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Competition's Effect on Teacher Pay and Teacher Characteristics

Casey S. Brasher
University of Kentucky, casey.brasher@uky.edu

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Casey S. Brasher, Student

Dr. John E. Garen, Major Professor

Dr. Jenny A. Minier, Director of Graduate Studies

COMPETITION'S EFFECT ON TEACHER PAY AND TEACHER CHARACTERISTICS

Dissertation

A dissertation submitted in partial fulfillment of the
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Casey S. Brasher

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Director: Dr. John E. Garen, BB&T Professor of Economics

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Abstract of Dissertation

COMPETITION'S EFFECT ON TEACHER PAY AND TEACHER CHARACTERISTICS

This dissertation adds to the literature that examines the effect of competition and school choice reform in elementary and secondary education. Specifically, we explore how three major forms of competition in U.S. schooling markets in Tiebout competition, charter competition, and private school competition affect the teaching profession by estimating a teacher wage equation and series of teacher characteristic equations. Since it has been well-established that all 3 forms of competition are likely endogenous, we present 2SLS estimates of competition's effect in addition to simple OLS estimates. Our findings confirm the importance of studies controlling for endogeneity concerns, particularly in regards to teacher earnings. In nearly all instances, OLS yields estimates of the effects of competition on wages that are biased toward zero for each of the three measures.

Additional findings suggest that policies aimed at promoting competition and choice-based reforms might well benefit traditional public school (TPS) teachers through higher pay, while competition would likely have little significant effect on earnings for charter teachers. In particular, we find TPS teachers working in MSAs with the average Tiebout competition receive a pay boost of almost 16.8%, while a 10-percent increase in charter competition corresponds to a nearly 20% rise in teacher pay for TPS teachers. While competition might benefit teachers through higher pay, it is unclear as to whether competition would change the type of teachers schools attract. Few systematic results emerge when exploring teacher characteristics. Some of the more interesting results include Tiebout competition raising the prevalence of TPS teachers having a Bachelor's in math, and charter competition reducing the incidence of state certification and unionization among TPS teachers. Finally, although competition appears to have few significant effects on charter teachers, substantial differences in pay and characteristics among charter teachers and TPS teachers exist. We document these differences.

KEYWORDS: Teacher Pay, Competition, Charter Schools, School Choice, Incentives

Casey S. Brasher

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Date

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By

Casey S. Brasher

Dr. John E. Garen
Director of Dissertation

Dr. Jenny A. Minier
Director of Graduate Studies

August 03, 2015
Date

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1 Introduction

Over the last decade or more, school accountability legislation like No Child Left Behind, and its spinoff, the Elementary and Secondary Education Act, has spurred on nearly every state and hundreds of districts throughout the 50 U.S. states to experiment with education reforms aimed at improving school quality. Particularly popular have been those reforms that seek to make the market for elementary and secondary education more competitive by giving parents more control over their children's education. These reforms are often referred to as school choice programs. Examples include school voucher programs in which students in underperforming schools are given a voucher to attend private schools, inter-district choice programs in which students, at no cost, can attend schools outside their own district in an effort to better meet the individual student's educational needs, and charter schools, which are public schools that provide a free, performance-based alternative to traditional public schools and private schools.

The central argument behind school choice programs and other competition-based reforms is that competition creates market-like incentives which force inefficient schools to improve school quality or be forced to close. This has led researchers to produce a considerable volume of literature on the potential effectiveness of competition in improving school quality, often measured by outcomes such as the test score performance of students, student retention and dropout, and post-school wages. However, relatively few studies look at competition's effect on what is one of the most important inputs in determining these outcomes—teachers. This paper seeks to fill this void by systematically analyzing the effect of various forms of competition on the organization of teaching jobs in public schools. Specifically, we examine the effect of Tiebout

competition, charter competition, and private school competition on the wages paid to teachers, as well as on the particular characteristics, skills, and attributes that teachers accumulate. We further analyze the effect of competition by exploring whether competition has different effects on teachers according to the school-setting in which teachers work, charter school or traditional public school (TPS). Finally, this paper provides evidence on differences in pay and characteristics among teachers working in public schools with varying incentive structures and organizational goals by comparing pay and characteristics of teachers working in charter schools to teachers working in TPSs.

Finding presented in this dissertation are largely consistent with other studies exploring competition's effect on the teaching profession, particularly in regards to pay.[1] We find that failing to eliminate endogeneity concerns often discussed in the literature lead to substantially biased OLS estimates. Therefore, we employ a 2SLS regression methodology to identify the impacts of Tiebout competition, charter competition, and private school competition. Our findings suggest competition to be associated with higher teacher pay, especially for TPS teachers. TPS teachers working in MSAs with the average amount of Tiebout competition see pay rise by a shade below 17%, while a ten-percent rise in the MSA charter enrollment share corresponds to roughly a 19.5% increase in wages. Additionally, Tiebout competition and charter competition appear to have little significant effect in regards to pay for charter teachers, and private school competition does not have a statistical impact on earnings for either TPS teachers or charter teachers. Finally, few systematic effects of competition on teacher characteristics exist. Some of the more interesting results of competition's effect on characteristics

[1] Hoxby (2002), Taylor (2010), and Jackson (2011) all find competition leads to higher pay.

include charter competition reducing the probability of unionization and state certification among TPS teachers, and Tiebout competition raising the prevalence of TPS teachers having a degree in Math.

The remainder of this paper proceeds as follows. Chapter 2 begins by reviewing the literature on teacher pay in U.S. public schools, followed by an examination of some of the more popular education reforms, and closes with a discussion of the effect of these education reforms on student achievement and teacher pay. Chapter 3 outlines the empirical strategy used to identify the effect of competition. Chapter 4 describes the data. Chapter 5 presents wage equation results, while Chapter 6 discusses characteristic equation results. Lastly, Chapter 7 concludes.

2 Literature

2.1 Teacher Pay in Traditional Public Schools

Changes in the way traditional public schools (TPSs) have compensated teachers have been few and far between. In fact, from the 1800's through more modern times, only three models of pay have pre-dominantly been used by schools and school district to compensate teachers.[2] These include the initial room and board model of pay, followed by a grade-based compensation system, and finally a change to the current single salary schedule. This chapter reviews the history of pay in U.S. public schools, beginning in the 1800's and continuing on through current pay schemes.

2.1.1 Room and Board Compensation

For most of the 1800's, public education in the U.S. was provided in a one-room schoolhouse setting. This largely reflected the fact that the majority of Americans lived in rural areas, and over half of all U.S. workers were farm workers (Prostik, 1995). Schools thus established policies that reflected the needs of a largely agricultural-based society, which often included child labor in crop production. Because child labor was vital to crop production, few children attended school all year and rural schools typically had a fewer number of school days than did city schools. Additionally, the school year was divided into two or more shortened sessions, often a winter and summer term, to facilitate crop production.

Teaching in the 1800's was generally not viewed as a profession and few individuals made a career out of teaching. Instead, teaching served as a supplementary income source to farming for men, while it served as a transition into marriage for

[2] Other pay systems have been tried, such as career ladders, but none have received widespread acceptance and use. This chapter reviews those pay models that are common to most TPSs.

women (Odden, 1995). In addition, few professional standards existed. Teachers often had little more than an elementary education and lacked formal training in educational methods. Teacher qualifications instead focused on basic knowledge of reading, writing, and arithmetic, and communities placed a high value on teachers possessing a sound moral character and middle-class appearance (Prostik, 1995). Finally, teachers were by-and-large local to the community in which they taught.

Out of this environment came the room and board model of pay. Although teachers received a small weekly stipend, the main component of a teacher's compensation was room and board in the homes of their students on a week-to-week, rotating basis. This model fit well with the nature of education in the 1800's. In particular, it allowed communities to directly monitor teachers to ensure they were of high moral character, which was considered to be of primary importance, and, in the absence of professional standards, the ability to closely monitor its teachers allowed communities to hold teachers accountable for performance.

Despite its advantages, the room and board model of teacher pay created considerable instability within the teaching ranks. While teaching often lost women teachers to marriage, men could usually find better paying job opportunities outside teaching. Additionally, moving from home–to-home on a weekly basis tended to be quite cumbersome, and many individuals, particularly men, sought alternative job opportunities because of the amount of scrutiny placed on the personal life of teachers. Ultimately, room and board pay faded as changes in the U.S. economy brought about changes in the educational landscape.

2.1.2 Grade-Based Pay

In the late 1800's and early 1900's, America began transitioning from an agricultural-based society to a more urban and industrialized nation as a result of the industrial revolution. This movement drastically changed the way education was perceived as the demand for more skilled and educated workers intensified with the new industrial-based economy. In addition, as states began outlawing child labor in factories and the farming industry declined, more and more children became attending school on a regular basis and for longer and more sustained periods of time.

With the changing economy came significant school reform. In particular, the one-room schoolhouse of the early 1800's diminished in favor of grade-based schools, separated by age and ability, as thousands of independent rural schools merged to form large public school districts under the ideology that larger state school systems with a common governance would produce more efficient schools (Prostik, 1995). States also began to raise requirements for becoming a teacher as laws were enacted requiring teachers to have more formal education and become certified to teach. These new standards led to a dramatic increase in the cost of entering teaching. In addition, white males typically filled higher-paying administrative positions created by these newly formed school systems, or exited the teaching profession altogether as they could earn a higher alternative wage outside teaching. As a consequence, the teaching ranks consisted mostly of women and minority teachers.

The establishment of grade-based schools, along with the prohibitively high cost of entering teaching, led to drastic changes in teacher pay. Many states began establishing minimum salary levels to reduce high turnover rates, and salary schedules

became commonplace in large, urban cities. Ultimately emerging was a grade-based model of teacher compensation, which paid teachers a cash salary according to grade-level taught. Secondary grade teachers typically received higher pay compared to their elementary grade counterparts under this model, which partly reflected the notion that elementary grade students were easier to educate than secondary grade students, but also reflected the higher alternative wage secondary grade teachers could earn outside teaching and the higher costs associated with obtaining more years of formal classroom education. Finally, largely as a by-product of societal norms, women and minority teachers received wages far below that of their white male counterpart (Prostik, 1995, Odden 1995).

Grade-based models of teacher pay were successful in helping contribute to the professionalization of teaching by requiring teachers to acquire more formal education, mandating teachers earn a teaching certificate or teachers' license, and equalizing teacher pay across schools by grade-level taught within cities. However, women and minority teachers typically received pay below that of white male teachers, and elementary grade teachers were paid less compared to secondary grade teachers. Moreover, higher-paying administrative positions in schools and school districts were generally reserved for white males. Differences in pay, particularly among women and minorities, ultimately led to a call for equal pay for work in public schools.

2.1.3 The Single Salary Schedule

In the early 1900's, teachers' organizations began advocating for equal pay practices in TPSs. Major contributors to this movement were teachers' organizations such as the Chicago Teachers' Federation (CTF), which lobbied the city of Chicago on

behalf of female teachers for more equitable teacher salaries and better working conditions, and the Interborough Association of Women Teachers (LAWT), which successfully lobbied the state of New York for legislation requiring all teachers receive equal pay for equal work (Prostik, 1995).

The push by teachers' organizations to eliminate inequalities in teacher pay ultimately led schools to adopt the single salary schedule. First introduced in Des Moines, Iowa and Denver, Colorado in the 1920's, the single salary schedule used two lone criteria, years of teaching experience and education attainment, to determine the annual base salary of teachers. Though total compensation sometimes varied, if, for instance, extra pay was awarded for overseeing an extracurricular activity or teaching summer school, teachers working in the same school district generally received equal pay according to a formula set forth by their district's single salary schedule and determined by their experience/education combination. By 1950, some form of the single salary schedule was in use in approximately 97% of all public schools (Prostik 1995), and the single salary schedule has continued to be the dominant method of pay more than 90 years after first being introduced.[3]

The single salary schedule revolutionized compensation policies in public schools. For the first time, factors such as age, race, gender, grade-level, nor subjective assessment played a role in the way schools compensated teachers. Schools instead began using objective criteria, largely experience and education, to set pay. Despite succeeding in eliminating discriminatory pay practices, the single salary schedule has been subject to several sharp criticisms over the years however. Perhaps most prominent

[3] According to Podgursky and Springer (2007), about 95% of all public schools still use single salary schedule.

being equal pay for teachers despite unequal performance, ability, and skill among teachers. Additionally, experience and education, the primary determinants of teacher compensation, have been found to have little or no correlation with the academic performance of students (Hanushek, 2003, Lavy, 2009). Finally, U.S. students have continually been outperformed by international students on achievement exams in math and science, leading to growing concern over the quality of public schools. Not surprisingly, teachers often receive the lion's share of blame for poor student outcomes, especially since the current salary structure does not provide TPSs the flexibility to adjust pay to compete with other, often more lucrative, professions for high ability teachers. Indeed, Hoxby and Leigh (2004) find greater pay opportunities outside teaching, and, in particular, reduced earnings potential within teaching have led high ability women to migrate out of teaching since 1960. These types of concerns have led schools to try a variety of education reforms. Some reforms attempt to make teacher pay more professionally competitive, while other reforms attempt to make the education marketplace more competitive. All reforms are intended to improve school quality.

2.2 Teacher Incentive Programs

Some of the most popular reforms in education have been those that institute some type of incentive pay, with a common theme being to tie teacher pay to the academic performance of students. These reforms, commonly referred to as teacher incentive programs, are designed to more directly link pay to performance, with the idea being to reward better teachers for better performance. Teachers, or groups of teachers, meeting the performance target receive bonus pay in addition to their predetermined academic year base salary. Those failing to trigger the performance incentive generally

only receive their annual base salary. Teacher incentive programs thus differ from traditional pay schemes, like the single salary schedule, by rewarding teachers with higher pay for superior classroom performance.

Teacher incentive programs have long been suggested as a way for schools to enhance quality.[4] Proponents often contend benefits occur primarily in one of the following ways. First, and most commonly argued, is that the opportunity to receive higher pay motivates existing teachers to supply more effort to the classroom. The second is that higher earnings opportunities attracts higher quality teachers to the profession since teachers would be able to earn relatively more under teacher incentive programs than they otherwise would have been able to under uniform pay schemes like the single salary schedule. Finally, low quality teachers may be forced out of teaching altogether if they are unable to meet minimum performance standards, and, as a result, are subject to reprimands such as being let go from teaching or a reduction in pay for poor performance. Therefore, supporters of teacher incentive pay programs believe that the net effect of such programs would be an increase in overall school quality, either through an increase in effort on the part of existing teachers or increases in the underlying quality of teachers in schools.

Teacher performance and school quality in general is commonly measured by the test score performance of students, although it is sometimes measured by an alternative outcome, such as graduation rates or GPA. In addition, a variety of teacher incentive programs have been tried, including individual incentive programs, rank-order tournaments, group incentives, and school-wide incentives. Studies evaluating the

[4] For example, a highly critical report on the state of public schools, *A Nation at Risk (1983)*, recommended teacher performance incentives to reform the single salary schedule.

effectiveness of teacher incentive programs have used a number of different econometric methods, and several studies find a positive relationship between incentive programs and school quality.

Figlio and Kenny (2007) provide one of the few studies on individual teacher incentives and school quality. Specifically, they look at the impact of individual teacher incentives on aggregate student test scores using student-level data from the National Education Longitudinal Study of 1988 (NELS:88) matched to their own private survey on the use of teacher incentives in schools sampled in the NELS:88. From the data they collect, they devise three measures of the strength of teacher incentives in NELS:88 schools, ranging from low to medium to high. Figlio and Kenny include each measure separately in a series of achievement equations to estimate the effect of incentive strength on cumulative test score performance of students. They find, for all measures of incentive strength, test scores are higher in schools that reward teachers for test score performance. On average, having any performance incentive raised student test scores by between 1.3 to 2.1 points, a magnitude they conclude is comparable to an increase of about 3 years in maternal education.

Despite Figlio and Kenny finding individual teacher performance incentives to be associated with higher academic performance, several issues may confound these results and warrant mention. Particularly troublesome is that the authors cannot rule out unobserved schools quality as the driving force behind finding an incentive effect, especially since incentives and unobserved school quality are likely to be positively correlated. In other words, schools with better achievement scores could also be the schools likely to institute policies like incentive programs, implying OLS estimates

would be biased toward finding an incentive effect. Also of concern to their analysis is the timing between the last wave of the NELS:88, their source of student achievement data, and their own survey on teacher compensation practices in NELS:88 schools. Specifically, an 8-year lag exists between the two, calling into question whether the incentive program had actually been in effect at the time the NELS:88 was conducted. Despite these concerns, Figlio and Kenny provide valuable insight into the potential benefit of teacher incentives.

Eberts, Hollenbeck, and Stone (2002) evaluate an incentive program designed to improve student retention in an alternative Michigan high school. The incentive program awarded teachers bonus pay for meeting the following two performance targets. First, a retention bonus of up to 12.5% of annual base pay was given to teachers having a large enough percentage of their students remaining enrolled at the end of the quarter. A second bonus was given to teachers receiving a high rating on student evaluations for four successive quarters. Teachers triggering the second incentive received a bonus equal to 5% of annual base pay and the retention bonus increased an additional 10%. Bonuses awarded were nontrivial in size, with the average beginning teacher with a bachelor's degree receiving a $5000 annual pay bump for meeting both performance targets. The author's employ a difference-in-difference (DID) approach that compared outcomes in the alternative school with the incentive program to a similar high school using a traditional pay scheme. They find, consistent with the program's goal, retention rates increased following implementation of the incentive program in the alternative school; however, other desired outcomes, including GPA and the pass rate of students remaining enrolled at the end of the quarter, were lower in the incentive school relative to the school

with traditional pay. Eberts, Hollenbeck, and Stone conclude that the program was successful insofar as it was originally intended to boost student retention. However, they also find negative outcomes on other achievement measures, potentially suggestive that teachers may have altered their teaching in ways that adversely affected achievement in an effort to game the system and obtain the performance award.[5]

Ladd (1999) studies the impact of a district-wide incentive program implemented in the Dallas independent school district. The program, running from 1991-92 through 1995-96, was designed as a rank-order tournament whereby district schools were ranked and ordered according to student test score gains. Top performing schools received a reward of $2000 toward school-related activities and teachers in winning schools were given a $1000 bonus. Using panel data on schools in several large Texas cities, Ladd estimates the Dallas program's effect on student test scores in math and science by regressing pass rates on the set of interaction terms between an indicator variable representing Dallas district schools and dummy variables for each year the program was in effect, including the year the program was implemented. Ladd's findings suggest, relative to other schools in large Texas cities, pass rates rose in Dallas schools, at least initially. However, given pass rates increased sharply the year of implementation—before the program took effect—the size and duration of the Dallas program's impact on student test score performance is questionable. At best, the program resulted in large gains in both math and reading test scores, and, at worst, test score improvements were slight and faded out shortly after implementation.

[5] A large literature examines distortions induced by incentive programs. Chapter 2.3 discusses this literature.

In a particularly rigorous study, Lavy (2009) evaluates an individual teacher incentive program targeted at underperforming schools in Israel. Teachers participating in the incentive program were ranked and ordered according to value-added measures of their students' performance on several matriculation exams. Top-performing teachers were divided into four groups, with each group receiving a bonus that ranged from $7,500 for the top group to $1,750 for the bottom group. Several identification strategies are implemented to determine the program's effect on achievement. In particular, measurement error in the assignment of schools to receive the incentive program gives rise to a quasi-natural experiment whereby Lavy is able to match a group of schools erroneously assigned to program status to a control group of schools that did not receive the teacher incentive program. For both the math and English matriculation exams, Lavy reports difference-in-difference estimates that indicate the take-up rate, pass rate, and average score increased in incentive schools relative to the control group of schools. Further analysis suggests these gains were the result of greater teacher effort, rather than dysfunctional behaviors that distort student achievement. Finally, teacher attributes, including age, gender, education, experience, and teaching certification, are found to be uncorrelated with teacher rankings, suggesting these attributes do not reflect teacher effectiveness.

In another study, Lavy (2002) evaluates a school-wide incentive program in Israeli schools. The program rewarded the top one-third of all schools with a cash bonus based on value-added gains in student achievement among schools. All teachers in winning schools received a bonus proportional to their income, with the largest bonus per teacher equaling almost $1,000 and the smallest $250. Lavy employs a regression

discontinuity design to estimate the program's effect on several student outcomes. The regression discontinuity is based on a threshold point that determined a school's eligibility for receiving the program. Specifically, a school was eligible for the program if it was the only one of its type in a community and a comprehensive school. Therefore, Lavy argues that the group of comprehensive schools in communities with only two schools makes for a good comparison group since they are likely to be similar in other observed and unobserved ways, except that they did not receive the program. Relative to the comparison group of schools, Lavy finds student test scores and participation rates increased in program schools, but the proportion of students entitled to a matriculation certificate was not statistically different from zero. Finally, a similar sized school resources program that endowed schools with additional inputs, such as teaching time, was administered concurrently with the school-wide teacher incentive program. For the resources program, Lavy also reports gains in student outcomes across several dimensions; however, the incentive program was determined to be a more cost-effective alternative.

In a randomized study, Glewwe, Ilias, and Kremmer (2003) evaluate a teacher incentive program in rural Kenyan schools. Prizes were awarded on the basis of overall school performance on several districts exams, administered in grades four to eight, with top-performing schools receiving a cash bonus between 21% and 43% of a teacher's monthly pay. Using a difference-in-difference approach, Glewwe, Ilias, and Kremmer find test scores were significantly higher in schools receiving the incentive program relative to schools not receiving the program for the shortened duration of the program. In addition, conditional on being enrolled, the test-taking rate of students increased in

incentive schools despite no difference in dropout rates between incentive schools and other schools. Upon dissolution of the program, test score gains did not persist. Glewwe et al. conclude that teachers responded to the incentive program in ways that boosted short-term results rather than encouraging long-term learning.[6]

Muralidharan and Sundararaman (2008) evaluate an experimental teacher incentive program in India. Schools selected to participate in the study were randomly assigned to one of four program groups, or alternatively a control group. All four program groups were endowed with a similar-size program, with two of the four groups receiving a teacher incentive program and the remaining two program groups receiving a resources program that awarded schools extra inputs. In addition, the teacher incentive program was targeted at individual teachers for one of the two experimental groups, while school-wide teacher incentives were used for the other group. For both teacher incentive programs, awards were tied to gains in student test scores, and the award averaged approximately 4-5% for each program. The analysis by Muralidharan and Sundararaman shows that student test scores in schools with any type of teacher incentive program (school-wide or individual) to be associated with higher test scores relative to a control group of schools. Point estimates also suggest that individual teacher incentive program had a slightly larger impact on test score gains than did the school-wide teacher incentive program, though the difference was not statistically significant. Finally, the authors find the school resources programs also improved student test scores, though the

[6] To this point, Glewe et al. (2003) find teacher attendance did not improve and the incidence of homework assignment did not change in program schools, while, at the same time, program schools encouraged students participation and increased test-taking preparation activities.

magnitude of the effect was not as large as that for either the individual teacher or school-wide incentive program.[7]

Finally, Atkinson et al. (2004) assess a teacher incentives program in U.K. schools. The program supplemented an existing pay scheme that paid teachers uniform salaries based only on experience and qualifications. Teachers eligible for the program received an annual bonus of 2000 pounds and advanced to a higher pay gradient on the uniform pay scale. Teachers became eligible only after demonstrating proficiency in five teaching areas. Atkinson et al. find mixed results regarding the program's effect. Difference-in-difference (DID) estimates show value-added science scores rose for program teachers compared to teacher not eligible for the program. However, math performance actually declined for students of program eligible teachers. Looking at cumulative exam scores, no significant differences were found. Concerned that teachers' experience-effectiveness profile may bias their DID estimates toward zero, Atkinson et al. turn to an achievement equation that includes a dummy variables for novice teacher. For their preferred specification, cumulative test score increased by a slight 0.5 points per student for students of program eligible teachers. Despite the underwhelming evidence in favor of the program, it should be noted program eligibility was a function of past performance and not present performance of teachers.

2.3 Nature of Teaching Hypothesis

Teacher incentive programs are ultimately designed to improve school quality, with the underlying premise being that teachers respond to performance incentives in positive ways. This notion is seemingly bolstered by a number of studies finding

[7] As with Lavy (2002), Muralidharan and Sundararaman (2008) find teacher incentive programs to be more cost-effective than a similar-sized school resource program.

generally positive effects of teacher incentive programs, at least insofar as these programs help schools achieve the objective for which the program was originally intended. Despite mounting evidence on the benefits, a relatively small number of incentive programs have been implemented and remain active in U.S. schools, and previous attempts at establishing merit-style or performance-based incentive schemes have been met with widespread failure and considerable skepticism.

