

A double draw of proximity: The importance of geography in teacher application and hiring decisions

AUTHORS

Kieran M. Killeen

University of Vermont

Susanna Loeb

Stanford University

Imeh Williams

ABSTRACT

This paper explores teacher labor markets with a new focus on the interplay between where teachers seek and obtain work. Prior research has assumed that the geographic constraints in the teacher labor operate through teacher preferences but, in fact, no research separates teachers' preferences for working close to their hometown, from employers' preferences for hiring local teachers. We use 2010 data from the largest on-line jobs clearinghouse for teachers in the United States to explore linkages between the characteristics of teachers, including their distance to a potential job, and their application behavior; and, at the same time to examine the relationship between candidates, their distance to a job, and the likelihood of a job offer. The paper finds that teachers tend to seek positions close to home and provides new evidence that employers also value proximity. Employers tend to hire teachers that live locally to them.

VERSION

November 2015

Suggested citation: Killeen, K., Loeb, S., & Townsend, J. (2015). A double draw of proximity: The importance of geography in teacher application and hiring decisions (CEPA Working Paper No.15-18). Retrieved from Stanford Center for Education Policy Analysis: <http://cepa.stanford.edu/wp15-18>

**A double draw of proximity:
The importance of geography in teacher application and hiring decisions**

Kieran M. Killeen, Ph.D. (Corresponding author)

Associate Professor
Educational Leadership and Policy Studies
University of Vermont
499B Waterman Hall
Burlington, VT 05405
Phone: (802)-656-3250
Email: Kieran.Killeen@uvm.edu

Susanna Loeb, Ph.D.
Barnett Family Professor of Education
Center for Education Policy Analysis at Stanford (CEPA)
Stanford University
520 Galvez Mall CERAS Building, Room 524
Stanford, CA 94305-3084
Phone: (650) 736-1258
Fax: (650) 723-9931
Email: sloeb@stanford.edu

Imeh Williams
Ph.D. Candidate
Center for Education Policy Analysis at Stanford (CEPA)
Stanford University
520 Galvez Mall CERAS Building, Room 524
Stanford, CA 94305-3084
Phone: (650) 736-1258
Fax: (650) 723-9931
Email: iwilliams@stanford.edu

March 3, 2013

Abstract

This paper explores teacher labor markets with a new focus on the interplay between where teachers seek and obtain work. Prior research has assumed that the geographic constraints in the teacher labor market operate through teacher preferences but, in fact, no research separates teachers' preferences for working close to their hometown, from employers' preferences for hiring local teachers. We use 2010 data from the largest on-line jobs clearinghouse for teachers in the United States to explore linkages between the characteristics of teachers, including their distance to a potential job, and their application behavior; and, at the same time to examine the relationship between candidates, their distance to a job, and the likelihood of a job offer. The paper finds that teachers tend to seek positions close to home and provides new evidence that employers also value proximity. Employers tend to hire teachers that live locally to them.

Highlights

- The novel jobs clearinghouse data reinforce prior findings that teachers tend to seek positions close to home and provide new evidence that employers also value proximity.
- 75% of all teaching jobs are applied for within a 150 mile distance from the applicant's current residence.
- Employers are less likely to hire applicants that are farther away

Keywords

- School teachers;
- Teacher labor markets;
- Teacher mobility;
- Teacher supply;
- Teacher hiring

JEL Classification

I20, J45, J62

Introduction

Among the mechanisms through which schools influence students, many of the strongest and most direct work through teachers (Goldhaber, Brewer, & Anderson, 1999; Darling-Hammond, 1999; Rockoff, 2004; Rivkin, Hanushek & Kain, 2005). Yet schools vary in the strength of their teacher workforce and their abilities to retain their teachers (Lankford, Loeb, & Wyckoff, 2002). Variation in student populations, school characteristics, and geographic location combine with teacher preferences to disadvantage some schools in teacher recruitment. Prior research shows clearly that different schools face different pools of teacher candidates from which to build their teacher workforce (e.g., Boyd et al., 2011a). In addition, schools and districts may make different choices even if faced with the same pool of applicants. That is, as with hiring for any job, teacher hiring is a two-way process that is defined by both the applicants who offer to work in available positions and those who the school selects as the best available candidates. Given that the teacher to whom a student is assigned is likely to meaningfully affect that students' learning, these differences in recruitment and hiring can affect students' educational opportunities (Nye, Konstantopoulos, & Hedges 2004; Rockoff 2004). Understanding the reasons for the differences in teacher quality across schools requires an understanding of both sides of the hiring process (Boyd et al., 2010). Unfortunately, it is often difficult to disentangle supply from demand because the only available data is the ultimate match of a teacher to a school. In this study, we use application and hiring data that allow us to distinguish supply and demand in the teacher labor market. We use these data to examine the role of geography in both the supply and demand side of the teacher labor market.

Existing research suggests that not only is the supply of teaching candidates influenced by geography, but that the teaching profession may be uniquely sensitive to geographic influence

relative to other professions (Boyd et al., 2005b; Reininger, 2012). However, the research on geographic proximity to date implicitly has assumed that the preference for geographic proximity comes from the teacher or supply side of the market. The assertion is that teachers are more likely than most professionals to work close to where they live or grew up for a variety of reasons including a closer connection to their original community. However, schools may also have a preference for more proximate teachers because these teachers may be easier to process through the hiring stages, may be less likely to leave after employment, may better understand the local context, or may be more likely to share unobserved traits with hiring officials. Hiring officials in schools alternatively may prefer teachers who are less proximate because these teachers are more likely to bring intellectual, pedagogical, or demographic diversity to the school setting. In either case, schools, districts and hiring officials may factor geography into their hiring decisions, and no research to date has distinguished the role of geography for teachers and employers.

This paper explores the interplay between where teachers seek work and where they are offered positions, specifically focusing on the relationship between geography and both the supply of and the demand for new teachers. There are many different types of teaching positions - different elementary school grades, elementary content specialists, middle school history positions, etc. In order to isolate geographic differences in the supply and demand of teachers from job differences, we first examine positions in all teaching areas then focus our analyses to a subset of teaching jobs, those in special education, science and math. We choose these fields because they have tended to be in high demand, with relatively low supply, and, as we demonstrate below, this tendency holds for the school districts that we examine as well. Better

understanding the way geography impacts hiring decisions could also be a step towards helping schools in geographic areas that have low teacher supply to fill open positions.

Extant data for this study provide novel opportunities for understanding teacher labor markets because they include information on all jobs applied to in a single state as well as whether or not the teacher was given an offer for that job. In particular, we use 2010 data from the largest on-line jobs clearinghouse for teachers to explore linkages between the characteristics of teachers - including their distance to a potential job - their application behavior, and the hiring behaviors of the schools and districts to which they apply. The clearinghouse includes all jobs posted in the state of Vermont for positions in public school districts. The dataset also includes positions in other states, but we do not include other states in this analysis because they are not fully covered by the clearinghouse.

The study addresses the following research questions:

1. What is the distribution of distance between teacher applicants and the employers to which they apply, and how does applicant distance vary by subject area?
2. To what extent does travel distance factor into a candidate's decision to apply to teaching positions in shortage areas?
3. To what extent do employers consider applicant distance when making job offers in shortage areas?

Background

The matching of teachers to schools is a function of two components: the prospective teachers looking for work and the teaching positions that schools wish to fill. As such, the hiring of teaching personnel by schools represents a two-way process with several distinct stages.

Figure 1 provides a conceptual portrait of this process. During the hiring season the stock of available teachers readies themselves for the job market. Teaching candidates include those newly certified, those certified but employed in other schools, and those with prior certification that are not currently employed. Schools determine their expected needs for new teachers. In some cases schools need teachers - perhaps, long-term substitutes - immediately and in other cases they advertise teaching positions months ahead of a start-date. Teaching candidates are constrained in their application behavior by the jobs that come available. Teachers combine their preferences with the available jobs in determining the jobs to which to submit application materials. School administrators or hiring officers sort through this pool of applications, rank them, conduct interviews and make job offers. Finally, teaching candidates decide whether to accept or reject the offer(s) that they receive. Though Figure 1 depicts this process as a series of stages or conditional events, it is likely that both teachers and administrators follow a more dynamic process with jobs becoming available at different times and choices changing as new information surfaces or preferences change. Although it is relatively straightforward to examine the outcome of these dynamics by looking at the personnel composition within schools, it is harder to disentangle these dynamics to identify the causes of the ultimate matching of teachers to schools.

In what follows, we highlight some of the existing literature that has attempted to separate the supply of teachers for particular jobs from the demand of schools for particular teachers in order to better explain the functioning of teacher labor markets.

