fully specified HLM models will address research question three by estimating what school and district characteristics are associated with TCE differentials. Further, because the resulting coefficients will be in per-pupil dollars, the magnitude of these differentials is easily interpretable. These models will provide substantial new empirical evidence on the associations and magnitude of TCE differentials while controlling for pupil-teacher ratios and student compensatory needs. Where the results of these models suggest that TCE differentials are substantial, there will be strong evidence of intradistrict resource inequities.

Chapter 4: Findings

This chapter presents the findings of these analyses in the order of the research questions and consists of three sections. The first section addresses the first part of research question one, which asks, "What proportions of school districts have substantial between-school variations in TCE as measured by the Gini coefficient?" This section includes descriptive statistics on the Gini coefficients by state, first with the means and standard deviations in Table 5, and then by the percentage distribution of districts by the Gini benchmarks used in this dissertation. The Gini coefficient has a number of advantageous properties for measuring district variation, but it is not an intuitively meaning metric. In an effort to provide some association between total district variation as measured by the Gini coefficient and the impact this TCE variation has on schools, this section also includes a number of tables and charts that contextualize these Gini coefficients. The second section addresses the second part of research question one, which asks, "What district characteristics are associated with this variation?" The second section presents the results of OLS regressions on district TCE variation as measured by the Gini coefficients for $TCE_{FTE,}$ TCE_{PP} and TCE_{PPW}. The third section addresses the second and third research questions. Section 3 begins with statistics that describe the proportion of schools affected by TCE differentials, and their average magnitudes. The remainder of the third section presents the results of the HLMs that examine school TCE differentials. The results of these HLMs reveal several important relationships between school characteristics and TCE differentials, and examine how student compensatory needs and teacher qualifications relate to these differentials.

Results on District TCE Variation

Table 5 presents the means and standard deviation of the Gini coefficients for TCE_{FTE} and TCE_{PP} in all 16 states in the TCS, and for TCE_{PPW} in the case study states. Across all 16 states, the average Gini coefficient is .028, which is slightly above the 0.025 Gini benchmark, but well below the 0.05 benchmark. Among these states, Texas has the lowest Gini for TCE_{FTE} at .021 and Colorado has the highest at .037. The Ginis for TCE_{FTE} in Minnesota and Florida are slightly above the overall average at .031. As discussed above in the section on benchmarking the Gini, the Gini coefficients for TCE_{FTE} are substantially smaller than the Gini coefficients for TCE_{PP} and TCE_{PPW}. For TCE_{PP}, the Gini ranges from a high in Colorado of .087 to a low in Texas of .063. As with the $TCE_{FTE,}$ Florida and Minnesota had TCE_{PP} Ginis near the average for all sixteen states, at around .076. Across the four case study states for which the Ginis for TCE_{PPW} were calculated, the measures were much larger than the Ginis for TCE_{FTE}, but less than for TCE_{PP}. As with the other two measures, the Ginis for TCE_{PPW} ranged from a high in Colorado of .069 to a low in Texas of .054, while Florida and Minnesota were close to the middle of that range.

The state's average Gini coefficients for these three measures indicate that there is a substantial amount of variation in each measure. Recall that the 0.025 Gini benchmark is associated with a district average TCE absolute difference between schools that is equal to 5% of the districts average for the same measure. For TCE_{FTE}, 5 of the 16 states had average Gini coefficients below that level. For all 16 states, the average is well below the .05 benchmark. The variation in both TCE_{PP} and TCE_{PPW} was much greater with

Table 5. Means and standard deviations for the Gini coefficients for average teacher salary, per-pupil teacher salary and per-pupil weighted teacher salary

	TCE_{FTE}		TCE_{PP}		TCE_{PPW}	
	Mean	(SD)	Mean	(SD)	Mean	(SD)
Arizona	.029	(.009)	.073	(.025)		
Colorado	.037	(.011)	.087	(.032)	.069	(.030)
Florida	.031	(.009)	.074	(.019)	.062	(.016)
Idaho	.028	(.009)	.079	(.038)		
Iowa	.030	(.009)	.074	(.019)		
Kansas	.025	(.006)	.081	(.029)		
Kentucky	.025	(.007)	.074	(.022)		
Louisiana	.020	(.007)	.081	(.029)		
Maine	.026	(.007)	.065	(.015)		
Minnesota	.031	(.009)	.076	(.028)	.063	(.022)
Mississippi	.031	(.008)	.084	(.028)		
Missouri	.027	(.008)	.075	(.020)		
Nebraska	.029	(.006)	.078	(.017)		
Oklahoma	.023	(.008)	.076	(.042)		
South Carolina	.033	(.008)	.076	(.021)		
Texas	.021	(.006)	.063	(.021)	.054	(.020)
Total	.028	(.008)	.076	(.025)	.062	(.022)

all of the states' district averages above the .05 threshold. Again, this indicates that the on average, the districts in each state have average absolute schools differences for both per-pupil measures of greater than 10% of the district average of the same.

Table 6 presents the distributions of districts in each state by each Gini category, which reflects the patterns found in Table 5. As an overall average, 60% of the districts in these states had Gini coefficients for TCE_{FTE} above the 0.025 benchmark, but very few were above the 0.05 benchmark. In contrast, almost all the districts in these states were above the .025 benchmark for TCE_{PP} and TCE_{PPW}, and the majority was above the .05 threshold.

Table 6. Percentage distribution of districts by categories of Gini coefficients for TCE_{FTE}, TCE_{PP}, and TCE_{PPW}, by state

	Gini TCE_{FTE} categories			Gini TCE_{PP} categories			Gini TCE_{PPW} categories		
State	0-.025	.025-.05	.05+	0-.025	.025-.05	.05+	0-.025	.025-.05	.05+
Arizona	36%	62%	2%	0%	23%	77%	-	-	-
Colorado	11%	75%	14%	0%	8%	92%	0%	21%	79%
Florida	22%	76%	2%	0%	14%	86%	2%	19%	79%
Idaho	33%	67%	0%	0%	24%	76%	-	-	-
Iowa	28%	72%	0%	0%	14%	86%	-	-	-
Kansas	56%	44%	0%	0%	13%	88%	-	-	-
Kentucky	61%	39%	0%	0%	12%	88%	-	-	-
Louisiana	83%	17%	0%	0%	10%	90%	-	-	-
Maine	44%	56%	0%	0%	17%	83%	-	-	-
Minnesota	23%	75%	3%	3%	15%	83%	0%	28%	73%
Mississippi	28%	72%	0%	0%	11%	89%	-	-	-
Missouri	39%	61%	0%	0%	11%	89%	-	-	-
Nebraska	33%	67%	0%	0%	0%	100%	-	-	-
Oklahoma	63%	33%	4%	0%	26%	74%	-	-	-
South Carolina	11%	87%	2%	0%	9%	91%	-	-	-
Texas	75%	25%	0%	0%	29%	71%	2%	46%	51%
Average	40%	58%	2%	0%	15%	85%	1%	28%	70%

The statistics in tables 5 and 6 describe the Gini coefficients in these states, but these numbers are not intuitively meaningful. Before presenting the results of multivariate analyses of the Gini coefficients, I present several tables and charts to provide a meaningful description of the variation associated with these Gini coefficients. I do this in two sections. First, I present tables and charts that gauge the size of the between-school differences associated with different Gini coefficients. Second, I present charts that examine what relationships the variation measured by these Gini coefficients may have with school characteristics.

Table 7. Interquartile ranges for TCE_{FTE}, TCE_{PP}, and TCE_{PPW}, by Gini categories

State	Gini TCE_{FTE} categories			Gini TCE_{PP} categories			Gini TCE_{PPW} categories		
	0-.025	.025-.05	.05+	0-.025	.025-.05	.05+	0-.025	.025-.05	.05+
Arizona	2,037	3,219	4,147		219	449			
Colorado	2,037	3,879	4,595		230	573		144	376
Florida	1,747	3,586	5,552		278	513	89	199	334
Idaho	1,930	3,368			391	479			
Iowa	1,421	3,856			304	559			
Kansas	2,153	2,848			220	579			
Kentucky	2,019	3,200			279	514			
Louisiana	1,628	3,083			220	561			
Maine	2,404	2,956			423	604			
Minnesota	2,329	4,329	8,493	88	296	614		220	389
Mississippi	1,949	3,333			230	551			
Missouri	1,938	3,784			296	558			
Nebraska	2,432	3,656			0	561			
Oklahoma	1,659	2,433	1,043		211	429			
South Carolina	1,981	3,479	5,362		260	517			
Texas	2,025	3,015			303	516	128	241	365
Average	1,981	3,376	4,865	88	260	536	108	201	366
Impact on average sized school ($1,000s)	$91	$155	$224	$70	$208	$429	$112	$209	$381

Contextualizing the Gini coefficient

Table 7 displays states' average interquartile ranges[27] for each TCE measure by categories of the Gini coefficient. These average interquartile ranges are useful indicators of the variation measured by the Gini coefficient but only contain data from two points in the distribution of schools in a district— the 75th and 25th percentiles. Nonetheless, they are useful because they indicate the minimum difference between 50% of the schools in a district—those above the 75th percentile and below the 25th percentile. Examining TCE_{FTE}

[27] The interquartile range of a measure is the 75th percentile value minus the 25th percentile value.

first, there is a clear positive association between the Gini and the interquartile range. On average, the 40% of districts (see Table 5) with TCE_{FTE} Ginis below the 0.025 standard have an interquartile salary range of just under $2000. The average interquartile salary gap for the 58% of districts between the 0.025 and the 0.05 benchmarks is nearly $3,400. The bottom row of Table 7 contains estimated total impacts for a school of average size in terms of the number of teachers (46 FTE teachers) and in terms of enrollment (801 students, 1040 students weighted). For the lowest Gini category, the average difference is $91,000, while the second and third categories of Gini coefficients are more than $155,000 and $223,000 respectively. Interquartile ranges are the minimum differences between half of districts' schools, and thus larger differentials exist in every district.

Examining the per-pupil measures reveals a similar pattern where districts in the lowest Gini category have small differences, amounting to less than $90 per pupil or $110 per pupil, weighted. In the middle Gini category, the average interquartile ranges are roughly twice that, at $260 per pupil for TCE_{PP} and $201 for TCE_{PPW}. In the .05 and above Gini category, which includes most districts, the interquartile gaps average $536 and $366, respectively, and amount to large differences of roughly $429,000 and $380,000 in average sized schools.

Tables 8 and 9 present two additional means of gauging these variations by looking first at the average absolute mean differences[28] across states, and second at the 90/10 range across states, which is similar to the interquartile ranges but examines the top and bottom 10% of schools in each district. Both of these measures reflect the differences in teacher salary expenditures in different ways and both complement the differences

[28] Also called Ginis mean difference, this figure is equal to the average of the absolute value of school differences in a district.

Table 8. Average absolute mean differences for TCE_{FTE}, TCE_{PP}, and TCE_{PPW}, by Gini categories

	Gini TCE_{FTE} categories			Gini TCE_{PP} categories			Gini TCE_{PPW} categories		
State	0-.025	.025-.05	.05+	0-.025	.025-.05	.05+	0-.025	.025-.05	.05+
Arizona	1,704	2,826	4,002		197	397			
Colorado	1,840	3,327	4,802		202	522		152	339
Florida	1,563	2,922	5,782		226	452	67	174	293
Idaho	1,645	2,710			274	425			
Iowa	1,678	3,066			246	501			
Kansas	1,766	2,649			177	528			
Kentucky	1,673	2,738			247	446			
Louisiana	1,387	2,420			225	493			
Maine	1,845	2,649			328	499			
Minnesota	2,082	3,533	5,609	154	250	531		181	326
Mississippi	1,634	2,827			205	477			
Missouri	1,595	2,979			223	495			
Nebraska	1,913	2,914			0	494			
Oklahoma	1,437	2,056	4,526		186	442			
South Carolina	1,720	2,927	4,139		238	474			
Texas	1,670	2,524			260	427	112	202	313
Average	1,697	2,817	4,810	154	218	475	89	177	318
Impact on average sized school ($1,000s)	$78	$130	$221	$123	$175	$380	$93	$184	$331

displayed in Table 7. The absolute mean differences displayed in Table 8 include data from all the schools in each district and can be interpreted as the average school differential from the district TCE mean. The absolute mean differences are similar to the interquartile ranges in Table 7, though slightly smaller.

Table 9 presents the 90/10 ranges in the same format as the previous two tables. By definition, the 90/10 ranges are equal to or larger than the interquartile ranges, and represents the differences between 20% of the schools in those districts. The 90/10 ranges are roughly twice the interquartile ranges for each TCE category. The impacts on average

Table 9. Differences between the 90th and 10th percentiles for TCE_{FTE}, TCE_{PP}, and TCE_{PPW},
by Gini categories

	Gini TCE_{FTE} categories			Gini TCE_{PP} categories			Gini TCE_{PPW} categories		
State	0-.025	.025-.05	.05+	0-.025	.025-.05	.05+	0-.025	.025-.05	.05+
Arizona	4,059	6,589	10,824		492	862			
Colorado	4,173	7,736	11,418		479	1174		352	745
Florida	3,208	6,669	11,434		485	995	143	379	649
Idaho	3,888	6,224			612	1003			
Iowa	4,278	7,245			602	1180			
Kansas	3,923	6,102			446	1221			
Kentucky	3,800	6,530			622	1058			
Louisiana	3,105	5,218			533	1108			
Maine	4,511	6,689			729	1239			
Minnesota	4,981	7,974	12,193	390	611	1222		409	748
Mississippi	3,651	6,741			420	1062			
Missouri	3,790	6,714			504	1153			
Nebraska	4,202	6,452			0	1134			
Oklahoma	3,306	4,813	18,792		429	1101			
South Carolina	3,930	6,857	6,797		580	1102			
Texas	3,804	5,731			598	956	273	449	697
Average	3,913	6,518	11,910	390	509	1098	208	397	710
Impact on average sized school ($1,000s)	$180	$300	$548	$312	$408	$880	$216	$413	$738

sized schools, shown in the bottom row of Table 9, indicate that for 20% of schools in the districts the teacher compensation expenditures differ substantially. For instance, even in the lowest Gini category for TCE_{FTE}, the average gap between the top and bottom 10% of schools is $180,000 on average. In the higher Gini categories, the average minimum differences between the top and bottom 10% of schools approach $300,000 and $548,000, respectively. For TCE_{PP} and TCE_{PPW}, the 90/10 ranges are much larger.

To make it easier to look across these differences concurrently, and to focus on the differences for the case study states in this dissertation, Tables 10 through 14 present the same data contained in tables 6, 7, 8, and 9 for the cases study states alone. Compared to all states a greater percentage of districts in Colorado, Florida, and Minnesota have TCE_{FTE} Gini coefficients between .025 and .05 (75, 76, and 75% respectively), however Texas has larger percentage of districts with TCE_{FTE} Ginis of less than .025 (75%) than all the other states except for Louisiana. The relatively higher Gini coefficients for TCE_{FTE}, TCE_{PP} and TCE_{PPW} in Colorado, Florida and Minnesota result in larger average interquartile ranges, absolute mean deviations and 90/10 ranges (across the four cases study states) compared to the other case study states. As a result, the estimated impacts on average size schools are larger for each measure in Table 13.

Taken together, these tables show that there is substantial variation in all three measures of teacher salary in a majority of districts. However, variation alone only indicates that in many districts, some schools receive more teacher compensation expenditures than others. The simple variation indicated by the Gini coefficients for TCE_{FTE} and TCE_{PPW} is a significant equity issue in and of itself, because some schools— and the students enrolled in them— receive less TCE than other schools.[29] However, if there are systematic associations with this variation and school or student characteristics then the problem moves beyond simple horizontal variation and becomes either a question of vertical equity or an issue of equality of opportunity. To present relationships between school characteristics and different amounts of TCE variation at the district level is impossible in tabular format. I use a series of bar charts that display district-level data on the differences between the averages of TCE_{FTE}, TCE_{PP}, and TCE_{PPW} for the top and

[29] The variation in TCE_{PP} may or may not be an equity problem since the differences between schools' students' compensatory needs may legitimately justify different allocations of teachers and district TCE variation.