The lack of teacher incentive programs in public schools has been a source of debate among researchers for quite some time. Ballou (2001), among others, suggests the opposition of teachers' unions is largely responsible since merit-style incentive schemes play a much larger role in teacher salaries the lesser the degree of influence teachers' unions have over public school districts.[8] On the other hand, Murnane and Cohen (1986), drawing heavily on the personnel economics literature to highlight a number of important concerns, argue that it is the type of work teachers do on a daily basis that make performance-based pay programs impracticable for use in public schools. Goldhaber (2005), as well as Podgursky and Springer (2007), have coined this the "Nature of Teaching" hypothesis.

Perhaps the most well-known and highly publicized "Nature of Teaching" problem is the multitasking problem highlighted by Holmstrom and Milgrom (1991). The complexity and multidimensionality of teachers' job, which can range from a variety of things such as imparting basic reading, writing, and math skills to promoting a drug-free environment to teaching creative thinking skills, makes accurately measuring what

[8] Ballou (2001) specifically finds that merit pay plans survive longer in districts that do not engage in collective bargaining or confer with a union, and the size of the merit award is larger the lesser the role unions play in school districts.

teachers do hard.[9] Moreover, to the extent multiple goals compete for the time and attention of teachers and for school resources, some objectives may go largely ignored in favor of other objectives. This is considered to be especially true if performance awards are tied to objectives that are, by necessity, easily observable and other important but hard to measure objectives are substitutes in the education production process. In this case, theory predicts teachers neglect objectives not explicitly rewarded to focus on objectives rewarded with higher pay.[10]

A second "Nature of Teaching" issue is team production. To a considerable extent, teams of teachers are responsible for student performance, making it difficult to measure the value of an individual teacher's contribution to student or school performance. Introducing performance incentives may create many unintended consequences among teachers within schools, including a breakdown in cooperation and communication between teachers. This could unintentionally harm student outcomes rather than benefit schools in achieving the desired goals of the program. Moreover, even school-wide performance incentives do not guarantee cooperation. Freeridership may encourage distortions in effort since the performance award to individual teachers is a function of the group performance, with each teacher typically receiving an equal share of the performance award regardless of individual effort.

A final "Nature of Teaching" issue Murnane and Cohen (1986) mention is the problem of performance evaluations. Incentive programs often try to measure teacher performance using some observable measure of their students' performance. Often times this is just the test score performance of students on a standardized exam. Other

[9] For a list of the various public school objectives, see Dixit (2002).
[10] This assumes tasks are substitutes in production. In the event tasks are compliments in production, rewarding a particular task also increases attention and effort on related tasks.

times, administrator evaluations or peer review may be the basis for rewards for good performance or sanctions for poor performance. Each comes with its own set of problems.

It is often believed standardized test scores are poor measures because they do not accurately capture teachers' contribution to student learning. Test scores are not only a function of current teachers and the things that they do that impact student learning, but also the effort of many previous teachers and these teachers' contribution to learning, as well as the underlying ability of students. This potentially suggests that some teachers' or schools' success or failure is random from year-to-year and based on the "luck of the draw" as determined by the ability of students, and not necessarily because of superior classroom performance or poor classroom performance. To alleviate these concerns, value-added test scores have been suggested as an alternative to test score levels. Value-added measures are intended to capture changes in exam performance and measure a teacher's true contribution by netting out mitigating factors, such as innate ability, demographics and socioeconomic influences, and per-pupil spending, which can all influence students' exam performance. To the extent more sophisticated value-added measures can be designed to accurately and robustly capture teacher performance, linking pay to performance may not be as problematic as it once was.

Merit-style programs are a type of incentive program that uses supervisor evaluation, and sometimes peer review, to evaluate performance and reward teachers for superior classroom performance. Murnane and Cohen (1986) argue merit evaluations fail because supervisors cannot specifically provide answers as to why teachers do not receive the performance award and what teachers' must do in order to achieve the award

in the future. As a result, they conclude merit pay may actually harm students if teachers lose morale over being given a rating below their expectation and exert less classroom effort in response. Ballou and Podgursky (1993), however, find no evidence suggesting this is the case in public schools. They report so long as evaluations are perceived to be fair, merit style pay schemes do not demoralize teachers, even among those not receiving the performance award.

These "Nature of Teaching" issues have led critics to argue incentive programs will encourage an assortment of unintended consequences, including teachers shifting attention away from other important aspects in the educational process and toward aspects with explicit financial rewards; neglect low ability students unlikely to meet minimum levels of performance; manipulate the composition of test-takers to improve exam scores; free-ridership; cheat; and strategically behave in a number of other distortionary ways. A bulk of economics literature documents several unintended consequences associated with performance incentive programs.

Jacob (2005) evaluates a high-stakes accountability program implemented in Chicago Public Schools in 1996-97. The program was designed to raise student performance, with teachers and administrators in low performing schools subject to severe penalties, including firing or reassignment. Using an approach similar to a difference-in-difference estimator, Jacob finds exam performance increased sharply on the high-stakes exam following introduction of the accountability program. However, around the same time, a similar exam was administered that did not punish schools for poor performance. For this low-stakes exam, no similar gains in the exam performance of students were found. This suggests, at least in part, the gains were a result of teachers

focusing on exam-specific skills, though increases in student test taking effort also played a role in exam score gains.

In another study of Chicago Public Schools, Jacob and Levitt (2003) examine teacher cheating in elementary grade schools after implementation of an accountability-based testing program. To detect cheating classrooms, Jacob and Levitt devise an algorithm based on unexpected exam score fluctuations year-to-year and unusual patterns of correlation on student answer strings within classrooms. They then estimate the prevalence of cheating by comparing the actual number of classrooms above a threshold value of correlation between the two indicators of cheating relative to the expected number of classrooms given that threshold. Their identifying assumption is based on the notion that unusually high correlation between the two indicators would likely occur only in instances where a classroom had, in fact, cheated. Using this strategy, Jacob and Levitt find that between 3.5 and 5.6 of all classrooms cheated on at least one subject exam per year from 1993-2000.[11]

Figlio and Winicki (2002), in an unusual study, look at whether Virginia schools altered the nutritional content of their school lunch in an apparent attempt to boost short-term cognitive functioning and improve student test scores. Since 1995, Virginia's Standards of Learning program has held schools accountable for meeting minimum performance levels on a state-mandated exam, with schools failing to meet these minimum levels subject to possible sanctions. Figlio and Winciki find, for schools under the threat of sanctions, caloric intake of students increased on testing days relative to non-testing days, while no similar change in caloric intake occurred in schools not under the threat of sanctions. In addition, schools manipulating the nutritional content of their

[11] This is based on a correlation threshold between the two indicators ranging from the 80^{th}-95^{th} percentile.

school lunch also saw the most improvement in student test scores, suggesting schools facing sanctions for performance may have engaged in strategic behaviors to improve student exam performance.

Several researchers look at the extent to which schools manipulate the composition of test-takers in an effort to inflate test scores. Figlio (2006) explores disparities in the punishments received by student involved in similar infractions based on their expected exam performance on Florida's high-stakes accountability exam the FCAT.[12] The FCAT, which was implemented at the start of the 1996-97 academic year, provided an extra layer of accountability by providing students in underperforming schools the opportunity to transfer to a better school via a voucher program. Figlio uses a difference-in-difference approach whereby he regresses the suspension duration of students on a three-way interaction term between dummy variables for high-stakes testing grade, high or low achiever, and testing window. His findings suggest expected low-achievers receive substantially longer suspensions relative to high achievers involved in similar incidences, and expected low-achievers were roughly 12% more likely to miss the high-stakes exam altogether compared to high-achievers as a result. Thus, it appears schools may have engaged in selective punishment, thereby removing students expected to perform poorly on the FCAT from counting against the cumulative exam performance of schools by missing the exam altogether.

Cullen and Reback (2006) study the relationship between a state-wide accountability program and changes in the composition of exam-takers in Texas schools from 1993-1998. Texas' accountability program, the Texas Assessment of Academic Skills (TAAS), tested students on various subjects in various grades, with extremely poor

[12] FCAT stands for Florida Comprehensive Assessment Test.

performing schools subject to disciplinary measures, including students being allowed to transfer to the school of their choice. Empirically, Cullen and Reback find that the percentage of exemptions increased in schools as the marginal benefit to schools from an increase in exemptions rose. Moreover, it appears most the rise in exemptions resulted from schools' classifying students as special needs or from increased absenteeism, possibly suggesting that schools with the most to gain from improved ratings tried to game exam scores by strategically removing students expected to perform poorly from the test pool either through the classification of students as special needs or encouraging student absenteeism on test days.

Figlio and Getzler (2002) likewise explore the extent to which high-stakes accountability testing led schools to behave strategically by classifying students into test exempt groups. Figlio and Getzler draw on student-level data from six anonymous districts in Florida to explore the ramifications of the implementation of Florida's FCAT in 1996-97. Their findings suggest, after Florida began FCAT, assignment of students to test exempt groups rose sharply, particularly for disabled and special education categories. In addition, high poverty schools were much more likely to reclassify students into test exempt categories, presumably because these schools had the most to gain from improved exam performance.

Ahn (2008) evaluates North Carolina's state-wide accountability program to discern the effects of teacher effort in public schools using data on individual teacher absences. North Carolina's accountability program is unique in that its primary performance mechanism is a cash bonus for teachers in schools producing student test score gains above a performance threshold, with teachers in top performing schools

earning a cash award as large as $1,500. In response to the accountability program, Ahn finds effort, as measured by teacher absences, to be positively associated with the exam score performance of students. Additionally, as the number of teachers within a school increased, so too did the number of days a teacher was absent from school. Given that the North Carolina accountability program employs school-wide rewards for performance, Ahn suggests this is indicative of a free-rider problem in which incentives for performance are weakened in groups.

2.4 School Choice Programs

Another widely popular set of education reforms are school choice programs. School choice programs contrast teacher incentive programs, which attempt to make teacher pay more professionally competitive, by attempting to make the education markets more competitive. In effect, school choice programs enhance competition in education by increasing the number of schooling alternatives available to parents, with the idea being the greater the number of available alternatives the greater the incentive for schools to improve school quality. Examples of school choice programs include vouchers for private schools, magnet schools, charter schools,, inter-district choice programs, and intra-district choice programs, among others. All choice programs extend traditional public school choice—that arising from parents' residential decision among local school districts—inter-district competition.[13]

2.4.1 Tiebout Competition

Competition in elementary and secondary education has been modeled in an assortment of ways. Several studies build on a conceptual framework similar to that developed by Brennan and Buchanan (1980), which portrays governmental bureaucrats

[13] This type of competition is commonly referred to as Tiebout competition.

as having a self-interested, big government agenda that can be mitigated, at least in part, by competition among local governments. Tiebout (1956) likewise perceived the potential benefits of competition, suggesting that the residential decision of households, when there exists a sufficiently large number of varying communities, can lead to the efficient sorting of households through preference revelation.[14] Studies drawing on these theoretical frameworks usually equate school district to local governments, with the idea being that the more school district fragmentation in a particular area, such as a county or metropolitan area, the stronger are the competitive forces at play. The basic assumption underlying these types of models is that parents explicitly value the quality of their children's education and can "vote with their feet" if their current district does not provided the desired quality of education. Therefore, the greater the school district fragmentation in an education market, the lower the cost to parents of exercising some form of choice.

Empirically, the impact of inter-district competition is unclear, at least in terms of its effect on student achievement. Hoxby (2000) is one of few researchers to examine inter-district competition and student achievement, while also attempting to correct for the likely endogeneity of observed market concentration measures based on district enrollment Confining her analysis to MSAs, Hoxby constructs an MSA-level Herfindahl index designed to capture the amount of inter-district competition among MSAs. However, because parents are likely to switch from unproductive districts to productive districts, the index of inter-district competition is probably endogenous to observed school performance. Hoxby thus instruments for inter-district competition using the count of MSA large rivers and small streams, arguing that large rivers and small streams

[14] Obviously Tiebout was referring to the provision of public expenditures and residences self-sorting.

are credible instrument since they were historical determinants of district boundaries in the early formation of school districts. Finding presented by Hoxby suggest that, for several outcomes, including student exam scores and school productivity, inter-district competition has positive and statistically significant effects, particularly when moving from minimum to maximum levels of inter-district competition.

Although Hoxby (2000) finds positive effects of inter-district competition, others find conflicting evidence. In particular, Rothstein (2011), in an attempt to replicate the results produced by Hoxby finds far less robust evidence on the effectiveness of inter-district competition as it relates to student exam scores in reading and math. Furthermore, Rothstein finds that Hoxby's main estimates are highly sensitive to the count of large rivers that Hoxby's analysis is largely based on. When specifying various alternatives large rivers and small streams variables as instruments, most if not all estimates decrease in size and become not statistically different from zero, especially for 8^{th} and 12^{th} grade reading exam scores.

2.4.2 Charter Competition

Other studies model competition as parents' ability to choose among an alternative school or group of schools. Such an example includes charter schools, which have been gaining in popularity as an alternative to TPSs over the last couple decades. Charter schools are unique in that they are public schools, open to all students choosing to attend free-of-charge, and operate under a performance contract with a chartering authority. In exchange for performance, charter schools receive freedom from local school districts and many of the red-tape policies and procedures that govern schools in these districts. Since charter schools are public in nature, like TPSs, they rely on public

funding or private donations to survive. In fact, charter schools receive a portion of taxpayer dollars appropriated for public schools for each student enrolling in a charter school. Because charter schools receive funds that otherwise would have gone to TPSs in their absence, TPSs have a financial stake in preventing students from attending charter schools, placing these two public school types in direct competition with each other for students and taxpayer dollars.

Several studies look at the effect of charter school competition on the academic performance of students, arguing that student achievement could improve if the threat of parents choosing charter schools spurs TPSs to improve school quality. The empirical evidence on the issue is seemingly mixed, with several studies reporting conflicting evidence on the effectiveness of charter school competition in improving the academic outcomes of students in TPSs. That is, some recent studies find positive effects, some find no effects, and others yet find negative effects. In large part, this is most likely due to the localized nature of the education market being examined.

Winters (2012) explores the impact of charter school competition on student outcomes using student-level data on students in New York City public schools in grades 3-8 from the 2005-06 through the 2008-09 school-year. Winters uses the longitudinal nature of the data to identify students leaving traditional publics school at year's end and enrolling in a charter school the following school-year to calculate the percentage of a school's students leaving for charters schools. Schools are assumed to face increasing competition from charter schools if the percentage of students leaving for charter schools is increasing. In addition, fixed effects at the student-level and/or school-level are employed to eliminate any unobserved differences in student ability. For models that

include student fixed effects only, student scores in math rise by 0.02 standard deviations as the percentage of students leaving for charter schools grows by 1%, and student scores in English Language Arts likewise sees a mild but statistically significant increase with an increase in charter competition.

Imberman (2011) uses data on students in a large urban school district located in the U.S. southwest to examine the effect of charter school competition on student achievement in TPSs. To measure charter competition, Imberman uses the share of charter enrollment in overlapping grades and within a 1.0 and 1.5 mile radius of TPSs. However, given the likely nonrandom location decision of charter schools, a 2SLS approach is employed whereby the availability of existing commercial space between 30k – 60k square feet near TPSs is used as an instrumental variable for charter share, with the idea being that charter schools tend to rent space or have space donated when first starting up and these types of structures are ideal for start-up schools.[15] Additionally, student fixed effects are included in all regressions to discount the possibility of student selection into charters biasing estimates. For both math and language arts, Imberman finds charter competition has a negative and statistically significant effect on test scores, with the effect being strongest for students in grades 1-5.

Booker, Gilpatric, Gronberg, and Jansen (2008) analyze student-level data in TPSs in Texas to evaluate the effect of charter penetration on changes in TASS achievement scores. The authors estimate several value-added achievement equations, including either a district-level measure or campus-level measure of charter penetration in each model. Also, to account for changes in student composition or underlying student

[15] Imberman (2009) also uses the # of shopping malls within a certain radius of TPSs as a second instrument.

ability potentially biasing estimates, campus fixed effects and/or student fixed effects are included in all regressions. Moreover, since charter penetration is likely nonrandom as well, they instrument for charter penetration to alleviate any further concerns of endogeneity. For their preferred specification, which includes both campus and student fixed effects, Booker et al. report IV estimates that indicate charter competition has a small but positive and statistically significant effect on TASS value-added scores in both reading and math. Moreover, these gains persist at both the district and campus-levels.

Bifulco and Ladd (2006), using student-level data on cohorts of third grade students in North Carolina between 1996-2000 and following the first two cohorts until the eighth grade and all other cohorts until 2001-02, examine student test score gains observed in TPSs both before and after the opening of a nearby charter school. For students in TPSs with the nearest charter school located between 2.5 and 5 miles and 5 and 10 miles, charter competition appears to have a positive and significant effect on math scores gains, while positive gains in reading occur only when the closest charter is located between 5-10 miles. No effects, in reading or math, are found for schools between 0-2.5 miles from the nearest charter. However, once allowing for student and school fixed effects, all estimates of charter competition lose statistical significance.

Sass (2006) utilizes student-level panel data on students in grades 3-10 in Florida public schools for the 2001-02 school-year to explore charter competition and exam performance on Florida's FCAT. To account for potential unobserved school quality biasing estimates of the charter effect, Sass estimates a school fixed effect model, including a variety of alternative charter measures within a 0-2.5, 2.5-5, and 5-10 mile radius of the closest TPSs. For each measure within these radii, Sass finds charter

competition has large, positive impacts on the test score performance of traditional public school students, with the effects in math being somewhat larger and more robust than the effects on reading scores.

Bettinger (2005) studies the effect of charter competition on reading and math scores of Michigan 4th graders in TPSs. Bettinger uses the number of charter schools within a 5-mile radius of TPSs as the relevant measure of charter competition. However, since a charter school's location decision is likely correlated with residual school achievement, an instrumental variables approach is used to identify charter competition's effect. Using a lagged dependent variable specification, Bettinger finds little significant evidence to suggest the number of charter schools within a 5-mile radius affects the exam performance of TPSs in reading or math. Moreover, to the extent charter schools draw the academically weakest students out of TPSs, small, positive, and insignificant point estimates may actually overstate the effect, even to the point where the true charter effect on academic performance could be negative.

Holmes, DeSimone, and Rupp (2003) also look at the effect of the distance of the nearest charter school relative to TPSs on average test score performance of students. Using data on North Carolina students in grades 3-8 between 1996-97 and 1999-00, Holmes et al. include various charter distance measures in several lagged dependent variable models. They find, for several alternative models, generally consistent evidence suggesting schools facing charter competition fare about 1% better on achievement exams compared to other schools. However, data limitations preclude Holmes et al. from distinguishing whether their findings result from charter competition or from changes in student composition. That is, whether the increase is due to less able students leaving for

charter teachers in hopes of finding a school that better meets students' needs. If this happens, it could simultaneously raise the average ability of TPS students and lower the average ability of charters.

Lastly, Hoxby (2002) evaluates the impact of charter school competition on student achievement in Michigan and Arizona. Hoxby uses a critical threshold of 6% of total district enrollment belonging to charter schools to separate schools facing charter competition from those facing no charter competition in these states. Using a difference-in-difference approach that compares test scores both before and after the introduction of charter legislation, Hoxby finds, in both Michigan and Arizona, average achievement improved by between 1 and 3 national percentile rank points in schools facing charter competition compared to other schools.

2.5 Competition and Teacher Pay

Economic theory suggests increased competition in the education market could not only benefit student, but also significantly affect the labor market opportunities of TPS teachers. First, schools facing increased competitive pressure could respond by hiring teachers particularly adept at attracting and retaining students since public funding is tied to student enrollment. This suggests a shift in the demand for high quality teachers, which could manifest into higher salaries for teachers. A second possibility is that increased competition could cause TPSs to have trouble retaining high quality teachers, resulting in a decrease in the supply of high quality teachers and also higher pay. Third, to the extent districts' with considerable market power depress wages, increased market pressures could result in salary competition and higher pay for teachers. Lastly, competition may reduce teacher pay if competition eliminates economic rents

generated by monopolistic districts if these rents are disbursed to school personnel. This Chapter reviews the empirical evidence, paying especially close attention to the effect of inter-district competition and charter competition on teacher salaries in TPSs.

2.5.1 Tiebout Competition

Hoxby (2002) and Taylor (2010) provide some of the few empirical studies regarding Tiebout competition and the teaching profession. Both studies equate schooling markets with MSAs, and each constructs an MSA-level Herfindahl index, the sum of the squared per-unit (district) enrollments over total MSA enrollment, to capture the amount of inter-district competition in MSAs. In addition, both use an instrumental variables approach to account for possible endogeneity issues associated with their Herfindahl construct, though the set of instrument differ between studies primarily because Hoxby (2002) is a national study of school teachers, while Taylor (2010) limits her analysis to teachers in Texas MSAs.

Hoxby (2002) estimates several equations to try and distinguish the effect of inter-district choice on the teaching profession. Her empirical approach is two-pronged. First, Hoxby estimates several quantity equations to determine if inter-district choice affects the number of teacher's possessing particular attributes, such as Master's degree or math and science skills. Secondly, Hoxby estimates a single wage equation that includes the Herfindahl index and the interaction between the Herfindahl index and each of the teacher attributes. The estimate on the various interaction terms yield the effect of inter-district choice on the incremental wage paid for each additional unit of the teacher attribute. This empirical strategy allows Hoxby to conclude whether inter-district choice encourages schools to differentiate teacher jobs by demanding more (less) of specific

teacher attributes by employing more (less) of and paying more (less) for these attributes. Her findings suggest that competition would raise the demand for teachers attending higher quality colleges, possessing more math and science skills, and placing extra effort in school (working more hours), and inter-district competition would lower the demand for Master's degrees and teaching certification.

Taylor (2010) also explores competition's effect on pay. Using panel data on Texas teachers, Taylor estimates several specifications, including a Herfindahl index and the square of the Herfindahl in each, to allow for possible non-linearities arising between competition and teacher salaries. Moreover, the model allows Taylor to examine monopsony and rent-sharing effects on pay, which, she argues, could have significant implications as to the effect of an increase in competitive on teacher pay. For all specifications, Taylor finds a highly significant, non-linear relationship between competition and teacher pay, implying the overall effect of competition on wages depends on the initial amount of competition in markets. In relatively competitive markets, wages fall as market concentration increases. However, in relatively concentrated markets, market concentration has the opposite effect on compensation. Thus, Taylor demonstrates both monopsony and rent-sharing behavior in Texas schools, and concludes policies aimed at encouraging competition could have different outcomes on pay depending on the initial amount of competition in teachers' market.

2.5.2 Charter Competition

Taylor (2006) studies the relationship between charter competition and teacher compensation in Texas public schools. Taylor focuses her analysis on urban school districts, where the vast majority of charter schools in Texas are located, and defines a

schooling market for each district as the district plus all districts within a reasonable commuting distance. To estimate charter competition's effect, the share of public enrollment in charter schools is used as the relevant measure of charter competition in districts' market. In addition, Taylor's model includes a Herfindahl index of traditional public school competition and the square of both charter share and the Herfindahl index to isolate the effects of charter competition and explore aspects of rent-sharing and oligopoly power. Since charter share is likely endogenous to the location decision of charter schools, a 2SLS approach is used to identify its effect on teacher compensation. The findings by Taylor suggest an oligopoly effect and wages increases with charter competition in markets with an initial charter share greater than 0.77%, while no pattern of rent-sharing emerges with charter competition. Also, charter competition is found to have differential effects on wages according to experience-level, with the charter share having the most beneficial effect on beginning teachers and no effect on the most experienced teachers.

Jackson (2011) examines the impact of charter competition on the wages of traditional public school teachers in North Carolina. The author takes a somewhat different tact than previous studies that explore the effect of charter school competition on pay by taking charter school entry within a reasonable vicinity of TPSs as the relevant measure of charter competition. Since charter entry is most likely nonrandom, a difference-in-difference approach is used to estimate the effect of charter entry on teacher salaries. Additionally, Jackson includes school fixed effects to eliminate any time-invariant, school-specific shocks that might bias cross-sectional estimates. Jackson finds that charter entry has a marginally significant but positive effect on teacher compensation

if charter entry occurs within a 10-mile radius of TPSs, with the effect being largest (about 1%) in hard-to-staff schools. No effect on pay is found when the radius is narrowed to 2-mile radius or expanded to a 20-miles radius. Jackson interprets this as evidence of a 10-mile radius as being the appropriate distance to measure the competitive effects of charter entry.

2.5.3 Private School Competition

Other studies examine more traditional forms of school choice, namely that arising from private schools. Vedder and Hall (2000), using district-level data on Ohio teachers, estimate teacher earnings equations that include a measure of both public competition (number of districts per county) and private school competition (share of student enrollment in private schools). They find, for both measures, competition increases the average annual salary of teachers, though the effects appear modest. Annual teacher salaries average about 2% more when moving from one district per county to 12 districts per county. Additionally, increasing the share of private enrollment by 20%, compared to districts having no private school enrollment, raises the pay teachers receive by about 3%, on average.