Teaching candidates' preferences for schools: The labor market for teachers includes those individuals for whom at least some teaching jobs are more attractive options than jobs in other occupations. Similarly, the supply of teachers that is available to fill a given teaching

position is determined by prospective candidates who find the position potentially more appealing than other potentially available options. To some extent teachers preferences for positions are influenced by aspects of the job-type or position itself (e.g. some individuals want to teach high school calculus). It also may be the result of the characteristics of the school in which the position is available. Existing research suggests that there are three categories of school attributes that are particularly salient to the supply of teachers available for positions in schools: the demographics of the student body, the functioning of the school including school leadership, and the location of the school.

A consistent body of recent research highlights the ways in which prospective teachers consider the demographics of the schools in which they might apply for positions (Guarino et al., 2006). Because teachers leave teaching largely by their own choice, researchers can learn about teacher preferences from the characteristics of schools they choose to leave. In their analysis of teacher mobility in Texas, Hanushek et al. (2004) found that teacher attrition is higher in schools with lower levels of student achievement and greater proportions of low-income and minority students. They also found that when teachers switch schools, they tend to move toward schools with higher levels of student achievement and lower proportions of low-income and minority students. Boyd et al. (2005a) similarly examined teacher mobility in New York and found that teachers are more likely to transfer or stop teaching in New York public schools when they are in schools with lower levels of student achievement or schools that serve greater proportions of nonwhite students. Although these studies provide suggestive evidence for the school characteristics that teachers prefer, they only include observations of teachers' career paths, not their application decisions nor their job offers. Without that information it is difficult to separate teachers' preferences from the opportunities that they have available. Boyd et al. (2011a) is one

of the few studies to use application data, though it is limited to those teachers hoping to transfer across schools within the New York City school district. The study found that teachers are more likely to apply away from and less likely to apply to schools with a higher proportion of students eligible for subsidized lunch as well as black and Hispanic students.

Research also provides some evidence that teachers care about working conditions separate from the characteristics of students. Loeb, Darling-Hammond and Luczak (2005) using data on California schools found that salaries and working conditions -including large class sizes, facilities problems, multi-track schools, and lack of textbooks -strongly predict teacher turnover and that when these conditions are taken into account, the influence of student characteristics on turnover is substantially reduced. Similarly, a substantial body of research points to the importance of school leadership for teachers' career decisions and again finds that differences in school leadership across schools explains at least some of the relationship between student characteristics and teachers' career choices (Grissom et al., 2012; Grissom, 2011; Grissom et al., 2011; Ladd, 2011; Boyd et al., 2011c) .

While students and working conditions contribute to teachers' assessments of the benefits of working at different schools, geographical location is also often an important consideration. Geography matters for at least two reasons. First, teachers have preferences for attributes of the neighborhoods in which schools are located. Second, teaching candidates may be sensitive to the geographic distance between a school and where they live or where they want to live. Boyd et al. (2011a) used teacher transfer application data from New York City to analyze the relationships between a detailed set of neighborhood characteristics and transfer decisions. They found that after controlling for school and teacher characteristics, models that predict whether teachers submit transfer applications and where teachers apply for transfers indicates that teachers are

more attracted to neighborhoods with higher median family income and less violent crime; teachers transferring to or from high-density areas are also attracted by the presence of amenities (e.g. grocery stores, libraries, restaurants, and bars).

A series of papers also has found that geographic proximity is an important characteristic of teachers' job matches. Boyd et al. (2005b) examined relationship between New York State teachers' first jobs and where those teachers went to college and high school. They found that after controlling for other school and teacher characteristics, teachers are far more likely to teach in schools that are closer to their hometowns and similar with respect to the urbanicity of their hometowns. Three additional studies reinforced this "draw to home" of teachers, but in doing so demonstrated the difficulty in disentangling supply and demand preferences from geography. Reininger (2012) used data from the National Education Longitudinal Study of 1988 to analyze the geographic mobility of teachers and to compare it to the mobility of individuals in other occupations. The study found that teachers, in comparison to other college graduates and professionals, move shorter distances between 10th grade and ten years later and are more likely to continue to live in their hometown. The "draw to home" thesis is also supported by Miller (2012) who examined the role of community amenities on the preferences of teachers to locate in rural areas. He found that proximity to one's home community was the dominant "amenity" feature for teachers' locational preferences. Similarly, Strauss et al. (2000) in a study of Pennsylvania schools found 40 percent of teachers were graduates of the districts in which they worked. None of these studies clearly separate supply-side causes from potential demand-side causes.

The pattern of geographic proximity to home may be explained by factors including attraction to familiar cultural values and experiences, or even attachment to social networks.

Cannata's (2010; 2011) followed 27 new teachers through the application and subsequent hiring process. She found a draw to home due, at least in part, by an interest in being close to parents who may be able to provide support for grandchildren. Overall, these findings suggest that teaching candidates are likely *uniquely* sensitive to geographic factors; however, they do not explicitly address the role of schools' hiring decisions in the geographic proximity of teachers ultimate job match.

Schools' preferences for teachers: There is a dearth of research on the demand side of the teacher labor market. Many of the studies discussed above rely on personnel data to describe the stock of teachers at their place of employment. These data can shed little light on the preferences of school hiring authorities. Most of the insights on the demand side of the market come from surveys and interviews. For example, Rutledge, Harris, Ingle, and Thompson (2010) used interviews of school principals in a midsized Florida school district to identify teacher characteristics principals prefer which included strong teaching skills, caring, subject knowledge, and experience, among other characteristics. This study did not assess principals' preferences for geographic proximity. Others have also queried school administrators to help understand what characteristics of teachers are preferable. These studies identify a variety of preferences, including some related to geographic characteristics of teaching candidates. For example, in a study of 31 Chicago principals, Engel, Finch and Huff (2012) found that principals in low-achieving schools often use hiring resources provided by the district and to hire their own substitutes and student teachers. Strauss et al. (2000) conducted a survey of Pennsylvania school districts superintendents in the late 1990's and found the most influential factors used to narrow the paper applicant pool for interviewing were having a major in area of teaching, overall grade point average and grade point average in major, past performance in teaching, and reference or

recommendations. The study also found that content knowledge and the caliber of certifying institution were about as important as indications of community involvement, willingness to assist in extracurricular activities, and non-teaching work experience.

Two papers to date have used administrative data to assess schools preferences for teachers. Boyd et al. (2013) uses readily available information on teacher and school matches and then using a game-theoretic two-sided matching model to assess school preferences for teachers. Using the method of simulated moments strategy Boyd et al. estimates the preferences of teachers and school hiring authorities that could result in the observed match. This study does directly assess the role of distance on both sides of the market and finds employers demonstrate preferences for teachers living in closer proximity to the school as well as for teachers having stronger academic achievement, measured by having more than a BA degree, the selectivity of their undergraduate college, and their score on the basic knowledge teacher-certification exam. While this is evidence of the importance of distance for employers, it is a highly parameterized simulation.

Teacher application data combined with data on teachers' job placement allows for some analyses into how schools choose among the candidates who apply for available positions. Boyd et al. (2011a), as described above, used data on applications by New York City teachers to transfer across schools. While the data did not include offers, the study was able to examine which of the applicants eventually worked in the school. They found that schools appear to prefer teachers with degrees from more selective undergraduate schools, more advanced degrees, and higher scores on basic certification exams. Because prospective employers in New York State do not directly observe certification exam scores, but rather are only aware of whether a particular candidate has a passing score, the authors posited that these scores are good proxies for

other desirable teacher characteristics. This study did not look specifically at the role of geography. In the current study we extend the aforementioned studies with novel data about teachers, their applications for jobs, the whether they receive an offer or not, and also the importance of geographic proximity in the job search and hiring process.

Data

We utilize multiple data sources to understand how travel distance affects supply and demand in the teacher labor market. First, we use information collected by a private firm, an online education jobs clearinghouse called *SchoolSpring.com* to obtain data on job applicants and employers. Then, we combine the SchoolSpring data with district demographic and fiscal data from the National Center for Education Statistics' (NCES) Common Core of Data (CCD). Finally, we add distance and travel-time information generated using ArcGIS and Google Maps API.

SchoolSpring.com: SchoolSpring facilitates the study of both the supply and demand sides of the teacher labor market by collecting information on all teacher candidates and employers for public schools in the state of Vermont for the 2006-07 to 2008-09 school years. SchoolSpring is the country's largest on-line jobs clearinghouse focused on education professionals with upwards of 40,000 unique visitors per day. More importantly, SchoolSpring has contracts with all school districts in Vermont, which allows us to study the entire Vermont public school teacher labor market. Our initial sample consists of approximately 3,500 jobs and 9,000 teacher candidates.