Table 10. Percentage distribution of districts by Gini categories for TCE_{FTE}, TCE_{PP}, and TCE_{PPW}, by case study state

	Gini TCE_{FTE} categories			Gini TCE_{PP} categories			Gini TCE_{PPW} categories		
State	0-.025	.025-.05	.05+	0-.025	.025-.05	.05+	0-.025	.025-.05	.05+
Colorado	11%	75%	14%	0%	8%	92%	0%	21%	79%
Florida	22%	76%	2%	0%	14%	86%	2%	19%	79%
Minnesota	23%	75%	3%	3%	15%	83%	0%	28%	73%
Texas	75%	25%	0%	0%	29%	71%	2%	46%	51%
Average	33%	37%	11%	17%	35%	33%	36%	44%	16%

Table 11. Interquartile ranges for TCE_{FTE}, TCE_{PP}, and TCE_{PPW}, by case study states

	Gini TCE_{FTE} categories			Gini TCE_{PP} categories			Gini TCE_{PPW} categories		
State	0-.025	.025-.05	.05+	0-.025	.025-.05	.05+	0-.025	.025-.05	.05+
Colorado	2,037	3,879	4,595		230	573		144	376
Florida	1,747	3,586	5,552		278	513	89	199	334
Minnesota	2,329	4,329	8,493	88	296	614		220	389
Texas	2,025	3,015	-		303	516	128	241	365
Average	2,035	3,702	6,213	88	277	554	108	201	366
Average total effect ($1,000s)	$94	$170	$286	$70	$222	$444	$112	$209	$381

Table 12. Absolute mean differences for TCE_{FTE}, TCE_{PP}, and TCE_{PPW}, by case study states

	Gini TCE_{FTE} categories			Gini TCE_{PP} categories			Gini TCE_{PPW} categories		
State	0-.025	.025-.05	.05+	0-.025	.025-.05	.05+	0-.025	.025-.05	.05+
Colorado	1,840	3,327	4,802		202	522		152	339
Florida	1,563	2,922	5,782		226	452	67	174	293
Minnesota	2,082	3,533	5,609	154	250	531		181	326
Texas	1,670	2,524			260	427	112	202	313
Average	1,809	2,756	5,398	237	377	500	202	282	384
Average total effect ($1,000s)	$83	$127	$248	$190	$302	$401	$210	$293	$399

Table 13. Differences between the 90th and 10th percentiles for TCE_{FTE}, TCE_{PP}, and TCE_{PPW}, by case study states

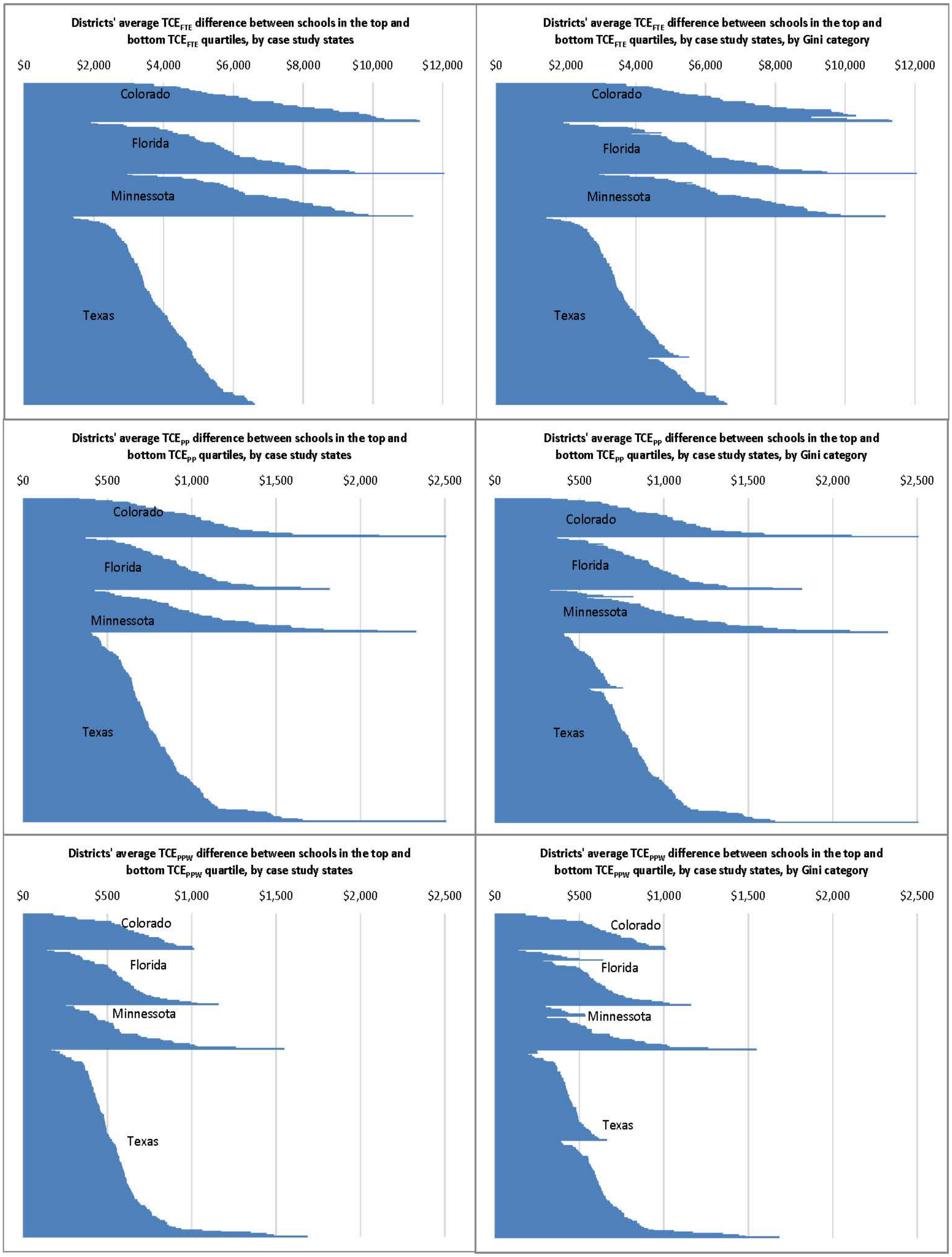
	Gini TCE_{FTE} categories			Gini TCE_{PP} categories			Gini TCE_{PPW} categories		
State	0-.025	.025-.05	.05+	0-.025	.025-.05	.05+	0-.025	.025-.05	.05+
Colorado	4,173	7,736	11,418		479	1,174		352	745
Florida	3,208	6,669	11,434		485	995	143	379	649
Minnesota	4,981	7,974	12,193	390	611	1,222		409	748
Texas	3,804	5,731			598	956	273	449	697
Average	4,029	6,241	11,682	541	843	1,076	450	626	795
Average total effect ($1,000s)	$185	$287	$537	$433	$675	$862	$468	$651	$827

bottom quartiles of schools in about 300 districts. I categorize schools into district quartiles on multiple measures to show different relationships.

The first of these charts is in Figure 3, which consists of six panels. The panels in the left column of Figure 3 present the difference between the average measure of TCE in the bottom and top quartiles of the same measure for each districts. Each line in each chart represents a single district. To illustrate, the top panel on the left side of Figure 3 displays the difference in the between the average TCE_{FTE} of schools in the highest quartile of TCE_{FTE}, and the average of the schools in the bottom quartile. The following discussion involves a number of differences, between states, TCE measures and between quartiles. For clarity of reference, I call the TCE differences between top and bottom quartiles Q4-Q1 gaps. The lines are sorted by state and by ascending Q4-Q1 gaps, and show that some districts have relatively small Q4-Q1 gaps (beginning, for instance, around $3,250 in Colorado) and others have much larger Q4-Q1 gaps (beyond $11,000 in some Colorado districts). The distribution in between is smooth and reflects a cumulative normal distribution. The second panel in the first column shows Q4-Q1 gaps in TCE_{PP}, and the third displays gaps in TCE_{PPW}. In both panels, the scale is equivalent, but both differ from the scale for TCE_{FTE} due to their different ranges. The shape of the bottom two panels are similar, however in all cases the TCE_{PPW} gaps are smaller than the TCE_{PP} gaps, as would be expected because the *de facto* pupil weights control for compensatory teacher allocations.

The panels in the second column of Figure 3 are very similar to those in the first column because they are the same data but sorted in a slightly different way. The first

Figure 3. Chart of district TCE_{FTE} differences between top and bottom TCE_{FTE} quartiles



column of panels is sorted by state and by Q4-Q1 differences, while the second column is sorted by state, Gini categories for the TCE measure being presented, and then by the Q4-Q1difference. One can see the differences in the graphs in the "hitches" in the curves for each state. These show that the Q4-Q1 difference are not perfectly in line with the Gini coefficients for these measures (if they were all the states curves in the panels one the right would mirror the curves on the left exactly as is the case with Colorado in the bottom two panels). However, the similarities between the curves demonstrate that the relationships between school characteristics and the Q4-Q1 gaps are similar to those characteristics and the Gini coefficients.

Figure 4 presents a different set of Q4-Q1 gaps for all three measures of TCE. The Q4-Q1 gaps in Figure 4 are not based on the TCE measure quartiles, but on three school characteristics. Previous literature on intradistrict differences in teacher salary have focused on school poverty, minority composition, and performance. The Q4-Q1 poverty gaps in Figure 4 are calculated by subtracting the average TCE for district schools in the highest-poverty quartile from the TCE average for district schools in the lowest-poverty quartile. The Q4-Q1 minority gaps and Q4-Q1 proficiency gaps are similarly calculated. Figure 4 displays these gaps graphically for student poverty in column 1, minority composition in column 2, and percent proficiency in column 3.[30] As in Figure 3, each line represents a district's Q4-Q1 gap. In contrast to Figure 3, where the Q4-Q1 gaps are absolute differences and are therefore all positive, the Q4-Q1 gaps in Figure 3 may be

[30] The quartiles are arranged such that the "highest quartile" is the quartile of schools with the lowest need. Therefore, for poverty and minority composition the "highest quartile" is actually the least poor or lowest percent minority. In this way, the advantages for high-need schools are always on the right side of the zero line.

negative (for instance, if the schools in the highest poverty quartile have higher TCE_{FTE} than schools in the lowest poverty quartile). Lines on the right of the zero line indicate the Q4-Q1 gaps in a district favor low-need schools, and lines on the left indicate the differences favor high-need schools.[31] The length of each line indicates the magnitude of the Q4-Q1 gap.

For example, the top line of the top left panel in figure 4 indicates the poverty Q4-Q1 gap in TCE_{FTE} is over $5000 for the Colorado district with the largest gap favoring low-need schools. The last line in the same panel for Colorado indicates the poverty Q4-Q1 gap in TCE_{FTE} favoring low- need schools is just over $4,000. These charts use a novel format to present a large amount of data and therefore take a moment to digest; however, once the form of the chart becomes clear the multiple charts present a great deal of information in a compelling and parallel fashion.

Examining Figure 4 from left to right by rows allows one to compare the relationships between poverty, minority composition and proficiency for each measure of TCE. Examining TCE_{FTE} first (the top row), the first panel shows the magnitudes of the Q4-Q1 poverty gaps are lowest in Texas and greatest in Minnesota. Another important aspect of the magnitude of these gaps is that they are smaller than the absolute gaps presented in Figure 3, which indicates that the relationships between poverty and TCE_{FTE} differentials only explain a portion of total TCE_{FTE} differences. Although not universal, a majority of districts in the case study states, favor low-poverty schools in terms of TCE_{FTE}, while a substantial minority of districts favor high-poverty schools. This small

[31] These Q4-Q1 differences are better than interquartile ranges because they include data from half the schools in each district. The Q4-Q1 differences include less data than the absolute mean difference, however since this measure includes all schools in the district, there is no intuitive means to sort the schools by poverty, minority composition or proficiency.

portion of district that favor high-need schools is important because it illustrates that though many of these gaps indicate substantial variation in districts— and therefore substantial Gini coefficients— the systematic relationship with poverty is not absolute.

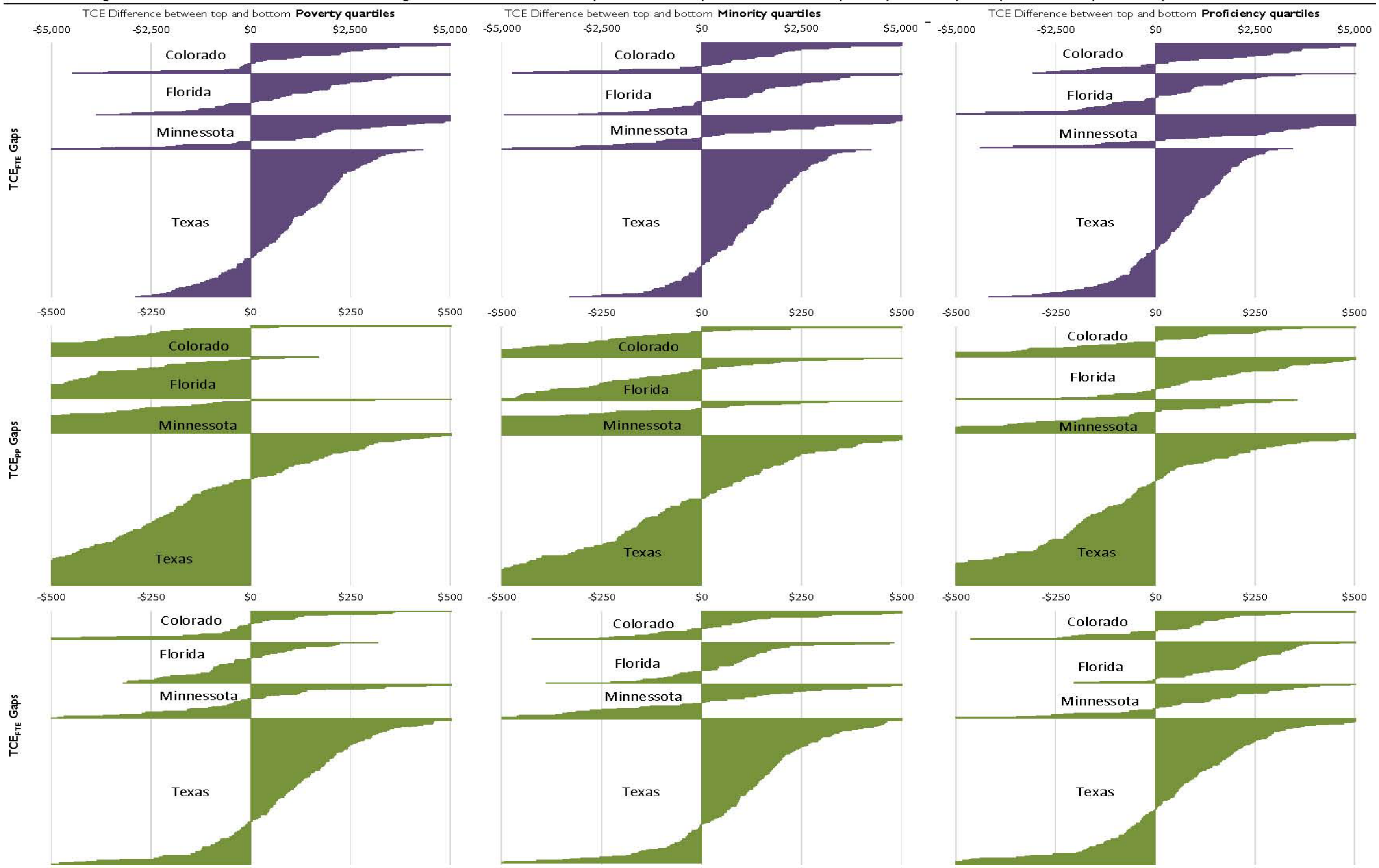
The middle panel in the top row shows a similar relationship for TCE_{FTE} and school minority composition. In Colorado, Florida and Texas, the Q4-Q1 minority gaps are slightly larger in proportion and magnitude, than the Q4-Q1 poverty gaps. Minnesota shows a different pattern in which more districts favor the high-minority schools, while more districts have Q4-Q1 minority gaps of greater magnitude compared to Q4-Q1 poverty gaps.

The right panel in row 1 shows Q4-Q1 proficiency gaps for TCE_{FTE}. In Colorado and Minnesota, the Q4-Q1 proficiency gaps are similar in number to the minority and poverty gaps, but have greater magnitudes. The opposite is true in Florida and Texas, where the magnitudes and proportions of the Q4-Q1 proficiency gaps are smaller than the poverty and minority gaps.

The second row in Figure 4 illustrates the very different association between school compositions and TCE_{PP}. Though the TCE_{FTE} gaps between these same districts favor low-need schools, differences in the pupil-teacher ratios that result from compensatory allocations of teachers leave the vast majority of districts in Colorado, Florida and Minnesota with Q4-Q1 poverty gaps that favor high-poverty schools.[32] The majority of districts in Texas also have Q4-Q1 poverty gaps that favor high-poverty schools, but a sizable minority (30%) favors low-poverty schools. The center panel in the

[32] It is important to note that the magnitudes on the first row of panels are on a different scale than the second and third rows, and are thus not comparable.

Figure 4. District differences between average TCE measures in the top and bottom quartile of student poverty, minority composition, and proficiency



Note: Bars to the right of the zero line indicate that districts favor low-poverty, low-minority, and low-proficiency schools. Bars to the left indicate districts favor high-poverty, high-minority, or high-proficiency schools.

second row of figure 4 shows that for all three states, the majority of districts Q4-Q1 minority gaps for TCE_{PP} favor high-minority schools, but to a lesser degree in terms of magnitude and proportion, compared to the Q4-Q1 poverty gaps. The right panel of row 2 shows the Q4-Q1 proficiency gaps for TCE_{PP} in Colorado and Minnesota move further to the right, compared to the minority or poverty gaps. The effect is more pronounced in Florida where a large majority of districts have Q4-Q1 proficiency gaps that favor high-proficiency schools and by large magnitudes. Texas shows a different pattern than the other states in which fewer districts have Q4-Q1 proficiency gaps that benefit low-need schools compared to the number of districts with Q4-Q1 minority gaps than benefit low-need schools.

The third row in Figure 4 shows Q4-Q1 gaps for TCE_{PPW}. These charts show a different pattern than the Q4-Q1 gaps for TCE_{FTE} and TCE_{PP}, though the influence of both is apparent. Examining Q4-Q1 poverty gaps in the left panel of row three, the Q4-Q1 poverty gaps are more balanced for Colorado, Florida and Minnesota than in either of the panels above it. In Texas, the Q4-Q1 poverty gaps favor low-poverty schools in a large majority of districts. The middle panel of the third row shows that the Q4-Q1 minority gaps favor low-minority schools by greater magnitudes and in greater proportions, compared to the Q4-Q1 poverty gaps. The shift to the right in the minority panel is more evident for Colorado, Florida and Minnesota than in Texas. The final panel in the third row shows Q4-Q1 proficiency gaps for TCE_{PPW}. Compared to the Q4-Q1 minority gaps panel, the curves for Colorado, Florida and Minnesota all shift further to the right, indicating the proficiency has a stronger relationship with TCE_{PPW} than minority composition or poverty. As was the case in the TCE_{FTE} and TCE_{PP} panels above, Texas shows a weaker relationship between TCE_{PPW} and proficiency compared to minority composition, but most districts still favor schools with higher proficiency by substantial magnitudes and proportions.