Hoxby (1994) also looks at the effect of public-private choice on teacher wages, among a host of other things. Hoxby uses the share of secondary enrollment in Catholic schools as the relevant measure of private school competition, and employs an instrumental variables approach to estimate private school competition's effect on pay since, she argues, the share of private enrollment is likely correlated with unobserved public school quality. That is, the share of private enrollment will be higher in counties with poor public schools. Findings by Hoxby suggest that private school competition has

a positive effect on the salaries of teachers working in public schools, with a 10 percentage point increase in the share of Catholic school enrollment generating a 6.5% increase in the average starting salary for teachers with a Bachelor's degree.

3 Empirical Strategy

The empirical analysis that follows in Chapter 5 seeks to identify competition's effect on teacher pay, while the analysis in Chapter 6 examines the relationship between competition and the characteristics, skills, and attributes of teacher working in public schools. In a comprehensive review of the empirical literature, Belfield and Levin (2000) suggest that the validity of an empirical analysis concerning competition's effect on outcomes in elementary and secondary education relies on the notion of an education market, construct of competition, and soundness of estimation technique. First, an education market is generally said to exist when parents have a feasible set of alternatives apart from the local school district. Potential alternatives could take the form of private schools, charter schools, homeschooling programs, intra-district choice programs, and inter-district competition.[16] Second, competition requires not only the existence of multiple education providers, but also consideration of the ways in which different education providers compete.[17] For example, intra-district competition (competition among TPSs within a district) would likely yield weaker competitive effects than inter-district competition (competition among districts) if TPSs do not have financial autonomy and school districts control the allocation of resources. On the other hand, charter schools could potentially generate strong competitive effects due to financial repercussions districts stand to incur when a student chooses a charter school over a local TPS. Finally, estimation plays perhaps the most important role in empirical studies of

[16] Homeschooling is another feasible alternative available to parents and a substantial fraction of students participate in homeschooling. However, data limitations prevent us from exploring homeschooling as another form of competition.

[17] Competition should also consider the costs associated with parents exercising schooling alternatives. Costs tend to be higher in areas with fewer readily available alternatives, such as in more rural areas. Costs also tend to differ along socioeconomic lines, with the costs of alternatives higher for low-income families. Costs are described in further detail below.

competition's effect. It has been well-established that many common measures of competition are correlated with unobservable factors that affect the supply and demand of competition. Therefore, appropriate steps should be taken to ensure that estimates of the effects of competition are free from potential biases, such as omitted variable bias and strict endogeneity issues. The remainder of this chapter is dedicated to describing the education market, competition construct, and estimation strategy used to identify the effect of three major forms of competition of interest to this study in Tiebout competition, charter competition, and private school competition.

3.1 Measuring Tiebout Competition

Competition among districts is commonly associated with Charles Tiebout, and, in fact, is often referred to as Tiebout competition. In a seminal paper, Tiebout (1956) noted the potential importance of "competition" among communities as it relates to achieving an efficient allocation of local public goods. Although Tiebout did not speak directly to competition, he did realize the significance of the number of communities in the provision of local public goods. On pg. 418, Tiebout states that "the greater the number of communities and the greater the variance among them, the closer the consumer will come to fully realizing his preference position." Tiebout suggests that, when households are free to vote with their feet, the solution to the local public goods problem is achieved by the efficient sorting of households through preference revelation—the greater the number of "competing" communities, the closer the provision to achieving the efficient allocation when households choose their residence according to these preferences.

The key assumption of the Tiebout model is that households register demand by freely moving from community to community. Hoxby (2000) outlines an alternative version of the Tiebout model whereby households are constrained by job location and income considerations and households are assumed to exercise Tiebout choice over all school districts within a reasonable commuting distance given their preferences for school expenditures and commuting distance. Potentially problematic to analyzing Tiebout competition's effect is the concept of an education market. Rural areas tend to have fewer school districts within a reasonable commuting distance than do urban areas, and some rural areas do not have any districts within reason. This makes exercising some form of Tiebout choice difficult and the costs of exercising Tiebout competition not very realistic in rural areas and areas where educational boundaries are not very well-defined in general. We thus correlate education markets with Metropolitan Statistical Areas (MSAs). MSAs are defined as geographic entities containing at least one urbanized cluster of 50,000 or more population, and consisting of one or more whole counties containing the urban core plus adjacent counties having a high degree of social and economic integration with the urban core.[18] MSAs comprise about a third of all U.S. counties in making up the 362 MSAs contained across the 50 states, and over three-fourths of all student enrollment can be found in MSAs.[19]

The amount of Tiebout competition varies greatly across MSAs. For example, some MSAs, such as Boston or New York, have many dozens of districts within a reasonable commuting distance. Other MSAs have very few or even a single school district serving the entire MSA, such as the Miami-Dade MSA. The variance in the

[18] See the U.S. Office of Management and Budget for more information.
[19] Based on the OMB's June 2003 standards.

amount of Tiebout competition across MSAs is directly associated with costs of households exercising Tiebout choice within MSAs. Additionally, as noted by Hoxby, the relevant costs of Tiebout competition are not relocation costs, but the costs associated with choosing a residence for its school spending and not for its other associated characteristics, such as commuting distance to work, parks, quality healthcare, and the like. These costs are incurred daily, whereas relocation costs are a one-time occurrence. For MSAs with many comparable districts in terms of school expenditures, the costs of exercising Tiebout choice are relatively low because households will have to compromise less on other important preferences in their residential decision since many comparable districts are within a reasonable distance. On the contrary, the costs will be higher in MSAs with few comparable districts since households will have to give up more of the other residential characteristics they prefer in order to obtain their preferred level of school spending.[20]

The costs of Tiebout competition appear to be inversely related to the number of comparable districts over which parents can exercise some form of choice. Therefore, a measure of Tiebout competition should, at a minimum, account for the number of districts, or feasible alternatives. Arguably the more comparable districts per MSA the lower are the costs of exercising Tiebout choice and the greater the amount of Tiebout competition within an MSA. However, some districts may be more desirable than others, possibly because they have more successful schools or higher levels of per-pupil expenditures which match parents' preferences. More desirable districts would likely have a greater share of the student enrollment than less desirable districts. Measures of

[20] Hoxby provides the example of a single MSA district in which most residences and jobs are located in the district, causing households to have to deviate far from their preferences for commuting distance to obtain their preference for school spending since the best alternative district is a long commute away.

Tiebout competition should also take district enrollment into consideration, in addition to the number of districts within MSAs. Following Hoxby (2000), among others, we measure the amount of Tiebout competition using a Herfindahl index based on district enrollment shares of total MSA enrollment.[21] Formally, the measure is given by:

$$T_m = 1 - \sum_{d=1}^{D} s_{dm}^2$$

where s_{dm}^2 is equal to district d's squared share of enrollment in MSA m. The measure of Tiebout-style competition varies continuously between 0 and 1, with a value of 1 indicating a very large number of equal-sized school district providers and a value equal to 0 corresponding to a single school district monopolizing the entire MSA. For example, as previously mentioned, New York and Boston have dozens of school districts throughout their respective MSAs with relatively proportional student enrollment, corresponding to a very high amount of Tiebout competition according to the described index above. Conversely, Miami has almost its entire student enrollment in the same school district, and, therefore, an index of Tiebout competition corresponding to 0, or minimal Tiebout competition. Finally, this measure has a rather intuitive interpretation. It is the probability that in a random meeting between two students from the same MSA, they would be enrolled in a TPS in different districts. For Boston or New York, this probability is well in excess of 0.90, while in Miami, this probability is nil. For most MSAs, this probability falls somewhere between the Boston and New York MSAs and the Miami MSA.

[21] The measure includes only TPS enrollment.

3.2 Measuring Charter Competition

Other studies model competition as parents' ability to choose an alternative school or group of schools apart from TPSs. Charter schools are a primary example of this and have become increasingly popular as an alternative to TPSs since the first two charter schools opened in St. Paul Minnesota more than two decades ago. As of December 2014, more than 2.5 million students nationwide were enrolled in over 6,500 charter schools, and some form of charter school legislation has been passed in 42 out of the 50 U.S. states.[22]

Charter schools are unique in that they are independent public schools that operate under a performance contract with a chartering authority, such as a local district or university.[23] In exchange for performance, charter schools are exempted from many of the rules and regulations that TPSs must follow. If charter schools underperform, the charter school's charter can be revoked and many have closed as a result of poor performance.[24] Additionally, charter schools are open to any student wishing to attend at no cost, and in the case of oversubscription, enrollment is determined at random by a lottery process. Finally, although who can operate charter schools and the particulars of what charter schools do varies from state to state, charter schools are schools of choice and rely on parents choosing to send their children to charter schools to remain in business. When a parent chooses a charter school, in some states as much as 100% of the funding tied to the student goes to the charter school.[25] In the absence of the charter, this

[22] Source: Center for Education Reform.
[23] The legal issuers of charters varies from state-to-state.
[24] Since 1992, as many as 15% of charter schools have closed for either poor performance or lack of funding.
[25] Charter schools receive an average of 64% of the average per-pupil funding that TPSs receive (Center for Education Reform).

is funding that would have otherwise gone to the district. Since charter schools are prohibited from charging tuition, they rely heavily on public support from attracting students. This places charter schools and school districts in direction competition whereby charter schools must attract students and their associated tax dollars in order to survive and districts have a financial stake in preventing students from leaving for charter schools.

Although the primary goal of charter schools is to improve the achievement of charter students, many have suggested a competition effect could emerge in which charter schools incentivize TPSs to improve student achievement and become more efficient education providers. The degree to which charter schools are perceived as competitors to school districts has been measured in a number of different ways, including the share of students exiting TPSs for charter schools from one year to the next, the distance a charter school locates from the nearest TPS, and the percentage of total charter school enrollment in an area. Since we confine the analysis to MSAs, we take the share of MSA enrollment attending charter schools as the relevant statistic. Formally, the measure is:

$$C_m = \left(\frac{Charter\ Enrollment}{Total\ Enrollment}\right)_m$$

where *m* denotes MSA. Charter enrollment is simply the total number of students enrolled in charter schools across the MSA and total enrollment is the total charter school, private school, and TPS enrollment within the MSA. Some states, such as Michigan and Arizona where charter schools have been in existence for well over a

decade, have a relatively large share of its student population attending charter schools. Other states have no charter law and consequently no charter school competition.[26]

3.3 Measuring Private School Competition

A third form of competition included in the analysis that follows in Chapters 5 and 6 is that arising from private school choice. Private schools have long been considered one of the foremost alternatives parents exercise choice over. Furthermore, despite the rise in the popularity of charter schools, private schools continue to enroll a substantial share of students, with enrollment in private schools more than double that of charter schools. Therefore, examining private school competition may lend additional insight into the effects of competition.

Private schools are routinely subjected to market forces that TPSs generally do not face. Similar to charter schools, private schools rely on attracting students to remain in business. Many have posited that this could create a competition effect in which private school competition would force inefficient schools out of business and/or cause TPSs to raise school quality and improve student achievement in particular. These studies typically use the percentage of students would attend a private school in a particular area as the relevant measure private school competition. Following the literature, we measure private school competition as the share of elementary and secondary students attending private schools in teachers' MSA. Formally, the measure is given by:

$$P_m = \left(\frac{Private\ Enrollment}{Total\ Enrollment}\right)_m$$

[26] Eight states do not have any current charter law. They are: Alabama, Kentucky, Montana, Nebraska, North Dakota, South Dakota, Vermont, and West Virginia.

where *m* denotes MSA. The numerator is simply the total student enrollment in private schools within MSAs, and the denominator is the total number of TPS, charter school, and private school enrollment.

The extent to which private school competition spurs TPSs to improve quality relies on the demand for private schooling. Demand is largely driven by the costs associated with parents exercising some form of public-private choice and the quality of local public schools. The primary cost to parents of private school choice comes mainly in the form of tuition. This is in addition to resources that parents must continue to contribute to public schools through property taxes. Private school choice is likely to be weak where the relative cost of exercising choice is high, and for low-income families, this may mean that private schools are not feasible alternatives, even if private schools better satisfy parents' preferences for schooling. The existing quality of public schools also plays an important role in the demand for private schooling. Areas where TPSs are weak would likely see a higher demand for private schools and areas with strong TPSs would likely have a lower demand for private schooling. It is reasonable to use the share of private school enrollment to measure private school competition so long as we include socioeconomic characteristics of MSAs to account for omitted variable bias and instrument for the private market share using credible instruments to correct for the correlation between public school quality and private school competition.

3.4 Estimation

The empirical strategy seeks to distinguish the effect of competition on the organization of teaching jobs in public schools. By organization of teaching jobs, we are referring to the way in which teachers are paid and the characteristics, skills, and

attributes that teachers accumulate. We include our measure of Tiebout competition, charter competition, and private school competition in all empirical analyses that follows as outlined in Chapters 3.1, 3.2, and 3.3.[27] Furthermore, since competition could well have very different effects depending on the incentive structure and organizational mission of the school in which teachers work, we also explore competition's effect on the pay and characteristics of teachers working in TPS and charter schools independently by estimating separate equations for charter teachers and TPS teachers. Thus, we estimate equations (1) and (2) as described below three times each. Once for all teachers combined, once for charter teachers alone, and once for TPS teachers, including the measures of competition in each. The empirical strategy can be summarized by two reduced-form equations.[28] The first is a basic wage equation given by:

$$(1) \qquad ln(W_{im}) = \beta_0 + \beta_1 T_m + \beta_2 C_m + \beta_3 P_m + \beta_4 I_{im} + \boldsymbol{X}_{im}\beta_5 + \boldsymbol{X}_m\beta_6 + \varepsilon_m + \varepsilon_{im}$$

where i indexes individual teachers and m indexes MSAs. The variable T_m is the index of Tiebout competition, the variable C_m is the share of MSA charter enrollment, the variable P_m is the MSA share of students attending private schools, I_{im} is an indicator variable equal to 1 if a teacher works in a charter school and 0 if a teacher works in a TPS to help control for differences in pay arising due to difference in the school-setting, $\boldsymbol{X}_{im}$ is a vector of individual teacher characteristics that controls for things like education and experience which likely affects teachers' pay, $\boldsymbol{X}_m$ is a vector of MSA characteristics, ε_m is a grouped error term since teachers are clustered by MSA and many of the key

[27] The Appendix supplies regression results using alternative measures of competition. These results are very similar to those presented in the text.

[28] Equations (1) and (2) show the baseline model for all teachers. The model changes only in that the indicator variable for charter or TPS teacher drops out when estimating effects for charter and TPS teachers separately.

independent variables depend mainly on variation among MSAs, and ε_{im} is an individual-specific error term. Lastly, the dependent variable, $ln(W_{im})$, is the natural log of all school-related pay for teacher *i* working in MSA *m*.[29]

The second part of the empirical strategy involves estimating the effect of Tiebout competition, charter competition, and private school competition on the characteristics, skills, and attributes of teachers. Other than the dependent variable, equation (2) differs from equation (1) only in that it excludes the vector of individual teacher characteristics ($\boldsymbol{X}_{im}$) since we are trying to discern the effect of competition on many of the individual teacher characteristics contained in $\boldsymbol{X}_{im}$. The characteristic equation is as follows:

$$(2) \qquad y_{im} = \alpha_0 + \alpha_1 T_m + \alpha_2 C_m + \alpha_3 P_m + \alpha_4 I_{im} + \boldsymbol{X}_m \alpha_5 + v_m + v_{im}$$

where *i* denotes teachers and *m* denotes MSAs. The vector $\boldsymbol{X}_m$ is the same exact set of MSA characteristics as in (1), v_m is a grouped error term, and v_{im} is an individual-specific error term. All remaining independent variables retain the same interpretation as in the wage equation. Lastly, the dependent variable, teacher characteristic *(y)* includes variables such as Master's degree, regular state certification, and so on.

The coefficients of primary interest in equations (1) and (2) are β_1 and α_1 which return the effect of Tiebout competition on teacher pay and teacher characteristics, respectively, and β_2 and α_2 which yield charter competition's effect on teacher pay and the characteristics of teachers. The vector $\boldsymbol{X}_m$ is included in each equation and contains a set of MSA market characteristics intended to control for influences other than the supply of competition that might affect teacher pay or the characteristics, skills, and attributes of

[29] Equation (1) also includes indicator variables for school-year.

teachers. For example, teachers working in MSAs with a higher average household income may be more likely to pay teachers higher wages regardless of the amount of competition within teachers' MSA if the cost of living is higher, or MSAs with a population having a higher average educational attainment may desire teachers with certain characteristics, like more math and science skills or more tech skills, more so than MSAs with a less educated population. Therefore, including market characteristics in equations (1) and (2) helps eliminate bias arising from omitted determinants affecting the demand for certain teachers and that are possibly correlated with the supply of competition. However, while $\boldsymbol{X}_m$ controls for many observed determinants, there may be other, unobserved, influences that are correlated with the Tiebout competition, charter competition, and private school competition.

Hoxby (2000) and Hoxby (2002) argues that measures of Tiebout competition based on district enrollment shares are likely endogenous to school productivity. That is, MSAs having a disproportionate number of unsuccessful schools also have a greater number of districts. The reasoning goes as follows. An MSA having little Tiebout competition is probably due to either there having always been a single district that has monopolized the MSA or it is the result of district consolidation.[30] If the latter is true, then MSAs with more Tiebout competition have more observed Tiebout competition because productive districts with successful schools declined to consolidate with unproductive districts that have many unsuccessful schools.[31] If this is indeed the case,

[30] See Kenny and Schmidt (1994) for a discussion regarding school district consolidation. They underscore the decline in public districts over the decades across states.

[31] Furthermore, Hoxby argues parents will want to send their children to successful schools in productive districts, which will cause them to "switch" out of unproductive districts with unsuccessful schools. For example, households with school-aged children moving from a central city school district to a suburban school district. Either implies the amount of Tiebout competition is endogenously determined by school productivity.

OLS will produce estimates of $\beta_1$and $\alpha_1$that are biased, inconsistent, and probably not representative of the true effects of Tiebout competition. Similarly, OLS will likely yield false estimate of the effects of charter competition. It has been well-established that the location decision of charter schools is non-random. Charter schools tend to locate in more urban areas, areas high in poverty and with more minorities, and areas where they are more likely to succeed in general. Therefore, unobservable factors that affect charter school conduct, like school quality, are likely to bias estimates of β_2 and α_2. Finally, estimates of the effects or private school competition will likewise be biased under simple OLS estimation of equations (1) and (2) since public school quality and the private market share are inversely correlated. Specifically, there is concern that parents choose private schools in areas where public school quality is low.

We rectify these endogeneity issues by employing a Two-Stage Least Square (2SLS) estimation approach. This requires that, for each endogenous competition variable included in the analysis, we have a set of instrumental variables that are correlated with the competition measure and do not have an independent effect on either $ln(W_{im})$ or y_{im}. Formally, the variables T_m, C_m, and P_m are all supposed endogenous in equations (1) and (2). That is, $E[\varepsilon_{im}, v_{im}|T_m] \neq 0$, $E[\varepsilon_{im}, v_{im}|C_m] \neq 0$, and $E[\varepsilon_{im}, v_{im}|P_m] \neq 0$. Then given a set of exogenous determinants of each endogenous competition variable, we can obtain a solution in two stages. The first-stage is:

$$(3) \quad T_m = \pi_0 + \boldsymbol{R}_m\pi_1 + \boldsymbol{X}_m\pi_2 + u_m$$

$$(4) \quad C_m = \delta_0 + \boldsymbol{L}_m\delta_1 + \boldsymbol{X}_m\delta_2 + \theta_m$$

$$(5) \quad P_m = \phi_0 + \boldsymbol{D}_m\phi_1 + \boldsymbol{X}_m\phi_2 + \omega_m$$

where $\boldsymbol{R}_m$ is a vector of instruments that satisfy E[$\mu_m|\boldsymbol{R}_m$] = 0 and Cor[$\boldsymbol{R}_m$,T_m] ≠ 0, $\boldsymbol{L}_m$ is a vector of instrument that satisfy E[$\theta_m|\boldsymbol{L}_m$] = 0 and Cor[$\boldsymbol{L}_m$, C_m] ≠ 0, and $\boldsymbol{D}_m$ is a vector of instruments satisfying E[$\omega_m|\boldsymbol{D}_m$] = 0 and Cor[$\boldsymbol{D}_m$, P_m] ≠ 0, among other conditions that satisfy properties of good instruments. We can then use the vector of variables given by [$\boldsymbol{R}_m$, $\boldsymbol{L}_m$, $\boldsymbol{D}_m$, $\boldsymbol{X}_m$] as a set of credible instruments to obtain 2SLS estimates by substituting in the predicted values from each first-stage regression of equations (3), (4) , and (5) in place of the actual values directly into equations (1) and (2) above and then re-estimating equations (1) and (2) via OLS. In particular, we obtain $\tilde{T}_m$ using the set of instruments given by [$\boldsymbol{R}_m$, $\boldsymbol{X}_m$] from the OLS estimation of equation (3) in which the dependent variable is the endogenous index of Tiebout competition (T_m), where $\boldsymbol{R}_m$ is a vector of variables that measure the number of large rivers and small streams in teachers' MSA and $\boldsymbol{X}_m$ is a vector of MSA market characteristics. Similarly, we obtain $\tilde{C}_m$ from the estimation of equation (4) in which now the dependent variable is the likely endogenous share of MSA charter enrollment (C_m) and using the set of instruments [$\boldsymbol{L}_m$, $\boldsymbol{X}_m$], where $\boldsymbol{L}_m$ is a vector of variables containing a measure of the strength of state charter laws and number of years elapsed since the charter law was first passed and $\boldsymbol{X}_m$ is the same vector of MSA market characteristics used throughout the analysis. And lastly we use the set of instruments [$\boldsymbol{D}_m$, $\boldsymbol{X}_m$] to obtain the fitted values $\tilde{P}_m$ from the OLS estimation of equation (5) in which the dependent variable is the endogenous MSA private school enrollment market share and $\boldsymbol{D}_m$ is a vector of church membership densities and $\boldsymbol{X}_m$ is the same vector of market characteristics of teachers' MSA. So long as the vector of instruments, [$\boldsymbol{R}_m$, $\boldsymbol{L}_m$, $\boldsymbol{D}_m$, $\boldsymbol{X}_m$], is correlated with the endogenous variables in question and does not independently affect teacher pay or teacher

characteristics, then OLS will yield consistent estimates of the effects of interest in this two-stage procedure.[32]

[32] Standard errors must be corrected in the 2nd stage using this two-step methodology for proper inference. We additionally correct the standard errors to account for clustering by MSA in the 2nd stage.

4 Data

4.1 Data Sources and Summary Statistics

The empirical strategy outlined in Chapter 3 requires data on individual public school teachers, data on charter school enrollment and TPS enrollment, private schooling, and characteristics of the education market in which teachers work. Additionally, since the index of Tiebout competition in teachers' MSA, share of MSA charter school enrollment, and fraction of MSA private school enrollment are all likely endogenous, we also require information on a set of variables that are correlated with the endogenous competition variables and uncorrelated with the error terms in equation (1) and equation (2). We propose using rivers and streams, state charter laws, and religiosity, respectively, as instruments for Tiebout competition, charter competition, and private school competition. Several data sources are combined to meet these requirements, all matched by school-year where possible. Finally, we restrict attention to MSAs, since our primary variables of interest, namely Tiebout competition and the share of MSA charter school enrollment, are available primarily at the MSA-level. The remainder of this chapter begins by describing the various data sources, followed by a discussion of Summary statistics for variables used throughout the analysis, and concludes by describing the methodology used to merge charter teachers and TPS teachers to MSAs.