SchoolSpring posts employment opportunities for a wide variety of education positions. As such, we conducted a keyword searching of job titles and other relevant fields to winnow

down the database to focus upon teachers seeking fulltime positions in public schools. The following types of teaching positions were excluded: summer program, after school, teaching assistants, child care, academic support center, Head Start, private preschool, speech and language pathologists, non-teaching behavior interventionists, and guidance counselors.

Teacher candidates using SchoolSpring complete a common application for which they supply information about their education credentials (i.e., college transcripts and test scores), prior work experiences, and professional references. Candidates can use the common application to apply to multiple jobs simultaneously. In addition, teacher candidates have the opportunity to tailor their applications by answering specific questions posed by employers.

SchoolSpring data on candidates includes a range of information not typically available in large-scale studies of teachers' career paths. This information includes prior teaching, experience, current salary, date available to begin work, gender, race, birth year, highest level of education, highest degree earned, gpa from bachelors' program, gpa from masters' program, major(s) from BA program, major(s) from MA programs, teaching examination scores (though the exam varies and the scores are difficult equate), certification status, certification area, proficiency in another language, veteran status, and address. In addition, SchoolSpring data include detailed text fields such as the applicants' introductory statement, cover letter, references submitted in applicants' behalf. For the analyses that we present in this paper, we use a subset of these data after examining the variables for quality and considering the variable's relevance in answering our research questions.

Table 1 provides a listing with descriptive information for the variables we use. Approximately 45 percent of all teacher candidates currently live out of state, as do 33 percent of candidates for special education, math or science positions. Ten percent of these teachers have

essentially no teaching experience, while 27 percent have one to three years and another 33 percent have four to nine years. Gender and race are missing for a large group of teachers, but 25 percent report being male and only five percent report not being white.

The SchoolSpring data also contains information on jobs and the advertisement of those jobs. This information includes number of positions such as job start date, job status (i.e., filled or not), job type (i.e., full time, part time), posting date, level of education preferred, position type (i.e., new, retirement), salary, prior experience required, grade level, benefits, number of references required, school location, type of school (e.g. public, charter, private), job title, employer's address, job requirements, and the job description. Table 2 provides descriptive statistics of employer fields used in analyses. For example, we see that, on average each position receives 23 applications, while the shortage fields receive an average of less than 13 applications; approximately 21 percent of jobs are for special education positions while math and science positions each comprise about 11 percent of all jobs.

NCES Common Core of Data: The CCD supplements the SchoolSpring data with demographic and fiscal data for school districts in Vermont. The CCD annually collects data from state education agencies that include name, addresses, demographic information about students and staff, and district-level revenues and expenditures. The data from the CCD provides descriptive information about the districts operating in Vermont and serves as controls in models that attempt to estimate the role of travel distance in supply and demand processes. Our sample comes from Vermont and, as shown in Table 2, 94 percent of district enrollment is white and 29 percent is poor. Forty-six percent of jobs are in rural districts, and only five percent are in urban districts.

Travel Information: We leverage the addresses from SchoolSpring and the CCD to estimate automobile travel distances. The first step in obtaining travel information is to convert candidate and employer addresses into map coordinates (i.e., longitude and latitude) using the spatial analysis technique of geocoding. In particular, we use ArcGIS software to geocode street addresses to obtain map coordinates. Then, we input the map coordinates to Google's Web API, which estimates automobile travel distance between candidates and employers. The use of travel distances improves upon the prior literature that use straight-line distances because straight-line distances do not take into account topographical features such as the layout of roads and the geographic barriers which typically lengthen travel distances. For example, Vermont has a network of roads that facilitate north/south travel, but it is very difficult to travel east or west across the state due to its mountainous terrain. So, there may be instances where a teacher candidate and potential employer are spatially close to one another but very far away by car. In this study we provide the results in terms of travel distances expressed in road miles, we also ran similar analyses using travel time. The findings are the similar regardless of whether travel distance is measured in miles or minutes.

Methods

In order to answer our research questions, we first define shortage areas. A shortage occurs when the demand for teachers exceeds the supply. In our study, shortage areas refer to math, science, and special education. Historically, schools district across the country have had a particularly hard time finding qualified applicants to fill these positions. We verify our definition of critical shortage areas by computing the mean number of applications by subject area along with standard deviations and 95 percent confidence intervals to allow for comparison across subjects.

Q1. What is the distribution of distance between teacher applicants and the employers to which they apply, and how does applicant distance vary by subject area? To address the first research question, we estimate the mean, standard deviation, and quartiles (25th, 50th, and 75th percentiles) of travel distance between applicants and employers. In addition to the estimation of descriptive statistics, we generate density plots showing the distribution of travel distances.

After analyzing the overall distribution, we explore that variation in travel distance across subject areas. First, we categorized jobs into the following subject areas using a key word search of job advertisements: social studies, English/language arts (ELA), art/music, limited English proficient, physical education/health, special education, science, math, and foreign language. Then, we estimate the mean applicant travel distance by subject area as well as the 95 percent confidence intervals to identify statistically significant differences.

Q2. To what extent does travel distance factor into a candidate's decision to apply to teaching positions in shortage areas? After verifying our choice of shortage areas, we estimate a discrete choice model to determine the relationship between travel distance and the likelihood of applying to a teaching position. We use a conditional logit model, specified below, to estimate the likelihood teacher i applies to an open position j :

$$\Pr(Y_{ij} = j | J_i) = \frac{e^{X_{ij}\beta}}{\sum_{j=1}^{J_i} e^{X_{ij}\beta}} \quad (1)$$

J_i represents the set of alternative jobs a teacher candidate can choose from and X_{ij} is a vector of job characteristics that include travel distance between employer and candidate (with a squared term), subject area, grade level, degree preferences, experience requirements, and district demographic data (i.e., enrollment, racial composition, poverty, and urbanicity). We report the results from the choice model in two formats: odds ratios and average marginal probabilities. First, we report the model results in the form of odds ratios (i.e., $p/(1-p)$). The odds ratio

provides insights to the relative relationship between travel distance and job application submission, specifically the probability of an applicant applying for a position. But, the measure does not provide information about the magnitude of the probability. Therefore, we also estimate the average marginal probability which captures the change in probability corresponding with a one-unit change in the independent variable, while holding all over variables constant at their mean). Estimating marginal probabilities from conditional logistic regression models is not ideal because the predicted probability depends on the group. Therefore, we report the average marginal probability conditional on the fixed effect being zero. In other words, we estimate the average marginal probability over the observed variables and set the fixed effect at the average for the sample.

We also extend the basic discrete choice model to determine whether the relationship between the likelihood of applying and travel distance varies by candidate or job attributes:

$$\Pr(Y_{ij} = j|I_i) = \frac{e^{X_{ij}\beta + W_{ij}\theta}}{\sum_{j=1}^J e^{X_{ij}\beta + W_{ij}\theta}} \quad (2)$$

W_{ij} , the additional term, is a vector of interactions between travel distance and candidate/job characteristics. We again report the results in the form of odds ratios and average marginal probabilities.

Q3. To what extent do employers consider applicant distance when making job offers in shortage areas? The aforementioned discrete choice models provide insights into applicants' preferences for teaching positions. Along the same lines, we estimate the role of travel distance on the demand side of the teacher hiring process. In particular, we estimate a conditional logit model predicting the likelihood employer i offers employment to a candidate c :

$$\Pr(Y_{ic} = c|C_i) = \frac{e^{X_{ic}\mu}}{\sum_{c=1}^C e^{X_{ic}\mu}} \quad (3)$$

C_i represents the set of alternative teacher applicants an employer can choose from and X_{ic} is a vector of applicant characteristics that include travel distance between employer and candidate (with a squared term), Vermont residency status, education, prior teaching experience, certification, language skills, gender, and race. We also extend the basic discrete choice model to determine whether the relationship between the likelihood an employer makes an offer and travel distance differs by candidate and/or job attributes.

Results

Table 1 presents statistics describing the teacher candidates in both the overall sample and shortage areas. We find that a substantial proportion of teacher candidates reside outside the state. Overall 45 percent of teacher applicants reside outside of Vermont; 33 percent of applicants applying to shortage areas reside outside the state. These findings are not surprising given that Vermont is the sixth smallest state in nation and borders three states (Massachusetts to the south, New Hampshire to the east, and New York to the west). The candidate pool is mostly white. Approximately 60 percent identify as white, while 37 percent do not report their race. It is likely that the vast majority of applicants not reporting race are white, given the National Center for Education Statistics (NCES) estimate that 97 percent of teachers in Vermont are white.¹

Table 1 also describes the education and experience of teachers. More than half (51 percent) of applicants earned a graduate degree. The proportion of applicants with graduate degrees is slightly higher, 54 percent, among applicants in shortage fields. These estimates are similar to statewide estimates from NCES showing that 57 percent of teachers in Vermont have a

¹ Statistic from the SASS Table Library. SOURCE: U.S. Department of Education, National Center for Education Statistics, Schools and Staffing Survey (SASS), "Public School Teacher Data File," 2007-08. http://nces.ed.gov/surveys/sass/tables/sass0708_2009324_t1s_02.asp

graduate degree. Not surprisingly, teacher applicants have less teaching experience than that of teachers in Vermont. Overall, 22 percent of teacher applicants and 26 percent of teacher applicants in shortage areas have 10 or more years of teaching experience compared to the statewide estimate of 58 percent. In sum, Vermont teacher applicants have similar levels of education and less teaching experience than the teacher workforce.