The charts in Figures 3 and 4 display a large amount of district-level information regarding the nature of TCE variation and the bivariate relationships between TCE and school poverty, minority composition and proficiency. Figure 3 shows that there are substantial TCE gaps in many districts, and that variation differs widely in districts in each state. Figure 4 shows that TCE variation is associated with the composition of schools' student populations. The comparative magnitudes of the Q4-Q1 gaps in Figures 3 and 4 indicate these associations are loose and only explain a portion of the total TCE variation within districts. With some exceptions, Figure 4 indicates that in general, minority composition is more strongly associated with TCE than poverty, and with the exception of Texas, proficiency is even more strongly associated with TCE. Figure 4 also shows that all districts systematically but not universally favor high-need schools, since a small proportion of districts in each state have higher TCE_{FTE} and TCE_{PPW} in schools in the highest poverty, minority, and performance quartiles.

Of course, in most schools and districts, poverty, minority composition, and proficiency are highly correlated, so the bivariate data in these charts are useful and illustrative but do not evaluate these relationships concurrently. Multivariate analyses are required to analyze these relationships. In the next section, I present the results from OLS regression of district Gini coefficients for $TCE_{FTE,}$ $TCE_{PP,}$ and TCE_{PPW} to examine what district characteristics are associated with overall between-school TCE variation. In the final section, I present the results of hierarchical linear models that examine what school and district characteristics are associated with school differentials from district TCE averages.

Results from OLS Regressions on District TCE Variation

This section presents the results from three sets of regressions that model district variation for case study state as measured by the Gini Index[33] for TCE_{FTE}, TCE_{PP}, and TCE_{PPW} (Tables 14, 16, and 18, respectively). I present the results for each table in seven blocks. The blocked presentation allows the reader to compare the impact of additional predictors to the model. Figure 4 separately exhibited the relationships between TCE variation and school poverty, minority composition and proficiency. However, since these school characteristics are typically correlated at the school level, it is helpful to see how the addition of one measure– like minority composition– affects the coefficient of an existing measure– like student poverty. The three sets of regressions are parallel, and analyze data from the four case study states.

Findings for the district-level regression for the Gini Index for TCE_{FTE}. The first column of coefficients in table 14 includes the following standardized[34] measures: the number of schools; percent Title I schools; percent elementary schools; unemployment in the district during 2006-07; average school special education enrollment percentage, and poverty (measured by the percentage of students qualified for free and reduced price meals). The model also includes binary measures for urban districts, town or rural

[33] The Gini Index is equal to 100 times the Gini Coefficient and is more readable in tables (e.g., 2.5 instead of 0.025), when looking small coefficients (e.g., 0.08 instead of 0.0008).

[34] These standardized measures are Z scores with a mean of zero and a standard deviation of one.

districts, and districts with high percentages of LEP students[35] (the reference groups are suburban school districts–the modal urbanicity category– and low LEP districts). To control for differences between states, fixed effects are included for Colorado, Minnesota and Texas.[36]

In block 1, the intercept for the Gini Index for TCE_{FTE} is 3.09, which matches the average for Florida in Table 5. The fixed effects for Colorado, Minnesota and Texas also match the differences between states found in Table 5 and show that Colorado has a higher average Gini by 0.56 and Texas has a much smaller Gini by about 1.10 index points. The only other significant predictor in the model is number of schools in the district, which indicates that districts that are a standard deviation above the mean number of schools have a Gini index 0.11 points higher than average. Controlling for all other measures, the model show no relationship between district variation and district poverty. The results for urban and town or rural districts are in the expected directions (positive for urban and negative for town or rural) however neither effect is significant. The R-squared for block 1 is 0.43, most of which is dues to the state fixed effects.[37]

Block 2 introduces the standardized measure of district average minority composition, which has a positive relationship with TCE_{FTE} variation. A standard deviation increase in minority composition is associated with a 0.27 point increase (approximately one-third of a standard deviation) in the Gini Index. The coefficients in block 2 show little change

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[35] The distribution of the district average percentage of LEP students was skewed sharply, so a binary measure for districts one standard deviation or more above the mean is used to control for LEP student percentage.

[36] State fixed effects at the bottom of the table; Florida is the reference group.

[37] State fixed effects alone explain 38% of the total variance.

from block 1. In block 3, the added standardized measure for mean school proficiency is negative and not significant. The only change between blocks 2 and 3 is a reduction in the coefficient for minority composition by about a third. The standardized measure for average teacher experience in block 4 is not significant and has little effect on the coefficients from the block 3. Blocks 1 to 4 include measures of central tendency for student and teacher composition in districts. Taken together, these measures explain 2.3 percent more variation in the Gini Index for TCE_{FTE} than block 1 (R-squared block 4, 0.456- R-squared block 1, 0.456-.023).

As mentioned in the methods section in chapter 3, the district averages of school composition measures may not be as strongly related to the variation in TCE as are the between-school variation in those measures. Blocks 5, 6 and 7 add the standardized coefficient of variation (CV) as a measure of variation for each of school poverty, minority and proficiency.

The first of these, the CV for poverty shows a significant positive association with the Gini for $TCE_{FTE.}$ One standard deviation increase in the CV is associated with a 0.13 point increase on the Gini Index. Adding the CV for poverty to the model increases the coefficient for percent elementary schools slightly, but enough that it becomes significant. The addition of the CV for minority percentage results in a significant coefficient that is slightly larger (0.15) than the coefficient for the CV for poverty in the previous block. Further, it explains a portion of the variance that the CV for poverty explained in block 5. Thus, the CV poverty coefficient is reduced and no longer significant. The CV for proficiency, added to the model in block 7, yields the largest coefficient in the models. A

Table 14. District-level regressions of the Gini Index for average teacher salary (TCE_{FTE}) by block

	Block 1	Block 2	Block 3	Block 4	Block 5	Block 6	Block 7
	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate
Intercept	3.09 ***	3.04 ***	3.05 ***	3.04 ***	3.03 ***	3.03 ***	2.83 ***
Schools (z)	.11 ***	.09 *	.10 *	.10 *	.10 *	.08 *	.06
Percent Title I (z)	.03	-.05	-.06	-.05	-.06	-.01	.02
Urban district	.20	.16	.14	.15	.12	.11	.09
Town or rural district	-.10	-.04	-.05	-.05	-.04	-.02	-.02
Percent Elementary schools	-.10	-.12	-.11	-.11	-.14 *	-.16 *	-.10
District unemployment	-.02	-.07	-.08	-.08	-.09	-.09	-.09
High LEP district	.12	-.03	.00	-.01	-.09	-.06	.02
Mean Special Education	-.09	-.03	-.03	-.03	-.04	-.04	-.05
Mean school Poverty	.00	-.06	-.07	-.07	.10	.03	-.01
Mean school minority students		.27 ***	.21 *	.21 *	.14	.28 *	.18
Mean school percent proficient			-.09	-.09	-.08	-.07	.08
Mean Teaher experience				-.01	-.04	-.05	-.04
CV percentage Poverty(z)					.13 *	.10	.08
CV Minority percentage (z)						.15 *	.09
CV Proficiency (z)							.48 ***
State Fixed effects							
Colorado	.56 *	.53 *	.51 *	.52 *	.55 *	.58 *	.45
Minnesota	.04	.14	.08	.10	.22	.31	.57 *
Texas	-1.10 ***	-1.20 ***	-1.16 ***	-1.14 ***	-1.11 ***	-1.23 ***	-.59 *
R square	.43	.45	.46	.46	.47	.48	.50

standard deviation increase in the CV for proficiency is related to an increase of 0.48 of a point on the Gini Index for TCE_{FTE}, which is more than half of a standard deviation. The addition of the CV for proficiency explains much of the variance explained by the poverty and minority CV's in blocks 5 and 6, such that in block 7 the coefficients are substantially smaller and no longer significant. It has the same effect on the coefficient for the number of schools reducing the coefficient by nearly half. The block 7 model explains 50% of the total variance in the Gini Index for TCE_{FTE}, up from 43% in block 1.

In several ways, the patterns of regression results for TCE_{PP} and TCE_{PPW} are similar to those for TCE_{FTE} found in Table 14. Before reviewing the results for the other two TCE measures, it is worthwhile to point out two primary implications of the patterns of results in Table 14 models. The first implication is that these relationships are linear and thus indicate what kinds of districts may have higher and lower TCE variation. The second implication is that the district characteristics that are associated with TCE variation are not independent of one another, but are still important, even if some are no longer significant in the later blocks.

The pattern of results in the blocks indicates that the measures of variation in school composition are all linearly associated with TCE_{FTE} variation in districts. For instance, in block 7 the CV for proficiency is positively associated with variation, which indicates that more intra-district variation in proficiency is associated with more TCE variation. The converse—that districts with below-average proficiency variation have less TCE_{FTE} variation—is also true. The positive linear associations between teacher salary variation and variation in school poverty, minority composition, and proficiency are consistent with the hypothesis that teacher sorting is a driver of TCE variation.

The second implication of these results is that the correlates of TCE_{FTE} variation are interdependent. Readers might interpret the results in block 7 to indicate that only the CV for proficiency is associated with variation in TCE_{FTE} and further, that the number of schools in a district or the variation in poverty or minority composition are not meaningfully related to TCE_{FTE} variation. However, that would be an oversimplification of these results and would dismiss important information. The CV for proficiency explains enough variation in the dependent variable that the other measures in the model are no longer significant, but that does not negate the importance of the relationships that are significant in prior blocks. For example, in blocks 1 through 6, there is a significant relationship between district size (in terms of number of schools) and TCE_{FTE} variation. While this relationship is no longer significant in block 7, it is not because the relationship is spurious or inconsequential. Instead, it means that controlling for the CV for proficiency, that relationship is no longer significant. Larger districts have greater variation in both proficiency and TCE_{FTE}. The relationship between district size and TCE_{FTE} variation remains, and is policy relevant because it allows policymakers to understand the district contexts where TCE variation is more likely to be an issue. The same logic applies to the other coefficients in the model.

Still, the changing magnitudes and significance evident in these models indicate important patterns. For example, the shifting coefficients for the poverty, minority composition and proficiency CVs indicate that these three kinds of variation are interdependent and correlated. The fact that latter measures displace the former indicates the latter are stronger predictors of TCE_{FTE} variation. The confirmatory models in Table 15 illustrate this point and confirm the association between school characteristics and teacher sorting. Table 15 contains four blocks of models. The first is block 7, the final block in table 14. The following three blocks add first the CV's for teacher experience, second the pupil teacher ratios, and finally both. The addition of the CV for teacher experience reduces the magnitude of the coefficient for CV proficiency. The R-squared in

Table 15. District-level regressions of the Gini Index for TCE_{FTE} by block including measures of the distribution of teachers

	Block 7	Block 8	Block 9	Block 10
	Estimate	Estimate	Estimate	Estimate
Intercept	2.83 ***	2.58 ***	2.85 ***	2.60 ***
Schools (z)	.06	.03	.05	.02
Percent Title I (z)	.02	.10	.02	.10
Urban district	.09	.07	.08	.06
Town or rural district	-.02	-.06	-.02	-.06
Percent Elementary schools	-.10	-.08	-.10	-.08
District unemployment	-.09	-.06	-.09	-.06
High LEP district	.02	-.12	.03	-.11
Mean Special Education	-.05	-.04	-.06	-.04
Mean school Poverty	-.01	.01	-.01	.00
Mean school minority students	.18	.06	.18	.06
Mean school percent proficient	.08	.16 *	.08	.15 *
Mean Teaher experience	-.04	.21 ***	-.05	.21 ***
CV percentage Poverty(z)	.08	.06	.08	.06
CV Minority percentage (z)	.09	.03	.09	.03
CV Proficiency (z)	.48 ***	.35 ***	.46 ***	.33 *
CV Teacher Experience (z)		.45 ***		.45 ***
CV Pupil teacher ratio (z)			.06	.05
State Fixed effects				
Colorado	.45	.96 ***	.44	.95 ***
Minnesota	.57 *	.89 ***	.54 *	.86 ***
Texas	-.59 *	-.22	-.60 *	-.23
R square	.50	.60	.50	.60

block 8 jumps from 50% to 60%, indicating that variation in teacher experience is a much more powerful predictor of TCE_{FTE} variation then any variable in blocks 1-7. As with the "displaced"[38] coefficients found in Table 14, the reduction of the CV proficiency coefficient does not mean the relationship between proficiency variation and TCE_{FTE} variation is in fact smaller than block 7 indicates. Far from undermining the importance of this relationship, the displacement in blocks 8 and 14 underscore the importance of the CV for proficiency by indicating that variation in teacher experience is a direct driver of overall TCE_{FTE} variation. The fact that the CVs for school compositional measures are displaced by the addition of measures of teacher qualifications provides evidence that variation in proficiency drives variation in teacher experience, although imperfectly. The changes to or displacements of the coefficient in these models adds evidence in support of the theory that teacher sorting drives overall TCE_{FTE} variation. These patterns are also evident in the regression results for TCE_{PP} and TCE_{PPW} variation presented in the following sections.

Findings for the district-level regression for the Gini Index for TCE_{PP}. Table 16 presents the results from the regressions on the Gini Index for TCE_{PP}. In block 1, the intercept is 7.01 and none of the coefficients is statistically significant. As was the case for the urbanicity coefficients in block 1 in table 14, the coefficients for urbanicity, district number of schools, and school average poverty are in the expected directions, but not significant. At .15, the R-squared for block 1 is much less than in the regressions for TCE_{FTE}, because the state fixed effects explain less of the variation in per-pupil TCE. In block 2, the coefficient for average minority composition is significant at 0.56,[39] and the

[38] I use the term "displaced" to refer to the reduction in a coefficient from a previous model due to the addition of another measure.

[39] Note that though the coefficient is larger in table 11 compared to table 10, the standard deviation of the Gini Index for TCE_{PP} is larger than for TCE_{FTE}, so the magnitudes are closer than they appear.

Table 16. District-level regressions of the Gini Index for per-pupil teacher salary (TCE_{PP}) by block

	Block 1	Block 2	Block 3	Block 4	Block 5	Block 6	Block 7
	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate
Intercept	7.01 ***	6.90 ***	6.94 ***	7.11 ***	7.15 ***	7.17 ***	6.73 ***
Schools (z)	.22	.18	.19	.18	.18	.15	.09
Percent Title I (z)	-.16	-.31	-.36	-.39	-.45	-.30	-.24
Urban district	.47	.40	.32	.29	.20	.18	.13
Town or rural district	-.11	.03	-.03	-.06	-.06	-.01	-.01
Percent Elementary schools	-.21	-.27	-.22	-.24	-.31	-.40	-.27
District unemployment	.18	.09	.03	.01	-.01	.00	-.01
High LEP district	.03	-.28	-.17	-.13	-.34	-.26	-.09
Mean Special Education	.21	.33	.32	.29	.24	.22	.20
Mean school Poverty	.20	.08	.01	.02	.52	.31	.24
Mean school minority students		.56 *	.27	.33	.09	.51	.33
Mean school percent proficient			-.42	-.42	-.39	-.36	-.05
Mean Teaher experience				.16	.11	.08	.09
CV percentage Poverty(z)					.39 *	.29	.25
CV Minority percentage (z)						.46 *	.33
CV Proficiency (z)							.99 *
State Fixed effects							
Colorado	1.36	1.30	1.20	1.06	1.07	1.15	.87
Minnesota	.63	.85	.55	.36	.62	.88	1.43
Texas	-.80	-1.00	-.80	-.94	-.86	-1.22	.10
R square	.15	.17	.18	.18	.19	.21	.22

coefficient for poverty shrinks. In block 3, the addition of average proficiency is not significant, but does affect the size of the mean school minority coefficient, reducing it by half and leaving it no longer significant. Adding mean teacher experience in block 4 results in no substantial change to any of the coefficients from block 3, and is not itself significant.

Table 16 presents a pattern of shifting results in blocks 5, 6, and 7 that is similar to the pattern in Table 14. The coefficient for the CV of poverty is significant in block 5, at 0.39 and with its addition, the coefficient for mean school poverty grows from 0.02 in block 4 to 0.52 though it is not significant. In block 6, the coefficient for the CV of poverty falls in magnitude and falls out of significance with the addition of the CV for minority composition, which has a larger (0.46) and significant effect. In block 7, the CV for proficiency has a similar effect on the CV minority composition coefficient found in block 6. The results in block 7 indicate that a standard deviation change in the CV for proficiency is associated with about a full point change in the Gini Index for TCE_{PP}, roughly equivalent to 40-50% of a standard deviation. Block 7 explains 22% of the overall variation in the Gini Index for $TCE_{PP.}$

The supplementary models for Table 16 are found in Table 17. The CV for teacher experience is significant at 0.41, and its addition reduces the coefficient for CV proficiency and yields it no longer significant. However, the importance of teacher experience is dwarfed by the addition of the CV for the pupil-teacher ratio, which is associated with nearly a three-point change in the Gini Index. Controlling for the variation in the pupil-teacher ratio greatly reduces the magnitudes for the CVs for poverty, minority composition and proficiency and the R-squared in blocks 9 and 14 exceeds 0.80. As with the TCE_{FTE} regression, these results confirm that both variations in teacher experience and in the compensatory allocation of teachers (CV pupil-teacher ratio) are strongly related to TCE_{PP} variation. Again, the fact that controlling for measures of the distribution of teachers explains away the coefficients for the student composition CV's supports the theory that the distribution and allocation of teachers drives TCE_{PP} variation, and underscores the importance of the student composition CV's.