4.1.1 SASS

Data on charter and TPS teachers come from the restricted-use version of the Schools and Staffing Survey (SASS). The SASS is a stratified random sample of public and private schools and school teachers administered by the National Center for Education Statistics (NCES) beginning in the mid-1980's and continuing approximately

every 3-4 years thereafter. Beginning with the 1999-00 wave, the SASS first began including charter schools in its sampling frame. Since charter schools make up only a small fraction of the total number of public schools sampled, we pool each wave of the SASS that includes charter schools in its sampling frame in order to maximize the total number of charter school teacher observations. Thus, we pool the four most recent waves of the SASS for the 1999-00, 2003-04, 2007-08, and 2011-12 school-years. The 1999-00 SASS consists of 42,086 TPS teachers and 2,847 charter teachers. For the 2003-04 wave, 42,073 TPS teachers and 1,171 charter teachers were sampled by the SASS. The 2007-08 edition of the SASS sampled 37,003 TPS teachers and 1,237 charter school teachers. Finally, the 2011-12 SASS sampled 34,956 TPS teachers, along with 2,541 charter teachers. Pooling each wave of the SASS results in a total combined sample of 163,914 public school teachers, including 156,118 TPS teachers and 7,796 charter teachers. After matching teachers to MSAs, and removing teachers with missing earnings data and other pertinent information, we are left with a final combined sample of 96,796 public school teachers, including 91,306 TPS teachers and 5,490 charter teachers, across 357 MSAs.[33] The vector $\mathbf{X}_{im}$ in equation (1) contains individual teacher variables derived from the SASS and used throughout the analysis, and only variables common to all four years are contained in $\mathbf{X}_{im}$. These variables include: Master's degree or better; years of teaching experience and its square; an indicator for having previously taught in private schools; an indicator for beginning teachers (those with 1-3 years of experience); an indicator variable for secondary school teachers; an indicator variable for special education teachers; an indicator for teachers possessing a standard state certification; an indicator variable for belonging to a teachers' union or similar employees' association; and a

[33] Matching teachers to MSAs is detailed below.

binary variable for the demographic make-up of teachers, including female, black, and Hispanic.

Table 1 provides summary statistics for variables contained in the vector $\boldsymbol{X}_{im}$ in equation (1) and also the variables used as the dependent variable in equation (2). As illustrated by the table, charter teachers and TPS teachers tend to have very different demographics, credentials, education, experience, and pay. Charter teachers are about 5.5 years of age younger than TPS teachers. A slightly larger fraction of charter teachers are female, although the mean is approaching 70% for both charter and TPS teachers. Charters tend to have a larger share of minority teachers relative to TPSs; 13% of charter teachers identify as black or African-American and 9.5% as Hispanic compared to only 7.5% of TPS teachers identifying as black or African-American and 5.2% Hispanic. In addition, fewer charter teachers teach traditional high school grades, and fewer charter teachers teach special education. Only 34.4% of charter teachers teach in grades 9-12 and only 6.4% of charters are assigned to teach special education, while almost 47% of TPS teachers teach grades 9-12 only and 12% of TPS teachers teach special education. A higher share of charter teachers have taught in a private school at some point in their teaching career relative to TPS teachers, with the difference in means more than 4 percentage points. Fewer charter teachers have a regular state certification. Only 65% of charter teachers are state certified compared to 89% of TPS teachers having obtained their state certification. Charter teachers are also far less unionized relative to TPS teachers, with 22.8% of charter teachers belonging to a union or similar employees' association compared to almost 77% of TPS teachers.

Charter schools and TPSs also appear to employ teachers with very different education attainment and experience levels. The share of charter teachers with only a Bachelor's degree greatly exceeds the share of TPS teachers with a Bachelor's only—nearly 61% of charter teachers have only a Bachelor's compared to just 46% of TPS teachers. In examining the type of Bachelor degree earned by teachers, TPS teachers have a very large share of teachers with a Bachelor's degree in an education field awarded through their college or university's Department of Education. The mean is over 70%. The share of charter teachers with an education degree drops to a just over 50%. Little difference exists between the share of charter teachers and TPS teachers receiving a degree in a math or science field, but charter teachers have a higher share of teachers having received a degree in a field outside their college or university's Department of Education relative to TPS teachers by about 11 percentage points. Additionally, and as implied by the sample means for Bachelor's degree, TPS teachers have a much higher percentage of teachers with a Master's degree or better compared to charter teachers. Over 52% of TPS teachers have a Master's degree, while the share of charter teachers with a Master's degree drops to 36%. Charter teachers are also less experienced than TPS teachers. TPS teachers have an average of 14 years of teaching experience compared to only 7.25 years for charter teachers. This is due, at least in part, to charter teachers being an average of over 5 years younger than TPS teachers. Also, as demonstrated in Table 1, charter teachers have a much larger share of teachers who are beginning teachers, while TPS teachers have a substantially larger share of teachers who are highly experienced. The mean number of teachers with 1-3 years of experience is nearly 38% for charters and only 16% for TPS teachers. On the other hand, the share of

highly experienced teachers (20+ years of experience) is less than 9% for charter teachers and almost 30% for TPS teachers. The majority of teachers sampled have an experience-level between 4-19 years. The share for both charter and TPS teachers is over 50%. Finally, large differences in pay exist between charter teachers and TPS teachers. The mean base salary for charter teachers is only $38,400, while base pay for TPS teachers is a little over $46,000. Examining all school-related earnings, which includes merit and incentive pay, bonus pay, and pay for coaching and other extra-circular activities, TPS teachers earn an average of over $8,000 more than charter school teachers.

4.1.2 CCD

Data on schools and school districts are obtained from the NCES's Common Core of Data (CCD). The CCD annually collects administrative data on the universe of U.S. public schools and school districts. Data collected includes enrollment at both the district-level and school-level for grades K-12 and comparable ungraded grades, county location, and the type of public school (charter, TPS). We primarily use information on school enrollment provided by the CCD's Public Elementary/Secondary School Universe Survey for the purpose of constructing a measure of the amount of Tiebout competition in teachers' MSA. Recall, Tiebout competition is based on a Herfindahl index based on district enrollment shares of total MSA enrollment in TPSs. Since Tiebout is based on district enrollment shares, it measures the amount of inter-district competition, or fragmentation among districts. The index is bounded between 0 and 1, with a value of 0 corresponding to minimal or no competition (monopoly district) in an MSA and a value of 1 corresponding to maximal competition (perfect competition) among MSA districts. Additionally, since the CCD includes enrollment data for charter schools, we also use the

CCD to calculate our measures of charter school competition—the share of total MSA student enrollment in charter schools. Since our sample of public school teachers consists of teachers for the 1999-00, 2003-04, 2007-08, and 2011-12 school-years, we calculate the index of Tiebout competition and the MSA share of charter enrollment for each year corresponding to the sample of teachers. Therefore, both Tiebout competition and the share of MSA charter enrollment vary by MSA and school-year. Since the share of MSA charter enrollment is a function of TPS enrollment and private school enrollment, in addition to charter enrollment, discussion of summary statistics will be reserved for the sub-section that immediately follows.

4.1.3 PSS

Data on private elementary and secondary schools come from the Private School Universe Survey (PSS). The PSS is conducted biannually by the NCES and provides an assortment of administrative data for every private school in the 50 U.S. states, including religious orientation, county, state, and MSA in which schools are physically located, school-level, and enrollment in grades K-12 and comparable ungraded students. Since our sample covers multiple school-years, we draw on the 1999-00, 2003-04, 2007-08, and 2011-12 editions of the PSS for the primarily purposes of constructing the share of MSA private school enrollment. We calculate the private share as total MSA private enrollment over the sum of MSA private enrollment, charter enrollment, and TPS enrollment, The share of MSA private enrollment varies, as with Tiebout competition and the share of MSA charter enrollment, both across MSA and across school-year.

Table 2 contains summary statistics for the share of MSA enrollment in private schools, share of MSA enrollment in charter schools, and the index of Tiebout

competition. For the sample combined, roughly 9% of all MSA K-12 enrollment is in private schools. Every MSA contains at least one private school, with the share of private enrollment reaching a maximum of nearly 31% and a minimum of 0.2%. In addition, the mean share of MSA private enrollment is 8.3%, 9.0%, 9.5%, and 9.6% for the 2011-12, 2007-08, 2003-04, and 1999-00 school-years, respectively, seemingly indicating enrollment in private schools, at least across MSAs, appears to be trending downward. Perhaps not so coincidently, the share of MSA charter enrollment has increased more than 5-fold during this same timeframe. Overall, the mean share of MSA charter enrollment for all 4 school-years combined is only 2%. However, for 2011-12, the share of MSA charter enrollment had reached a high of nearly 4% of all K-12 enrollment, up from just a 0.7% market share in 1999-00. Additionally, the share of MSA charter enrollment hit a maximum of only 10% in 1999-00, and jumped all the way to a maximum of over 31% by 2011-12. Thus, simple Summary statistics seemingly suggest the share of MSA charter enrollment is becoming an important share of all school enrollment. Finally, Summary statistics for the measure of district fragmentation, Tiebout competition, indicate the amount of inter-district competition among districts has remained about the same over the years. For the 2011-12, 2007-08, 2003-04, and 1999-00 school-years, the mean amount of Tiebout competition is 0.807, 0.781, 0.778, 0.792, and for all 4 years combined, the Tiebout competition measure has a mean of approximately 0.800. This means the average MSA in the sample has about 5 equally-sized school districts. However, some MSAs have many more districts, like Boston MA which has over 70 districts, corresponding to a high degree of Tiebout competition, and

some MSAs have much fewer districts, like Miami FL, which has only 1 district, corresponding to a very little amount of Tiebout competition.

4.1.4 PEP, SAIPE, BLS, and Census 2000

In order to isolate the effects of our primary variables of interest, Tiebout competition and the share of MSA charter school enrollment on the school-related earnings of teachers—as well as on our teacher characteristic equation—it is important to control for characteristics of the MSA in which teachers work since the distribution of characteristics is likely to vary across teachers' MSA. For example, MSA's with a higher average household income could reasonably be expected to pay teachers higher wages regardless of the amount of competition within teachers' MSA, or MSAs with a land area with more square miles may reasonably be expected to have a greater number of districts included in teachers' MSA. Failing to control for such things could cause our estimates to over-state or under-state the true effect of competition if these things are, in fact, correlated with our measures of competition or have an independent effect on teacher pay. To control for the potential of omitted variable bias, we employ an array of data from the Census Bureau's Population Estimates Program (PEP), the Census Bureau's Small Area Income and Poverty Estimates (SAIPE), the Bureau of Labor Statistics (BLS), and the Census 2000 to control for difference in teacher pay and other teacher characteristics arising due to differences in the distribution of MSA characteristics in which teachers work and eliminate any omitted variable bias. These variables are contained in the vector $\mathbf{X}_m$ in equations (1) and (2), and include the following variables: the log of population; the log of land area, log of average household income; the Gini coefficient of household income; the fraction of the population age 19 and under; the

fraction of the population age 65 and over; the fraction of population who are Hispanic; the fraction of the population who are black; the fraction of the population age 25 and over with a bachelor's degree or higher; the fraction of the population age 25 and over with a high school degree only; the unemployment rate; and the fraction of the population 17 and under in poverty. All data are at the MSA-level and matched by school-year where possible.[34]

Table 3 contains summary statistics for the set of MSA-level variables drawn from the various data sources and used as explanatory variables in all regressions that follow. As illustrated by the table, charter teachers can be found in 175 MSAs, while TPS teachers are spread across all 357 MSAs included in the analysis. Also, charter teachers tend to work in MSAs with both a larger population base and a larger land area. The average household income of the MSA in which charter teachers works is slightly larger than that of TPS teachers, probably due, in part, to charter teachers working in larger, more densely populated MSAs. In addition, charter teachers work in MSAs with a higher share of the population age 25+ who are Hispanic, yet there is virtually no difference in the mean share of the population age 25+ who are black for the MSAs charter teachers work in and the MSAs TPS teachers work in. Little difference exists between the age distribution of MSAs in which charter and TPS teachers work, and few differences arise in the education distribution between MSAs in which charter teachers work and TPS teachers work. MSAs in which charter teachers work have a slightly higher unemployment rate of 6% compared to only 5.6% for MSAs in which TPS

[34] Census 2000 data can be matched to MSAs, but not school-year. These variables include: average household income, the Gini coefficient of household income, fraction of population age 25+ with a Bachelor's, and fraction of population age 25+ with a high school degree only. All remaining data are matched by MSA and school-year.

teachers work. Finally, both charter teachers and TPS teachers tend to work in MSAs with an average poverty-level for children 17 and under of around 4.5%.

4.1.5 GNIS

Data on rivers and streams are obtained from the U.S. Geological Survey's Geographic Names Information System (GNIS). The GNIS is a comprehensive database containing information on all current and historical physical geographic features within the U.S., excluding roads and highways. The GNIS uniquely identifies all rivers and streams, as well as provides information on every county and state through which rivers and streams flow and the source and destination latitude and longitude coordinates of rivers and streams. These data are used to calculate the total distance rivers and streams flow and to disaggregate total MSA rivers into large rivers and small streams.[35] We thus use the count of large rivers and small streams to produce 2SLS estimates of the effects of Tiebout competition to eliminate endogeneity concerns arising from OLS. This follows the methodology proposed by Hoxby (2000). She argues that the observed amount of Tiebout competition is endogenous to school productivity, and areas with a greater amount of Tiebout competition could potentially be the result of an endogenously larger number of districts with unsuccessful schools. Since, historically, rivers and streams and other physical features were natural determinants of school district boundaries, Hoxby argues that physical features, such as rivers and streams, can act as credible instruments since they are correlated with the number of school districts and uncorrelated with school productivity. While fundamentally, Hoxby's argument is valid, others have questioned her methodology. Specifically, the way in which she constructs her large rivers and small streams variables has been well-scrutinized. Therefore, we

[35] Following Hoxby (2000) large streams are those longer than 3.5 miles.

adopt Rothstein's (2011) alternative definition of larger rivers and smaller streams in our analysis. Rothstein counts MSA rivers and streams by flow rather than by destination, which eliminates the problem of losing rivers like the Mississippi River, which empties into a non-MSA county despite following through several large MSAs. Moreover, we adopt the number of inter-county rivers as large rivers and define the number of small rivers as the number of intra-county rivers since we do not have data on river and stream width, which Hoxby incorporates into her definition of large streams. Although crude measures for the variation of interest, as argued by Rothstein, these measures should also act as credible instruments.

4.1.6 CER

Data on state charter school laws comes from the Center for Education Reform. The CER is a non-profit organization that strongly advocates for school choice and, in particular, charter schools. In the mid-1990's, the CER began ranking state charter laws based on certain provisions contained within states' charter law that make for a more favorable environment for the formation, sustainability, and success of charter schools. We draw on the CER's ranking of state charter laws for the years matching our sample of teachers for the 1999-00, 2003-04, 2007-08, and 2011-12 school-years.[36] For each year, the CER rated the same 10 provisions of states' charter law on a 0-5 point scale, with a 5 indicating that the provision is particularly favorable to the success of charter schools and a 0 indicating that the provision is unfavorable to the success of charter schools. We use the CER's aggregate score on the 10 provisions, as a percentage of the maximum, as an

[36] Data are obtained from the CER's annual report, "Charter School Laws Across the States: Rankings and Scorecard" for each school-year corresponding to the sample of teachers.

instrument for the share of MSA charter enrollment.[37] The charter law strength ranges between 0 and 1, with values close to 1 implying that a state has strong charter laws that are favorable to the formation and success of charter schools, and values close to or equal to 0 indicating a state has weak laws (or no laws) that are not favorable to the formation and success of charter schools. In addition to charter laws, we also use the number of years since the charter law was first passed into state law as a second instrument.

4.1.7 CCM

Data on religious composition are drawn from the 1952 Survey of Churches and Church Membership Study (CCM).[38] The CCM periodically collected county-level church and church membership information on many Christian and Jewish denominations in the U.S. beginning in 1952 and continuing through 1980. Data on historical church membership are used to construct church membership densities for 10 major denominations within the U.S., and the densities are in turn used to obtain instrumental variable (2SLS) estimates of the private school enrollment MSA market share in equations (1) and (2) since the private market share has been well-documented as endogenous to public school quality. That is, in areas where private enrollment is high, TPS quality is likely to be low, and vice versa. Hoxby (1994) and Hoxby (2002), among others, proposes using religious composition as instruments since a large portion of private schools have a religious affiliation, and it is generally less costly to provide denominational schooling in areas with a higher share of that denomination. In particular, it is argued that historical church membership is exogenous since this was a time in

[37] Post 2007-08, the CER introduced a new ranking scale for states' charter law. It appears certain provisions were merged to create a single provision; thus, reducing the number of provisions ranked from 10 to 7. We, therefore, use the aggregate law score, as a percentage of the maximum, rather than each of the 10 provisions as separate instruments.

[38] CCM survey data are obtained from The Association of Religious Data Archives, or ARDA.

which donor bases and endowments for denominational schooling were first established, allowing current tuition costs to be reduced or partially subsidized. Areas with a larger donor base likely have more places to offer at lower costs. The 10 major church membership densities derived from the data and used in all instrumental variables regressions that follow are: Catholic, Mormon, Jewish, Baptist, Methodist, Presbyterian, Episcopalian, Lutheran, Disciples of Christ, and the Christian Church. Table 4 contains summary statistics for each set of instruments used to obtain 2SLS estimates of the effects of competition.

4.2 Matching Teachers to MSAs

We equate education markets with Metropolitan Statistical Areas. MSAs are defined as geographic entities containing at least one urbanized cluster of 50,000 or more population, and consist of one or more whole counties containing the urban core plus adjacent counties having a high degree of social and economic integration with the urban core. The U.S. Office of Management and Budget (OMB) is the federal agency responsible for issuing the standards that define MSAs. Our analysis relies on the June 2003 standard as set forth by the OMB, which designated 1,090 counties and the District of Columbia as belonging to an MSA. In total, the OMB designated 362 MSAs across the 50 U.S. states. [39] To facilitate matching teachers to MSAs, we first construct an intermediate dataset containing all 362 MSAs and their associated counties. It is important to note that MSAs consist of whole counties, and no one county can span multiple MSAs. Therefore, we can uniquely match up counties with their respective

[39] These standards were first published by the OMB on December 27, 2000, and supersede the 1990 standards for defining Metropolitan Areas.

MSA. Therefore, this creates a crosswalk of sorts between MSAs and counties (MSA-county crosswalk).

Several intermediate datasets are created to facilitate matching all the various data to MSAs. We begin by creating a dataset that acts as a crosswalk between districts and MSAs to aid in merging teachers to the MSA in which they work. We draw on the CCD's Local Education Agency Universe Data (district) file for this purpose since the CCD provides a complete accounting of every public school district known to exist in the U.S.. From the CCD's district file, we are supplied with a variable that uniquely identifies each school district (LEAID) and a variable that corresponds to the county of physical location (CONUM) for each school district observed. We then use the CCD's designation of school districts to counties to uniquely match school districts to MSAs based on the OMB's June 2003 assignment of counties to MSAs.[40] Thus, we create an intermediate dataset (LEAID-MSA crosswalk) that contains a variable that uniquely identifies school districts and a variable that identifies the MSA corresponding to the county of physical location of each district.

We then use the LEAID-MSA crosswalk to assign charter teachers and TPS teachers in the SASS to MSAs. The restricted-use version of the SASS permits users to merge teacher-level data with their accompanying school-level and district-level data files for the sample of teachers included in the SASS. Merging teachers with their respective school-level and/or district-level data file allows users to obtain a unique district identification number (CCDIDLEA) for the district in which teachers in the SASS work. The district identification number (CCDIDLEA) supplied by the SASS is

[40] This is accomplished using the intermediate dataset, MSA-county crosswalk, which contains all 362 MSAs and their associated counties.

identical to the district identification number (LEAID) supplied by the CCD. This allows one to uniquely match teachers to their respective district file from the CCD. Therefore, we are able to match teachers to MSAs by merging teachers in the SASS with their school-level and/or district-level data file provided by the SASS in order to obtain their unique district id number (CCDIDLEA), and then using CCDIDLEA to merge teachers to MSAs using the LEAID-MSA crosswalk since CCDIDLEA = LEAID.[41]

Using the outlined procedure to match teachers to MSAs, a total of 67,174 teacher observations were lost. Table 5 provides a breakdown of the number of teacher observations lost and the reason for their loss. As indicated by the table, we lose over 55,000 teachers whose school district is not part of an MSA based on the methodology described above. In addition, due to the data requirements, we lose Alaska and Hawaii due to missing data on church membership since neither Alaska nor Hawaii had achieved statehood by 1950.[42] Teachers not teaching grades K-12 or comparable ungraded grades are also excluded from the sample, as are teachers who are not regular, full-time teachers. This results in another 9,006 and 138 teachers falling out of the sample, respectively. Additionally, one MSA did not have information on private schooling for 1999; one MSA did not have data on church membership; and one MSA did not have rivers and streams information available. MSAs missing these data result in another 76 teachers being dropped. Finally, 18 teachers fall out of sample due to missing information on earnings.

[41] Because the 1999-00 SASS did not provide an id (CCDIDLEA) for charter schools, we use zip-codes corresponding to charter schools provided by SASS to assign charter schools to counties. We then assign charter teachers to MSAs based on the county corresponding to the zip-code for the charter school in which they work. Zip-codes spanning multiple MSAs are dropped.
[42] Alaska and Hawaii also are missing data on rivers and streams.

Table 1: Summary Statistics, SASS Teachers

	All Teachers		Charter Teachers		TPS Teachers	
Variables	Mean	S.D.	Mean	S.D.	Mean	S.D.
Charter teacher	0.057	0.231	---	---	---	---
Base earnings (1000s)	45.62	14.50	38.39	11.69	46.05	14.54
All school earnings (1000s)	47.18	15.06	39.35	12.28	47.65	15.08
Teaches grades 9-12	0.461	0.499	0.344	0.475	0.469	0.499
Taught at private school	0.094	0.292	0.136	0.343	0.092	0.289
Regular state certification	0.875	0.331	0.654	0.476	0.888	0.315
Union	0.736	0.441	0.228	0.420	0.767	0.423
Age (yrs.)	42.10	11.30	36.95	11.07	42.41	11.24
Female	0.680	0.467	0.699	0.459	0.679	0.467
Black	0.078	0.268	0.133	0.340	0.075	0.263
Hispanic	0.054	0.227	0.095	0.293	0.052	0.222
Less than Bachelor's degree	0.019	0.137	0.029	0.167	0.019	0.135
Bachelor's degree only	0.467	0.499	0.611	0.488	0.459	0.498
Master's degree	0.514	0.500	0.360	0.480	0.523	0.499
Bachelor's degree field:						
Education	0.706	0.456	0.588	0.492	0.713	0.452
Math	0.022	0.146	0.026	0.158	0.022	0.146
Science	0.047	0.211	0.054	0.226	0.047	0.211
Other	0.226	0.418	0.334	0.472	0.220	0.414
Teaching experience (yrs.)	13.66	10.09	7.25	7.48	14.05	10.10
Years of Experience:						
1-3	0.172	0.377	0.395	0.489	0.158	0.365
4-19	0.542	0.498	0.523	0.500	0.543	0.498
20+	0.287	0.452	0.082	0.274	0.299	0.458

Table 1: (Continued):

Main teaching assignment:						
Special education	0.120	0.325	0.064	0.245	0.124	0.329
Math	0.113	0.317	0.124	0.330	0.112	0.316
Science	0.091	0.288	0.092	0.290	0.091	0.288
Other	0.675	0.468	0.719	0.449	0.673	0.469
Year = 1999-00	0.268	0.443	0.374	0.484	0.261	0.439
Year = 2003-04	0.259	0.438	0.152	0.359	0.265	0.441
Year = 2007-08	0.226	0.418	0.150	0.358	0.230	0.421
Year = 2011-12	0.248	0.432	0.323	0.468	0.243	0.429
MSAs represented		357		175		357
N		96,796		5,490		91,306

Source: Schools and Staffing Survey. Summary statistics are for teachers working in MSAs based on OMB's June 2003 standard.

Table 2: Summary Statistics, Measures of Competition

	MSAs	Mean	S.D.	Min.	Max.
All School-Years Combined:					
Index of Tiebout competition	357	0.789	0.219	0.000	0.985
Charter school Herfindahl	357	0.551	0.427	0.000	0.992
Private school Herfindahl	357	0.937	0.087	0.309	0.999
Charter enrollment share	357	0.020	0.027	0.000	0.313
Private enrollment share	357	0.091	0.043	0.002	0.314
N = 96,796					
2011-12 School-Year:					
Index of Tiebout competition	350	0.807	0.214	0.000	0.985
Charter school Herfindahl	350	0.676	0.397	0.000	0.992
Private school Herfindahl	350	0.937	0.090	0.309	0.998
Charter enrollment share	350	0.038	0.037	0.000	0.313
Private enrollment share	350	0.083	0.040	0.005	0.294
N = 24,002					
2007-08 School-Year:					
Index of Tiebout competition	350	0.781	0.231	0.000	0.985
Charter school Herfindahl	350	0.603	0.410	0.000	0.991
Private school Herfindahl	350	0.933	0.090	0.353	0.999
Charter enrollment share	350	0.022	0.025	0.000	0.129
Private enrollment share	350	0.090	0.042	0.007	0.310
N = 21,859					
2003-04 School-Year:					
Index of Tiebout competition	351	0.778	0.225	0.000	0.983
Charter school Herfindahl	351	0.517	0.421	0.000	0.992
Private school Herfindahl	351	0.938	0.085	0.386	0.999
Charter enrollment share	351	0.013	0.018	0.000	0.128
Private enrollment share	351	0.095	0.045	0.002	0.253
N = 25,036					

Table 2: (Continued)

1999-00 School-Year:

Index of Tiebout competition	353	0.792	0.205	0.000	0.982
Charter school Herfindahl	353	0.425	0.433	0.000	0.984
Private school Herfindahl	353	0.941	0.083	0.391	0.999
Charter enrollment share	353	0.007	0.011	0.000	0.100
Private enrollment share	353	0.096	0.045	0.013	0.314

N = 25,899

Source: 1999-00, 2003-04, 2007-08, and 2011-12 Common Core of Data. Includes only those MSAs with teacher observations.