Table 2 presents descriptive statistics regarding the characteristics of jobs in our sample. We find that jobs in shortage areas receive fewer applications than the average job. While the typical job in our sample receives about 23 applications, jobs in shortages receive about half as many applications (13 applications). Special education jobs are the most common jobs in shortage areas (52 percent). In terms of grade level, nearly 60 percent jobs in both samples target middle school teachers. Finally, the majority of open positions are located in small town or rural areas that serve majority white students (94 percent) and a significant concentration of poor students (30 percent).

Before we explore the results from the choice models in detail, we present evidence to support our characterization of shortage areas. Figure 2 presents the mean number of application submissions by the teaching subject area. Social studies has the highest mean number of applications among the subject areas, with 38 applications per job. English Language Arts (ELA) has 26; art or music, 19; and PE or health, 17. Special education, science and math have far fewer applicants per position, approximately 12 on average for any of the three positions. Foreign language positions also have few applicants per position, but these jobs openings are not as common, so we do not include them in the subsequent analyses.

Q1. What is the distribution of distance between teacher applicants and the employers to which they apply, and how does applicant distance vary by subject area? We find variation in

the distance between applicants and employers. Figure 3 shows a density plot of the travel distance distribution with vertical lines identifying quartiles (i.e., 25th, 50th, and 75th percentiles) as well as the mean for all teaching applicants. The figure shows that most applicants for teaching positions are within a short distance of their current residence. The distribution of travel distance is right-skewed with the concentration of observations below 100 miles and relatively few observations between 200 and 1000 miles. A simple comparison of the mean and median travel distance supports this observation. The mean applicant distance is greater than the median travel distance (131 miles compared to 43 miles) and closer to the 75th percentile. We also observe the 25th percentile at 17 miles and 75th percentile at 152 miles. The interquartile range (distance between first and third quartiles) for the distribution is 135 miles and the range (max – min) of the distribution is approximately 1,000, which suggests that travel distances are concentrated in small segment of the range of travel distances. In other words, 50 percent of the observed travel distances are concentrated in approximately 14 percent of the range of travel distances.

We also find variation in travel distance when we disaggregate the data by subject area. Figure 4 presents mean applicant travel distance for the various subject areas. We observe a fair amount of variation with science, math and special education applicants applying, on average, to jobs the farthest away (193 miles) than social studies, art and music, and foreign language applicants.

Figure 5 replicates Figure 3 but instead of plotting the distance between applicants and job positions, we plot the distance between jobs and the candidates to whom the hiring authority gave job offers. Again, the density plot shows that most offers go to teachers who live a short distance from the school. The distribution of travel distance is right-skewed with the

concentration of observations below 50 miles and relatively few observations between 60 and 200 miles. Thus, similar to the travel distance for applicants in Figure 3, the travel distances for candidates receiving offers is, in most cases, not very far. The key distinction to note is that the travel distances in Figure 5 are substantially smaller than the travel distances in Figure 3, suggesting that not only do applicants consider distance when choosing where to apply, but given their applicant pool, schools consider distance in choosing to whom to offer jobs. We explore both the applicant and the offer sides of the market in more detail below.

Q2. To what extent does travel distance factor into a candidate's decision to apply to teaching positions in shortage areas? In order to understand the relationship between travel distance and the likelihood of applying to teaching positions in shortage areas, we employ techniques that take into account the characteristics of jobs, estimating discrete choice models pioneered by McFadden (1973).

Results of the analyses provide evidence that, on average, applicants are less likely to apply to teaching positions as travel distance increases. While clear that the distance to the job substantially reduces the probability of applying, the effect of distance itself grows less influential as it increases. Table 3 presents estimates in the form of both odds ratios and average marginal probabilities. The odds ratio results show a negative and statistically significant association between travel distance and likelihood of applying. The average marginal probability estimates corroborate the odd ratio estimates where an additional ten miles between an employer and job candidate lowers the probability of applying by approximately four percentage points. Moreover, the relatively stable estimates with the inclusion of observable job characteristics suggests that travel distance is not simply picking up other job characteristics over which applicants have preferences.

Figure 6a plots the average marginal probability estimates at various distances, providing a more nuanced perspective of travel distance estimates. The direction of the relationship between travel distance and applying depends on the specific distance. For example, travel distance is negatively associated with applying for approximately the first 300 miles but the relationship becomes very small as the distance increases past 200 miles. The negative effect of distance on applications is consistent with prior research that has examined the relationship between a teacher's job location and where he or she attended high school and college (Boyd et al., 2005b). The lack of the negative effect of distance after 300 miles may result from a relative indifference to distance given the need to move.

Table 3 also provides some insights into the relationship between application behavior and characteristics of jobs aside from distance. In keeping with prior literature, teachers are more likely to apply to positions with higher proportion of white students, and they are less likely to apply to the most rural district. Perhaps more specific to Vermont, teachers in our sample are slightly more likely to apply to districts with a higher proportion of poor students, to larger districts, and to elementary and middle-school positions rather than to high schools. These trends may be due to the proximity of these higher poverty districts to other districts that are appealing to live in for teachers and other college graduates.

We find some evidence that the relationship between travel distance and the decision to apply varies over job characteristics. Table 4 presents results from the discrete choice model of an applicant's decision to apply with interaction terms between travel distance and job characteristics. The relationship between travel distances and applying varies by shortage area. The odds ratio estimates show that candidates are less sensitive to distance when applying to math and science teaching jobs compared to special education jobs. Teachers applying to special

education may be especially sensitive to distance, but the differences are small. Candidates applying to jobs in poorer districts also seem somewhat less sensitive to distance.

The relationship between travel distance and application also varies somewhat with candidate characteristics, and these differences are more intuitive. Table 5 presents these results. First, candidates from out of state are less negatively affected by travel distance - perhaps because they are likely to have to move residence to take a position in Vermont regardless of the position. In fact, there is very little relationship between distance and applying for out of state residents. Figure 6b plots these relationships. We also find an interactions between distance and both teaching experience and gender. More experienced candidates are more sensitive to travel distance, perhaps because they are more settled meaning they own homes, have older and more elaborate social networks, and/or close family ties. These findings imply that it is especially difficult for schools in less desirable geographic locations to attract experienced teachers. Female candidates are also more sensitive to travel distance than are male candidates, though this difference is not great.

Q3. To what extent do employers consider applicant distance when making job offers in shortage areas? Table 6 presents results from the model predicting employers' selection of employees from a pool of applicants. We are able to conduct this analysis because SchoolSpring provides a field for whether the school made an offer to the candidate. Overall, employers are less likely to hire applicants that are farther away. An additional 10 miles of travel distance decreases the probability an employer makes an offer of employment by 1 percentage point. This result provides evidence that employers value proximity in their candidates, though slightly less than do the applicants. The estimate is significant, but lower.

Figure 7a plots these results. Again, the effect of distance is negative through at least 300 miles but the effect of distance decreases in magnitude as distance increases. Interestingly, very few other candidate characteristics that we measure appear to affect the decisions of hiring authorities. One exception is that schools appear to prefer teachers with less than ten years of experience to more experienced applicants which may reflect a preference for less expensive hires.

Table 7 displays additional relationships between travel distances and candidate characteristics, and important differences. The odds ratio results provide evidence that distance isn't as important for employers' assessments of out of state applicants. The plot of marginal probability estimates for travel distance disaggregated by residency status (Figure 7b) shows that travel distance remains close to zero and statically insignificant for the entire range of distances for non-Vermont residences. In contrast, travel distance is negative associated with employers making offers to Vermont residences from about 0-200 miles. Moreover, employers are also less likely to extend offers of employment to teachers with standard certification as distance increases, and they are more likely to extend offers to minority applicants than white teachers as travel distance increases.

In the final analysis, Table 8 provides evidence of variation in travel distance estimates by job characteristics. The largest interaction with distance is for school level. Distance appears to matter little for high schools but more for middle schools and even more for elementary schools. Figure 7c plots these results. We also find some differences by district enrollment and by the proportion of poor students in the district. Figures 7d and 7e plots these results, showing that distance matters less in smaller districts and in districts with fewer poor students.