Table 17. District-level regressions of the Gini Index for TCE_{PP} by block including measures of the distribution of teachers

	Block 7	Block 8	Block 9	Block 10
	Estimate	Estimate	Estimate	Estimate
Intercept	6.73 ***	6.52 ***	7.82 ***	7.64 ***
Schools (z)	.09	.06	-.08	-.10
Percent Title I (z)	-.24	-.17	-.03	.03
Urban district	.13	.11	-.12	-.14
Town or rural district	-.01	-.04	.10	.08
Percent Elementary schools	-.27	-.25	-.28 ***	-.27 ***
District unemployment	-.01	.02	-.01	.01
High LEP district	-.09	-.22	.25	.14
Mean Special Education	.20	.21	.05	.06
Mean school Poverty	.24	.25	-.15	-.13
Mean school minority students	.33	.21	.26	.17
Mean school percent proficient	-.05	.02	-.09	-.04
Mean Teaher experience	.09	.31	.00	.19
CV percentage Poverty(z)	.25	.24	.04	.03
CV Minority percentage (z)	.33	.27	.18	.14
CV Proficiency (z)	.99 *	.88	-.25	-.35
CV Teacher Experience (z)		.41 *		.45 ***
CV Pupil teacher ratio (z)			2.94 ***	2.93 ***
State Fixed effects				
Colorado	.87	1.33	.64	1.02 ***
Minnesota	1.43	1.71 *	-.10	.14
Texas	.10	.43	-.39	-.11
R square	.22	.23	.82	.83

Findings for the district-level regression for the Gini Index for TCE_{PPW}. Table 18 presents the results for the regressions on the district Gini Index for TCE_{PPW}. In block 1, the intercept is 6.42, again similar to the means presented in Table 5. The coefficient for the number of schools in a district indicates that a standard deviation increase in the number for district schools is associated with a 0.24 unit change in the Gini Index for TCE_{PPW}, or approximately 12% of a standard deviation. The percentage of elementary schools in a district is negatively associated with the Gini Index for TCE_{PPW} with a coefficient of 0.38. The negative relationship between TCE_{PPW} variation and the percentage of elementary schools suggests that in districts fewer elementary schools, and therefore the more middle and high schools, the higher the TCE_{PPW} variation. [40] The coefficient for mean school poverty is 0.38, suggesting that districts with more poor students have greater variation in TCE_{PPW}. Block 2 includes the average minority composition, which explains some of the variance previously explained by the average poverty measure, which is about 30% smaller and no longer significant. In block 3, the addition of the average proficiency measure reduces the coefficients for average poverty and minority composition, neither of which is significant. The only other substantial change in block 3 is that the coefficient for Title I percentage increases by about 10% at

[40] It is also possible that there is a relationship between the percentage of elementary schools, or more specifically the diversity of school types, in a district and the *de facto* weights used to create the TCE_{PPW} measure. If the *de facto* weights do not sufficiently control for the different school levels, the relationship between the Gini Index for the TCE_{PPW} measure could be an artifact of the weighting. It is more probable that the relationship is real, as the coefficients are in the same direction in the regressions presented in tables 10 and 11, and these effects could be additive when applied to TCE_{PPW}, which combines both teacher salaries and teacher allocations into the same dependent measure.

Table 18. District-level regressions of the Gini Index for per-pupil teacher salary weighted (TCE_{PPW}) by block

	Block 1 Estimate	Block 2 Estimate	Block 3 Estimate	Block 4 Estimate	Block 5 Estimate	Block 6 Estimate	Block 7 Estimate
Intercept	6.42 ***	6.30 ***	6.35 ***	6.37 ***	6.42 ***	6.44 ***	5.89 ***
Schools (z)	.24 *	.21	.22 *	.22 *	.22 *	.19	.12
Percent Title I (z)	-.24	-.37	-.42 *	-.42 *	-.47 *	-.37	-.29
Urban district	.29	.22	.16	.15	.08	.07	.02
Town or rural district	-.02	.09	.03	.02	.02	.06	.08
Percent Elementary schools	-.38 *	-.43 *	-.38 *	-.38 *	-.45 *	-.51 ***	-.35
District unemployment	.25	.16	.10	.10	.09	.09	.08
High LEP district	.05	-.21	-.09	-.08	-.27	-.22	-.01
Mean Special Education	-.24	-.13	-.14	-.14	-.19	-.21	-.24
Mean school Poverty	.38 *	.27	.21	.21	.62 *	.48	.39
Mean school minority students		.50 *	.21	.21	.03	.31	.08
Mean school percent proficient			-.42 *	-.41 *	-.39 *	-.37	.02
Mean Teaher experience				.03	-.02	-.04	-.04
CV percentage Poverty(z)					.32 *	.25	.21
CV Minority percentage (z)						.31	.15
CV Proficiency (z)							1.23 ***
State Fixed effects							
Colorado	.03	.00	-.11	-.13	-.14	-.12	-.47
Minnesota	.14	.35	.05	.02	.23	.39	1.09
Texas	-1.13 *	-1.28 *	-1.10 *	-1.12 *	-1.06	-1.33 *	.31
R square	.13	.15	.16	.16	.17	.18	.21

which point it becomes significant. In block 4, the district average for teacher experience is not significant and makes almost no difference to the coefficient found in block 3.

Block 5 includes the CV for poverty, which is significant, and with this addition, the coefficient for mean school poverty increases threefold. These results indicate that controlling for the CV for poverty, districts that are standard deviation above the average in school poverty are 0.62 points higher on the Gini Index (28% SD). In addition, holding all else constant, including district average poverty; districts with a standard deviation increase in the CV for poverty are 0.32 points higher on the Gini Index (14% SD). The coefficient for mean school proficiency remains statistically significant in block 5. In block 6, the CV for minority percentage is not significant but is in the expected direction and of moderate magnitude, and it reduces the schools is associated with a 0.24 unit change in the Gini Index for TCE_{PPW}, or approximately 12% of a standard deviation. The percentage of elementary schools in a district is negatively associated with the Gini Index for TCE_{PPW} with a coefficient of 0.38. The negative relationship between TCE_{PPW} variation and the percentage of elementary schools suggests that in districts fewer elementary schools, and therefore the more middle and high schools, the higher the TCE_{PPW} variation.[41] The coefficient for mean school poverty is 0.38, suggesting that districts with more poor students have greater variation in TCE_{PPW}. Block 2 includes the average minority composition, which explains some of the variance previously explained by the average poverty measure, which is about 30% smaller and no longer significant. In block 3, the addition of the average proficiency measure reduces the coefficients for average poverty and minority composition, neither of which is significant. The only other substantial change in block 3 is that the coefficient for Title I percentage increases by about 10% at which point it becomes significant. In block 4, the district average for teacher experience is not significant and makes almost no difference to the coefficient found in block 3.

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[41] It is also possible that there is a relationship between the percentage of elementary schools, or more specifically the diversity of school types, in a district and the *de facto* weights used to create the TCE_{PPW} measure. If the *de facto* weights do not sufficiently control for the different school levels, the relationship between the Gini Index for the TCE_{PPW} measure could be an artifact of the weighting. It is more probable that the relationship is real, as the coefficients are in the same direction in the regressions presented in tables 10 and 11, and these effects could be additive when applied to TCE_{PPW}, which combines both teacher salaries and teacher allocations into the same dependent measure.

Block 5 includes the CV for poverty, which is significant, and with this addition, the coefficient for mean school poverty increases threefold. These results indicate that controlling for the CV for poverty, districts that are standard deviation above the average in school poverty are 0.62 points higher on the Gini Index (28% SD). In addition, holding all else constant, including district average poverty; districts with a standard deviation increase in the CV for poverty are 0.32 points higher on the Gini Index (14% SD). The coefficient for mean school proficiency remains statistically significant in block 5. In block 6, the CV for minority percentage is not significant but is in the expected direction and of moderate magnitude, and it reduces the coefficients for the CV and average poverty enough that they are no longer statistically significant. As was the case in Tables 14 and 16, the addition of the CV for proficiency in block 7 of Table 16 yields the largest coefficient of all at 1.23 Gini Index points, well beyond half a standard deviation. The addition of the CV for proficiency also reduced the intercept from 6.44, roughly where is had remained for blocks 1 to 6, to 5.89. The large effect for the CV for proficiency makes a profound difference in the estimated Gini Index of a district. For instance, compare a district that is a standard deviation below the mean for the CV for proficiency, which would have an estimated Gini index of 4.66, to one a standard deviation above the CV for proficiency, which would have an estimated Gini index of 7.12. Neither of these Ginis are below the 2.5 Gini Index benchmark,[42] but the difference between the two is striking. With this addition to the model in block 7, all the coefficients that were significant in previous blocks are substantially reduced and none remains statistically significant. The model in block 7 explains 21 percent of the variation in the Gini Index for TCE_{PPW}.

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[42] A 2.5 on the Gini Index is equivalent to Gini coefficient of 0.025.

Table 19. District-level regressions of the Gini Index for TCE_{PPW} by block

	Block 7	Block 8	Block 9	Block 10
	Estimate	Estimate	Estimate	Estimate
Intercept	5.89 ***	5.51 ***	6.42 ***	6.04 ***
Schools (z)	.12	.09	.02	-.01
Percent Title I (z)	-.29	-.18	-.09	.02
Urban district	.02	-.01	-.18	-.21
Town or rural district	.08	.03	.15	.10
Percent Elementary schools	-.35	-.31	-.36 ***	-.31 *
District unemployment	.08	.10	.02	.04
High LEP district	-.01	-.16	.27	.12
Mean Special Education	-.24	-.18	-.24	-.19
Mean school Poverty	.39	.39	.09	.09
Mean school minority students	.08	-.07	.03	-.12
Mean school percent proficient	.02	.10	.01	.09
Mean Teaher experience	-.04	.27	-.08	.24
CV percentage Poverty(z)	.21	.18	.05	.03
CV Minority percentage (z)	.15	.07	.01	-.07
CV Proficiency (z)	1.23 ***	1.06 *	.38	.21
CV Teacher Experience (z)		.57 ***		.45 ***
CV Pupil teacher ratio (z)			2.06 ***	2.06 ***
State Fixed effects				
Colorado	-.47	.28	-.24	.53
Minnesota	1.09	1.54 *	.25	.70
Texas	.31	.83	.25	.79
R square	.21	.24	.58	.62

The supplementary models for TCE_{PPW} are presented in Table 19. Like the previous supplementary tables, these indicate that variation in teacher experience and pupil teacher ratios completely explain the CV coefficients, once again supporting the theory that teacher sorting along the lines of school composition drives overall TCE_{PPW} variation. In block 8, the CV for teacher experience is significant at 0.57 and reduces the coefficient for the CV of proficiency. In block 9, the CV for pupil-teacher ratio reduces the coefficient for CV proficiency even further and the R-squared for the model increase dramatically, to 58%. In block 10, the addition of both measures are each significant, further reduce the coefficient for CV proficiency, and explain 62% of the variation in the Gini Index for TCE_{PPW}.

Summary of Results of District-level regression on TCE variation. Taken as a whole, these parallel district-level regressions reveal several associations between district characteristics and TCE variation that are worth highlighting. The first is that districts with more schools tend to have greater variation in TCE and those with fewer schools tend to have less. For all three dependent measures of TCE, the coefficients are in the same direction, though they are only significant for the TCE_{FTE} and TCE_{PPW} regressions. This relationship is consistent with the theory that teacher sorting drives salary variation as districts with more schools are likely to have more diverse school contexts for teachers to sort between. Of course, when controlling for district variation the district size measure is no longer significant. The district size coefficients are not significant in the TCE_{PP} regressions, perhaps because the majority of the variance in TCE_{PP} is due to differential teacher allocations, which may have a more varied relationship to district size.

Consistently, the proportion of elementary schools is negatively related to TCE variation in all three regressions, though they are only significant in some of the TCE_{FTE} and TCE_{PPW} models. Again, this might indicate that the allocation of positions does not vary with the proportion of elementary schools as teacher salaries do. The significant negative effects for TCE_{FTE} and TCE_{PPW} variation in districts with higher proportions of elementary schools may be due to more pronounced teacher sorting across high schools and middle schools, which would yield greater overall variation in districts with relatively fewer elementary schools. The exact nature of this relationship is uncertain.

The district averages student composition variables (poverty, minority composition and proficiency) all indicate significant relationships with TCE variation, under various controls. Of these correlated measures, minority composition generally shows a stronger association than poverty does, with proficiency stronger still. Each of these is associated with TCE variation such that districts with more high-need schools, or those with higher need schools, have more overall variation.

The CV's for the student composition measures show a similar pattern, in which the CV for minority composition displaces the CV poverty effect, and the CV for proficiency further displace both. Again, the displacing effect each CV has on the previous measure does not indicate that there is no association between the displaced measures and TCE variation. There are associations as indicated in the bivariate displays in Figure 4. However, proficiency is the strongest among these correlated and overlapping associations.

The supplementary tables for each dependent variable show that adding direct measures of the variation in district teacher experience and pupil-teacher ratios explain away much or all of the relationships between the CV's for school compositional measures and TCE variation. The relationships between TCE variation and the CV's for teacher experience and pupil-teacher ratios are not surprising given the direct links with single-salary schedules and compensatory allocations. However, the displacement effect these measures have on the CV's for school compositional measures supports the theory that teacher sorting is greater in districts with more variation in school composition, and that greater variation in TCE results from the sorting along those aspects of schools.

These regression results add important findings to understand what districts have more or less TCE variation. Nonetheless, the equity implications are still unclear. Certainly, districts with more variation in TCE are likely to have schools with larger between-school TCE differentials. However, these regressions do not establish a relationship between TCE variation and specific school characteristics. To determine what school characteristics are associated with TCE advantages or disadvantages requires school-level analyses. The following sections presents descriptive statistics on the proportion of schools affected by different magnitudes of school-level TCE differentials followed by the results of hierarchical linear models of within-district school-level TCE differentials.

Findings on School-level TCE Differentials

The first part of the second research question for this dissertation asks what proportions of schools are affected by substantial TCE variations. Table 20 presents the average district percentage of schools whose TCE differs from the district mean by 5 and 10%. These results are presented for all three TCE measures. The first column in table 20 indicated the average percentage of district schools with at least ±5% deviation from the district mean for TCE_{FTE} is 28% across all states. Deviation of ±10% is much less common with an average across states of about 5% (column2, table 20). A much larger proportion of district schools have ±5% and 10% deviation for TCE_{PP} with averages of

Table 20. Average percentage of districts schools with 5% and 10% deviation from the district TCE mean, by state

	TCE_{FTE}		TCE_{PP}		TCE_{PPW}	
	5% deviation	10% deviation	5% deviation	10% deviation	5% deviation	10% deviation
Arizona	30%	5%	66%	40%		
Colorado	42%	12%	73%	46%	64%	36%
Florida	33%	7%	70%	45%	64%	33%
Idaho	28%	5%	71%	41%		
Iowa	34%	6%	73%	42%		
Kansas	23%	4%	70%	43%		
Kentucky	22%	2%	67%	42%		
Louisiana	13%	1%	69%	43%		
Maine	25%	1%	66%	37%		
Minnesota	32%	7%	67%	43%	66%	33%
Mississippi	33%	6%	74%	45%		
Missouri	26%	4%	69%	45%		
Nebraska	30%	4%	72%	46%		
Oklahoma	20%	1%	63%	38%		
South Carolina	36%	6%	70%	39%		
Texas	17%	1%	64%	33%	58%	26%
Average	28%	5%	69%	42%	63%	32%

69% and 42%, respectively. In the four case study states, the percentage for district schools that deviate by ±5% and 10%, are somewhat smaller than for TCE_{PP}, but these deviations are still substantial for a large proportion of schools. Table 20 indicates that in most districts, TCE differentials affect substantial proportions of schools are affected by TCE differentials.

Results from HLM models of intradistrict TCE differentials. Tables 21, 23 and 25 present the results from the models of school TCE differentials from the district average. Each table presents parallel HLMs for schools in case study states using a blocked presentation. The tables present the results in six parts, four for model coefficients—school characteristics, district characteristics, district variation, state fixed effects— one for random effects, and one for fit measures. An important difference between traditional HLM models and those in this study is that the intercept is fixed to zero in these models. The intercept typically varies in HLM models, but since the dependent variable is centered at zero in each district (since the dependent measure is the deviation from the district average of zero) there is no between group variation in the dependent variable.

HLMs of TCE_{FTE} differentials. The first block in Table 21 contains the base model for TCE_{FTE} differentials. Beginning with schools characteristics, larger schools have above-average teacher salaries with a standard deviation in the number of students associated with a $213 salary advantage. Elementary schools, on average have below-average salaries by about $179. These are relatively small effects compared to a standard deviation for TCE_{FTE} differentials of about $2500. Title I schools have a much lower average salary compared to non-Title I schools in the same district. On average the differential is -$872, about 35% of a standard deviation below the district average. This finding is consistent with previous research examining the effect of teacher sorting on Title I schools (Roza & Hill, 2004; Roza, 2005; Heuer & Stillich, 2012).

The effect for town or rural schools appears large at -$592, compared to the suburban school reference group. However, this coefficient is largely an artifact of the model. The first significant district characteristic is for town or rural districts, which is positive and of a comparable magnitude. Since the majority of town or rural schools are in town or rural districts, for the vast majority of schools these two effects cancel out. The net difference for these schools is about the same size as the differential for urban schools, which is not statistically significant. There are no other significant relationships between-school differentials and district characteristics or measures of district variation (CV's). The lack of significant relationships is not surprising given that the dependent variance is centered on zero in every district.