Table 3: Mean Characteristics, MSAs

Variables	All	Charter	TPS
Population (1000's)	2,699.3	3,688.3	2,639.9
Log (population)	13.892	14.525	13.854
Land area (square miles)	4,593.6	5,972.0	4,510.7
Log (land area)	8.117	8.397	8.100
Average HH Income (1000s)	56.0	59.1	55.8
Log (average HH income)	10.916	10.976	10.912
Gini coefficient of HH income	0.420	0.421	0.420
% of population age 19 and under	0.280	0.282	0.280
% of population age 65 and over	0.121	0.120	0.121
% of population Hispanic	0.124	0.180	0.121
% of population black or African-American	0.119	0.116	0.119
% of population 25+ with a Bachelor's or better	0.258	0.266	0.257
% of population 25+ with a HS diploma only	0.279	0.260	0.280
% of population 17 and under in poverty	0.044	0.046	0.044
Unemployment rate	0.056	0.060	0.056
Census Division:			
Population in New England Census Division	0.088	0.046	0.091
Population in Mid-Atlantic Census Division	0.085	0.084	0.085
Population in East North Central Census Division	0.124	0.196	0.120
Population in West North Central Census Division	0.111	0.042	0.115
Population in South Atlantic Census Division	0.166	0.162	0.166
Population in East South Central Census Division	0.071	0.001	0.075
Population in West South Central Census Division	0.110	0.097	0.111
Population in Mountain Census Division	0.136	0.211	0.132
Population in Pacific Census Division	0.108	0.162	0.105
N	96,796	5,490	91,306
MSAs represented	357	175	357

Notes: The table contains means of each MSA characteristics used as explanatory variables in all regressions. Data are from the Census 2000, BLS, PEP, and SAIPE.

Table 4: Summary Statistics, Instruments

	Mean	Standard Deviation
Panel A: Tiebout Competition Instruments		
# of large rivers	52.5	43.5
# of small streams	140.8	148.6
Panel B: Charter Competition Instruments		
Charter law score (%)	0.497	0.281
Years since law passed	8.9	5.9
Panel C: Private School Competition Instruments		
Density, Catholic Church	30.5	70.7
Density, Mormon Church	0.6	3.6
Density, Jewish Church	3.6	22.4
Density, Baptist Church	1.5	2.9
Density, Methodist Church	8.6	8.4
Density, Episcopal Church	2.7	6.4
Density, Presbyterian Church	3.2	5.4
Density, Lutheran Church	5.9	11.6
Density, Christian Church	2.5	5.8
Density, United Church of Christ	1.5	2.5

Notes: Means and Standard Deviations are at the MSA-level. Statistics for charter law score is out of the maximum law score possible (50). Church membership densities are the number of adherents per square mile.

Table 5: Teacher Observations Lost and Reason for Observation Lost

Observations Lost	Reason for Loss
55,504	School is not part of MSA
2,369	Teachers in AK and HI
9,006	Not full time
138	Teaches pre-K only
28	Missing private school enrollment (Logan UT MSA)
23	Missing church membership (Carson City, NV MSA)
33	Missing rivers and streams (Midland, TX MSA)
18	Missing school-related earnings

Notes: The total number of combined teacher observations for the 1999-00, 2003-04, 2007-08, and 2011-12 editions of the Schools and Staffing Survey are 163,960. After merging teachers to MSAs, and removing teachers for reasons described above, the number of remaining teacher observations is 96,796 charter and TPS teachers,. In addition, for the 4 school-years combined, 46 MSAs do not contain any teacher observations. This includes 10 for the 1999-00 school-year, 13 for 2003-04, 14 for 2007-08, and 9 for the 2011-12. For the sample combined, 357 out of a possible 362 MSAs are represented in at least one school-year.

5 Wage Equation Results

Table 6 presents estimates and standard errors from the estimation of equation (1)—the natural log of all school-related pay on our key competition variables (index of Tiebout competition, share of MSA charter school enrollment, and private school market share), individual teacher characteristics, and characteristics of the MSA in which teachers work.[43] Baseline OLS regression results are presented in columns (1) – (3) of the table. Furthermore, since each of the three measures of competition is likely correlated with the error term in equation (1), we also obtain 2SLS estimates and standard errors. These can be found in columns (4) – (6) of the same table. Additionally, since competition may affect teachers differently depending on the type of institution in which a teacher works, separate results for charter teachers and traditional public school (TPS) teachers are presented in the table. Finally, given that teacher observations are limited to MSAs only, and several of the independent variables in equation (1) vary only by MSA, teacher observations within MSAs are likely correlated. Therefore, standard errors have been adjusted to reflect clustering by MSA.[44]

5.1 OLS

Before turning to the effect of competition on pay, it is useful to first examine how individual teacher characteristics affect teacher pay. Recall, equation (1) contains a vector of teacher characteristics, skills, and other attributes that help eliminate any differences in pay attributable to differences in the make-up of teachers. Examining the rows associated with these teacher characteristics in Table 6 shows that many teacher

[43] All regressions also include indicator variables for the 9 census divisions and indicator variables for school-year.

[44] Teacher observations are likely correlated within district as well. Estimates obtained when clustering by district are present in the Appendix. Results are very similar when clustering by MSA presented below.

characteristics have a highly significant effect on the pay received by teachers. For example, teacher pay in TPSs has historically been a function of educational attainment and years of teaching experience as determined by the single salary schedule of the school district in which teachers work. As would be expected, Table 6 indicates both education and experience have a positive and highly significant relationship with pay for all teachers, with the effects slightly larger for TPS teachers. TPS teachers with a Master's degree earn, on average, 11.6% higher pay compared to teachers with a Bachelor's degree or less, while Charter teachers with a Master's earn around 9.8% more. Experience exhibits a diminishing effect on pay for both TPS and charter teachers. A single year of experience is worth 3% for TPS teachers and 2.52% for charter teachers, with the second year of experience being worth slightly less at 2.91% for TPS teachers and 2.43% for charter teachers, and each subsequent year seeing slightly lower returns to experience.[45]

In addition to education and experience, it appears many of the other characteristics, skills, and attributes that teachers accumulate over their career factors into the pay decision of schools and school district, with many significant at the 1% level of significance and non-trivial in size. Public school teachers having previously taught in a private school receive lesser pay, on average, of about 3.2% compared to teachers having never taught in private schools. Charter schools appear to value private school teaching experience far less than TPS teachers, with charter teachers receiving upwards of an average of 6.5% lower pay and TPS teachers receiving about 3% lesser pay. These results could suggest that public schools value teachers with greater familiarity and

[45] When experience reach slightly more than 32 year for TPS teachers and slightly less than 28 years for Charter teachers, the returns to experience reaches 0.

experience in dealing with the challenges of working in the public school environment, especially since many public schools are subject to high-stakes testing and accountability reforms that private schools are exempted from. Grade-level taught also appears to affect pay substantially. Secondary school teachers earn an average of more than 2.4% more than elementary school teachers. Charter teachers working in secondary schools are paid even more, earning over 5% higher pay than charters in elementary schools. This could support the notion that secondary grade students are inherently more difficult to teach relative to elementary grade students, or it could reflect greater specialization on the part of high school teachers, particularly since high school teachers typically teach a specific subject-matter that requires more advanced training in and deeper knowledge of the subject-matter, such as math or science. State certification likewise has a highly significant effect on pay, especially for charter teachers. Charter teachers with a regular state certification earn 3.7% more compared to those not having a regular certification, while state certified TPS teachers receive only about half that of charter teachers. To the extent that schools are able to hire teachers that are not fully certified on a temporary basis or for a probationary period contingent upon completing certification requirements for full employment status, it is plausible to believe that these teachers would receive lower pay until they meet this requirement and receive their regular state certification. Union status likewise plays a significant role in teacher pay. Teachers that belong to a teachers' union or a similar employees' association receive an average pay boost of roughly 3.4% compared to teachers not union affiliated, with charter teacher receiving the biggest boost at over 6.6% compared to just 3% for TPS teachers.[46] This finding could

[46] Some states, such as Florida, mandate by law that charter teachers belonging to a union receive union negotiated pay. This is one reason why unionization may be associated with higher pay for charters.

be suggestive of the ability of teachers' unions to negotiate better working conditions and higher salaries for its members. While all teachers would probably experience the benefit of union negotiated better working conditions (e.g., fewer working hours, reduced class size, etc.), it is likely that only those teachers belonging to the teachers' union itself would experience the full benefit of union membership and higher pay. Lastly, the demographic make-up of public school teachers appears to make little difference in regards to pay, with the unexpected exception of gender. Female teachers are found to receive over 4% less pay relative to their male counterpart, with the pay gap narrowing to 2.64% in charter schools. This result is hard to explain given one of the stated goals of the single salary schedule was to eliminate gender bias in pay.[47] However, it is in line with much recent research and media attention on gender pay disparities across industry and within occupation.

Of primary interest is the effect of competition on the organization of teaching jobs in public schools, and, in particular, competition's effect on wages. We thus enter measures of Tiebout competition, charter competition, and private school competition into equation (1). Column (1) shows results for all teachers combined in a single equation, while columns (2) and (3) show results for charter and TPS teachers separately. For all teachers combined, column (1) indicates a positive relationship exists between Tiebout competition and teacher pay. Changing the probability that, in a random encounter between two students in the same MSA, the two students would be enrolled in TPSs in different school districts from 0 to 1 sees pay rise by an average of 3.4%. While increasing the amount of Tiebout competition from a single monopoly school district

[47] One possible explanation for male teachers earning higher pay is that male teachers often receive additional pay for higher-paying extracurricular activities, such as coaching a sport.

provider to a perfectly competitive market is not very plausible, the average MSA has a mean amount of Tiebout competition equal to roughly 3 school districts.[48] This implies that teachers in MSAs with the mean amount of Tiebout competition earn about 2.3% higher wages. The effect is slightly stronger for TPS teachers, with these teachers earning about 2.5% more in MSAs with the average amount of Tiebout competition. On the other hand, raising the amount of Tiebout competition appears to make charter teachers worse off through lower pay, with charter teachers working in MSAs with the mean Tiebout competition receiving about 2.2% less pay. However, for charter teachers, the effect is not statistically different from zero at conventional levels of significance. Columns (1) – (3) also indicate that charter competition, as measured by the share of MSA enrollment in charter schools, has no discernable effects on pay for TPS teachers or charter teachers.. However, if we consider the point estimates irrespective of significance, it would seem that, if anything, raising the MSA charter share would work to raise pay for TPS teachers and reduce pay for charter teachers. Lastly, column (1) indicates, as expected, charter teachers receive lower pay compared to their TPS counterparts by approximately 7%.

5.2 2SLS

The above analysis demonstrates the potential benefit of Tiebout competition, particularly for TPS teachers. As previously discussed, however, OLS estimates of Tiebout competition's effect is likely confounded by endogeneity issues arising from measures based on district enrollment shares. Moreover, it is likely that the included measure of charter competition is also endogenous since charter schools tend to locate in

[48] This value corresponds to mean MSA statistics not weighted by teachers per MSA and are available from the author upon request.

areas where parents may be dissatisfied with local schools and they are more likely to succeed in general, and the private market share is likewise endogenous to public school quality. If Tiebout competition, charter competition, and private school competition are indeed endogenous, then OLS estimates of competition's effects are biased, inconsistent, and not very likely to be representative of the true effects of competition. We turn to a 2SLS approach to remedy potential endogeneity issues and identify the true effects of Tiebout competition and charter competition as detailed in Chapter 3.

5.2.1 First-Stage Results

Before turning to the 2SLS estimates, it is important to first discuss first-stage regression results for each endogenous competition variable. Identification of the true effect of competition relies on exogeneity of the instruments selected and that the instruments selected are correlated with the endogenous competition variable in question. Table 7 contains estimates and standard errors for the first-stage regression for each endogenous variable included in equation (1).[49] Panel A shows results for the regression of endogenous Tiebout competition on the excluded instruments, large rivers and small streams. As column (1) of Panel A indicates, both rivers variables are positive and statistically significantly correlated with the index of Tiebout competition based on district enrollment shares. However, the large rivers variable has a much stronger independent effect on Tiebout competition than the small streams variable, and it is significant at the 1% level. The small streams variable is significant at only 10%. For both large rivers and small streams, the estimated relationship with Tiebout competition suggests that an increase in the number of MSA rivers and streams raises the probability

[49] Table 7 also includes first-stage results for regressions specifying alternative versions of the competition measures. Second-stage results for these regressions can be found in the Appendix.

that in a random meeting between students from the same MSA, they would be enrolled in TPSs located in different school districts. In addition to independently having predictive power, large rivers and small streams are also jointly different from zero. The F-statistic is 21.30, and the associated p-value for the probability of observing a greater F-statistic is 0.0000.

Turning to the first-stage regressions for charter competition, the excluded instruments are the strength of states' charter law and the number of years since states' charter law first passed into state law. Panel B of Table 7 indicates that there is a strong, positive, and highly statistically significant relationship between the share of MSA charter enrollment and each excluded instrument. For the strength of charter law, a 1% increase in the CER's score of a state's charter law is associated with a 1.8% rise in the share of MSA charter enrollment. Likewise, our second excluded instrument, years since the charter law was implemented, has a positive relationship with charter competition, and implies that, on average, a 10-year increase in the number of years since the charter law first entered into state law translates into a 1.3% increase in the MSA share of charter school enrollment. Each effect is independently statistically significant at the 1% level. Additionally, the null hypothesis that the excluded instruments are jointly zero is soundly rejected given a p-value equal to 0.0000 for the probability of observing a greater F-statistic than that observed.

Panel C of Table 7 shows the relationship between the 10 church membership densities as excluded instruments and the private school enrollment market share. Particularly important is the Catholic density, since a large share of private schools are

affiliated with the Catholic Church.[50] As would be expected, the Catholic density is positive and statistically significantly related to the share of private enrollment. On average, holding all else constant, MSAs with a higher number of Catholic Church members per square mile see the share of MSA private school enrollment rise. Several of the other church membership densities are also statistically significant, mostly at the 1% level, and they are all negatively associated with the share of private enrollment. The F-statistic for the joint significance of the 10 church membership densities is 23.64 and the associated p-value is 0.0000. Thus, the 10 densities are jointly different from zero at the 1% level of significance.

Panels A-C of Table 7 indicate that the selected sets of instruments are potentially credible instruments in that they have an independent effect on the endogenous variable in question and are jointly significant. Thus, the first condition, that the instruments be correlated with the potentially endogenous competition variable, has been met. The second condition, that the instruments are exogenous, is more difficult to corroborate, but it's hard to see how the set of instruments might have an independent effect on wages. Moreover, with the exception of the excluded instruments for the share of MSA charter enrollment, all instruments have been accepted in other studies on teacher pay and/or student achievement as credible instruments. In addition, in studies questioning the validity of results based on instrumental variables that use some of the same instruments used in this analysis—namely, large rivers and small streams—critics question the researcher's methodology in parsing rivers into large rivers and small streams and not necessarily the validity of the instruments as exogenous. In addition, we follow

[50] Approximately 24% of all private schools are affiliated with the Catholic Church (Source: Private Schools Universe Survey, 2011-12).

Rothstein (2011) in parsing large rivers and small streams directly from the GNIS database based on length only rather than Hoxby's (2000) preferred method which hand counts large streams directly from the USGS's 1/24,000 quadrangle maps according to width and length. The former methodology introduces less decision-making and human error into the classification of large rivers and small streams that received much heated debate.

5.2.2 Second-Stage Results

Table 6 contains 2SLS estimates from the regression of the log of all school-related pay on the key competition variables, along with a host of other MSA-level and individual teacher-level explanatory variables in order to isolate the effects of competition.[51,52] The 2SLS results contained in the table are directly comparable to OLS results previously noted and also contained in the same table. The first row of columns (4) – (6) shows how Tiebout competition affects public school teachers when treating Tiebout competition as endogenous. In particular, column (4) indicates that the 2SLS estimate of the effect of Tiebout competition on all teachers combined increases dramatically as compared to OLS estimates obtained in column (1). The effect is now nearly 8 times larger in size, and it continues to be statistically different from zero at conventional levels of significance. Similarly, for TPS teachers, column (6) indicates a 7-fold increase in the magnitude of the effect of Tiebout competition. On average, for TPS teachers, a change in the number of large rivers and small streams in MSAs that

[51] Care should be taken when interpreting 2SLS results presented in Chapters 5 and 6. Griliches (1977) discusses how correcting one problem using an instrumental variable approach actually exacerbates other problems, leading to substantial bias in instrumental variable estimates.

[52] Ideally, one would include an MSA or state fixed effect in the analysis to eliminate any time-invariant things, such as state regulations, that might influence estimates. However, since we analyze MSAs only, a large number of observations are lost since some states have only 1 MSA.

generates an increase in the index of Tiebout competition from 0 to 1 raises teacher pay by over 24%. Moreover, for TPS teachers working in the average MSA, this translates into a pay increase of a little less than 17%. For charter teachers, although still insignificant, the effect of Tiebout competition on pay, as shown in column (5), also indicates a dramatic rise in wages. Whereas under OLS the effect was negative 3%, 2SLS estimates indicate that the actual effect could be closer to positive 18%. These results seemingly suggest that once any potential confounding influences are eliminated, Tiebout competition substantially raises pay, at least for TPS teachers. Furthermore, point estimates tend to indicate a positive association between Tiebout competition and pay for charter teachers, though the effect is too imprecisely measured to be significant at conventional levels.

Turning to charter school competition, as measured by the share of MSA enrollment in charter schools, columns (4) and (6) of Table 6 reveal a substantial increase in charter competition's effect on wages over that obtained under OLS and contained in columns (1) and (3). Whereas all OLS estimates are insignificant, 2SLS estimates of the effect of charter competition are positive and statistically significant at the 1% level of significance. For TPS teachers, a change in charter law strength and the number of years since the charter law passed into state law that yields an increase in the share of MSA charter enrollment equal to the mean generates an increase in pay of approximately 4%. For charter teachers, although still insignificant, the point estimate in column (5) tends to suggest that raising the share of MSA charter enrollment could also potentially benefit charter teachers through higher pay. This result contrast OLS estimates which signal a

negative relationship. However, the standard errors are again too large to confer statistical significance.

These results as a whole illustrate the importance of accounting for endogeneity concerns when examining the relationship between pay and both Tiebout competition and charter competition. Many of the previously insignificant relationships produced under OLS estimation become statistically significant when estimated using 2SLS techniques. Comparing naïve OLS estimates to 2SLS estimates in columns (1) – (6) of Table 6 also reveals the direction of the resulting bias. For both Tiebout competition and the share of MSA enrollment in charter schools, OLS estimates are biased toward finding no significant effect. This result is largely consistent with similar studies finding biases toward zero. Additionally, the magnitude of the effects of competition on pay are generally similar for both TPS teachers and charter teachers, although 2SLS estimates are by and large too imprecisely estimated to be significant for charter teachers. This could be due, at least in part, to the relatively small sample of charter teachers. Finally, these results are consistent with a story in which school districts behave as a monopsony buyer of teacher services.[53] Under this scenario, increased competition causes teacher pay to rise as the market power of school districts is reduced and school districts can no longer hold wages below market value as competition bids wages up.

5.3 School Characteristics

One might worry that differences in the characteristics of schools or districts might lead to a compensating differential of sorts since some schools and school districts might offer other, non-pecuniary things that teachers might prefer. For example, some

[53] This is particularly relevant given the pay of charter schools and private schools, two of the primary competitors to school districts, offer wages below that of school districts.

schools might offer teachers reduced class sizes, teachers might have more or better classroom resources at their disposal at certain schools, or a school might be located in a more desirable neighborhood. Teachers might well be inclined to take lesser pay if these non-pecuniary things are important to them in order to work at such schools. On the other hand, if certain schools are perceived as undesirable from the standpoint of teachers, schools may be forced to pay teachers a wage premium to work at these schools. Examples could include schools that are located in high crime neighborhoods, schools that have been reprimanded for poor performance, or schools that have a relatively large number of students with disciplinary problems. Therefore, we re-estimate equation (1) via OLS and 2SLS and include school characteristics as explanatory variables to control for compensating differentials that might arise due to differences in the quality of schools in which teachers work.

We explore the impact of school characteristics on teacher pay by first estimating equation (1) when excluding all measures of competition and including only school and teacher characteristics. As can be seen in columns (1) – (3) of Table 8, many school characteristics independently have a statistically significantly effect on teacher pay in the absence of the competition measures. It appears that both charter teachers and TPS teachers are paid more for working in schools with a higher share of minority students. TPS teachers working in schools with a higher share of both black or African-American students and Hispanic students receive a wage boost, with both effects significant at the 1% level and the effect about twice as large for teachers working in schools with a higher share of black or African-American students. Only the school share of Hispanic students significantly affects the pay that charter teachers receive, with a 1% increase in the share

of a school's student population that is Hispanic leading to 5% higher wages. Also, the school share of students approved for free lunch appears to actually reduce pay for TPS teachers, while it has no effect on charter teachers. For TPS teachers, a 1% increase in the share of students free lunch approved in the teacher's school is associated with about 5% lower pay, on average. Finally, while the fraction of student with an Individual Education Plan (IEP) has no effect on pay, the share of students in teachers' school that are Limited English Proficient (LEP) leads to about 7% higher pay for both charter and TPS teachers with both effects significant at 5% or better.

Table 8 also shows results for regressions that include the index of Tiebout competition and the share of MSA charter enrollment, while also including school characteristics to control for possible differences among schools. As seen in columns (4) – (6), most of the school characteristics remain statistically significant and similar in magnitude even after adding in the competition measures. Particularly interesting, however, are the measures of competition and whether controlling for any compensating differential might mitigate or even eliminate any wage effect resulting from an increase in competition. OLS estimates found in these same columns remain consistent with previous OLS estimates when excluding school characteristics (Table 6, columns (1) – (3)). If anything the wage effect has risen slightly in magnitude, but remains the same in terms of statistical significance. However, as noted earlier, OLS estimates are biased, inconsistent, and not representative of the true effect of Tiebout competition or the MSA share of charter enrollment since they are likely endogenous. Therefore, columns (7) – (9) show regression results for specifications that include school characteristics, the competition measures, and that correct for possible endogeneity issues. By and large,

2SLS estimates found in these columns are consistent with 2SLS results when excluding school characteristics in sign, magnitude, and significance for each regression. If anything, for TPS teachers, adding school characteristics to control for differences among schools slightly strengthens the effect of Tiebout competition on teacher pay, and marginally lessens the impact of the share of MSA charter enrollment on wages. Therefore, while differences among schools may lead to pay differentials among teachers, it appears competition still results in a significant wage effect, especially for TPS teachers.