Discussion

The novel application and hiring decision data provided by SchoolSpring both reinforce prior findings that teachers tend to seek positions close to home and provide new evidence that employers also value proximity. First, we find that 75% of all jobs are applied for within a 150 mile distance from the applicant's current residence. With respect to applications for traditional teacher shortage areas in science, math and special education, applicants' travel distance is shorter than other subject areas. Teacher applicants in general are much less likely to apply for positions as travel distance increases; the average marginal probability estimates show that with the addition of a 10 mile travel increment between an employer and job candidate the probability of a candidate applying for a job decreases by 4 percentage points. Because the available data contains employer hiring decisions, we are able to examine the relationship between distance and the likelihood of job offers. Employers are less likely to hire applicants that are farther away; an additional 10 mile travel increment between an employer and job candidate decreases the probability an employer will make a job offer by approximately one percentage point. This latter finding is particularly novel in the research on teacher labor markets.

Overall the study points to the importance of distance plays in both the supply side and the demand side of the teacher labor market. We call this the double draw of proximity. The preference for proximity on both sides of the market has implications for schools, perhaps particularly disadvantaging remote schools and schools farther from areas in which college graduates like teachers tend to live. First, on the supply side, remote schools will have a more difficult time attracting teachers because the share of college graduates is often lower in remote areas and thus the schools will need to recruit from farther away. On top of the direct effect of distance, we find some evidence that teachers prefer not to teach in the more remote or rural

areas, perhaps because of lower access to amenities. These findings are in keeping with earlier work both about the supply of teachers to rural areas (Miller, 2012) and about the importance of amenities to teachers' choices (Boyd et al., 2011b). Taken together, rural schools, which advertise for close to 50% of the observed jobs in shortage areas, appear to be having a difficult time attracting teachers to meet their demand.

This study's most novel findings are the expressed demand for teachers by employers. When choosing between prospective applicants, schools appear to prefer more proximate teachers. Our results from models that include interactions between distance and school characteristics indicate that preferences for more local teaching candidates is consistent across school types and that our results are not being driven by a particular subset of schools. Schools' apparent preferences for more local applicants may stem from several sources. Because candidates often apply to multiple schools simultaneously, schools may adopt hiring strategies that reduce the cost and risk of failed job searches. Local candidates are less likely to require travel for local interviews and are more likely to participate in face-to-face meetings. Presumably local candidates signal to employers an increased likelihood of accepting a job and remaining in the position given that they have already "matched" their interests to the local community. Hiring officers may lean on their experience which dictates that they use teacher proximity to gauge the likelihood that a candidate will accept an offer. It is also possible that because only a relatively small amount of observable information is available in the applications that teaching candidates submit, schools may supplement these with information that they obtain through informal channels such as professional or social networks. To some extent, the localness of a job candidate may be an observable measure of this supplemental yet informally obtained information about a candidate. Finally, schools may value geographic proximity because it is

associated with desirable characteristics such as familiarity with a specific area or town's history, culture, and residents. Regardless of the reasons why schools express greater demand for teachers who are located nearby, this tendency may act in concert with teachers' preferences to disadvantage rural schools. In particular, by preferencing more local teachers, remote schools may be reducing the breadth of the teacher workforce they consider, and forsaking new ideas and potential for improvement.

Although it seems that geography plays a clear role in the teacher labor market, crafting policy that responds to this tendency might require a more thorough understanding of the phenomenon. For example, our analyses of teacher applications could be supplemented with analyses of teacher and administrator survey and social network data in order to determine whether and in what ways things such as the informal flow of information manifest themselves as geographic influences on teacher supply and demand.

Figure 1. Conceptual model of teacher hiring process

Fig. 1 portrays the hiring of teaching personnel by schools as essentially a two-way process with several distinct stages. During the hiring season the stock of available teachers are constrained in their decision to apply for jobs by which jobs come available and their preferences for jobs. School administrators sort through this pool of applications, rank them, conduct interviews and make job offers. Finally, teaching candidates decide whether to accept or reject the offer(s) that they receive.

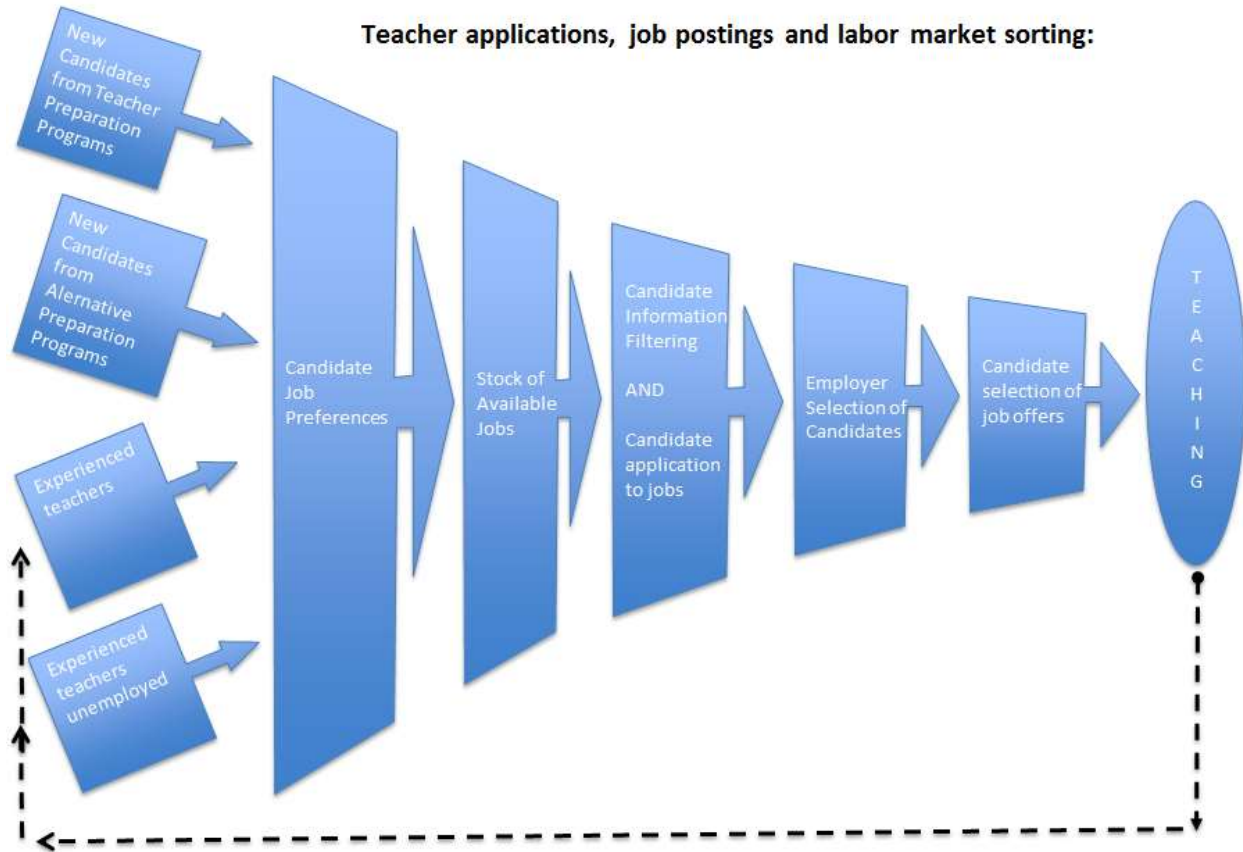


Figure 2: Mean Number of Applications Per Job by Subject Area

Fig. 2. presents the mean number of application submissions by teaching subject area. Social studies has the highest mean number of applications among the subject areas, with 38 applications per job. Special education, science and math have far fewer applicants per position, approximately 12 on average for any of the three positions.