The state fixed effects show some moderate differences for the intercept. In Colorado and Minnesota, the average school has a negative differential of between -$226 and -$260, while Florida has a positive fixed effect that is not significant. These effects are primarily included as controls that allow the model to isolate relationships within districts while controlling for between state differences, and therefore are not focused on here.

In block 2, the group-centered standardized scores for percent special education, LEP and poor students are added with random effects for each. All three measures have significant relationships to TCE_{FTE} differentials. On average, schools with a standard deviation above their district mean for Special Education students have a $100 salary advantage, while the same change in the percentage of LEP and poor students is associated with salary deficits of $243 and $377, respectively. The poverty salary deficit is a moderate effect of about 15% of a standard deviation for salary differentials. The additions of these measures make two changes to the base model. First, the effects for elementary schools and Title I schools essentially disappear. The change in the Title I effect is not surprising given the direct relationship between Title I status and percentage of poor students. The other change is the dramatic reduction in the magnitude and significance of the state fixed effects. These added measures explain 8% of the school-

Table 21. Results of blocked HLM models for intradistrict school differentials in TCE_{FTE}

	Block1	Block 2	Block 3	Block 4	Block 5
	Estimate	Estimate	Estimate	Estimate	Estimate
Intercept	20	35	21	-49	-4
School Characteristics					
School size (z)	213 ***	217 ***	248 ***	260 ***	256 ***
Elementary school (0/1)	-179 *	78	-4	-217 **	-232 **
Title I school (0/1)	-872 ***	-35	-16	-42	-47
Urban school (0/1)	71	132	205 *	188 *	188 *
Town/rural School (0/1)	-592 ***	-613 ***	-618 ***	-632 ***	-632 ***
Percent LEP (z)		-243 ***	-130 **	-117 **	-113 **
Percent Special Education (z)		100 **	83 *	107 **	105 **
Percent Poverty (z)		-377 ***	-94	-19	-13
Percent Minority (z)			-418 ***	-369 ***	-372 ***
Percent Proficient (z)				324 ***	343 ***
Percent Proficient (z)*Gini TCE_{FTE} (z)					140 ***
District Characteristics					
Urban District (0/1)	-11	-106	-154	-90	-100
Town/rural District (0/1)	513 ***	461 ***	470 ***	506 ***	513 ***
Number of Schools (z)	-47	-38	-38	-64	-72
District mean Special Education (z)	24	15	16	28	36
District mean LEP (z)	1	-5	-8	-3	10
District mean Poverty (z)	70	14	14	-13	-23
District mean Minority (z)	-59	-63	-63	-19	-23
District mean Proficiency (z)	-103	-30	-35	-171 *	-171 *
District unemployment (z)	68	16	14	8	-2
District Variation					
C.V. Percent LEP (z)	-21	-9	-9	-11	4
C.V. Percent Special Education (z)	48	20	22	8	7
C.V. Percent Poverty (z)	16	-5	-4	-21	-41
C.V. Percent Minority (z)	-58	-5	-3	-6	-18
C.V. Percent Proficient (z)	-29	4	0	50	48
Gini TCEFTE (z)					37
State fixed effects					
Minnesota (0/1)	-280 *	-28	-21	-36	-93
Florida (0/1)	154	90	92	156 *	93
Colorado (0/1)	-246 **	3	11	29	-37
Random Effects					
School size (z)	94086 ***	98201 ***	87670 ***	72228 ***	68673 ***
Percent LEP (z)		61159 **	55302 **	59493 **	59640 **
Percent Special Education (z)		44648 *	40257 *	43652 *	45725 **
Percent Poverty (z)		171483 ***	87038 **	25379	25525
Percent Minority (z)			140215 ***	109646 ***	97738 ***
Percent Proficient (z)				94006 ***	92356 ***
Residual	5642576	5175856	5077439	5025337	5024117
Fit measures					
-2 Res Log Likelihood	144451	144000	143873	143796	143764
AIC (smaller is better)	144455	144010	143885	143810	143778

level variation in TCE_{FTE} differentials.[43]

The group-mean centered standardized measure schools minority percentage is added in block 3. Schools that are a standard deviation above their districts' mean minority percentage have an average salary deficit of $418. Controlling for minority compositions reduces the effects associated with special education, LEP and poor students, and leaves the effect for poverty no longer significant; the displacement of these relationships by the minority composition effect is once again due to their correlation at the school level and is similar to the pattern of findings in the district OLS regressions. The relative strength of the percent minority measure, relative to the special education, LEP and poverty measures, suggests than on average, schools' minority composition has the strongest relationship to the sorting of teacher qualifications and salary of all these measures. The random effects for the special education, LEP and poverty measures are lower in block 3, though all remain significant. With the added control for minority composition, the coefficient for urban schools increases and becomes significant. This is likely due to the higher proportion of minority students in urban schools, which have higher salaries after controlling for their increased minority populations. Block 3 explains about 2% more of the variance in the base model than was explained in block 2.

Adding the group-centered, standardized measure of school proficiency in block 4 reduces the relationship between TCE_{FTE} differentials and a minority composition, but only slightly. On average, schools a standard deviation above the district proficiency mean have a salary advantage of $324, holding all else constant, including minority

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[43] The variance explained is computed by taking the block 3 residual minus block 1 residual, and dividing by the block 1residual ((5,642,576-5,175,865)/ 5,642,576=8.3 percent). Similar calculations are made for other blocks but calculations will not be shown.

composition, which still has an associated deficit of \$369. Controlling for school proficiency further reduces the poverty coefficient and its random effect, but makes little change to the LEP and special education coefficients. The only other substantive change in the model is that the coefficient for district mean proficiency becomes significant at -\$171.

In block 4, the random effect for school average proficiency is significant and left free to vary across districts. There are two more coefficients in the model in block 5. The first is the standardized district Gini coefficient for TCE_{FTE}, which has no significant relationship to TCE_{FTE} differentials. The second addition is a cross-level interaction between the Gini for TCE_{FTE} and school proficiency. This interaction is significant and indicates that in districts with greater variation in teacher salary there is stronger relationship with proficiency. In districts with an average Gini, the proficiency gap is similar to what it is in block4 at \$343, however in districts with a standard deviation higher Gini coefficient, the effect is \$483 (\$343+140). Again, this interaction is a linear relationship, meaning that while the effect of proficiency is greater in districts with more salary variation, the relationship is weaker in districts with less variation.[44]

Taken together, these models reveal several important relationships. The first is that Title I schools have a large salary deficit. This deficit is of particular interest because of the Title I comparability policy that excludes salary differences from comparability requirements. The average Title I differences amount to more than a \$40,000 deficit in average sized, perhaps enough to fund an additional FTE teacher. There is also a set of

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[44] Similar interactions were significant in exploratory analyses for minority composition and poverty under various controls. However, to keep the presentation of results manageable and parallel across TCE measures, the only one presented here is the proficiency.

school characteristics related to teacher salary averages that include school percentages for LEP, special education, poor, minority and proficient students. Except for the percentage of special education students, all of these relationships benefit low-need schools with higher TCE, and with the exception of poor students, these relationships compound to some degree such that schools with multiple needs have lower teacher salaries compared to the average schools in these districts. Finally, the interaction between proficiency and the Gini for TCE_{FTE} indicates that proficiency has a stronger relationship with salary in districts with greater salary variation. This interaction does not negate the base relationship, suggesting that the influence of school characteristics on teacher sorting and TCE are not limited to a few districts, but occur in most districts.

Similar to the district regressions, adding measures of teacher qualifications to the model confirm the link between school characteristics and teacher sorting. Table 22 compares the final two blocks of table 21 to models with controls for teacher qualifications. In block 4a, the group- centered standardized measures of teacher experience and advanced degrees are large and significant predictors of salary differentials. Controlling directly for schools' teacher qualifications account for all the relationships between salary differentials and all the school compositional measures, except for LEP composition, which is diminished. The measures of teacher qualifications explain 73% of the school variation found in the base model in table 21. Block 5b includes an interaction between teacher experience and the Gini coefficient for $TCE_{FTE,}$ similar to the interaction between the Gini and school proficiency in block 4b. As was the case with the interaction of proficiency and the Gini for TCE_{FTE}, the interaction with teacher experience indicates that the relationship between teacher qualifications and

Table 22. Secondary Results of blocked HLM models for intradistrict school differentials in TCE_{FTE} including measures of teacher sorting

	Block 4 Estimate	Block 4b Estimate	Block 5 Estimate	Block 5b Estimate
Intercept	-49	-50	-4	-34
School Characteristics				
School size (z)	260 ***	150 ***	256 ***	150 ***
Elementary school (0/1)	-217 **	-154 ***	-232 **	-151 ***
Title I school (0/1)	-42	-34	-47	-41
Urban school (0/1)	188 *	69	188 *	59
Town/rural School (0/1)	-632 ***	-31	-632 ***	-29
Percent LEP (z)	-117 **	-95 ***	-113 **	-91 ***
Percent Special Education (z)	107 **	-9	105 **	-9
Percent Poverty (z)	-19	-20	-13	-13
Percent Minority (z)	-369 ***	42	-372 ***	38
Percent Proficient (z)	324 ***	2	343 ***	11
Percent Proficient (z)*Gini TCE_{FTE} (z)			140 ***	59 *
Mean Teacher Experience (z)		1611 ***		1786 ***
Mean Advanced Degree (z)		337 ***		333 ***
Mean Teacher Experience*Gini TCE_{FTE} (z)				595 ***
District Characteristics				
Urban District (0/1)	-90	20	-100	25
Town/rural District (0/1)	506 ***	66	513 ***	66
Number of Schools (z)	-64	-36	-72	-38
District mean Special Education (z)	28	28	36	30
District mean LEP (z)	-3	14	10	20
District mean Poverty (z)	-13	-26	-23	-27
District mean Minority (z)	-19	9	-23	5
District mean Proficiency (z)	-171 *	17	-171 *	18
District unemployment (z)	8	4	-2	5
District Variation				
C.V. Percent LEP (z)	-11	3	4	7
C.V. Percent Special Education (z)	8	-14	7	-13
C.V. Percent Poverty (z)	-21	-30	-41	-34
C.V. Percent Minority (z)	-6	2	-18	-1
C.V. Percent Proficient (z)	50	49	48	47
Gini TCE_{FTE} (z)			0	10
State fixed effects				
Minnesota (0/1)	-36	-31	-93	-46
Florida (0/1)	156 *	43	93	24
Colorado (0/1)	29	-28	-37	-56
Random Effects				
School size (z)	72228 ***	42163 ***	68673 ***	37524 ***
Percent LEP (z)	59493 **	39043 ***	59640 **	35045 **
Percent Special Education (z)	43652 *	22184 **	45725 **	20166 **
Percent Poverty (z)	25379	19569 **	25525 **	17479 **
Percent Minority (z)	109645.9 ***		97738 ***	
Percent Proficient (z)	94006 ***	71409 ***	92356 ***	69046 ***
Mean Teacher Experience	0	384650 ***	0	60641 ***
Residual	5025337	1507875	5024117	1508976
Fit measures				
-2 Res Log Likelihood	143796	134955	143764	134596
AIC (smaller is better)	143810	134969	143778	134610

salary differentials is substantially greater in districts with more salary variation. The interaction between teacher experience and the Gini coefficient in block 6b explains about 84% of the variation in the random effect for teacher experience found in block 5b, though the relationship still varies measurably across districts in the final block. The interaction with experience and the Gini coefficient also reduces the effect for the proficiency interaction, though it is still positive and significant. These confirmatory HLM results show that school' composition drives TCE_{FTE} differentials through teacher sorting. They also show that these relationships only partially explain teacher sorting, as a large amount of variation remains in block 5. These results are consistent with the district differentials by Q4/Q1 gaps presented in Figure 4, which show that on average TCE gaps favor low-need schools, but not universally.

HLMs of TCE_{PP} differentials. Table 23 presents the results from the HLM's for TCE_{PP}. The intercept for the block one model is $53. Large schools and elementary schools both have significant negative coefficients indicating they receive less per-pupil compensation than average. Title I schools receive $150 more than average per-pupil TCE (more than 33% of a standard deviation), which is expected given that Title I schools receive targeted compensatory funds. Given the average salary gap found in table 21, the positive relationship for per-pupil salary confirms the notion that Title I schools receive more teachers, but with lower average salaries than non-Title I schools. The net Title I surplus in table 23 suggests the compensatory allocation of teaching positions is widespread and substantial. Town or rural schools have lower TCE_{PP} than average by $76, and this gap is not balanced by the town or rural district coefficient as it was in Table 21.

Table 23. Results of blocked HLM models for intradistrict school differentials in TCE_{PP}

	Block1 Estimate	Block 2 Estimate	Block 3 Estimate	Block 4 Estimate	Block 5 Estimate
Intercept	53 ***	45 ***	44 ***	52 ***	49 ***
School Characteristics					
School size (z)	-93 ***	-71 ***	-68 ***	-69 ***	-70 ***
Elementary school (0/1)	-86 ***	21	21	-9	-11
Title I school (0/1)	152 ***	2	3	10	9
Urban school (0/1)	23	29 *	31 *	31 *	30 *
Town/rural School (0/1)	-76 ***	-50 ***	-50 ***	-50 ***	-49 ***
Percent LEP (z)		-14	-11	-10	-10
Percent Special Education (z)		100 ***	100 ***	100 ***	100 ***
Percent Poverty (z)		82 ***	92 ***	99 ***	100 ***
Percent Minority (z)			-16	-12	-12
Percent Proficient (z)				28 **	31 ***
Percent Proficient (z)*Gini TCE_{FTE} (z)					17 *
District Characteristics					
Urban District	-31 *	-26	-28 *	-33 *	-33 *
Town/rural District	3	7	8	10	11
Number of Schools (z)	17 *	10	10	20 **	21 **
District mean Special Education (z)	-6	-4	-4	-5	-4
District mean LEP (z)	-1	0	0	-5	-5
District mean Poverty (z)	5	17 *	17 *	15	14
District mean Minority (z)	20	12	12	12	15
District mean Proficiency (z)	27 *	15	15	-11	-11
District unemployment (z)	-16 *	-4	-4	-9	-11
District Variation					
C.V. Percent LEP (z)	12	10	10	11	11
C.V. Percent Special Education (z)	-3	4	4	5	5
C.V. Percent Poverty (z)	-2	1	1	0	0
C.V. Percent Minority (z)	25 **	11	11	12	13
C.V. Percent Proficient (z)	-1	-3	-3	-5	-5
State fixed effects					
Minnesota (0/1)	182 ***	136 ***	137 ***	116 ***	120 ***
Florida (0/1)	62 ***	76 ***	76 ***	68 ***	72 ***
Colorado (0/1)	110 ***	64 ***	64 ***	70 ***	80 ***
Random Effects					
School size (z)	15894 ***	8723 ***	8756 ***	7647 ***	7506 ***
Percent LEP (z)		6346 ***	6067 ***	5806 ***	5800 ***
Percent Special Education (z)		4202 ***	4168 ***	4330 ***	4328 ***
Percent Poverty (z)		8810 ***	8032 ***	7512 ***	7641 ***
Percent Minority (z)			3358 ***	2871 **	2841 **
Percent Proficient (z)				4218 ***	4014 ***
Residual	145866	115099	113660	110951	110965
Fit measures					
-2 Res Log Likelihood	116010	114618	114579	114477	114458
AIC (smaller is better)	116014	114628	114591	114491	114472

Several small relationships exist between TCE_{PP} differentials and district characteristics or variation. Schools in urban districts and in districts with higher unemployment receive slightly less TCE_{PP} than average, while larger districts, districts with higher average proficiency and those with higher variation in minority composition have slightly above-average TCE_{PP}. All of these effects are relatively small. All three state fixed effects are significant indicating each differs from Texas. These differences may be due to more aggressive compensatory programs in these states, but the ultimate import of the fixed effects is uncertain.

Block 3 includes measures of school LEP, special education and poverty percentages. The coefficient for LEP is not significant, which is not what one would expect since districts typically allocate additional teachers to schools with higher proportions of LEP students. However, given the persistent salary deficit in Table 21 and the correlation between poverty and LEP in many districts, the flat finding for LEP students may indicate that districts make compensatory allocations for LEP students, but not with enough strength to have a net positive effect on TCE_{PP}. The percentage for special education and poor students are both positively associated with TCE_{PP} differentials of between $80-100, or roughly 20% of a standard deviation. Controlling for these measures, the Title I relationship again disappears, as would be expected, as do the small district effects found in block 1. The model in block 2 explains 21% more of the school-level variation in TCE_{PP} differentials than block 1.

In block 3, the addition of the measure for school minority composition makes no substantive differences to the model and is not significant. The lack of an association between minority composition and TCE_{PP} is not necessarily surprising since additional positions are not allocated to minority students as they are to students in poverty. Further, the salary deficit for high-minority schools in Table 21 is correlated with the poverty deficit, so controlling for both in block 3 unsurprisingly shows no minority relationship.

The addition of school average proficiency in block 4 and of the interaction between school proficiency and the Gini for TCE_{FTE} in block 5 have little effect on the other coefficients in the model, however both are related to TCE_{PP} surpluses. The stronger relationship between proficiency and TCE_{FTE}, relative to the other compositional measures in Table 21, appears to carry over into the distribution of TCE_{PP} resulting in small surpluses for schools with above-average proficiency. The majority of the variance explained in TCE_{PP} differentials is attributable to the coefficients added in block 2, as the model in block 5 only explains 3% more variation.