Table 6: Wage Equation Regressions

	OLS			2SLS		
	All (1)	Charter (2)	TPS (3)	All (4)	Charter (5)	TPS (6)
Panel A: Regression Results						
Index of Tiebout competition	0.0344	-0.0336	0.0369	0.2434	0.1833	0.2466
	(0.0111)***	(0.0426)	(0.0116)***	(0.1126)**	(0.1795)	(0.1120)**
Charter enrollment share	0.1345	-0.2101	0.1934	2.0278	0.7017	1.9586
	(0.1173)	(0.1902)	(0.1294)	(0.4385)***	(1.8455)	(0.4353)***
Charter teacher	-0.0693			-0.0731		
	(0.0071)***			(0.0077)***		
Private enrollment share	-0.1812	0.2886	-0.2108	0.2370	0.4188	0.2329
	(0.0817)**	(0.1479)*	(0.0833)**	(0.4767)	(0.9372)	(0.4802)
Master's	0.1158	0.0978	0.1160	0.1156	0.0981	0.1158
	(0.0024)***	(0.0073)***	(0.0024)***	(0.0026)***	(0.0076)***	(0.0026)***
Experience	0.0298	0.0252	0.0300	0.0298	0.0249	0.0300
	(0.0004)***	(0.0021)***	(0.0004)***	(0.0004)***	(0.0021)***	(0.0004)***
Experience-squared	-0.0005	-0.0004	-0.0005	-0.0005	-0.0004	-0.0005
	(0.0000)***	(0.0000)***	(0.0000)***	(0.0000)***	(0.0000)***	(0.0000)***
Taught at private school	-0.0327	-0.0654	-0.0290	-0.0338	-0.0654	-0.0303
	(0.0021)***	(0.0088)***	(0.0022)***	(0.0023)***	(0.0088)***	(0.0024)***
1 – 3 years experience	0.0040	-0.0040	0.0023	0.0042	-0.0042	0.0024
	(0.0028)	(0.0090)	(0.0029)	(0.0030)	(0.0090)	(0.0030)

Table 6: (Continued)

Teaches grades 9 – 12	0.0247 (0.0020)***	0.0502 (0.0086)***	0.0241 (0.0020)***	0.0240 (0.0023)***	0.0515 (0.0085)***	0.0233 (0.0023)***
Special education	-0.0095 (0.0018)***	-0.0006 (0.0119)	-0.0099 (0.0018)***	-0.0102 (0.0020)***	0.0010 (0.0120)	-0.0106 (0.0020)***
Certified	0.0204 (0.0028)***	0.0369 (0.0068)***	0.0185 (0.0028)***	0.0203 (0.0029)***	0.0375 (0.0065)***	0.0184 (0.0028)***
Female	-0.0419 (0.0015)***	-0.0264 (0.0061)***	-0.0427 (0.0014)***	-0.0419 (0.0015)***	-0.0264 (0.0062)***	-0.0427 (0.0015)***
Hispanic	0.0000 (0.0035)	-0.0155 (0.0107)	0.0024 (0.0035)	-0.0001 (0.0045)	-0.0140 (0.0111)	0.0019 (0.0044)
Black	0.0051 (0.0050)	0.0007 (0.0099)	0.0063 (0.0051)	0.0063 (0.0047)	0.0014 (0.0101)	0.0073 (0.0049)
Union	0.0340 (0.0025)***	0.0658 (0.0103)***	0.0302 (0.0026)***	0.0342 (0.0030)***	0.0647 (0.0106)***	0.0306 (0.0033)***
Constant	6.5633 (0.3775)***	8.2019 (0.9252)***	6.4770 (0.3855)***	7.4870 (0.7217)***	8.3816 (1.4659)***	7.4248 (0.7121)***
Panel B: Regression Statistics						
R^2	0.6744	0.5950	0.6749			
Probability > F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MSAs represented	357	174	357	357	174	357
N	96,796	5,485	91,306	96,796	5,485	91,306

Notes: The dependent variable is the log of all school-related earnings. Clustered standard errors are in parenthesis. MSA characteristics, year indicators, and census division indicator variables are included as additional explanatory variables in all regressions. *** significant at 1%, ** significant at 5%, * significant at 10%.

Table 7: First-Stage Regression Results

Panel A: Regression of Tiebout Competition on Excluded Instruments

	Dependent Variable		
	Tiebout Competition Index	Tiebout Competition Index (Total Enrollment)	Tiebout Competition Index
	(1)	(2)	(3)
# large streams (100s)	0.0773	0.0613	0.0773
	(0.0205)***	(0.0174)***	(0.0205)***
# small streams (100s)	0.0112	0.0091	0.0112
	(0.0059)*	(0.0050)*	(0.0059)*
R-squared	0.5247	0.5277	0.5247
$F_{(2,1378)}$	21.20	18.80	21.20
P-value, all excluded instruments jointly equal zero	0.0000	0.0000	0.0000
N	1,404	1,404	1,404

Panel B: Regression of Charter Competition on Excluded Instruments

	Dependent Variable		
	Charter Enrollment Share	Charter Enrollment Share	Charter Enrollment Herfindahl
	(1)	(2)	(3)
Charter law score (%)	0.0180	0.0180	0.3673
	(0.0029)***	(0.0029)***	(0.0347)***
# years since law passed	0.0013	0.0013	0.0138
	(0.0001)***	(0.0001)***	(0.0022)***
R-squared	0.4103	0.4103	0.6167
$F_{(2,1378)}$	93.55	93.55	160.12
P-value, all excluded instruments jointly equal zero	0.0000	0.0000	0.0000
N	1,404	1,404	1,404

Table 7: (Continued)

Panel C: Regressions of Private School Competition on Excluded Instruments

	Dependent Variable		
	Private Enrollment Share	Private Enrollment Share	Private Enrollment Herfindahl
	(1)	(2)	(3)
Density, Catholic Church	0.0004 (0.0000)***	0.0004 (0.0000)***	0.0001 (0.0000)*
Density, Mormon Church	-0.0010 (0.0002)***	-0.0010 (0.0002)***	-0.0012 (0.0006)*
Density, Jewish Church	-0.0003 (0.0000)***	-0.0003 (0.0000)***	-0.0009 (0.0001)***
Density, Baptist Church	-0.0038 (0.0005)***	-0.0038 (0.0005)***	-0.0053 (0.0013)***
Density, Methodist Church	-0.0003 (0.0001)*	-0.0003 (0.0001)*	-0.0012 (0.0004)***
Density, Episcopal Church	-0.0010 (0.0003)***	-0.0010 (0.0003)***	0.0011 (0.0008)
Density, Presbyterian Church	0.0001 (0.0002)	0.0001 (0.0002)	0.0000 (0.0007)
Density, Lutheran Church	0.0001 (0.0001)	0.0001 (0.0001)	0.0000 (0.0003)
Density, Christian Church	-0.0012 (0.0004)***	-0.0012 (0.0004)***	-0.0026 (0.0010)**
Density, United Church of Christ	-0.0010 (0.0002)***	-0.0010 (0.0002)***	-0.0017 (0.0006)**
R-squared	0.5216	0.5216	0.5830
$F_{(10,1370)}$	23.64	23.64	10.66
P-value, all excluded instruments jointly equal zero	0.0000	0.0000	0.0000
N	1,404	1,404	1,404

Notes: Each first-stage regression includes MSA characteristics, year indicators, and census division indicator variables as explanatory variables. First-stage results shown in column (1) correspond to 2SLS regression results discussed in Chapters 5 and 6. Estimates shown in columns (2) and (3) correspond to alternative 2SLS results found in the Appendix. *** significant at 1%, ** significant at 5%, * significant at 10%.

Table 8: Wage Equation Regressions Including School Characteristics

	OLS						2SLS		
	School Characteristics Only			School Characteristics and Competition Variables			School Characteristics and Competition Variables		
	All	Charter	TPS	All	Charter	TPS	All	Charter	TPS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A: Regression Results									
Index of Tiebout comp.				0.036	-0.014	0.038	0.257	0.243	0.261
				(0.011)**	(0.041)	(0.011)**	(0.113)**	(0.215)	(0.113)**
Charter enrollment share				0.121	-0.175	0.174	1.958	1.965	1.883
				(0.115)	(0.187)	(0.129)	(0.447)**	(2.444)	(0.444)**
Private enrollment share				-0.185	0.267	-0.212	0.276	0.493	0.274
				(0.082)**	(0.158)*	(0.084)**	(0.486)	(1.181)	(0.497)
Charter teacher	-0.072			-0.075			-0.078		
	(0.007)**			(0.007)**			(0.008)**		
% school Hispanic	0.029	0.057	0.030	0.029	0.058	0.030	0.027	0.055	0.027
	(0.010)**	(0.020)**	(0.011)**	(0.010)**	(0.020)**	(0.011)**	(0.011)**	(0.025)**	(0.012)**
% school black	0.047	0.016	0.059	0.048	0.015	0.059	0.049	0.021	0.060
	(0.008)**	(0.020)	(0.008)**	(0.008)**	(0.020)	(0.008)**	(0.009)**	(0.025)	(0.009)**
% school free lunch	-0.051	-0.002	-0.056	-0.051	-0.002	-0.055	-0.051	0.000	-0.056
	(0.004)**	(0.016)	(0.005)**	(0.004)**	(0.016)	(0.005)**	(0.005)**	(0.019)**	(0.005)**
% school IEP	0.001	-0.018	0.002	0.004	-0.019	0.005	0.000	-0.013	0.001
	(0.006)	(0.024)	(0.007)	(0.006)	(0.024)	(0.007)	(0.007)	(0.028)	(0.007)

Table 8: (Continued)

% school LEP	0.073	0.069	0.070	0.073	0.068	0.069	0.073	0.074	0.070
	(0.012)**	(0.030)**	(0.013)**	(0.012)**	(0.029)**	(0.013)**	(0.014)**	(0.032)**	(0.015)**
Master's	0.115	0.099	0.116	0.115	0.099	0.115	0.115	0.099	0.115
	(0.002)**	(0.007)**	(0.002)**	(0.002)**	(0.007)**	(0.002)**	(0.002)**	(0.008)**	(0.002)**
Experience	0.030	0.026	0.030	0.030	0.026	0.030	0.030	0.026	0.030
	(0.000)**	(0.002)**	(0.000)**	(0.000)**	(0.002)**	(0.000)**	(0.000)**	(0.002)**	(0.000)**
Experience-squared	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**	(0.000)**
Taught private school	-0.035	-0.064	-0.032	-0.034	-0.064	-0.031	-0.035	-0.064	-0.032
	(0.002)**	(0.008)**	(0.002)**	(0.002)**	(0.008)**	(0.002)**	(0.002)**	(0.009)**	(0.002)**
1 – 3 years exp.	0.004	0.000	0.002	0.004	0.000	0.002	0.004	0.000	0.002
	(0.002)	(0.008)	(0.002)	(0.002)	(0.008)	(0.002)	(0.003)	(0.009)	(0.003)
Teaches grades 9-12	0.022	0.053	0.021	0.023	0.051	0.022	0.022	0.053	0.021
	(0.002)**	(0.008)**	(0.002)**	(0.002)**	(0.008)**	(0.002)**	(0.002)**	(0.009)**	(0.002)**
Special education	-0.009	0.004	-0.010	-0.009	0.003	-0.010	-0.010	0.004	-0.010
	(0.001)**	(0.012)	(0.001)**	(0.001)**	(0.012)	(0.001)**	(0.002)**	(0.012)	(0.002)**
Certified	0.019	0.033	0.018	0.019	0.032	0.018	0.019	0.033	0.018
	(0.002)**	(0.007)**	(0.002)**	(0.002)**	(0.007)**	(0.002)**	(0.002)**	(0.007)**	(0.002)**
Female	-0.041	-0.026	-0.042	-0.041	-0.025	-0.042	-0.042	-0.025	-0.042
	(0.001)**	(0.006)**	(0.001)**	(0.001)**	(0.006)**	(0.001)**	(0.001)**	(0.006)**	(0.001)**
Hispanic	-0.003	-0.026	0.000	-0.002	-0.027	0.000	-0.002	-0.025	0.000
	(0.003)	(0.010)**	(0.003)	(0.003)	(0.010)**	(0.003)	(0.004)	(0.012)**	(0.004)
Black	-0.001	-0.001	-0.003	-0.001	-0.002	-0.002	0.000	-0.002	-0.001
	(0.004)	(0.010)	(0.004)	(0.004)	(0.010)	(0.004)	(0.004)	(0.012)	(0.004)

Table 8: (Continued)

Union	0.034	0.068	0.030	0.034	0.067	0.030	0.034	0.066	0.030
	(0.002)**	(0.010)**	(0.002)**	(0.002)**	(0.010)**	(0.002)**	(0.003)**	(0.011)**	(0.003)**
Constant	6.929	7.979	6.874	6.671	8.328	6.585	7.628	8.724	7.566
	(0.354)**	(0.856)**	(0.363)**	(0.369)**	(0.931)**	(0.377)**	(0.726)**	(1.712)**	(0.720)**
Panel B: Regression Statistics									
R^2	0.6739	0.5976	0.6743	0.6747	0.5985	0.6753			
Probability > F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
# of MSAs	357	174	357	357	174	357	357	174	357
N	90,187	5,050	85,132	90,187	5,050	85,132	90,187	5,050	85,132

Notes: The dependent variable is the log of all school-related earnings. Cluster-robust standard errors are in parenthesis. MSA characteristics, census division indicator variables, and year indicator variables are also included as independent variables in all regressions. The number of observations differs from Table 6 because schools missing information on school characteristics were dropped from the analysis. ** significant at 5% or better, * significant at 10%.

6 Characteristic Equation Results

Tables 9-15 present estimates and standard errors from the estimation of equation (2). Recall, equation (2) differs from equation (1) only in that we now take a specific individual teacher characteristic, skill, or attribute as the dependent variable and therefore exclude the vector of individual teacher characteristics, $\mathbf{X}_{im}$. Similar as to the analysis of teacher pay, we first obtain baseline OLS estimation results and follow-up with a more rigorous 2SLS estimation procedure to account for the likely endogeneity of the index of Tiebout competition, share of MSA charter enrollment, and private school MSA market share. All tables remain similar in structure to those found in Chapter 5, with columns (1) – (3) containing baseline OLS coefficient estimates and standard errors and columns (4) – (6) containing comparable 2SLS results. First-stage regression results used to obtain 2SLS estimates and standard errors are the same as those previously discussed in Chapter 5 and found in column (1) of Table 7. Standard errors that account for teachers clustering by MSA are in parenthesis in each table.[54]

6.1 Master's Degree

Table 9 presents regression results when taking Master's degree as the dependent variable in equation (2), which equals 1 if a teacher has a Master's and zero if not. R-squared for each regression in columns (1) – (3) is slightly above 0.042, implying that about 4.2% of the variation in Master's degree is explained by the variation in the set of competition variables, characteristics of the MSA in which teachers work, census division indicators, and school-year dummy variables included as explanatory variables

[54] The Appendix shows results for alternative specification of our competition measures. In particular, results in which an MSA-level charter enrollment Herfindahl is used in place of the share of MSA charter enrollment. Results obtained using the charter enrollment Herfindahl are nearly identical to those discussed below. These results also include a private enrollment Herfindahl.

in the regressions. Examining the coefficients, Tiebout competition appears to have little impact on the probability that teachers have a Master's degree for each regression in columns (1) – (3). Charter competition, as measure by the share of MSA charter school enrollment, likewise has few statistically significant results. The exception is in column (2). For charter teachers, raising the share of MSA charter enrollment is associated with a decrease in the probability of obtaining a Master's degree. Lastly, column (1) shows charter teachers are much less likely to have a Master's degree compared to charter teachers. Columns (4) – (6) return 2SLS estimates and standard errors. Estimates shown in these columns illustrates that 2SLS strengthens the relationship between Tiebout competition and Master's degree for TPS teachers. The estimate on Tiebout has increased substantially. Moreover, the estimated effect is now significant at the 10% level of significance. For TPS teachers, raising the amount of Tiebout competition in teachers' MSA raises the likelihood of teachers' having a Master's degree or better. For charter teachers, column (5) illustrates few significant competition effects emerge.[55]

6.2 Beginning Teacher

OLS and 2SLS estimation results for the regression of teachers with 1 – 3 years of teaching experience are presented in Table 10. The dependent variable is equal to 1 if a teacher has only 1 – 3 years of experience and 0 if they have more than 3 years of experience. Column (1) shows OLS results for all teachers. R-squared for the regression is 0.0276. Although little variation is explained by the set of explanatory variables, the F-statistic on the test that all coefficients are jointly equal to zero is 34.40, suggesting that the model is valid. Additionally, the primary competition variables, Tiebout competition

[55] Some states, such as Kentucky, require teachers to have their Master's within the first few years. These results do not differ substantially from results on Master's in which we examine teachers with 1-3 years of experience only.

and the share of MSA enrollment in charter schools, are jointly significant at the 10% level. Moving along to the coefficients in columns (1) – (3), charter teachers have a considerably higher probability of only 1 – 3 years of experience, on average, compared to TPS teachers. Also, OLS results suggest that raising the share of MSA charter enrollment reduces the share of beginning level teachers, and this result holds for TPS teachers as shown by column (3). Tiebout competition, on the other hand, appears to make little difference in this probability for either charter teachers or TPS teachers in regards to beginning level teachers. Columns (4) – (6) present second-stage results after taking steps to eliminate any potentially biasing influences. As can be seen, any statistical significance among the competition variables is by and large eliminated. For charter teachers, 2SLS point estimates in column (5) seem to indicate that more competition would actually lead to a reduction in the number of beginning teachers, which contrast OLS point estimates suggesting the opposite. In neither case are results statistically significant at conventional levels, however. Finally, column (4) indicates charters are much more likely to be beginning level teachers relative to their TPS counterparts, with the result significant at 1%.

6.3 State Certification

Columns (1) – (3) of Table 11 present estimates from the OLS and 2SLS regression of teachers' having regular state certification on the competition variables of interest and a host of other MSA-level explanatory variables. R-squared for the regression runs from as little 0.0009 for TPS teachers to as high as 0.0990 for charter teachers. For all teachers, R-squared is approximately 0.0373. Column (1) shows regression results for all teachers, and indicates that charter teachers are significantly less

likely to have a regular state certification. This result holds when moving to a 2SLS estimation strategy as shown in column (4). Additionally, column (2) illustrates that neither the amount of Tiebout competition faced by districts nor the share of MSA charter enrollment significantly impacts charter teachers. These results persist when moving to 2SLS, as shown in column (5). For TPS teachers, second-stage estimates shown in column (6) tend to indicate OLS estimates of competition's effect on state certification are biased toward finding no effect. The 2SLS estimates are much larger in absolute magnitude, and both Tiebout and the share of MSA enrollment become significant at conventional levels. An increase in the amount of Tiebout competition in teachers' MSA increases the likelihood of TPS teachers having a regular certification, while a rise in the share of MSA charter enrollment reduces the probability of TPS teachers holding a regular state certification. The former result is statistically significant at the 1% level, and the latter is significant at 5%.

6.4 Union Status

Table 12 shows results from both the OLS and 2SLS regression of teachers belonging to a union or similar employees' association on the key competition variables. The dependent variable is equal to 1 if teachers belong to a union or similar employees' association and zero otherwise. Column (1) shows the regression for charter teachers and TPS teachers in a single equation. R-squared for the regression is .2156, and the p-value for the probability all coefficients are zero is 0.0000. As can be seen, charter teachers are far less likely to belong to a union or similar employees' association compared to TPS teachers, with the result significant at the 1% level. However, OLS results shown in columns (1) – (3) suggest competition has little significant effects on the union status of

public school teachers. The table also presents results of 2SLS estimation. Columns (4) – (6) appears to indicate moving from OLS to 2SLS strengthens the relationship between competition and union status. For all teachers, the share of MSA charter enrollment is now positively associated with the likelihood teaches belong to a union or similar employees' association, at the 10% level of significance, and column (4) also shows charter teachers are significantly less likely to be unionized. For charter teachers alone, the share of MSA charter enrollment is not statistically significant, but the amount of Tiebout competition is found to actually raise the probability of unionization, and the result is statistically different from zero at the 5% level. Lastly, for TPS teachers, column (6) indicates the share of MSA enrollment in charter schools, on average, reduces the probability of belonging to a union or similar employees' association at the 10% significance level, while the amount of Tiebout competition does not statistically affect union status.

6.5 Math Degree

Table 13 contains results for regressions in which the dependent variable is equal to one if a teachers has a Bachelor's degree in math and zero if they received a Bachelor's in another field from their college or university.[56] Very little variation in the dependent variable in each regression is explained by the variation in Tiebout competition, share of MSA charter enrollment, and other MSA-level covariates as indicated by the low R-squared in columns (1) – (3). However, the F-statistic on the null hypothesis that all explanatory variables are jointly equal to zero is 9.04, with an associated p-value for the probability of observing a greater F-statistic equal to 0.0000.

[56] The dependent variable is equal to one if the teacher has a degree in a math field and the degree was awarded outside the school's Department of Education.

Thus, we reject the null hypothesis, and conclude the model is valid. Moving on to the estimates, few statistically significant results emerge in columns (1) – (3)., which show results for OLS. However, 2SLS estimates found in columns (4) – (6) tell a much different story, and seem to suggest OLS understates the true effects of competition, particularly for TPS teachers. An increase in Tiebout competition is associated with an increase in the likelihood of TPS teachers possessing a Bachelor's degree in a math field, and the result is significant at the 5% level. Although not significant at conventional levels, the point estimate for the share of MSA enrollment in charter schools also suggests an increase in the likelihood of TPS teachers holding a math degree. Interestingly, the probability estimate switches sign from negative under OLS to positive when accounting for potential endogeneity issues biasing estimate of charter competition's effect as seen in column (6). For charter teachers and as shown in columns (2) and (5), neither OLS nor 2SLS estimation yield any significant competition effects. However, if point estimates are taken at face-value, Tiebout competition would raise the probability of a math degree for charter teachers, and the share of MSA charter enrollment would lower this probability. Finally, no difference in math degree exists between TPS teachers and charter teachers, as indicated by OLS estimated coefficient found on charter teacher in column (1), and reaffirmed by 2SLS results shown in column (4).

6.6 Teaches Secondary School Grades

Table 14 contains estimates and standards errors for regressions in which the dependent variable equals 1 if teachers only teach in secondary schools (grades 9-12) and zero otherwise. R-squared for the OLS regression of the model including all teachers in a

single equation is 0.0107. The F-statistic for the null hypothesis that all slopes equal zero is 7.79, which is reject at the 1% level of significance. Column (1) indicates charter teachers, relative to TPS teachers, are less likely to teach only those grades associated traditional secondary school. In addition, OLS results suggest the share of MSA charter enrollment increases the probability of secondary school grades, for both charter teachers and TPS teachers, as shown in columns (2) and (3), respectively. However, when turning to 2SLS, found in columns (5) and (6), despite increasing the magnitude of the effect for both charter and TPS teachers, the share of MSA charter enrollment loses statistical significance. Additionally, estimates on the index of Tiebout competition become positive under a 2SLS regression scheme for both charter teachers and TPS teachers. However, in neither instance is Tiebout competition statistically significant. Thus, it appears TPS teachers, overall, are more likely to be found in secondary schools relative to charter teachers, but neither the amount of Tiebout competition in teacher's MSA nor the share of MSA enrollment in charter schools affects the prevalence of secondary school assignment for charter teachers or TPS teachers.

6.7 Previously Taught in a Private School

OLS and 2SLS estimates for the regression in which the dependent variable is equal to 1 if a teacher has previously taught in a private school and zero otherwise is shown in columns (1) – (6) of Table 15. For each regression, the p-value for the null hypothesis that all coefficients are jointly equal to zero is 0.0000, implying that each regressions shown in columns (1) – (6) is significant at the 1% level of significance and valid. Examining column (1), for all teachers combined, it appears that raising the amount of Tiebout competition reduces the likelihood of having previously taught in a

private school, and the result is significant at 10%. Columns (2) and (3) show this result is largely driven by the sample of TPS teachers. For TPS teachers, the amount of Tiebout competition within teachers' MSA is negatively associated with the probability of having private school experience at the 5% level. For charter teachers, column (2) indicates neither the amount of Tiebout competition nor share of MSA charter enrollment has much effect on having previously taught in a private school. Moving on to the 2SLS estimates as shown in columns (4) – (6), the index of Tiebout competition loses statistical significance in each 2SLS regression. It is worthy to note, however, that for both charter teachers and TPS teachers, the sign changes from OLS to 2SLS. If anything it would appear that the amount of Tiebout competition raises the likelihood of having private school experience for TPS teachers and reduces the probability for charter teachers. As under OLS, the share of MSA enrollment in charter schools has little statistical significance for the probability of having taught in a private school for any of our sample of teachers. Lastly, column (4) indicates that charter teachers, relative to TPS teachers, are about 5% more likely to have taught at a private school at some point in their teaching career.

Table 9: Master's Degree Regressions

	OLS			2SLS		
	All	Charter	TPS	All	Charter	TPS
	(1)	(2)	(3)	(4)	(5)	(6)
Index of Tiebout competition	0.0106	-0.0162	0.0128	0.2570	0.1089	0.2478
	(0.0199)	(0.0629)	(0.0206)	(0.1312)**	(0.4499)	(0.1311)*
Charter enrollment share	-0.0697	-0.8734	-0.0342	0.1016	-6.7689	-0.0047
	(0.1579)	(0.4899)*	(0.1644)	(1.4105)	(7.6722)	(1.3832)
Charter teacher	-0.1684			0.0524		
	(0.0125)***			(0.1031)		
Private enrollment share	-0.3121	0.2144	-0.3805	-0.1178	1.0639	-0.1477
	(0.1094)***	(0.2816)	(0.1145)***	(0.2605)	(1.0977)	(0.2672)
Year = 1999-00	-0.0275	-0.2421	-0.0156	-0.0425	-0.2982	-0.0317
	(0.0148)*	(0.0437)***	(0.0152)	(0.0209)**	(0.0897)***	(0.0214)
Year = 2003-04	-0.0304	-0.1627	-0.0224	-0.0402	-0.2166	-0.0334
	(0.0122)**	(0.0325)***	(0.0126)*	(0.0165)**	(0.0771)***	(0.0168)**
Year = 2007-08	-0.0011	-0.1462	0.0060	-0.0176	-0.1751	-0.0108
	(0.0139)	(0.0404)***	(0.0144)	(0.0185)	(0.0762)**	(0.0189)
Constant	-1.5036	0.9568	-1.6862	-1.1240	2.0937	-1.2353
	(0.6840)**	(1.5010)	(0.7032)**	(0.8709)	(2.9608)	(0.8694)
R^2	0.0461	0.0431	0.0423			
Probability > F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MSAs represented	357	174	357	357	174	357
N	96.796	5,485	91,306	96.796	5,485	91,306

Notes: Dependent variable equals 1 if teacher has a Master's degree and 0 otherwise. Cluster-robust standard errors are in parenthesis. MSA characteristics, census division indicator variables, and year indicator variables are included as independent variables in all regressions. *** significant at 1%, ** significant at 5%, * significant at 10%.