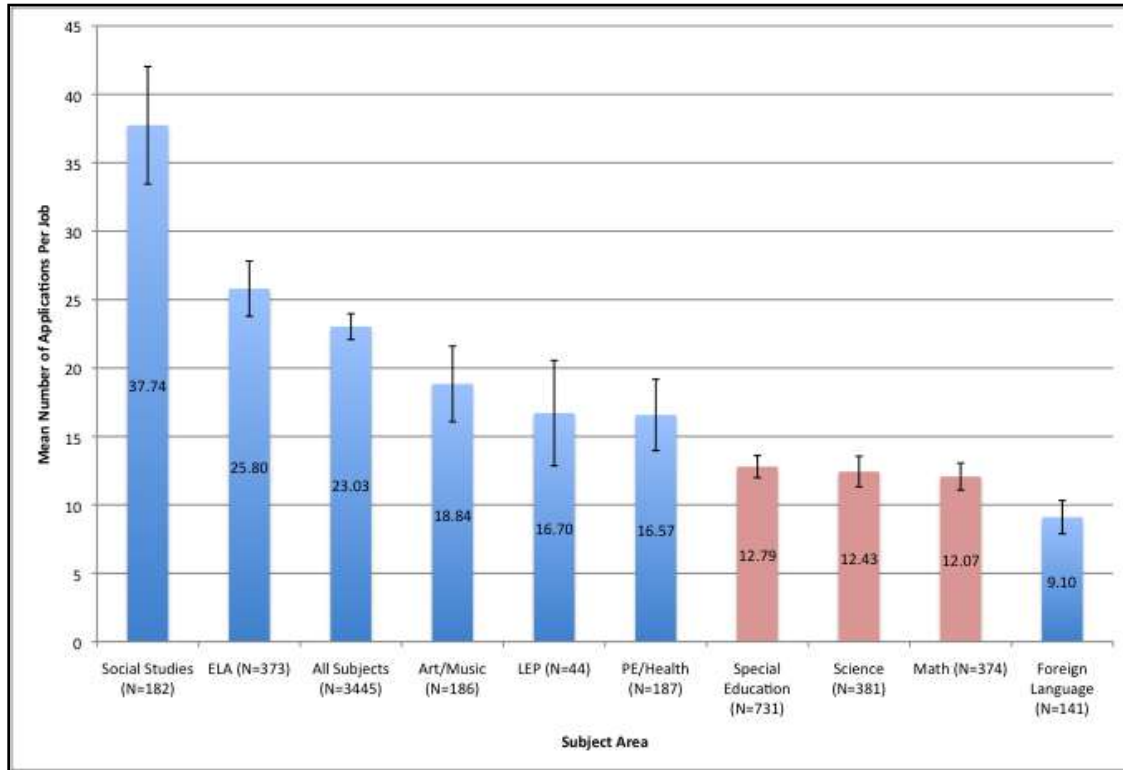


Figure 3: The Distribution of Application Travel Distance

Fig. 3. shows a density plot of the travel distance distribution with vertical lines identifying quartiles (i.e., 25th, 50th, and 75th percentiles) as well as the mean for all teaching applicants. The figure shows that most applicants for teaching positions are within a short distance of their current residence. The distribution of travel distance is right-skewed with the concentration of observations below 100 miles and relatively few observations between 200 and 1000 miles.

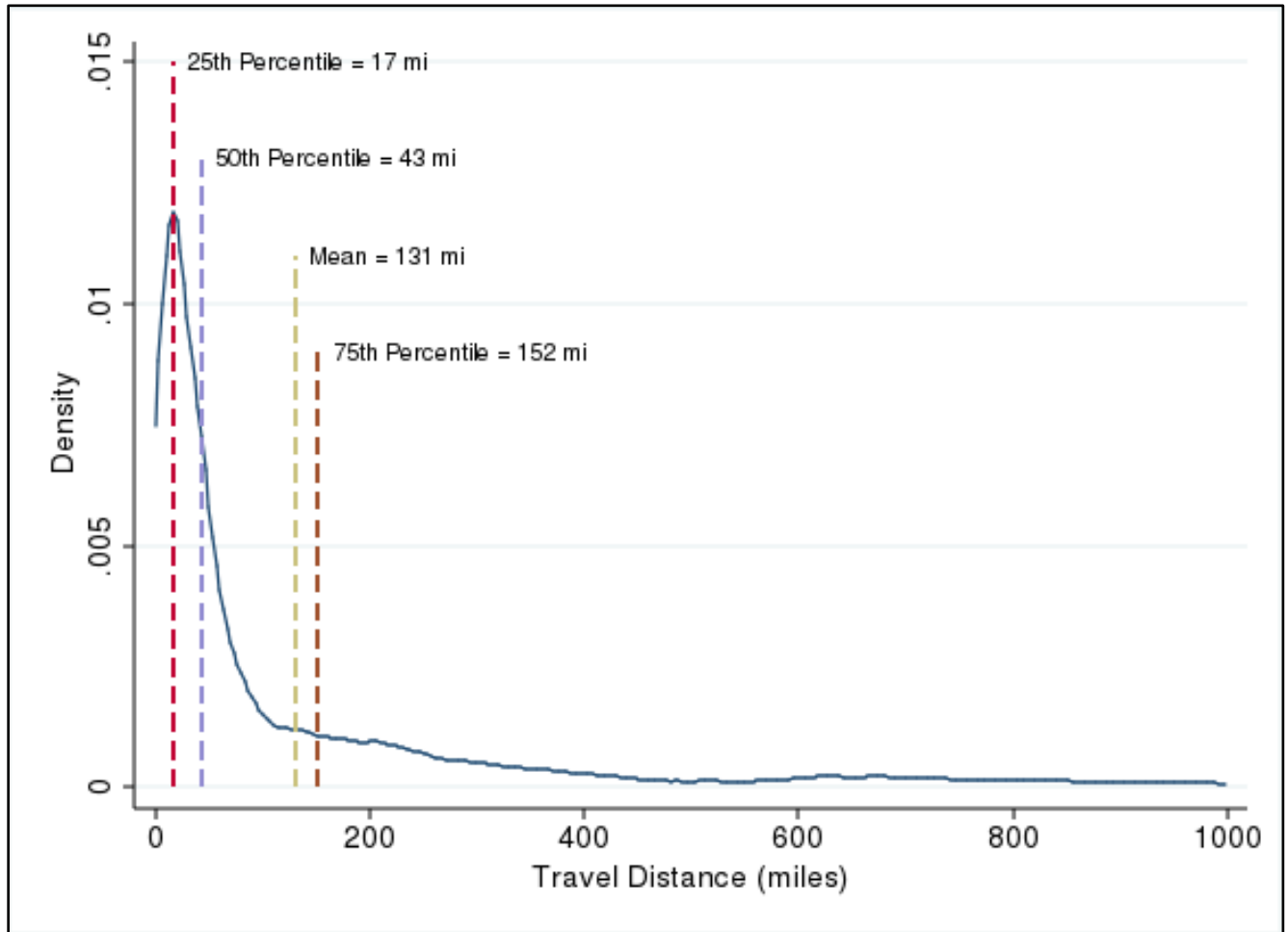


Figure 4: Mean Application Distance by Subject Area

Fig. 4. mean applicant travel distance for the various subject areas. We observe a fair amount of variation with science, math and special education applicants applying, on average, to jobs the farthest away (193 miles) than social studies, art and music, and foreign language applicants.