The models in Table 24 show a different pattern of results than the models in Table 22 because the nature of the variation in TCE_{PP} differentials is dissimilar from that of TCE_{FTE} differentials. The addition of school measures of teacher experience and advanced degrees are both significant and substantial at \$110 and \$48 dollars per-pupil respectively. However, these measures do not change the coefficients for school special education and poverty percentages as they did in the same block in table 21. The poverty and special education relationships persist in these models because their influence on per-pupil salaries relates to the allocation of positions, not average salaries. The measures of teacher qualifications explain a good deal of variation in TCE_{PP} differentials, 37% of the base model residual in block 5b, but the extra variance explained is in addition to that which is explained in block 5. This stands in stark contrast to table 22, where the teacher qualifications explain the same variation previous models explain, and more.

Table 24. Secondary results of blocked HLM models of intradistrict school differentials in TCE_{PP} including measures of teacher sorting

	Block 4 Estimate	Block 4b Estimate	Block 5 Estimate	Block 5b Estimate
Intercept	52 ***	56 ***	49 ***	51 ***
School Characteristics				
School size (z)	-69 ***	-80 ***	-70 ***	-80 ***
Elementary school (0/1)	-9	3	-11	2
Title I school (0/1)	10	10	9	10
Urban school (0/1)	31 *	22	30 *	20
Town/rural School (0/1)	-50 ***	-10	-49 ***	-7
Percent LEP (z)	-10	-10	-10	-10
Percent Special Education (z)	100 ***	94 ***	100 ***	93 ***
Percent Poverty (z)	99 ***	101 ***	100 ***	102 ***
Percent Minority (z)	-12	13	-12	13
Percent Proficient (z)	28 **	3	31 ***	5
Percent Proficient (z)*Gini TCE_{FTE} (z)			17 *	14 *
Mean Teacher Experience		110 ***		115 ***
Mean Advanced Degree		48 ***		48 ***
Mean Teacher Experience*Gini TCE_{FTE} (z)				26 ***
District Characteristics				
Urban District (0/1)	-33 *	-27 *	-33 *	-26
Town/rural District (0/1)	10	-21	11	-21
Number of Schools (z)	20 **	24 ***	21 **	26 ***
District mean Special Education (z)	-5	-6	-4	-5
District mean LEP (z)	-5	-4	-5	-5
District mean Poverty (z)	15	15	14	14
District mean Minority (z)	12	12	15	15
District mean Proficiency (z)	-11	1	-11	1
District unemployment (z)	-9	-10	-11	-11
District Variation				
C.V. Percent LEP (z)	11	11	11	11
C.V. Percent Special Education (z)	5	4	5	5
C.V. Percent Poverty (z)	0	0	0	1
C.V. Percent Minority (z)	12	13	13	14
C.V. Percent Proficient (z)	-5	-7	-5	-6
Gini TCE_{FTE} (z)			0	-9
State fixed effects				
Minnesota (0/1)	116 ***	114 ***	120 ***	121 ***
Florida (0/1)	68 ***	57 ***	72 ***	63 ***
Colorado (0/1)	70 ***	64 ***	80 ***	78 ***
Random Effects				
School size (z)	7647 ***	6313 ***	7506 ***	6113 ***
Percent LEP (z)	5806 ***	5012 ***	5800 ***	5060 ***
Percent Special Education (z)	4330 ***	4396 ***	4328 ***	4350 ***
Percent Poverty (z)	7512 ***	7429 ***	7641 ***	7545 ***
Percent Minority (z)	2871 **	3385 ***	2841 **	3430 ***
Percent Proficient (z)	4218 ***	5180 ***	4014 ***	5009 ***
Mean Teacher Experience		1783 ***		1221 ***
Residual	110951	92317	110965	92275
Fit measures				
-2 Res Log Likelihood	114477	113213	114458	113162
AIC (smaller is better)	114491	113229	114472	113178

Taken together, the models in tables 23 and 24 reveal a different set of patterns between school characteristics and TCE_{PP} differentials than were found for TCE_{FTE} differentials. The different set of patterns show that TCE_{PP} is a fundamentally different measure of TCE, because so much of its variation across schools is due to the number of teachers per-pupil. Schools with greater percentages of special education and poor students have higher TCE_{PP} because more teachers per-pupil are allocated to these schools. There remains a positive association between proficiency and TCE_{PP} because proficiency is positively related to TCE_{FTE}, which is an important component of TCE_{PP} differentials.

The results from Tables 21 and 23 indicate that TCE_{FTE} favors low-need schools and that, TCE_{PP} generally favors high-need schools. The TCE_{PP} models are insufficient bases for equity claims, because it is impossible to determine whether the legitimate compensatory allocations that alter the TCE_{PP} relationships are completely attributable to compensatory needs or whether they also compensate for differentials in TCE_{FTE}. The following section presents results from the HLM on TCE_{PPW} differentials, which provide a better basis to evaluate school-level TCE equity.

HLMs of TCE_{PPW} differentials. Table 25 presents the results from the HLM's for TCE_{PPW} differentials. The patterns in these results show similarities to the results for TCE_{FTE} and TCE_{PP} because TCE_{PPW} is a composite of both measures. The intercept for block 1 in table 25 is small but significantly different from zero, indicating a slight TCE_{PPW} surplus, on average controlling for other factors. However, the differential is quite small and with so many controls in the model is not particularly meaningful. School size has a large and negative coefficient indicating that schools that are a standard deviation larger than their district mean have a TCE_{PPW} deficit of \$62. Elementary schools also have a small average deficit of \$20 TCE_{PPW}. On average, Title I schools have a TCE_{PPW} deficit of \$85 which is a large effect of about 29% of a standard deviation. The average overall effect of this Title I deficit, based on the school-average number of weighted students in case study states, is almost \$90,000, and based on the median the deficit totals to over \$72,000, on average.[45] The Title I deficit is of great importance because it shows a net deficit after controlling for the compensatory allocations that yielded a positive effect for TCE_{PP}. This is the first indication in these analyses that after controlling for compensatory differences between schools (not in the model, but in the weighted measure of TCE) Title I schools do not receive a fair share of district TCE dollars. Urban and town or rural schools also have significant effects; however, the district effects for the same urbanicity largely cancel these out.

The only significant district effect in block one is a very small \$8 surplus for schools with above-average CV's for special education. The state fixed effects in the model are significant and positive for Minnesota and Florida, and not significant for Colorado.

Again, block 2 contains measures of school LEP, special education, and poverty percentages. The percentage for LEP and poor students are associated with deficits of \$38 and \$28, respectively. These deficits indicate that after controlling for differences in school's compensatory needs, high-need schools receive fewer TCE dollars than low-need schools. The random effects for of school LEP, special education, and poverty

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[45] Under the weighting scheme, students are weighted by adding to the actual student count for each school. Thus the TCE_{PP} coefficients are multiplied by the average number of students (801) the TCE_{PPW} coefficients are multiplied by the weighted number (mean=1,046; median=870).

Table 25. Results of blocked HLM models for intradistrict school differentials in TCE_{PPW}

	Block1 Estimate	Block 2 Estimate	Block 3 Estimate	Block 4 Estimate	Block 5 Estimate
Intercept	17 *	19 **	19 *	20 **	20 *
School Characteristics					
School size (z)	-62 ***	-58 ***	-56 ***	-56 ***	-56 ***
Elementary school (0/1)	-20 *	19 *	15	-14	-15
Title I school (0/1)	-85 ***	-4	-2	3	3
Urban school (0/1)	29 **	29 **	33 **	34 ***	33 **
Town/rural School (0/1)	-32 **	-35 **	-35 **	-35 **	-35 **
Percent LEP (z)		-38 ***	-32 ***	-33 ***	-33 ***
Percent Special Education (z)		6	5	7	7
Percent Poverty (z)		-28 ***	-13	-3	-2
Percent Minority (z)			-21 ***	-15 *	-15 *
Percent Proficient (z)				34 ***	35 ***
Percent Proficient (z)*Gini TCE_{FTE} (z)					12 *
District Characteristics					
Urban District (0/1)	-18	-23 *	-25 *	-26 *	-27 *
Town/rural District (0/1)	20	17	17	20	20
Number of Schools (z)	10	11 *	11 *	17 **	17 **
District mean Special Education (z)	-6	-7	-7	-8	-8
District mean LEP (z)	4	3	3	0	1
District mean Poverty (z)	6	1	0	0	-1
District mean Minority (z)	3	1	1	0	2
District mean Proficiency (z)	-7	1	1	-24 **	-23 *
District unemployment (z)	2	-3	-3	-5	-6
District Variation					
C.V. Percent LEP (z)	-2	-1	-1	0	0
C.V. Percent Special Education (z)	8 *	6	6	6	6
C.V. Percent Poverty (z)	-1	-4	-4	-3	-4
C.V. Percent Minority (z)	-1	3	3	4	4
C.V. Percent Proficient (z)	-2	2	1	0	1
Gini TCEFTE (z)					0
State fixed effects					
Minnesota (0/1)	42 **	65 ***	66 ***	56 ***	57 ***
Florida (0/1)	39 ***	33 ***	33 ***	31 ***	31 **
Colorado (0/1)	5	28 **	29 **	31 **	35 *
Random Effects					
School size (z)	5338 ***	4925 ***	4887 ***	4480 ***	4414 ***
Percent LEP (z)		1630 ***	1614 ***	1629 ***	1630 ***
Percent Special Education (z)		812 ***	774 ***	738 **	736 **
Percent Poverty (z)		653 *	828 **	536 *	573 *
Percent Minority (z)			805 **	543 *	554 *
Percent Proficient (z)				1351 ***	1312 ***
Residual	77072	71053	70307	69136	69106
Fit measures					
-2 Res Log Likelihood	110933	110491	110457	110361	110345
AIC (smaller is better)	110937	110501	110469	110375	110359

percentages are significant and left free to vary across districts. The addition of school poverty to the model negates the Title I effect found in block 1, as expected. There are no other substantive changes to the model.

The school minority measure added in block 3 is significant and indicates that schools that are one standard deviation above the district mean for minority percentage have an average TCE_{PPW} deficit of $21. Again, this coefficient indicates that schools with higher proportions of minority students receive less TCE than schools with fewer minority students, with an average total deficit of $22,000. As was the case in the TCE_{FTE} HLMs, the minority measure displaces the effect for poverty in block 2. Beyond its effect on the poverty measure, the school minority measure makes no other substantive changes to the model.

In block 4, the addition of the school proficiency reduced the minority coefficient. Schools that are a standard deviation above their district proficiency mean have an average $34 TCE_{PPW} surplus, which is about 12% of a standard deviation. While reduced, the minority measure associates with a $15 deficit. The addition of the proficiency measure and its random effect also reduces the random effect estimates for the poverty and minority measures. The only other substantive change to the model is for the district-mean proficiency measure, which indicates that after controlling for school proficiency, schools in districts that are a standard deviation above the mean for proficiency have a TCE_{PPW} deficit of about $24. In block 5, the interaction between the Gini for TCE_{PPW} and school proficiency is again significant with an associated surplus of $12 TCE_{PPW}. The interaction indicates that the effects of school proficiency on teacher sorting are more influential in districts with greater variation in teacher pay. In districts that are a standard deviation above the mean for Gini for TCE_{FTE}, schools that are a standard deviation above the district proficiency mean have a TCE_{PPW} deficit of $47, averaging to a total average difference of $49,000.

Table 26 presents models that include teacher qualifications. Both the coefficients for teacher experience and advanced degrees are associated with TCE_{PPW} surpluses of $85 and $37, respectively, which are equivalent to about 30% and 14% of a standard deviation for TCE_{PPW}. As in the TCE_{FTE} models, teacher qualifications explain the variation previously explained by school composition measures (with the exception of percentage LEP students). The only other interesting change to the model is that the addition of teacher qualifications to the model reduces coefficients for town or rural school and town or rural district in tandem. The simultaneous reduction of these coefficients supports the earlier interpretation than these coefficients are interdependent effects that effectively cancel each other out. In block 5a, the added interaction between teacher experience and the Gini coefficient for TCE_{FTE} is again significant and explains away some of the interaction between proficiency and the Gini found in block 5. As in previous tables, the addition of teacher qualifications explains a much larger portion of the between-school variation in TCE_{PPW} differentials than earlier models (26% versus 10% for the earlier models).

These dissertation analyses present a great deal of new information about the intradistrict distribution of TCE for a large sample of states and districts. The following chapter summarizes the key findings of the current research and discusses the implications of these findings for policy and research.

Table 26. Secondary Results of blocked HLM models of intradistrict school differentials in TCE_{PPW} including measures of teacher sorting

	Block 4	Block 4b	Block 5	Block 5b
	Estimate	Estimate	Estimate	Estimate
Intercept	20 **	23 **	20 *	21 **
School Characteristics				
School size (z)	-56 ***	-64 ***	-56 ***	-64 ***
Elementary school (0/1)	-14	-5	-15	-5
Title I school (0/1)	3	5	3	5
Urban school (0/1)	34 ***	27 **	33 **	26 **
Town/rural School (0/1)	-35 **	-3	-35 **	-2
Percent LEP (z)	-33 ***	-32 ***	-33 ***	-32 ***
Percent Special Education (z)	7	1	7	0
Percent Poverty (z)	-3	-1	-2	0
Percent Minority (z)	-15 *	5	-15 *	5
Percent Proficient (z)	34 ***	12	35 ***	14 *
Percent Proficient (z)*Gini TCE_{FTE} (z)			12 *	9
Mean Teacher Experience		85 ***		89 ***
Mean Advanced Degree		37 ***		37 ***
Mean Teacher Experience*Gini TCE_{FTE} (z)				21 ***
District Characteristics				
Urban District (0/1)	-26 *	-22 *	-27 *	-21 *
Town/rural District (0/1)	20	-4	20	-4
Number of Schools (z)	17 **	20 ***	17 **	21 ***
District mean Special Education (z)	-8	-9 *	-8	-8 *
District mean LEP (z)	0	1	1	1
District mean Poverty (z)	0	-1	-1	-2
District mean Minority (z)	0	1	2	3
District mean Proficiency (z)	-24 **	-12	-23 *	-12
District unemployment (z)	-5	-5	-6	-6
District Variation				
C.V. Percent LEP (z)	0	0	0	0
C.V. Percent Special Education (z)	6	5	6	5
C.V. Percent Poverty (z)	-3	-3	-4	-3
C.V. Percent Minority (z)	4	5	4	5
C.V. Percent Proficient (z)	0	-1	1	0
Gini TCE_{FTE} (z)			0	-4
State fixed effects				
Minnesota (0/1)	56 ***	54 ***	57 ***	57 ***
Florida (0/1)	31 ***	22 *	31 **	25 *
Colorado (0/1)	31 **	27 *	35 *	34 *
Random Effects				
School size (z)	4480 ***	3830 ***	4414 ***	3726 ***
Percent LEP (z)	1629 ***	1056 ***	1630 ***	1074 ***
Percent Special Education (z)	738 **	542 **	736 **	535 **
Percent Poverty (z)	536 *	457 *	573 *	516 *
Percent Minority (z)	543 *	865 **	554 *	905 **
Percent Proficient (z)	1351 ***	1767 ***	1312 ***	1749 ***
Mean Teacher Experience		1363 ***		1044 ***
Residual	69136	57297	69106	57212
Fit measures				
-2 Res Log Likelihood	110361	109027	110345	108980
AIC (smaller is better)	110375	109043	110359	108996

Chapter 5: Discussion and Future Research

This dissertation contributes novel conceptual and methodological approaches and substantial new empirical evidence on the intradistrict distribution of TCE. In this chapter, I discuss the current dissertation in four sections. In the first section, I overview the empirical, conceptual, and methodological contributions this study adds to the literature on TCE. The second section reviews the key findings from this dissertation study and discusses how those findings corroborate and extend prior research on TCE. In the third section, I discuss the implications the key findings from this study have for policy and research. The final section reviews the limitations to this study.

Contributions of this Study

The purpose of this dissertation research is to investigate intradistrict TCE variation at the school and district levels. The findings of this study significantly expand the empirical evidence on TCE variation through the examination of a larger sample than scholars have used previously. This study examines all schools in a large number of districts across several states. Further, with this expansive database, this research is the first to use multivariate methods to examine district TCE variation and the district characteristics that are associated with it.

In addition to empirical contributions, the conceptual and methodological approaches in this dissertation add to the research on TCE variation because they enable analyses that look beyond average teacher salaries (TCE_{FTE}), to make valid per-pupil TCE comparisons. Most prior research looks only at average teacher salaries to measure TCE. The average measure cannot account for the district practice to allocate additional teaching positions to balance salary differences. This dissertation expands previous conceptual approaches that gauge TCE equity by comparing weighted per-pupil TCE. The methodological application of district *de facto* allocation weights makes this conceptual shift possible. The *de facto* weighting scheme statistically controls for between-school differences in the number of FTE teachers allocated according to student compensatory needs. I use the *de facto* weights to create the TCE_{PPW} measure that allows for valid per-pupil TCE comparisons. Further, since the *de facto* weights control for between-school differences in student compensatory needs, the analyses of TCE_{PPW} provide a better vantage to evaluate TCE equity. Similar TCE comparisons have not been possible with the methods employed in previous TCE research because prior methods did not control for between-school differences in either pupil-teacher ratios or differences in student compensatory needs.