Table 10: Beginning Teacher Regressions (1-3 Years of Experience)

	OLS			2SLS		
	All	Charter	TPS	All	Charter	TPS
	(1)	(2)	(3)	(4)	(5)	(6)
Index of Tiebout competition	-0.0035	0.0272	-0.0088	-0.0074	-0.2795	-0.0053
	(0.0108)	(0.0598)	(0.0108)	(0.0420)	(0.2598)	(0.0432)
Charter enrollment share	-0.1907	0.3116	-0.1558	-0.0812	-1.2627	-0.0308
	(0.0823)**	(0.3225)	(0.0829)*	(0.2089)	(2.9669)	(0.2104)
Charter teacher	0.2360			0.2336		
	(0.0118)***			(0.0117)***		
Private enrollment share	-0.0171	0.0013	-0.0061	0.0295	-1.0212	0.0405
	(0.0550)	(0.2477)	(0.0530)	(0.2326)	(1.7320)	(0.2273)
Year = 1999-00	0.0107	0.1249	0.0038	0.0139	0.1204	0.0064
	(0.0087)	(0.0365)***	(0.0087)	(0.0106)	(0.0762)	(0.0105)
Year = 2003-04	0.0051	0.0185	0.0041	0.0071	0.0154	0.0058
	(0.0066)	(0.0284)	(0.0065)	(0.0079)	(0.0661)	(0.0078)
Year = 2007-08	0.0251	-0.0154	0.0268	0.0264	-0.0079	0.0276
	(0.0081)***	(0.0348)	(0.0082)***	(0.0088)***	(0.0524)	(0.0089)***
Constant	0.1025	0.6164	0.0095	0.1081	-0.6897	0.0128
	(0.2532)	(1.4295)	(0.2461)	(0.3370)	(2.5120)	(0.3252)
R^2	0.0276	0.0411	0.0067			
Probability > F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MSAs represented	357	174	357	357	174	357
N	96.796	5,485	91,306	96.796	5,485	91,306

Notes: Dependent variable equals 1 if teacher has 1-3 years of experience and 0 otherwise. Cluster-robust standard errors are in parenthesis. MSA characteristics, census division indicator variables, and year indicator variables are included as independent variables in all regressions. *** significant at 1%, ** significant at 5%, * significant at 10%.

Table 11: State Certification Regressions

	OLS			2SLS		
	All	Charter	TPS	All	Charter	TPS
	(1)	(2)	(3)	(4)	(5)	(6)
Index of Tiebout competition	-0.0038	-0.0861	0.0120	0.1207	0.2447	0.1442
	(0.0123)	(0.0783)	(0.0118)	(0.0662)*	(0.5261)	(0.0624)**
Charter enrollment share	-0.1689	-0.5859	-0.2869	-0.7198	-6.2641	-0.7948
	(0.1134)	(0.3967)	(0.0982)***	(0.3083)**	(5.6632)	(0.2954)***
Charter teacher	-0.2182			-0.2168		
	(0.0174)***			(0.0176)***		
Private enrollment share	0.0400	0.1810	-0.0015	0.3033	1.3033	0.3311
	(0.0764)	(0.3657)	(0.0625)	(0.4267)	(4.1492)	(0.3560)
Year = 1999-00	-0.0641	-0.2514	-0.0529	-0.0829	-0.3684	-0.0723
	(0.0092)***	(0.0484)***	(0.0084)***	(0.0164)***	(0.1750)**	(0.0155)***
Year = 2003-04	-0.0502	-0.2433	-0.0413	-0.0640	-0.3470	-0.0556
	(0.0083)***	(0.0405)***	(0.0077)***	(0.0128)***	(0.1484)**	(0.0122)***
Year = 2007-08	-0.0393	-0.1172	-0.0361	-0.0510	-0.1770	-0.0485
	(0.0087)***	(0.0421)***	(0.0082)***	(0.0130)***	(0.1216)	(0.0129)***
Constant	0.4921	-1.5124	0.7135	0.7349	-0.3986	1.0411
	(0.3010)	(1.9701)	(0.2741)***	(0.5711)	(5.3839)	(0.4994)**
R^2	0.0373	0.0907	0.0099			
Probability > F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MSAs represented	357	174	357	357	174	357
N	96.796	5,485	91,306	96.796	5,485	91,306

Notes: Dependent variable equals 1 if teacher is regular state certification and 0 otherwise. Cluster-robust standard errors are in parenthesis. MSA characteristics, census division indicator variables, and year indicator variables are included as explanatory variables in all regressions. *** significant at 1%, significant at 5%, * significant at 10%.

Table 12: Union Status Regressions

	OLS			2SLS		
	All	Charter	TPS	All	Charter	TPS
	(1)	(2)	(3)	(4)	(5)	(6)
Index of Tiebout competition	0.0360	0.0734	0.0392	0.1056	1.2503	0.0459
	(0.0275)	(0.0726)	(0.0287)	(0.1102)	(0.6045)**	(0.1173)
Charter enrollment share	-0.2248	-0.1595	-0.2531	-1.2139	-3.8594	-1.2787
	(0.2384)	(0.5414)	(0.2704)	(0.6830)*	(6.0670)	(0.7227)*
Charter teacher	-0.5589			-0.5554		
	(0.0244)***			(0.0234)***		
Private enrollment share	0.2014	0.8434	0.1348	0.7952	1.1087	0.8644
	(0.1348)	(0.5787)	(0.1448)	(0.6864)	(3.1063)	(0.7430)
Year = 1999-00	0.0368	-0.0048	0.0403	0.0089	-0.1640	0.0143
	(0.0202)*	(0.0599)	(0.0217)*	(0.0295)	(0.1567)	(0.0317)
Year = 2003-04	0.0189	-0.0449	0.0234	-0.0027	-0.1653	0.0023
	(0.0166)	(0.0448)	(0.0177)	(0.0226)	(0.1225)	(0.0243)
Year = 2007-08	0.0272	0.0308	0.0284	0.0146	-0.0996	0.0198
	(0.0188)	(0.0548)	(0.0201)	(0.0233)	(0.1046)	(0.0247)
Constant	-2.8403	-2.3381	-2.8919	-2.2708	-0.6969	-2.2715
	(0.6854)***	(2.5598)	(0.7299)***	(1.0035)**	(4.4241)	(1.0806)**
R^2	0.2155	0.1453	0.1563			
Probability > F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MSAs represented	357	174	357	357	174	357
N	96.796	5,485	91,306	96.796	5,485	91,306

Notes: Dependent variable equals 1 if teacher belongs to a union or similar employees' association and 0 otherwise. Cluster-robust standard errors are in parenthesis. MSA characteristics, census division indicator variables, and year indicator variables are included as explanatory variables in all regressions. *** significant at 1%, ** significant at 5%, * significant at 10%.

Table 13: Math Degree Regressions

	OLS			2SLS		
	All	Charter	TPS	All	Charter	TPS
	(1)	(2)	(3)	(4)	(5)	(6)
Index of Tiebout competition	0.0014	0.0139	0.0012	0.0342	0.0049	0.0359
	(0.0029)	(0.0132)	(0.0031)	(0.0174)**	(0.0595)	(0.0181)**
Charter enrollment share	-0.0222	-0.0954	-0.0222	0.0849	-0.1936	0.0922
	(0.0222)	(0.0789)	(0.0236)	(0.0934)	(0.7442)	(0.0955)
Charter teacher	0.0015			0.0012		
	(0.0023)			(0.0024)		
Private enrollment share	-0.0257	0.0309	-0.0302	-0.0059	0.1405	-0.0159
	(0.0165)	(0.0623)	(0.0168)	(0.0728)	(0.2998)	(0.0736)
Year = 1999-00	0.0224	-0.0039	0.0238	0.0219	-0.0036	0.0234
	(0.0024)***	(0.0145)	(0.0025)***	(0.0035)***	(0.0204)	(0.0036)***
Year = 2003-04	0.0031	-0.0059	0.0036	0.0030	-0.0065	0.0036
	(0.0016)*	(0.0094)	(0.0017)***	(0.0026)	(0.0153)	(0.0027)
Year = 2007-08	0.0054	-0.0049	0.0059	0.0036	-0.0047	0.0040
	(0.0019)***	(0.0129)	(0.0020)***	(0.0027)	(0.0151)	(0.0028)
Constant	0.0463	-0.0695	0.0461	0.1040	0.1154	0.0997
	(0.0888)	(0.4216)	(0.0896)	(0.1318)	(0.5245)	(0.1334)
R^2	0.0037	0.0038	0.0041			
Probability > F	0.0000	0.0000	0.0000	0.0000	0.0007	0.0000
MSAs represented	357	174	357	357	174	357
N	96.796	5,485	91,306	96.796	5,485	91,306

Notes: Dependent variable equals 1 if teacher has a Bachelor's degree in math and 0 otherwise. Cluster-robust standard errors are in parenthesis. MSA characteristics, census division indicator variables, and year indicator variables are included as explanatory variables in all regressions. *** significant at 1%, ** significant at 5%, * significant at 10%.

Table 14: Secondary School Regressions

	OLS			2SLS		
	All	Charter	TPS	All	Charter	TPS
	(1)	(2)	(3)	(4)	(5)	(6)
Index of Tiebout competition	-0.0358	-0.0648	-0.0328	0.1913	0.5954	0.1969
	(0.0223)	(0.0941)	(0.0236)	(0.1204)	(0.4660)	(0.1261)
Charter enrollment share	0.5610	-1.0349	0.5624	0.5178	3.5184	0.6102
	(0.1769)***	(0.4970)**	(0.2038)***	(0.5601)	(5.5970)	(0.5743)
Charter teacher	-0.1299			-0.1245		
	(0.0193)***			(0.0196)***		
Private enrollment share	0.2430	1.0474	0.1636	0.2225	0.5602	0.2337
	(0.1263)*	(0.4011)***	(0.1262)	(0.5447)	(3.1147)	(0.5441)
Year = 1999-00	0.0974	-0.2757	0.1175	0.0783	-0.2285	0.1000
	(0.0177)***	(0.0658)***	(0.0183)***	(0.0248)***	(0.1390)*	(0.0260)***
Year = 2003-04	0.0969	-0.1834	0.1106	0.0864	-0.1404	0.1008
	(0.0142)***	(0.0515)***	(0.0144)***	(0.0197)***	(0.1239)	(0.0204)***
Year = 2007-08	0.1013	-0.1272	0.1119	0.0847	-0.1333	0.0957
	(0.0163)***	(0.0592)**	(0.0165)***	(0.0208)***	(0.0987)	(0.0218)***
Constant	1.4434	-0.1812	1.5568	1.6163	-0.3569	1.8517
	(0.5548)***	(2.3532)*	(0.5580)***	(0.8249)**	(4.3723)	(0.8195)
R^2	0.0107	0.0841	0.0092			
Probability > F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MSAs represented	357	174	357	357	174	357
N	96.796	5,485	91,306	96.796	5,485	91,306

Notes: Dependent variable equals 1 if teacher teaches grades 9-12 only and 0 otherwise. Cluster-robust standard errors are in parenthesis. MSA characteristics, census division indicator variables, and year indicator variables are included as explanatory variables in all regressions. *** significant at 1%, ** significant at 5%, * significant at 10%.

Table 15: Previously Taught in Private Schools Regressions

	OLS			2SLS		
	All	Charter	TPS	All	Charter	TPS
	(1)	(2)	(3)	(4)	(5)	(6)
Index of Tiebout competition	-0.0116	0.0251	-0.0168	0.0215	-0.0111	0.0176
	(0.0069)*	(0.0342)	(0.0070)**	(0.0266)	(0.1471)	(0.0268)
Charter enrollment share	0.0228	0.0208	0.0703	0.0431	0.7798	0.0095
	(0.0546)	(0.1549)	(0.0555)	(0.1633)	(1.7073)	(0.1593)
Charter teacher	0.0480			0.0474		
	(0.0060)***			(0.0062)***		
Private enrollment share	0.3125	0.0555	0.3366	-0.0009	0.2203	0.4388
	(0.0488)***	(0.1618)	(0.0447)***	(0.0108)	(0.7078)	(0.1851)
Year = 1999-00	0.1025	0.0077	0.0011	0.0985	0.1977	0.0928
	(0.0058)***	(0.0101)	(0.0021)	(0.0074)***	(0.0370)***	(0.0072)***
Year = 2003-04	0.0971	0.1557	0.0941	0.0952	0.1660	0.0917
	(0.0047)***	(0.0195)***	(0.0046)***	(0.0059)***	(0.0319)***	(0.0055)***
Year = 2007-08	0.0921	0.1380	0.0899	0.0895	0.1437	0.0871
	(0.0048)***	(0.0217)***	(0.0048)***	(0.0053)***	(0.0248)***	(0.0053)***
Constant	-0.1114	-1.5917	-0.0802	0.0022	-1.3345	0.0110
	(0.1893)	(0.9936)	(0.1859)	(0.2686)	(1.2412)	(0.2486)
R^2	0.0293	0.0571	0,0268			
Probability > F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MSAs represented	357	174	357	357	174	357
N	96.796	5,485	91,306	96.796	5,485	91,306

Notes: Dependent variable equals 1 if teacher has previously taught in a private school and 0 otherwise. Cluster-robust standard errors are in parenthesis. MSA characteristics, census division indicator variables, and year indicator variables are included as explanatory variables in all regressions. *** significant at 1%, ** significant at 5%, * significant at 10%.

7 Conclusion

Many education reforms, such as charter schools and private school vouchers, are premised, in part, on the notion that increased competition in the market for elementary and secondary education incentivizes schools to become more efficient education providers when parents have some form of school choice. A substantial body of literature has explored this notion, focusing mainly on the impact of competition on student achievement. Relatively few studies however explore the importance of competition on the labor market outcomes of teachers. The latter is important precisely because student achievement is largely a function of the things that past and present teachers do to promote student learning and growth. It has thus been theorized that competition could create incentives for schools to attract and keep those teachers that promote efficiency and enhance schools' profile with parents.[57]

This paper sheds light on this issue by estimating competition's effect on the wages paid to teachers and on the characteristics, skills, and attributes of teachers. We extend previous literature in three important ways. First, while many studies focus on a specific form of competition, we estimate a more comprehensive effect of competition by estimating models that include measures of Tiebout competition, charter school competition, and private school competition simultaneously. Second, we estimate competition's effect on both charter teachers and TPS teacher separately. This is important because policies that foster competition could have very different effects on teachers depending on the incentive structure of schools and the overall organizational goals of schools. Lastly, our model allows us to examine differences in teacher pay and

[57] See Hoxby (2002).

teacher characteristics according to differences in school-setting by comparing pay and characteristics of teachers working in charter schools to TPS schools.

Findings presented in this paper indicate that competition-based reforms would likely benefit teachers through higher pay. After controlling for potential omitted variable bias and endogeneity concerns, we find competition to be positively associated with teacher pay, particularly for TPS teachers. Changing the amount of Tiebout competition from a single monopoly district to simulate perfect competition would raise a TPS teacher's wages by approximately 24.5%. This translates into a non-trivial amount of almost $11,000 per school-year in all school-related earnings for the average teacher. Results of charter competition yield similar conclusions, though the relationship between pay and charter competition is reduced at just under 4% more for the average teacher.[58] Finally, although always insignificant, point estimates are suggestive that competition-based reforms could benefit charter teachers through higher pay as well, with the magnitude of the effects being slightly less than the wage effect for TPS teachers.

Findings presented in Chapter 6 tend to indicate that competition-based reforms would likely have little consensus impact on the type of teachers schools employ. After controlling for potential endogeneity concerns, 2SLS estimates generally return few robust effects of competition on the teacher characteristics examined. Of particular note however is that Tiebout competition appears to raise the likelihood of teachers with a Bachelor's degree in math for TPS teachers; raise the likelihood of teachers having a Master's degree for TPS teachers; and raise the likelihood of teachers having a regular state certification for TPS teachers. Additionally, for TPS teachers, charter competition lowers the probability of teachers having a regular state certification and lowers the

[58] This is equivalent to a little under $2,000.

likelihood of teachers belonging to a union or similar employees association. Lastly, competition appears to have little statistical relationship with the characteristics, skills, and attributes of charter teachers.

Other findings presented in Chapters 5 and 6 highlight a number of important differences between teachers working in charter schools and TPS teachers that warrant mention. Charter school teachers tend to receive significantly less compensation than do TPS teachers, and the characteristics, skills, and attributes also vary quite substantially between the public school types. On average, charter teachers receive more than 7% less pay relative to their TPS counterpart. Moreover, as described above, competition has little statistical influence on the wages paid to charter teachers, which dramatically contrasts with the effect of competition, both Tiebout and charter, for teachers working in TPSs. Other important differences include charter teachers being much less likely to hold a Master's degree, far more likely to be beginning-level teachers (1-3 years of experience), and considerably less likely to have a regular state certification or belong to a teachers' union relative to TPS teachers. Charter teachers are also more likely to have come from private schools, and they are less likely to be confined to teaching traditional secondary school grades (grades 9-12) than are teachers in TPSs. Lastly, as noted above, neither school-choice reforms such as charter schools nor traditional forms of competition like Tiebout competition appear to make much of a difference in the characteristics, skills, and attributes of teachers in charter schools. This contrast with TPS teachers seeing some change in credentials due to competition.

Finally, it has been long been noted in the education literature that a number of the measures of competition used in this very analysis are confounded by unobservable

influences, requiring an instrumental variables approach. We introduce two new instruments to the mix in estimating the effect of charter competition, along with specifying proven instruments used in previous analyses to produce instrumental variables estimate of Tiebout competition and private school competition. Specifically, we take the strength of charter law and time elapsed since the law first passed. First-stage results seemingly indicate that these two new instruments are highly correlated with charter competition and prove as credible instruments. Furthermore, 2SLS results show the importance of correcting for unobserved influences in estimating charter competition's effect on pay. OLS produces negative and statistically insignificant estimates, whereas 2SLS results yield positive and statistically significant wage effects. Instrumenting for both Tiebout competition and private school competition likewise raise the magnitude and/or significance of estimates. These findings underscore the notion that failing to correct for confounding influences will lead to false conclusions regarding the effects of competition, and highlight the importance of taking care to eliminate endogeneity concerns when studying competition.

Appendix Alternative Measures of Competition

Appendix Table 1: Means and Correlation Among Alternative Competition Measures

Panel A: Summary Statistics

	Mean	S.D.	Min.	Max.
Index of Tiebout competition	0.789	0.219	0.000	0.985
Herfindahl index based on total MSA enrollment	0.828	0.187	0.042	0.989
Charter enrollment Herfindahl	0.551	0.427	0.000	0.992
Private enrollment Herfindahl	0.937	0.087	0.309	0.999
Charter enrollment share	0.020	0.027	0.000	0.313
Private enrollment share	0.091	0.043	0.002	0.314

N = 96,796

Panel B: Correlation Among the Measures of Competition

		(1)	(2)	(3)	(4)	(5)	(6)
Index of Tiebout Competition	(1)	1.00					
Herfindahl index based on total MSA enrollment	(2)	0.99	1.00				
Charter enrollment Herfindahl	(3)	0.32	0.34	1.00			
Private enrollment Herfindahl	(4)	0.48	0.52	0.50	1.00		
Charter enrollment share	(5)	0.13	0.16	0.58	0.16	1.00	
Private enrollment share	(6)	0.21	0.29	0.12	0.48	-0.13	1.00

Appendix Alternative Wage Equation Results

Appendix Table 2: Wage Equation Regressions Using Herfindahl Index Based on District Shares of Total MSA Enrollment

	OLS			2SLS		
	All	Charter	TPS	All	Charter	TPS
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Regression Results						
Herfindahl index	0.0293	-0.0389	0.0308	0.3054	0.2307	0.3094
	(0.0136)**	(0.0549)	(0.0143)**	(0.1516)**	(0.2311)	(0.1513)**
Charter enrollment share	0.1357	-0.1893	0.1975	2.0288	0.7032	1.9596
	(0.1174)	(0.1956)	(0.1295)	(0.4651)***	(1.9253)	(0.4626)***
Charter teacher	-0.0693			-0.0731		
	(0.0071)***			(0.0078)***		
Private enrollment share	-0.2006	0.3024	-0.2318	0.2372	0.4188	0.2331
	(0.0811)***	(0.1474)**	(0.0825)***	(0.5041)	(0.9694)	(0.5126)
Master's	0.1158	0.0978	0.1160	0.1156	0.0981	0.1158
	(0.0024)***	(0.0073)***	(0.0024)***	(0.0026)***	(0.0076)***	(0.0026)***
Experience	0.0298	0.0252	0.0300	0.0298	0.0249	0.0300
	(0.0004)***	(0.0021)***	(0.0004)***	(0.0004)***	(0.0020)***	(0.0004)***
Experience-squared	-0.0005	-0.0004	-0.0005	-0.0005	-0.0004	-0.0005
	(0.0000)***	(0.0000)***	(0.0000)***	(0.0000)***	(0.0000)***	(0.0000)***
Taught at private school	-0.0327	-0.0654	-0.0290	-0.0338	-0.0654	-0.0303
	(0.0021)***	(0.0088)***	(0.0022)***	(0.0024)***	(0.0089)***	(0.0024)***
1-3 years experience	0.0039	-0.0040	0.0022	0.0042	-0.0042	0.0024
	(0.0028)	(0.0090)	(0.0029)	(0.0030)	(0.0090)	(0.0031)

Appendix Table 2: (Continued)

Teaches grades 9-12	0.0247	0.0503	0.0240	0.0240	0.0515	0.0233
	(0.0020)***	(0.0086)***	(0.0020)***	(0.0023)***	(0.0086)***	(0.0023)***
Special education	-0.0095	-0.0007	-0.0099	-0.0102	0.0010	-0.0106
	(0.0018)***	(0.0118)	(0.0018)***	(0.0020)***	(0.0121)	(0.0020)***
Certified	0.0203	0.0370	0.0185	0.0203	0.0375	0.0184
	(0.0028)***	(0.0068)***	(0.0028)***	(0.0029)***	(0.0065)***	(0.0028)***
Female	-0.0418	-0.0265	-0.0426	-0.0419	-0.0264	-0.0427
	(0.0015)***	(0.0061)***	(0.0014)***	(0.0015)***	(0.0062)***	(0.0015)***
Hispanic	0.0001	-0.0156	0.0026	-0.0001	-0.0140	0.0019
	(0.0035)	(0.0107)	(0.0035)	(0.0046)	(0.0112)	(0.0045)
Black	0.0051	0.0008	0.0063	0.0062	0.0014	0.0073
	(0.0050)	(0.0099)	(0.0051)	(0.0048)	(0.0103)	(0.0050)
Union	0.0341	0.0660	0.0303	0.0342	0.0647	0.0306
	(0.0025)***	(0.0103)***	(0.0027)***	(0.0031)***	(0.0107)***	(0.0034)***
Constant	6.5669	8.2004	6.4790	7.7279	8.5646	7.6689
	(0.3782)***	(0.9235)***	(0.3860)***	(0.7776)***	(1.5242)***	(0.7762)***
Panel B: Regression Statistics						
R^2	0.6743	0.5950	0.6747			
Probability > F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MSAs represented	357	174	357	357	174	357
N	96,796	5,485	91,306	96,796	5,485	91,306

Notes: The dependent variable is the log of all school-related earnings. Standard errors clustered by MSA are in parenthesis. MSA characteristics, census division indicator variables, and year indicator variables are included as additional explanatory variables in all regressions. *** significant at 1%, ** significant at 5%, * significant at 10%.