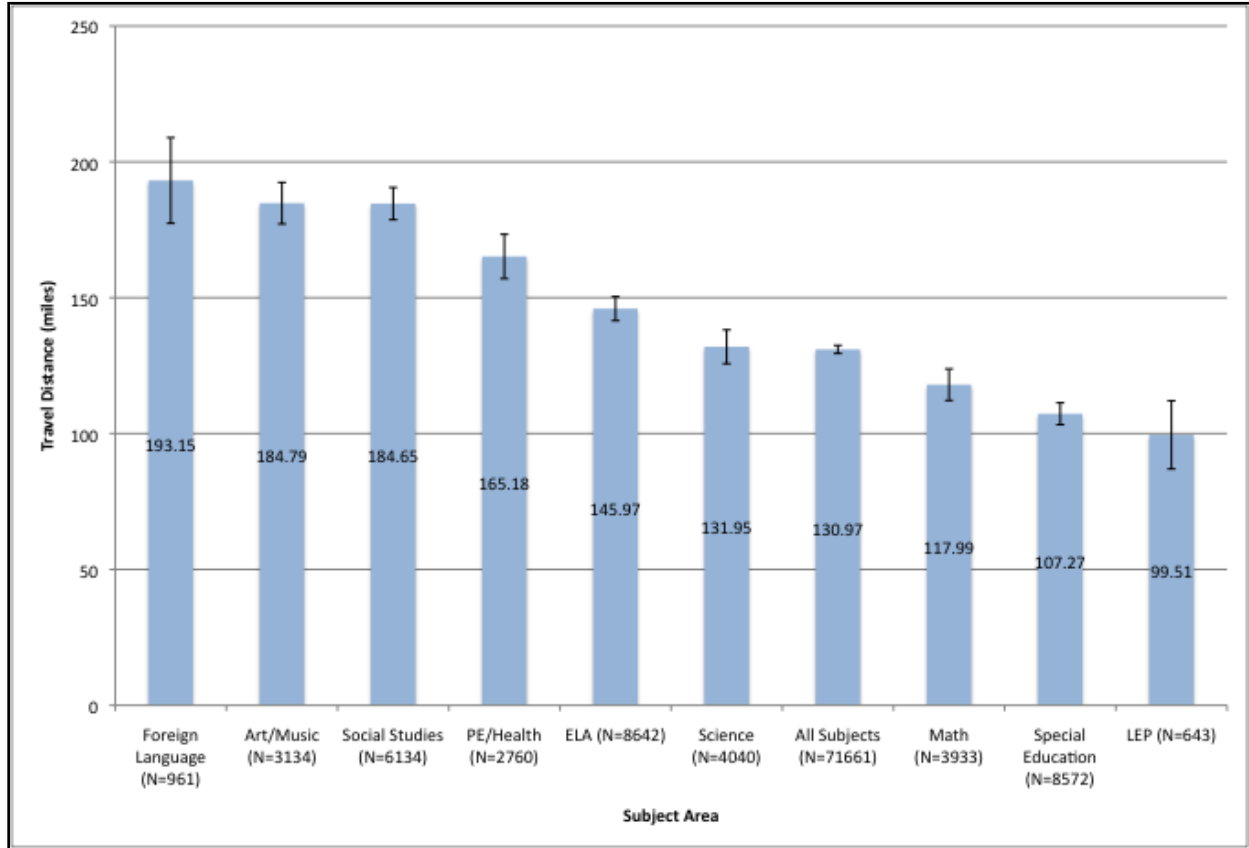


Figure 5: The Distribution of Travel Distance between Jobs and Candidates Who Received Offers.

Fig. 5. replicates plots the distance between jobs and the candidates to whom the hiring authority gave job offers. The plot shows that most offers go to teachers who live a short distance from the school. Similar to the travel distance for applicants in Figure 3, the travel distances for candidates receiving offers is, in most cases, not very far. The key distinction to note is that the travel distances in Figure 5 are substantially smaller than the travel distances in Figure 3.

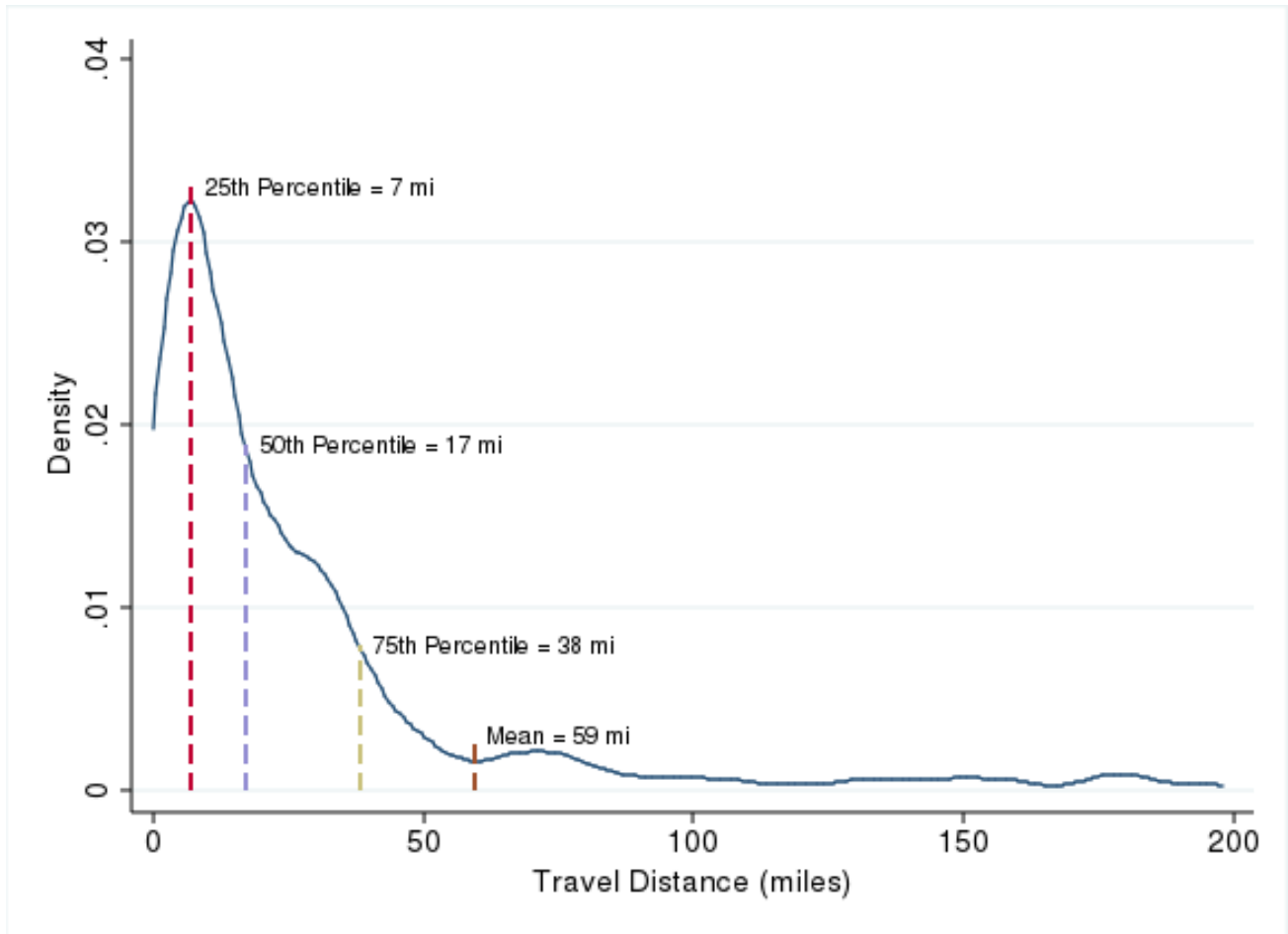


Figure 6a: Average Marginal Probability Estimates of the Effect Travel Distance on the Likelihood of Applying to a Job

Fig. 6a. plots the average marginal probability estimates at various distances. The direction of the relationship between travel distance and applying depends on the specific distance. For example, travel distance is negatively associated with applying for approximately the first 300 miles but the relationship becomes very small as the distance increases past 200 miles.

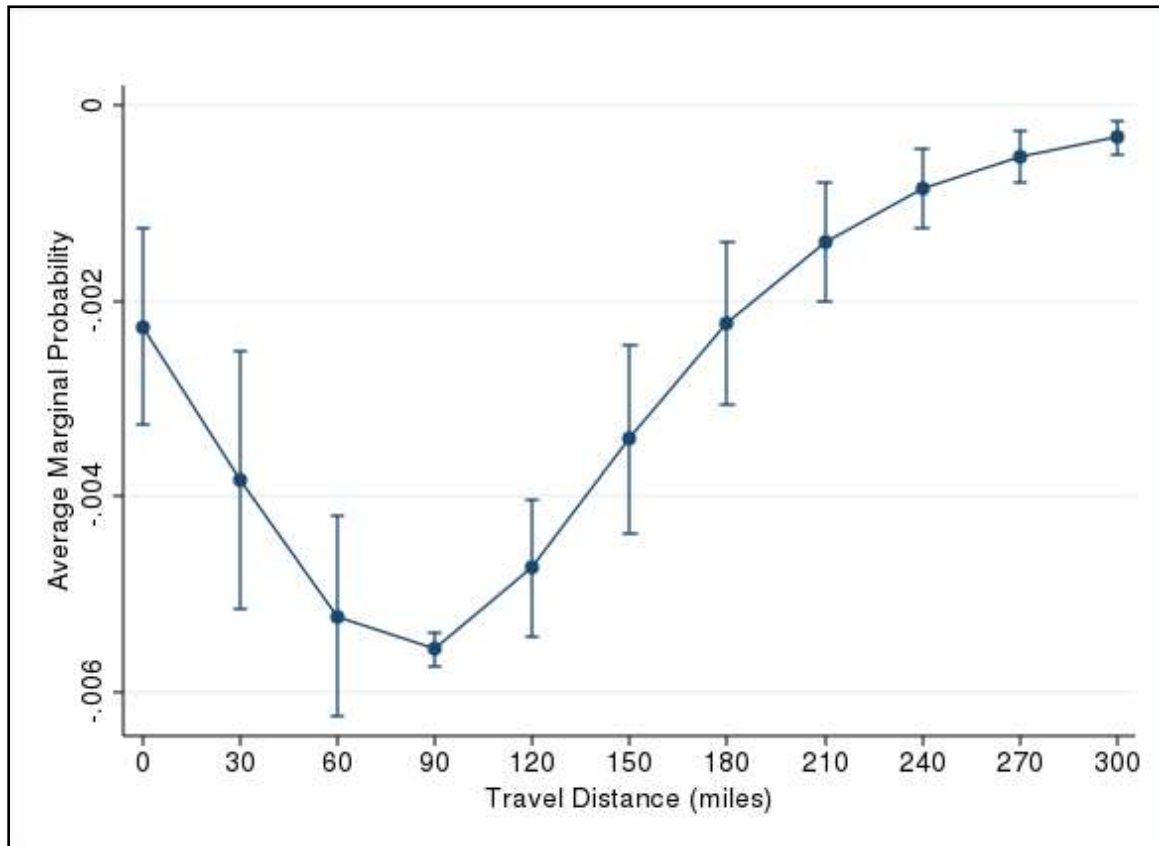


Figure 6b: Average Marginal Probability Estimates of the Effect Travel Distance on the Likelihood of Applying to a Job by Vermont Residency Status

Fig. 6b. shows that the relationship between travel distance and application behavior also varies somewhat with candidate characteristics. Candidates from out of state are less negatively affected by travel distance - perhaps because they are likely to have to move residence to take a position in Vermont regardless of the position. In fact, there is very little relationship between distance and applying for out of state residents.