The current research also includes multivariate analyses that examine district TCE variation and school-level TCE differentials within districts in multiple states. Researchers have not published multivariate analyses of district TCE variation to date, and they have not used data for school-level TCE multivariate analyses as wide ranging or as detailed as the data in this study.[46] Specifically, the analyses in this dissertation gauge the scope of TCE variation to measure the distribution and magnitude of TCE variation at the district level and the distribution and magnitude of school-level TCE deviations from the district mean. The multivariate analyses and the weighted measure of TCE are possible thanks to newly available data in the TCS and to supplemental state

[46] To date, scholars have conducted school-level analyses of TCE differentials in only two states, and have reported findings in policy brief form only. See Miller, 2010 and Cohen & Miller, 2011.

data files, which provide a breadth (across many states) and depth of data (sufficient to estimate district *de facto* weights and include all district schools).

Key Findings.

This dissertation has three overarching findings. First, this research shows that intradistrict TCE variation is a widespread phenomenon that has substantial impacts on a large percentage of schools. Second, this research finds that TCE variation usually advantages low-need schools and disadvantages high-need schools. Third, this research indicates that teacher sorting across schools within districts drives TCE variation. In the pages that follow, I examine each key finding in turn and discuss how each finding relates to prior research.

Intradistrict TCE variation is widespread. This study uses two functional benchmarks for the Gini coefficient, at 0.025 and 0.05, which are useful for TCE measures and the context of this study. Table 5 (page 127) reveals that the average district Gini coefficient for TCE_{FTE} is above the 0.025 Gini benchmark in most states but well below the 0.05 benchmark in all states. The average Gini coefficients for both per-pupil measures are substantially greater than for TCE_{FTE}. The percentage distribution of districts by Gini benchmarks presented in Table 6 (page 128), show the TCE Gini coefficients are above the benchmarks for a large proportion of district. The descriptive statistics found in tables 5 and 6 are consistent with the intercepts in the OLS regressions on district Gini coefficients. These descriptive statistics corroborate findings from previous research and indicate a large proportion of school districts in this study's sample have significant amounts of TCE variation. Since the Gini coefficient measures the average between-school variation as a percentage of the district TCE mean, these results indicate that in most districts the average between-school difference in TCE_{FTE} is greater than 5% of the district average teacher salary (based on the 0.025 Gini benchmark). For TCE_{PP} and TCE_{PPW}, the average between-school difference in the majority of districts is beyond 10%. These TCE differences are widespread and substantial.

The results of these analyses not only show substantial TCE variation in a large proportion of districts, but also show that TCE differentials affect a large proportion of schools. Table 20 (page 159) indicates that TCE_{FTE} differed by more than 5% from the district average for about three in ten schools, while only about one in twenty schools differed by 10% or more. A much larger share of schools had more the 5% deviation for TCE_{PP} (69%) and for TCE_{PPW} (63%), and a sizable share differed by 10% for each (42% and 32%, respectively). These figures are averages across all districts, not just districts with Ginis above the benchmarks, and indicate that a large proportion of schools receive TCE that are substantially higher or lower than their district's mean TCE. While the magnitudes of the TCE deviations found in these analyses are consistent those found in previous research on TCE_{FTE} (e.g.; Roza & Hill, 2004; Argue, Honeyman, & Schlay, 2006), earlier research has not provided a sense of the proportion of schools with significant TCE differentials. The descriptive statistics in this study are the first to offer insight into the proportionality of the phenomenon and suggest that TCE differentials substantially affect about one in four schools.

School-level TCE differentials are policy relevant not only because of their frequency, but also because of their magnitudes. Tables 6 through 9 (pages 128-133) include various measures of the between-school differences found in districts above and below the Gini benchmarks. The absolute mean differences (AMD) presented in Tables 7 and 9 indicate that, on average, the TCE_{FTE} AMD (or the average between-school salary difference) for districts ranges from $1,700 to $2800 to $4,800 by Ginis categories. The TCE gaps for TCE_{PP} are $150, $220, and $475 by the same categories. For TCE_{PPW} the AMDs are slightly lower than for TCE_{PP}, at $90, $177, and $318. To put this in perspective, these are the average TCE differences between all schools in the districts, and the gaps are substantial enough that in average-sized schools, these differences sum to more than enough to fund at least one FTE teacher.[47]

The size of the TCE differentials found in this study are in line with the differences found in previous research on TCE differentials (e.g.; Roza & Hill, 2004; Argue, Honeyman, & Schlay, 2006). However, previous research examined either only a few districts or only a portion of the schools in a larger number of districts (Education Trust, 2005; Miller, 2011). Table 8 presents average differences for a much larger number of districts and all the schools within those districts. The findings in tables 6 through 9 indicate that substantial TCE differences are common. The interquartile and 90/10 ranges presented in Tables 6, 8 and 9 offer additional descriptions of the magnitude of school TCE differentials. The tables show that between-school differences are large for half the schools in the districts and even larger for the 20% of schools in the top and bottom deciles of TCE.

The descriptive results in the current study corroborate and add to findings from previous literature. For instance, as does the current study, multiple prior studies have

[47] Based on the average teacher salary in the case study states.

found that intradistrict resource variation[48] is substantial (e.g., Burke, 1999; Hertert, 1999; Lankford, Loeb, & Wyckoff, 2002). Research like Roza and Hill's (2004) found substantial between-school TCE differentials in large urban districts (see also Argue, Honeyman, & Schlay, 2006; Education Trust West, 2005; Miller, 2011), which are in line with the current study results for the size of TCE differentials and are consistent with the finding of high TCE variation and large Gini coefficients. The results of my analyses confirm these earlier findings and extend them across a much larger range of districts, suggesting the results from earlier studies with a few districts are neither anecdotal nor limited to a small proportion of district schools.

While prior TCE studies focused primarily on large urban districts, the current results do not provide compelling evidence to support any particular association between TCE variation and urbanicity. Although in this study it is difficult to measure the association between TCE variation and urbanicity, these analyses do not suggest that TCE variation is a phenomenon particular to urban districts. The measurement difficulty arises for two reasons. First, the models in this study controls for many of the features by which urban districts are distinct from other districts (such as district and school size, and school compositional measures). Second, HLM models control for district and school urbanicity simultaneously. While it is important to control for urbanicity at each level it makes for difficult interpretation. Nonetheless, as a whole, the current results indicate that TCE variation affects a large proportion of schools and districts in the states I examined.

TCE variation shortchanges high-need schools. The descriptive statistics and the multivariate results presented here provide strong evidence that TCE differentials

[48] In terms of total resources and in terms of salary-determinant teacher qualifications.

advantage low-need schools and disadvantage high-need schools. The HLMs results for TCE_{FTE} and for TCE_{PPW} indicate that school poverty, minority composition and proficiency level all associate with TCE differentials. These three relationships are linear and indicate that schools above their district's mean in poverty and minority percentage and below their district's mean in proficiency have average salaries and average TCE_{PPW} that is below the district average. The converse also holds. Lower poverty, lower minority and higher proficiency schools received more TCE_{FTE} and TCE_{PPW}. Further, the relationship between TCE and Title I schools indicates that Title I schools have lower TCE_{FTE} and TCE_{PPW} than non-Title I schools.

The results from the HLMs for TCE_{FTE} and TCE_{PPW} are consistent with previous research that showed how average salaries favor low-need schools (e.g., Roza & Hill, 2004; Education Trust West, 2006; Miller 2010). Thanks to HLM results from the expansive database, the current findings substantially extend previous research because they reveal average relationships across all schools in many districts in several states. The statistically significant relationships in my sample indicate that relationships between school composition and TCE function in similar ways across a large number of districts. If the relationships between benefit and low-needs schools that were present in earlier research existed in several districts but not across a range of districts, one could conclude that TCE differentials are a local phenomenon rather than a wide-ranging occurrence. However, based on the evidence in this dissertation, TCE variation and differentials are a broad policy concern.

The findings in this dissertation provide evidence on why districts allocate staff to high-need schools. The TCE_{PPW} HLMs allow comparisons across schools with varying proportions of student populations with compensatory needs. The TCE_{PP} HLMs show that compensatory needs play a role in the distribution of TCE. The TCE_{PP} HLMs reveal substantial positive associations between student compensatory needs, primarily the Title I, special education and student poverty coefficients, and TCE_{PP}. Given the negative association between TCE_{FTE} and poverty, the positive associations between TCE_{PP} and poverty are only possible if districts allocate additional positions to high-poverty schools. In contrast, the TCE_{PP} HLMs show no positive association with the percentage of minority students and indicate only a small positive relationship to proficiency.[49] Moreover, the addition of measures of school minority composition and average proficiency does not change the coefficients for compensatory needs in the TCE_{PP} HLMs, as they do in the TCE_{FTE} HLMs. Taken together, these models indicate that districts allocate additional positions to schools based on student compensatory needs rather than to balance differences in teacher salaries.

The current findings are consistent with previous research that suggests that teacher sorting and the associated TCE_{FTE} differentials influence federal, state, and local compensatory funds in ways that undermine the intent of compensatory programs. Title I funding is an apt illustration. Title I funds are sent to districts that use those funds to provide additional teachers to high-need schools. As Roza (2005, 2011) and others have argued because districts account for the associated with district average salaries, when low-salaried teachers fill these positions in Title I schools and when some of the compensatory funding does not reach targeted schools. The difference between teacher

[49] The small positive relationship with proficiency is probably due to the higher average salaries in these schools. The TCE_{FTE} HLMs show that proficiency is the compositional measure most strongly related to TCE_{FTE}, and both compensatory allocations and TCE_{FTE} influence TCE_{PP}

salaries that teach in Title I schools and the district average salary ultimately funds the above-average salaries in non-Title I schools. Salary differentials in high-need schools can influence the flow of other categorical funds in similar ways. The findings in this dissertations show that Title I schools and high-poverty schools have substantial salary differentials, suggesting that the effects of compensatory funding may be frequently undermined.

The different effects on the TCE_{FTE} and TCE_{PP} HLM coefficients revealed through the block modeling of school compositional measures have significant implications for the possibility of teacher quality/quantity tradeoffs. The TCE_{PP} HLM results are consistent with the often-observed teacher quality/quantity tradeoffs, discussed in chapter two of this dissertation. However, the pattern of HLM results indicate that apparent tradeoffs are not tradeoffs at all, but result from extra FTE teaching positions allocated through categorical funding streams to schools with students who have legitimate educational needs. The finding regarding compensatory needs and teacher allocation is an important addition to the research on intradistrict TCE because it casts doubt on the likelihood that districts commonly allocate extra teaching positions to balance TCE_{FTE} differentials. That tradeoff assertion, found so often in earlier studies of the intradistrict distribution of teacher salaries, is important because it fosters the notion that district officials allocate additional positions to balance TCE_{FTE} differentials. As noted in the literature review in chapter 2, there is no evidence in the literature on district resource allocation that supports the idea that district officials attempt to balance TCE_{FTE} differences with additional staff. Likewise, the findings in this dissertation do not provide evidence in support of the idea.

The differences between the TCE_{FTE} and TCE_{PP} HLM results show that legitimate compensatory needs do substantively affect per-pupil TCE. As the charts in figure 4 (page 116) suggest, districts allocate additional teachers to schools with compensatory needs such that these schools receive above-average TCE_{PP}. However, once district compensatory allocations are controlled for in the TCE_{PPW} measure, the association between school compositional measures—those legitimately related to education resources and those that are not— and TCE_{FTE} are still apparent. If teacher salary expenditures should be included in school resource equity comparisons, these results indicate that the districts often allocate compensatory funds to high-need schools without considering the already existing inequity based on TCE distribution. Specifically in terms of Title I funding, if districts closed the comparability loophole and included teacher salary differences to calculate the comparability requirements, many districts would prove to be supplanting instead of supplementing base funding with Title I monies. The findings in this study corroborate earlier claims regarding differentials in TCE_{FTE} (e.g., Roza, 2011). However, the TCE_{PPW} measure in this dissertation allows for legitimate comparisons between schools by controlling for between-school differences in compensatory need. The results provide evidence that districts inequitably distribute TCE in terms of both average salaries and salary per-pupil.

Teacher sorting drives TCE variation. Researchers who study the distribution of TCE often attribute TCE differences to teacher sorting. The results from this dissertation corroborate those attributions. For instance, the results of the OLS regressions on district Gini coefficients found in tables 21, 23 and 25 (pages 161, 168, and 173, respectively) reveal three key relationships that suggest that district contexts that are more conducive to teacher sorting have greater TCE variation. The first two of these relationships are that district size and district-average minority student percentages are positively associated with TCE_{FTE} variation. The opportunities for teachers to sort across schools are greater in districts with more schools, and districts with more minority students may have more diverse school compositions and thereby have weaker functional teacher preferences for sorting. The third finding is that variation in school poverty, minority composition and proficiency levels are interrelated predictors of TCE variation. Scholars have established all three predictors as components of teacher preferences in the literature on teacher sorting cited in chapter 2. The current results support previous literature that attributes between-school TCE differences to teacher sorting. Simply put, in districts where schools differ more on characteristics that are associated with teachers' labor market preferences, we find greater variation in TCE. Additionally, prior research (Roza & Hill, 2004; Education Trust West, 2005; Miller, 2011) also concentrated on between-school differences in student poverty, minority, and proficiency levels as the drivers of teacher sorting and TCE differences. The current findings echo those concentrations.

The supplementary tables for each set of regressions provide further evidence in support of the link between teacher sorting and TCE differentials. The secondary tables show that measures of variation in teacher experience and allocations substantially explain TCE variation. This relationship is expected. More important for this research is that school compositional measures no longer associate with TCE variation in the models that control for teacher experience and pupil-teacher ratios. The results do not suggest that schools compositional measures are unimportant. Instead, the findings from the secondary regression models in this study support the connection between school composition and teacher sorting such that *both* associate with TCE variation.

The secondary HLM results for TCE_{FTE} and TCE_{PPW} provide similar evidence at the school level because adding teacher qualifications to the models largely negates the associations between school composition and TCE differentials. As was the case in the district OLS regressions, the displacement of these relationships across HLM blocks is consistent with the theory that school composition influences teacher sorting which drives TCE differences. However, for the secondary HLM tables for $TCE_{PP,}$ the effects for poverty and special education percentages hold even after controlling for teacher qualifications. Taken together, the contrasts between the secondary analyses show that schools' compositions affect TCE differentials through teacher sorting rather than through allocations of additional teaching positions. The contrasted findings not only support the theory that teacher sorting drives TCE differences, but also provide further evidence that districts do not allocate teaching positions to balance differences in average teacher salaries.

The results in this dissertation generally affirm the findings of previous research. An additional affirmation of prior research by the current study is evident in the amount of variation the current models explain. In the HLM models, the amount of variation in the school-level residual term (in some ways akin to an R-squared in OLS regression) that the models explain is significant, but large portions of unexplained variation remain. One might consider the remaining unexplained variation as a limitation for the current results; however, I interpret the outstanding variation as consistent with the complexities of teacher preferences and teacher sorting. Previous literature has established teachers' labor market preferences for low-poverty, low-minority and high-performing schools. I include these measures in the HLM models. This literature has also shown other school characteristics—such as school leadership quality, school climate, location, resource availability, and student behavior (Rice, Rollke, Sparks & Kolbe, 2009)— that are as important or more important teacher preferences that vary substantially across districts (Clotfelter, et al., 2006; Hanushek, Kain & Rivkin, 2004). The HLM models in this study only include widely available measures that are not fine-grained enough to capture all of teachers' preferences in the workplace. Thus, unexplained variation in school TCE differentials remains.

The findings from this dissertation show that the intradistrict distribution of TCE is inequitable in a substantial portion of districts and schools. These findings add evidence to a body of research that have several implications for education policy and research. The following section discussed the implications of this research.

Implications for Policy and Future Research

The findings in this dissertation have several implications for education policy and research. To begin the discussion of the implications of this study, I review three policy issues related to the dissertation findings. After reviewing the policy implications, I discuss the implications for future research.

Implications for policy. Based on the findings in this study, policymakers now have the opportunity to address the following three issues. First, policymakers can address and change policies to address intradistrict TCE inequity. Second, policymakers have reason to insist that districts use actual school-level salary data when calculating school budgets and when accounting for compensatory needs. Third, policymakers should create mechanisms to ensure that compensatory aide reaches targeted students and that between-school TCE differences do not divert compensatory funds.

This dissertation demonstrates that many districts inequitably distribute TCE across schools in ways that disadvantage high-need schools and violate standards of horizontal and vertical equities, as well as equality of educational opportunity (as described in chapter 2). Policymakers should address these TCE inequities with policy change. The findings in this study corroborate previous research found using average salaries, and extend those findings by analyzing per-pupil TCE after controlling for students' compensatory needs. Students with legitimate compensatory needs do receive more TCE per pupil. However, the surplus TCE_{PP} is associated with compensatory funding, which indicates that for a large portion of schools in a large portion of districts, school-financing schemes inequitably distribute base TCE funding. Unequal base funding violates the horizontal equity standard. The TCE_{PPW} HLMs show that a negative relationship between student poverty and TCE remains after controlling for compensatory teacher allocations. Districts allocate additional teachers positions to students in poverty, but the remaining net negative association with TCE indicates widespread violations of vertical equity. Further, the associations between TCE and students' race and proficiency violate the equality of educational opportunity standard.

This study also demonstrates that TCE variation is a widespread problem. TCE inequities are important at the student level, because they shortchange students on bases that have no legitimate association with resource allocations. While this dissertation study focuses on examining equity between students there is also a school-level equity implication. In the current climate of school accountability, between-school TCE differentials are also inequities for schools that share the same accountability requirements, but receive unequal resources.