Appendix Table 3: Wage Equation Regressions Using Charter Enrollment Herfindahl and Private Enrollment Herfindahl

	OLS			2SLS		
	All	Charter	TPS	All	Charter	TPS
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Regression Results						
Index of Tiebout competition	0.0428	-0.0374	0.0479	0.2643	0.0560	0.2763
	(0.0110)***	(0.0426)	(0.0116)***	(0.1084)**	(0.1892)	(0.1121)**
Charter enrollment Herfindahl	0.0388	-0.0656	0.0386	0.1195	0.0063	0.1133
	(0.0083)***	(0.0271)**	(0.0084)***	(0.0275)***	(0.1047)	(0.0284)***
Charter teacher	-0.0729			-0.0738		
	(0.0067)***			(0.0068)***		
Private enrollment Herfindahl	-0.1596	-0.1357	-0.1646	0.1163	-0.3382	0.1534
	(0.0338)***	(0.1099)	(0.0346)***	(0.2109)	(0.3826)	(0.2220)
Master's	0.1158	0.0979	0.1161	0.1154	0.0981	0.1156
	(0.0024)***	(0.0073)***	(0.0024)***	(0.0027)***	(0.0075)***	(0.0027)***
Experience	0.0298	0.0251	0.0300	0.0298	0.0251	0.0300
	(0.0004)***	(0.0021)***	(0.0004)***	(0.0005)***	(0.0021)***	(0.0004)***
Experience-squared	-0.0005	-0.0004	-0.0005	-0.0005	-0.0004	-0.0005
	(0.0000)***	(0.0000)***	(0.0000)***	(0.0000)***	(0.0000)***	(0.0000)***
Taught at private school	-0.0331	-0.0641	-0.0293	-0.0337	-0.0649	-0.0301
	(0.0021)***	(0.0088)***	(0.0022)***	(0.0023)***	(0.0089)***	(0.0023)***
1-3 years experience	0.0041	-0.0038	0.0025	0.0042	-0.0038	0.0025
	(0.0028)	(0.0089)	(0.0029)	(0.0029)	(0.0089)	(0.0030)

Appendix Table 3: (Continued)

Teaches grades 9-12	0.0251	0.0514	0.0244	0.0239	0.0528	0.0232
	(0.0020)***	(0.0085)***	(0.0020)***	(0.0022)***	(0.0081)***	(0.0022)***
Special education	-0.0097	0.0004	-0.0101	-0.0100	0.0002	-0.0103
	(0.0018)***	(0.0117)	(0.0018)***	(0.0020)***	(0.0120)	(0.0020)***
Certified	0.0209	0.0369	0.0188	0.0208	0.0376	0.0188
	(0.0028)***	(0.0067)***	(0.0029)***	(0.0027)***	(0.0063)***	(0.0028)***
Female	-0.0418	-0.0261	-0.0426	-0.0420	-0.0256	-0.0428
	(0.0015)***	(0.0060)***	(0.0014)***	(0.0015)***	(0.0058)***	(0.0015)***
Hispanic	0.0003	-0.0145	0.0026	-0.0002	-0.0118	0.0017
	(0.0035)	(0.0108)	(0.0035)	(0.0036)	(0.0115)	(0.0037)
Black	0.0050	0.0006	0.0062	0.0061	0.0011	0.0073
	(0.0049)	(0.0098)	(0.0050)	(0.0045)	(0.0102)	(0.0046)
Union	0.0335	0.0654	0.0297	0.0342	0.0635	0.0305
	(0.0025)***	(0.0106)***	(0.0026)***	(0.0027)***	(0.0106)***	(0.0029)***
Constant	7.0490	8.1308	6.9922	7.1665	8.4868	7.0463
	(0.3455)***	(0.9589)***	(0.3536)***	(0.6251)***	(1.2097)***	(0.6406)***
Panel B: Regression Statistics						
R^2	0.6758	0.5954	0.6762			
Probability > F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MSAs represented	357	174	357	357	174	357
N	96,796	5,485	91,306	96,796	5,485	91,306

Notes: The dependent variable is the log of all school-related earnings. Standard errors clustered by MSA are in parenthesis. MSA characteristics, census division indicator variables, and year indicator variables are included as additional explanatory variables in all regressions. *** significant at 1%, ** significant at 5%, * significant at 10%.

Appendix Wage Equation Results Clustering by District

Appendix Table 4: Wage Equation Regressions, Standard Errors Clustered by District

	OLS			2SLS		
	All	Charter	TPS	All	Charter	TPS
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Regression Results						
Index of Tiebout competition	0.0346	-0.0498	0.0360	0.2485	0.2383	0.2465
	(0.0145)**	(0.0480)	(0.0153)**	(0.1219)**	(0.1952)	(0.1252)**
Charter enrollment share	0.1165	-0.3341	0.1714	1.4821	-1.2072	1.4510
	(0.0945)	(0.1932)*	(0.1024)*	(0.4359)***	(1.6742)	(0.4363)***
Charter teacher	-0.0837			-0.0842		
	(0.0071)***			(0.0084)***		
Private enrollment share	-0.1593	0.3367	-0.1954	0.3266	0.8614	0.2994
	(0.0673)**	(0.1976)*	(0.0711)***	(0.5775)	(1.2087)	(0.6043)
Master's	0.1164	0.0860	0.1171	0.1159	0.0861	0.1168
	(0.0021)***	(0.0088)***	(0.0021)***	(0.0029)***	(0.0090)***	(0.0028)***
Experience	0.0302	0.0288	0.0302	0.0303	0.0285	0.0303
	(0.0004)***	(0.0023)***	(0.0004)***	(0.0004)***	(0.0021)***	(0.0004)***
Experience-squared	-0.0005	-0.0005	-0.0005	-0.0005	-0.0005	-0.0005
	(0.0000)***	(0.0000)***	(0.0000)***	(0.0000)***	(0.0000)***	(0.0000)***
Taught at private school	-0.0298	-0.0682	-0.0272	-0.0309	-0.0675	-0.0284
	(0.0026)***	(0.0123)***	(0.0026)***	(0.0028)***	(0.0128)***	(0.0028)***
1-3 years experience	0.0074	0.0145	0.0057	0.0075	0.0140	0.0058
	(0.0028)**	(0.0110)	(0.0029)*	(0.0029)**	(0.0114)	(0.0030)*

Appendix Table 4: (Continued)

Teaches grades 9-12	0.0244	0.0420	0.0237	0.0238	0.0444	0.0232
	(0.0023)***	(0.0106)***	(0.0023)***	(0.0024)***	(0.0114)***	(0.0024)***
Special education	-0.0103	0.0011	-0.0106	-0.0109	0.0034	-0.0111
	(0.0022)***	(0.0126)	(0.0023)***	(0.0024)***	(0.0126)	(0.0024)***
Certified	0.0184	0.0242	0.0187	0.0183	0.0249	0.0186
	(0.0031)***	(0.0090)***	(0.0033)***	(0.0032)***	(0.0099)**	(0.0033)***
Female	-0.0419	-0.0243	-0.0427	-0.0418	-0.0231	-0.0427
	(0.0016)***	(0.0076)***	(0.0016)***	(0.0016)***	(0.0078)***	(0.0017)***
Hispanic	0.0009	-0.0242	0.0037	0.0006	-0.0243	0.0030
	(0.0053)	(0.0131)*	(0.0052)	(0.0071)	(0.0142)*	(0.0066)
Black	0.0086	0.0148	0.0082	0.0097	0.0134	0.0093
	(0.0083)	(0.0114)	(0.0093)	(0.0074)	(0.0131)	(0.0082)
Union	0.0362	0.0782	0.0329	0.0362	0.0769	0.0332
	(0.0031)***	(0.0115)***	(0.0033)***	(0.0033)***	(0.0127)***	(0.0034)***
Constant	6.4061	8.3985	6.2742	7.4973	9.2000	7.3663
	(0.4530)***	(1.0029)***	(0.4707)***	(0.8845)***	(1.6863)***	(0.9051)***
Panel B: Regression Statistics						
R^2	0.6420	0.5358	0.6452			
Probability > F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MSAs represented	356	151	356	356	151	356
N	70,897	3,431	67,461	70,897	3,431	67,461

Notes: The dependent variable is the log of all school-related earnings. Standard errors clustered by district are in parenthesis. MSA characteristics, census division indicators, and year indicator variables are included as additional explanatory variables in all regressions. Lose 1999-00 school-year due to missing LEAID for charter teachers. *** significant at 1%, ** significant at 5%, * significant at 10%.

Appendix Alternative Teacher Characteristic Equation Results

Appendix Table 5: Master's Degree Regressions

	OLS			2SLS		
	All	Charter	TPS	All	Charter	TPS
	(1)	(2)	(3)	(4)	(5)	(6)
Index of Tiebout competition	0.0149	-0.0306	0.0198	0.3056	-0.2586	0.3050
	(0.0202)	(0.0639)	(0.0210)	(0.1441)**	(0.5006)	(0.1463)**
Charter enrollment Herfindahl	0.0069	-0.0823	0.0098	-0.0235	-0.7249	-0.0261
	(0.0129)	(0.0493)*	(0.0132)	(0.0798)	(0.3805)*	(0.0808)
Charter teacher	-0.1699			0.1790		
	(0.0122)***			(0.1266)		
Private enrollment Herfindahl	-0.0165	0.0916	-0.0312	0.2586	0.3679	0.2758
	(0.0492)	(0.2368)	(0.0501)	(0.2665)	(0.6091)	(0.2720)
Year = 1999-00	-0.0277	-0.2058	-0.0170	-0.0604	-0.2578	-0.0517
	(0.0144)*	(0.0385)***	(0.0149)	(0.0273)**	(0.0756)***	(0.0284)*
Year = 2003-04	-0.0324	-0.1378	-0.0258	-0.0541	-0.1775	-0.0489
	(0.0119)***	(0.0313)***	(0.0123)**	(0.0194)***	(0.0546)***	(0.0202)**
Year = 2007-08	-0.0022	-0.1244	0.0040	-0.0267	-0.1358	-0.0212
	(0.0140)	(0.0410)***	(0.0145)	(0.0219)	(0.0646)**	(0.0228)
Constant	-1.1834	0.5909	-1.2806	-1.3613	0.9128	-1.4985
	(0.6894)*	(1.5607)	(0.7128)*	(0.7817)*	(2.9173)	(0.7986)*
R^2	0.0458	0.0418	0.0418			
Probability > F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MSAs represented	357	174	357	357	174	357
N	96.796	5,485	91,306	96.796	5,485	91,306

Notes: Dependent variable equals 1 if teacher has a Master's degree and 0 otherwise. Cluster-robust standard errors are in parenthesis. MSA characteristics, census division indicator variables, and year indicator variables are included as explanatory variables in all regressions. *** significant at 1%, ** significant at 5%, * significant at 10%.

Appendix Table 6: Beginning Teacher Regressions (1-3 Years of Experience)

	OLS			2SLS		
	All	Charter	TPS	All	Charter	TPS
	(1)	(2)	(3)	(4)	(5)	(6)
Index of Tiebout competition	-0.0092	0.0285	-0.0138	0.0004	-0.1857	-0.0087
	(0.0105)	(0.0608)	(0.0108)	(0.0530)	(0.2706)	(0.0545)
Charter enrollment Herfindahl	0.0034	0.0792	-0.0008	0.0014	-0.0158	0.0030
	(0.0057)	(0.0475)*	(0.0056)	(0.0154)	(0.1606)	(0.0157)
Charter teacher	0.2330			0.2328		
	(0.0118)***			(0.0119)***		
Private enrollment Herfindahl	0.0182	-0.2949	0.0283	0.0322	0.1189	-0.0093
	(0.0246)	(0.2105)	(0.0245)	(0.1072)	(0.5102)	(0.1088)
Year = 1999-00	0.0152	0.1167	0.0067	0.0138	0.1183	0.0085
	(0.0090)*	(0.0336)***	(0.0090)	(0.0127)	(0.0579)**	(0.0129)
Year = 2003-04	0.0080	0.0145	0.0061	0.0070	0.0131	0.0073
	(0.0068)	(0.0272)	(0.0067)	(0.0094)	(0.0478)	(0.0093)
Year = 2007-08	0.0262	-0.0261	0.0279	0.0257	-0.0093	0.0282
	(0.0085)***	(0.0335)	(0.0085)***	(0.0100)***	(0.0440)	(0.0101)***
Constant	0.1064	1.3077	-0.0250	0.0451	0.2430	0.0000
	(0.2480)	(1.3487)	(0.2424)	(0.3100)	(1.8425)	(0.3088)
R^2	0.0275	.0419	0.0067			
Probability > F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MSAs represented	357	174	357	357	174	357
N	96.796	5,485	91,306	96.796	5,485	91,306

Notes: Dependent variable equals 1 if teacher has 1-3 years of experience and 0 otherwise. Cluster-robust standard errors are in parenthesis. MSA characteristics, census division indicator variables, and year indicator variables are included as explanatory variables in all regressions. *** significant at 1%, ** significant at 5%, * significant at 10%.

Appendix Table 7: State Certification Regressions

	OLS			2SLS		
	All	Charter	TPS	All	Charter	TPS
	(1)	(2)	(3)	(4)	(5)	(6)
Index of Tiebout competition	-0.0057	-0.0915	0.0079	0.0851	0.1502	0.1171
	(0.0125)	(0.0795)	(0.0119)	(0.0779)	(0.4718)	(0.0733)
Charter enrollment Herfindahl	-0.0273	-0.1292	-0.0253	-0.0567	-0.4915	-0.0585
	(0.0077)***	(0.0614)**	(0.0067)***	(0.0220)***	(0.2931)*	(0.0205)***
Charter teacher	-0.2162			-0.2153		
	(0.0175)***			(0.0184)***		
Private enrollment Herfindahl	-0.0130	0.3968	-0.0278	-0.0781	0.0469	-0.0382
	(0.0315)	(0.2865)	(0.0282)	(0.1821)	(1.1111)	(0.1552)
Year = 1999-00	-0.0620	-0.2350	-0.0485	-0.0696	-0.3075	-0.0602
	(0.0093)***	(0.0471)***	(0.0083)***	(0.0185)***	(0.1043)***	(0.0172)***
Year = 2003-04	-0.0471	-0.2336	-0.0366	-0.0515	-0.2841	-0.0438
	(0.0082)***	(0.0391)***	(0.0075)***	(0.0145)***	(0.0845)***	(0.0136)***
Year = 2007-08	-0.0349	-0.0999	-0.0312	-0.0408	-0.1241	-0.0393
	(0.0087)***	(0.0399)**	(0.0081)***	(0.0128)***	(0.0613)**	(0.0129)***
Constant	0.3624	-2.6503	0.6332	0.4797	-2.4574	0.7058
	(0.2904)	(1.9932)	(0.2757)**	(0.4597)	(3.8454)	(0.4202)*
R^2	0.0367	0.0101	0.0922			
Probability > F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MSAs represented	357	174	357	357	174	357
N	96.796	5,485	91,306	96.796	5,485	91,306

Notes: Dependent variable equals 1 if teacher has regular state certification and 0 otherwise. Cluster-robust standard errors are in parenthesis. MSA characteristics, census division indicator variables, and year indicator variables are included as explanatory variables in all regressions. *** significant at 1%, ** significant at 5%, * significant at 10%.

Appendix Table 8: Union Status Regressions

	OLS			2SLS		
	All	Charter	TPS	All	Charter	TPS
	(1)	(2)	(3)	(4)	(5)	(6)
Index of Tiebout competition	0.0266	0.0718	0.0305	0.1392	0.9701	0.0976
	(0.0284)	(0.0713)	(0.0300)	(0.1489)	(0.6099)	(0.1603)
Charter enrollment Herfindahl	0.0034	-0.1718	0.0048	-0.0916	-0.2897	-0.0985
	(0.0153)	(0.1063)	(0.0158)	(0.0495)*	(0.3938)	(0.0525)*
Charter teacher	-0.5624			-0.5573		
	(0.0239)***			(0.0234)***		
Private enrollment Herfindahl	-0.0314	0.0964	-0.0448	0.2855	-0.6783	0.3767
	(0.0678)	(0.3347)	(0.0690)	(0.3019)	(1.4132)	(0.3337)
Year = 1999-00	0.0451	-0.0149	0.0489	0.0110	-0.0797	0.0119
	(0.0202)**	(0.0570)	(0.0220)**	(0.0356)	(0.1435)	(0.0391)
Year = 2003-04	0.0258	-0.0489	0.0302	0.0029	-0.0859	0.0048
	(0.0168)	(0.0430)	(0.0180)*	(0.0273)	(0.1093)	(0.0298)
Year = 2007-08	0.0298	0.0297	0.0310	0.0183	-0.0452	0.0210
	(0.0188)	(0.0553)	(0.0202)	(0.0269)	(0.0855)	(0.0289)
Constant	-2.9768	-3.7418	-2.9568	-3.5952	-1.0876	-3.8034
	(0.6756)***	(2.7844)	(0.7119)***	(0.8954)***	(5.6584)	(0.9342)***
R^2	0.2153	0.1463	0.1561			
Probability > F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MSAs represented	357	174	357	357	174	357
N	96.796	5,485	91,306	96.796	5,485	91,306

Notes: Dependent variable equals 1 if teacher belongs to a union or similar employees' association and 0 otherwise. Cluster-robust standard errors are in parenthesis. MSA characteristics, census division indicator variables, and year indicator variables are included as explanatory variables in all regressions. *** significant at 1%, ** significant at 5%, *** significant at 10%.

Appendix Table 9: Math Degree Regressions

	OLS			2SLS		
	All	Charter	TPS	All	Charter	TPS
	(1)	(2)	(3)	(4)	(5)	(6)
Index of Tiebout competition	0.0013	0.0126	0.0010	0.0286	-0.0094	0.0312
	(0.0029)	(0.0127)	(0.0030)	(0.0173)*	(0.0741)	(0.0181)*
Charter enrollment Herfindahl	0.0001	-0.0207	0.0011	0.0075	-0.0045	0.0082
	(0.0019)	(0.0128)	(0.0020)	(0.0058)	(0.0409)	(0.0059)
Charter teacher	0.0012			0.0012		
	(0.0023)			(0.0024)		
Private enrollment Herfindahl	0.0008	-0.0378	0.0018	-0.0252	-0.0345	-0.0235
	(0.0083)	(0.0542)	(0.0084)	(0.0372)	(0.1378)	(0.0384)
Year = 1999-00	0.0227	-0.0001	0.0241	0.0229	0.0028	0.0241
	(0.0024)***	(0.0132)	(0.0024)***	(0.0044)***	(0.0191)	(0.0045)***
Year = 2003-04	0.0032	-0.0029	0.0036	0.0036	-0.0007	0.0039
	(0.0016)*	(0.0087)	(0.0017)**	(0.0030)	(0.0134)	(0.0032)
Year = 2007-08	0.0055	-0.0026	0.0058	0.0038	-0.0016	0.0041
	(0.0019)***	(0.0122)	(0.0020)***	(0.0030)	(0.0149)	(0.0031)
Constant	0.0682	-0.0269	0.0742	0.1586	0.0170	0.1626
	(0.0887)	(0.4370)	(0.0900)	(0.1169)	(0.4608)	(0.1168)
R^2	0.0037	0.0041	0.0040			
Probability > F	0.0000	0.2043	0.0000	0.0000	0.0003	0.0000
MSAs represented	357	174	357	357	174	357
N	96.796	5,485	91,306	96.796	5,485	91,306

Notes: Dependent variable equals 1 if teacher has a Bachelor's degree in math and 0 otherwise. Cluster-robust standard errors are in parenthesis. MSA characteristics, census division indicator variables, and year indicator variables are included as explanatory variables in all regressions. *** significant at 1%, ** significant at 5%, * significant at 10%.

Appendix Table 10: Secondary School Teacher Regressions

	OLS			2SLS		
	All	Charter	TPS	All	Charter	TPS
	(1)	(2)	(3)	(4)	(5)	(6)
Index of Tiebout competition	-0.0306	-0.0891	-0.0267	0.2369	0.6932	0.2439
	(0.0225)	(0.0959)	(0.0236)	(0.1597)	(0.5443)	(0.1646)
Charter enrollment Herfindahl	-0.0072	-0.0932	0.0030	0.0290	0.2031	0.0394
	(0.0141)	(0.0792)	(0.0145)	(0.0427)	(0.3383)	(0.0439)
Charter teacher	-0.1223			-0.1265		
	(0.0193)***			(0.0201)***		
Private enrollment Herfindahl	0.1645	-0.1283	0.1594	0.2181	0.3750	0.2232
	(0.0640)***	(0.4314)	(0.0640)**	(0.3361)	(1.2548)	(0.3430)
Year = 1999-00	0.0821	-0.2373	0.1034	0.0642	-0.2770	0.0856
	(0.0174)***	(0.0650)***	(0.0181)***	(0.0344)*	(0.1266)**	(0.0360)**
Year = 2003-04	0.0867	-0.1530	0.1003	0.0745	-0.1857	0.0884
	(0.0141)***	(0.0509)***	(0.0145)***	(0.0266)***	(0.1005)*	(0.0278)***
Year = 2007-08	0.0967	-0.1104	0.1064	0.0749	-0.1656	0.0850
	(0.0162)***	(0.0622)*	(0.0166)***	(0.0255)***	(0.0849)*	(0.0269)***
Constant	1.0321	-1.0170	1.2817	1.0876	-1.4074	1.3260
	(0.5359)*	(2.4418)	(0.5408)**	(0.8300)	(4.0154)	(0.8313)
R^2	0.0103	0.0089	0.0781			
Probability > F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MSAs represented	357	174	357	357	174	357
N	96.796	5,485	91,306	96.796	5,485	91,306

Notes: Dependent variable equals 1 if teacher teaches grades 9-12 only and 0 otherwise. Cluster-robust standard errors are in parenthesis. MSA characteristics, census division indicator variables, and year indicator variables are included as explanatory variables in all regressions. *** significant at 1%, ** significant at 5%, * significant at 10%.

Appendix Table 11: Previously Taught in Private Schools Regressions

	OLS			2SLS		
	All	Charter	TPS	All	Charter	TPS
	(1)	(2)	(3)	(4)	(5)	(6)
Index of Tiebout competition	-0.0207	0.0232	-0.0250	0.0197	0.0345	0.0126
	(0.0071)***	(0.0343)	(0.0072)***	(0.0251)	(0.1564)	(0.0252)
Charter enrollment Herfindahl	0.0068	0.0539	0.0038	0.0040	0.0483	0.0007
	(0.0043)	(0.0241)**	(0.0043)	(0.0110)	(0.1002)	(0.0107)
Charter teacher	0.0467			0.0466		
	(0.0058)***			(0.0059)***		
Private enrollment Herfindahl	0.0776	0.1520	0.0778	0.0635	0.1716	0.0580
	(0.0184)***	(0.1394)	(0.0184)***	(0.0500)	(0.1680)	(0.0508)
Year = 1999-00	0.1040	0.1852	0.0984	0.1009	0.1834	0.0958
	(0.0058)***	(0.0219)***	(0.0058)***	(0.0074)***	0.02576)***	(0.0073)***
Year = 2003-04	0.0991	0.1544	0.0958	0.0973	0.1529	0.0943
	(0.0046)***	(0.0189)***	(0.0046)***	(0.0052)***	(0.0215)***	(0.0052)***
Year = 2007-08	0.0918	0.1369	0.0898	0.0898	0.1345	0.0880
	(0.0048)***	(0.0210)***	(0.0049)***	(0.0052)***	(0.0232)***	(0.0053)***
Constant	-0.4480	-1.9306	-0.4414	-0.5071	-1.8186	-0.5038
	(0.2109)***	(1.0701)*	(0.2117)**	(0.2274)**	(1.0005)*	(0.2261)**
R^2	0.0286	0.0580	0.0259			
Probability > F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
MSAs represented	357	174	357	357	174	357
N	96.796	5,485	91,306	96.796	5,485	91,306

Notes: Dependent variable equals 1 if teacher has previously taught in a private school and 0 otherwise. Cluster-robust standard errors are in parenthesis. MSA characteristics, census division indicator variables, and year indicator variables are included as explanatory variables in all regressions. *** significant at 1%, ** significant at 5%, * significant at 10%.

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Vita

Casey S. Brasher

Birthplace: Corbin, KY

Education

Master of Science, Economics, University of Kentucky, Lexington KY, December 2006

Bachelor of Science, Economics, University of Kentucky, Lexington, KY August 2002

Professional and Research Experience

Assistant Professor of Economics, Stafford School of Business, Abraham Baldwin Agricultural College, August 2015 –

Adjunct Faculty Member, Business Department, Midway College, January 2014 – December 2014

Research Assistant, Department of Economics, University of Kentucky, August 2011 – May 2012

Instructor, Public Economics, University of Kentucky, Fall 2009

Research Assistant, Center for Business and Economic Research, University of Kentucky, Spring 2009

Teaching Assistant, Department of Economics, University of Kentucky, August 2006 – August 2008

Academic Awards and Honors

Research Challenge Trust Fund II Gatton Doctoral Fellowship, University of Kentucky, 2006-2008

Publications

Jepsen, Christopher, Kenneth Troske, and Casey Brasher. (2009). "Estimates of the Costs and Benefits of Expanding the Early Childhood Education Program in Kentucky." Prepared for the Pritchard Committee for Academic Excellence.