Several of the scholars cited in the literature review for this dissertation are consistent with Betts and colleague's observation that in many districts schools are divided between the "haves", and the "have nots" (Betts, et al. 2000; Presley, White, & Gong, 2005; Lankford, et al., 2002; DeAngelis, Presley & White, 2005; Roza, 2011). Schools with more historically difficult-to- educate students have been shown to also employ teachers who have the lowest qualifications. The current research confirms assertions made in studies on the distribution of average teacher salaries that suggest that "have not" schools not only have more difficult-to-educate students and lower teacher qualifications, but also receive less than their share of district salary dollars. The current study shows that school compositions relate to TCE in a large number of districts, and that allocations of additional teachers to "have not" schools do not ameliorate salary differences. In short, the current research establishes that researchers and policymakers should add TCE to the list of resources that high-need schools "have not."

Although policies need to address TCE inequities, a policy solution will not be easy because the root causes are structural. Teachers make job placement decisions in a labor market system substantially defined by district policies. Common structural staffing policies create the context in which teachers pursue their individual preferences for job placement. Ultimately, this is a structural problem and policymakers should not mistake it for a problem with teacher's decision-making. Cumulatively, teacher-sorting decisions influence the distribution of TCE; however, it would be unreasonable to attribute the effects of sorting to teachers' preferences, because the problem lies in the district job placement policy structures that allow, if not encourage, teacher sorting based on workplace preferences and reward systems. To assign blame to teachers for the downstream effects of their cumulative labor market decisions and build policies that only target teacher behavior would make no more sense than to blame principals for trying to hire the best teachers away from other schools to work in their schools.

Specific policy recommendations to change the district policies that enable or encourage TCE inequity are beyond the scope of this dissertation. The purpose of this study is to empirically investigate TCE distributions and provide information that may improve future policymaking. To ameliorate TCE inequities will be a challenge because to change longstanding district policies will most likely be complicated and politically contentious. Nonetheless, TCE inequities will persist unless policymakers alter staffing policies or allocate additional resources to balance TCE differences.

A policy recommendation that this study does permit is one of additional transparency in school-budget reporting and district accounting. The widespread use of district salary averages in school budgets and district accounting hides intradistrict differences in TCE and in total resources. This dissertation research required voluminous amounts of data and complicated analyses to uncover differences that would be plain if districts accurately reported school budgets. Federal, state and local policy have begun to change the use of salary averages and these policies should continue. District data systems have the capacity to report school budgets accurately and policy should ensure that districts do so.

Transparency and accuracy are not only important for school budgets, they are important for effective compensatory aid programs as well. This dissertation is consistent with previous research that suggests that teacher sorting influences the flow of compensatory funds to schools, and this influence has substantial policy implications. The inadvertent transfers of federal, state, and local compensatory funding are possible when districts use compensatory funds to supply additional teachers to high-need schools and account for these funds with district salary averages. Unfortunately, these conditions are common. The current study adds weight to calls to close the Title I "comparability loophole" (the provision in Title I policy that allows districts to qualify for comparability by using district salary averages, discussed in detail in Chapter 3). Change at the federal level would not only help ensure that Title I funds reach targeted schools, but also be a positive influence on state and local compensatory policies.

Researchers and practitioners should inform local policymakers and district officials on how TCE differences affect the flow of compensatory funds. Anecdotal evidence (Miller and Rubenstein, 2008) suggests that district policymakers do not grasp the impact teacher sorting has on TCE distribution and differentials. If true, it is nearly certain that policymakers do not understand the secondary effects that teacher sorting has on categorical aid. Given the size of categorical aid programs and their important equity goals, policymakers at the federal, state and local levels need to grapple with the implications of this research and amend policy to ensure compensatory funds provide resources for students in need.

In summary, this dissertation adds substantial evidence to bolster the findings of previous research on intradistrict TCE. Policymakers should give careful and thoughtful consideration to the intradistrict distribution of TCE based on the magnitude of the differences evident in this and earlier studies, and based on the large numbers of students and schools these differences affect. Additional research by the education research community will help policymakers to make changes. The second section on the implications of this study discusses possible avenues for future research in this area.

Implications for research. While this dissertation study expands the research on intradistrict TCE variation, it also raises new questions that future research should address. I discuss five areas for future research. The first area involves expanding intradistrict TCE analyses to accumulate a greater breadth of evidence across more states and districts and to contextualize TCE variation within overall resource variation. Second, researchers can pursue smaller scale comparative analyses of TCE differentials across time and across different district contexts. Third, researchers can pursue methodological work that evaluates and improves the district *de facto* weighting scheme to validate and improve adjusted per-pupil salary measures (TCE_{PPW}). Fourth, scholars can explore the theoretical and methodological bases to develop equity benchmarks for intradistrict TCE. Finally, as methods for evaluating teacher quality advance, researchers can try to measure the relationship between TCE differences and teacher quality across schools. Below I discuss each of these opportunities for research in turn.

This dissertation study demonstrates that intradistrict TCE variation is widespread and substantial. Compared to the amount of *inter*district equity research, *intra*district equity is under-examined. The current findings add weight to previous calls for more intradistrict equity research (e.g., Berne and Stiefel, 1999; Guthrie, 2007). The pace of interdistrict equity research seems to have slowed in recent years because of the growing focus on adequacy. The growing attention to adequacy research is good; however, since schools within districts share the same revenue bases adequacy does not complicate intradistrict equity comparisons as it does between districts. Education scholars should pursue additional research on intradistrict equity because intradistrict inequity is a problem and the framework for intradistrict equity is straightforward.

The substantial inequities found in this study are important but still represent only a fraction of US schools. This dissertation includes complete analyses of TCE_{FTE} and TCE_{PPW} for only four states, and is not representative beyond those states. The TCE_{PPW} measure used in this dissertation provides more nuanced and compelling findings on TCE differences. This measurement approach allows for equity comparisons of schools with varying student populations, comparisons that have been previously impossible. Additional research should extend these analyses for TCE_{FTE} and TCE_{PPW} across more states and districts.

Of course, equity in TCE is not the ultimate equity goal. The primary concern for intradistrict resource equity is total resource equity, not TCE equity. This dissertation finds widespread TCE inequity of sufficient magnitude to imply overall resource inequity; however, this study is not sufficient for such conclusions. Additional research should examine overall intradistrict resource equity as data become available. Further research should investigate whether TCE differences do in fact drive overall inequities, whether districts allocate additional resources to mitigate TCE differences, and whether districts distribute other resources equitably apart from TCE.

Future research should also gauge TCE variation with comparative analyses across varied district contexts. In particular, researchers need to examine TCE variation in districts across time, across budgeting methods and across districts with varied TCE distributions. Looking across time, research could examine how stable TCE differences are. The structure of schools makes their student compositions relatively stable over time, which suggests that TCE differential persist over time. If this is the case, the inequities students experience are likely to persist as they move through grade levels within schools. Further, since feeder schools typically draw from similar geographic areas and student populations, TCE inequities may not only be consistent over time within schools, but also with collections of schools connected by district feeder patterns. If TCE differentials follow school feeder patterns the effect of TCE differentials over a student's educational career would be cumulative and represent greater inequities.

Future research should also compare TCE differentials across districts with different budgeting and teacher-allocation mechanisms. For instance, districts that use student-based budgeting systems may have smaller TCE differentials compared to districts that used school-based budgeting. Alternatively, this research might identify the non-teacher resources that districts that use student based budgeting allocate to balance salary differentials. To identify such resources that counterbalance TCE differentials are a necessary first step to evaluate the productive capacity of resource tradeoffs. To flip the search for governance and budgetary mechanisms that might lessen TCE differentials on its head, future research should examine district that have equitable or progressive TCE allocations, which would favor high-need schools. A minority of districts in the four case study states display such a distribution in the charts in Figure 4. The identification of what separates these districts from the majority would add to our understanding of the products of varied district practices.

Future research should evaluate the *de* facto weighting scheme used in this dissertation and continue to explore how districts allocate teaching positions. The conceptual contribution of this dissertation is the use of the TCE_{PPW} measure, which depends on effective *de facto* allocation weights. The TCE_{PPW} measure allows equity comparisons between schools with varied compositions. Future research should independently replicate the methodology for estimating *de facto* weights to validate and improve it. Another way to test these methods would be in-depth, small-scale district studies that compare the derived *de facto* allocation weights to stated district allocation policies, and to actual distributions of teaching positions. Roza (2005; 2011) has written extensively on intradistrict allocation differences noting that in many districts the distribution of teaching positions is a product of historic allocations and political maneuvers, as well as policy. Additional research on how districts allocate teaching positions, in terms of base and compensatory allocations, would inform the methods and findings for this study and future intradistrict research.

Future research should develop widely applicable frameworks to measure equity with varied resource measures in various contexts and provide rationales for setting appropriate benchmarks for those measures. This dissertation relied on the Gini coefficient to measure district TCE variation. While the Gini is well suited for this purpose, additional theoretical and methodological research should develop meaningful standards for intradistrict equity and for measures like the Gini coefficient. Scholars need to develop theoretical approaches to equity that establish at what magnitude differences in various measures amount to inequities. This theoretical work should carefully consider the contexts and measures under scrutiny. For example, most school-finance research uses Odden and Picus's 0.05 Gini benchmark for interdistrict finance. While theirs is a functional benchmark, it does not have a thorough rationale grounding it. This study used two benchmarks for the Gini (0.025 and 0.05) which correspond to TCE variations of 5% and 10% of the district mean, respectively. These benchmarks are useful for intradistrict TCE differences because the sources of variation for intradistrict teacher pay are smaller than the sources of variation for interdistrict finance.

The average between-school TCE_{FTE} differences in districts with Ginis above 0.025 but below 0.050 are too substantial to consider equitable (The total estimated effect on average sized schools is $129,000 per Table 7, or enough to fund almost three additional FTE teachers at average salaries.). Thus, Odden and Picus's (2004) 0.05 Gini benchmark is too generous an equity standard for this study. While the two benchmarks used here are functional for this study, they do not follow an established rationale. A comprehensive framework for setting such benchmarks would be useful. Scholars should ground theoretical work on equity standards in methodological work that examines the distribution of the resource under study and base benchmarks in a rationale that can apply to varied resource objects.

The fact that the distribution of teacher qualifications drives TCE inequities has obvious policy implications for the distribution of district funds. However, examining TCE equity in isolation will prevent us from understanding the full extent of resource inequities. This dissertation research adds TCE to the list of resources that divide schools between the "haves" and "have nots." Unfortunately, there is a possibility that to some degree, teacher quality may be similarly distributed. Researchers still need to examine the connection between the distributions of TCE dollars and teacher quality. As discussed earlier, research suggests that high-need schools may have below-average teacher quality. If it were true that the same kinds of schools that receive less than their share of district

TCE also tend to have below-average teacher quality, the policy importance of both distributions would be greater than if these distributions were unrelated. Specifically regarding compensatory teacher allocations, the tradeoff between teacher quantity and quality is relevant as well. Some evidence suggests that additional teachers may not be as effective at educating students as higher-quality teachers (Clotfelter, Ladd & Vigdor, 2007). If the unattractive aspects of high-need schools that push higher paid teachers away also push more effective teachers away then compensatory allocations of positions might not only be diluted in terms of TCE, but also in terms of effectiveness or capacity or both. Research on teacher quality is still under development, but as measures of teacher effectiveness improve, researchers should examine the overlap in the distributions of teacher pay, compensatory allocations and teacher quality.

Taken together, the implications of this research are substantial. Intradistrict TCE equity is a longstanding problem in US public schools that deserves attention from policymakers and the education research community. It is my hope that the contributions of this study will spur additional research and effective policies to improve resource equity, especially for the most disadvantaged schools and students.

Limitations of this Dissertation Study

While this dissertation study provides additional empirical evidence on the intradistrict distribution of TCE, readers should consider several limitations when interpreting these findings. Limitations include limited representation, potential bias in the estimation of *de facto* allocation weights, omitted school-level measures, capturing causality regarding teacher sorting, and an inability to assess either overall resource distributions or the educational productivity associated with the distribution of resources across schools.

Limited representation. While the data used in this dissertation substantially expands the empirical evidence on the intradistrict distribution of TCE, they are only representative of districts in states that are included in the analyses. For those states that are included in the analyses, these data are a full representation of the intradistrict distribution of teacher compensation, conditional on the quality of the state administrative records gathered in the TCS.

Potential bias in the estimation of *de facto* allocation weights. A second limitation involves the validity of the measures of teacher compensation, particularly the validity of the TCE_{PPW} measure. The TCE_{FTE} and TCE_{PP} measures are likely very accurate measures as they are drawn from administrative records; however, the derived *de facto* district allocation weights rest on two assumptions that may introduce some error into the TCE_{PPW} measure. The first relevant assumption is that the regressions used to derive the teacher-allocation weights include all the measures that relate to district teacher-allocation practices. There are certainly districts that include factors in their teacher-allocation formulae that these relatively simple regressions do not capture. In defense of my weighting strategy, I based the regressions in the available literature on district resource-allocation practices, and I use the regressions to calculate *de facto* district-average teacher-allocation weights. I do not use regressions to specify district practices or recreate actual allocation formulae. These *de facto* weights can identify school staffing variations that differ from the district mean. However, to the degree that relevant measures are missing, these omissions may introduce measurement error to the regression estimates, and the measures of TCE_{PPW} that rest upon them.

The second relevant assumption is that I can reliably calculate *de facto* weights for all included districts. I have included business checks which remove districts whose estimates produce implausible values (e.g., special education weights greater than 5 times the district base weight) and districts where the variance explained by the regression models falls below 90% (R-squared must be greater than 0.9). Despite these checks, estimating *de facto* weights with such small sample sizes includes a risk that the weights will include some bias. While the 90% R-squared criterion for including districts should minimize the likelihood of including data with errors, a potential for bias remains especially in small districts.

While some measurement error is unavoidable, I do not consider this a fundamental weakness in the current analyses for two related reasons, one that is methodological and one that is normative. First, for the majority of districts the *de facto* weights include the predominant policy levers associated with vertical equity adjustments. Thus, this method is consistent with all but marginally influential district policies and practices. Simply, this method captures the compensatory needs that make the largest differences in teacher allocations. While the first reason potential measurement error is not a fundamental weakness is based on a methodological concern, the second is based on a normative concern. That is, this weighting technique captures the compensatory differences that vertical equity adjustments are most concerned with from a normative perspective, specifically poverty, English proficiency and disability status. Capturing the average district teacher allocations associated with gifted students or students in vocational programs may improve the *de facto* weights in a few districts, but this technique functionally captures the primary categories of student disadvantage.

Simply, this weighting method captures the most important differences between students that are widely reflected in education policy and practice. Any weighting method for capturing district policies across such a wide range of districts is bound to include some measurement error; however, from both methodological and normative perspectives, this weighting approach captures the majority of the differences with which policymakers and researchers are concerned.

Omitted school-level measures. Just as the validity of the *de facto* allocation weights are contingent on the inclusion of the appropriate variables, the district Gini coefficient regressions and the HLM models are dependent on proper specification and inclusion of all relevant variables. Measures of all potentially important constructs are not available in these data. For instance, district use of seniority privileges and LIFO policies that may strongly relate to TCE differentials and the total TCE variation within districts are not available measures at the district level. The omissions of some measures that influence the distribution of TCE are unavoidable limitations to this study.

Causality and teacher sorting. This dissertation research includes a number of findings that associate teacher preferences and teacher sorting with TCE variation, but it cannot establish the causality of these associations. This study incorporates variables in blocked models and multiple measures of TCE to evaluate the association between TCE variation and school measures related to teacher sorting. However, these data are not capable of closing a causal loop between teacher sorting and TCE variation. Previous literature provides a theoretical basis for including school characteristics associated with teacher sorting and the findings in this dissertation are quite consistent with that literature. However, this study can neither confirm nor refute whether the latter drives the former.

Assessing overall resource distribution. Another conceptual limitation is that I cannot draw inferences about overall resource equity from this study with certainty. The literature reviewed for this study identifies no commonplace district-allocation mechanism that allocates non-teacher resources to make substantial intradistrict TCE differentials equitable, but formal or informal allocation mechanisms may function this way. Since the outcome measures used in this dissertation cannot account for the full value of resources that schools receive, the reader should interpret any equity implications as specific only to TCE differentials. Notably, the current analyses do not include data on the distribution of instructional aides across schools, which may be a significant limitation for this study. Instructional aides are expensive inputs that could account for a large portion of the TCE_{PPW} gaps between schools, and the inequity measured by the district Gini coefficients. Put simply, district officials may allocate instructional aides to balance spending differences made by TCE differentials. Still, the literature on district allocation does not document instances where districts do allocate aides to balance TCE differences but as part of base allocations or compensatory programs. Without such documented instances, it is reasonable to surmise that districts do not systematically allocate aides to balance TCE differentials, especially differentials as large as previous literature and current findings reveal. Nonetheless, the reader should consider the results of these analyses with this limitation in mind.

Educational productivity and the distribution of resources. Finally, while this study addresses resource input equity from a monetary basis, it does not directly address the productive capacity of those resources. Neither the intradistrict distribution of teacher quality nor the aggregate productive capacity of schools strongly associates with teacher compensation. Previous research suggests a positive correlation between the distribution of teacher compensation and teacher quality at the school level, but this dissertation provides no evidence regarding this relationship. Further, some evidence suggests that teacher quantity/quality trade-offs may not result in equivalent productive capacities, but the per-pupil TCE measures used in this study would equate teacher quantity and teacher salary trade-offs on a dollar-for-dollar basis. Given that the primary concern for equity in schooling hinges on student outcomes rather than system inputs, the importance of variations in TCE is a debatable topic.

Future research should seek to overcome the limitations in this study as we continue to examine these issues and promote resource equity. However, despite its limitations, this dissertation provides valuable and, to date, unequaled empirical evidence on a broad scale to measure intradistrict distribution of TCE. The study takes advantage of a richer and more detailed database than those used by earlier scholars, in order to isolate school TCE differentials beneath the district averages.

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