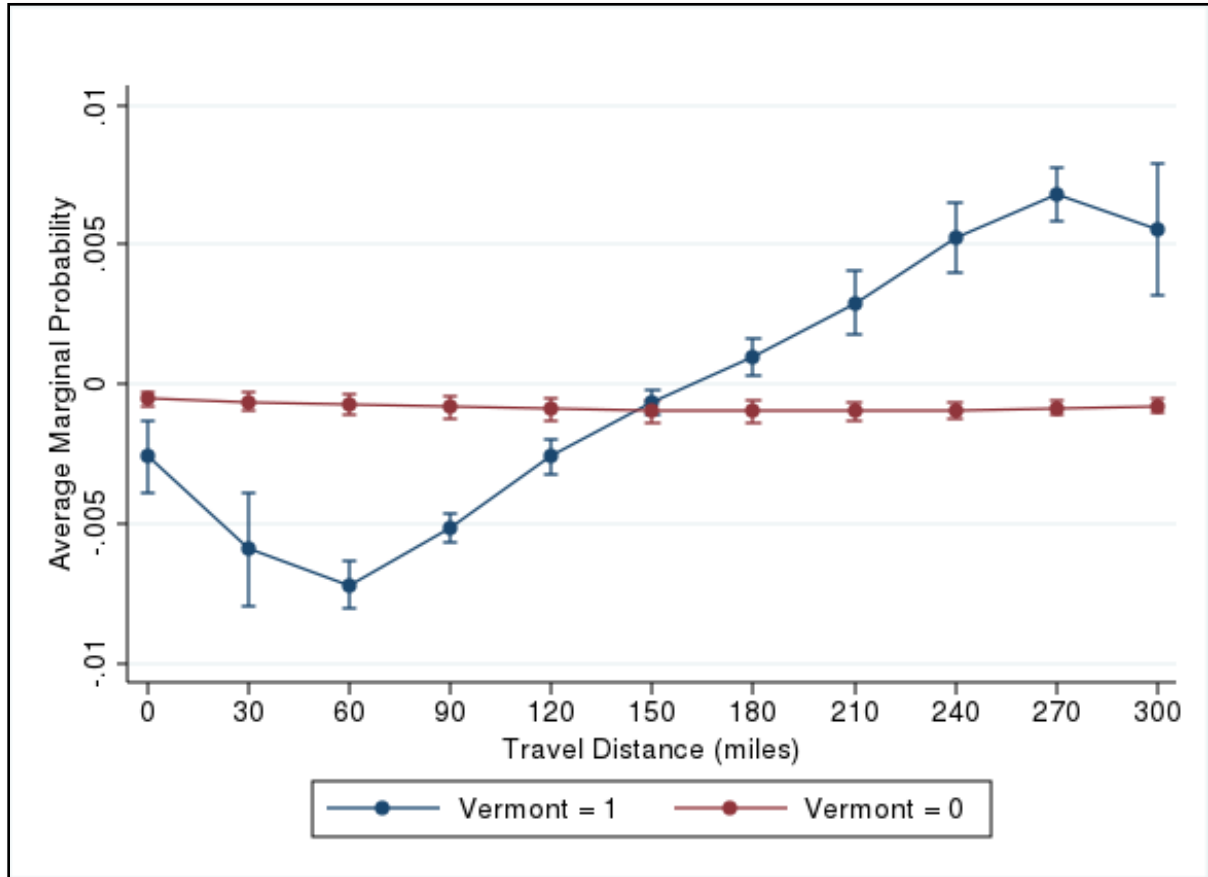


Figure 7a: Average Marginal Probability Estimates of the Effect Travel Distance on the Likelihood of Making an Offer of Employment

Fig. 7a. shows how employers are less likely to hire applicants that are farther away. An additional 10 miles of travel distance decreases the probability an employer makes an offer of employment by 1 percentage point. This result provides evidence that employers value proximity in their candidates, though slightly less than do the applicants. The effect of distance is negative through at least 300 miles but the effect of distance decreases in magnitude as distance increases.

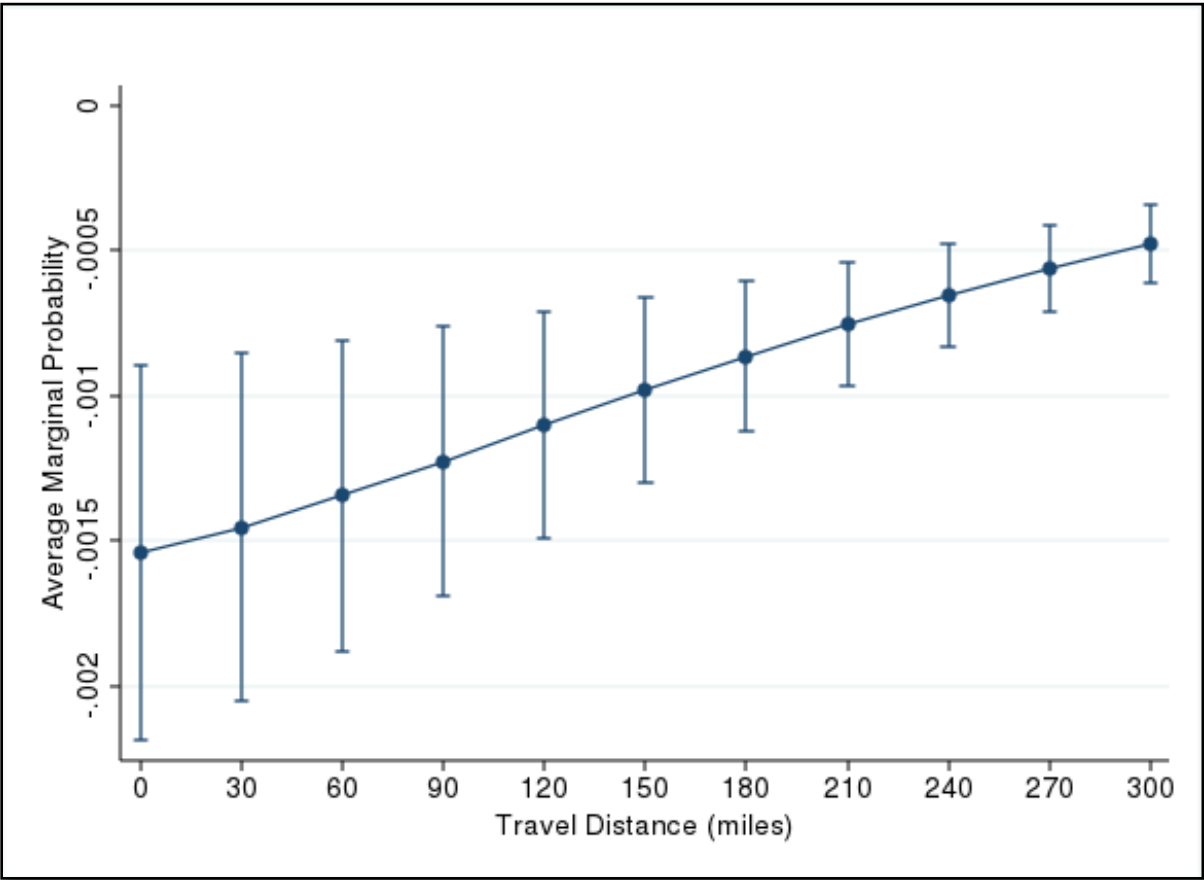


Figure 7b: Average Marginal Probability Estimates of the Effect Travel Distance on the Likelihood of Making an Offer of Employment by Vermont Residency Status

Fig. 7b. . disaggregates the marginal probability estimates for travel distance by residency status (Vermont or non-Vermont). The plot shows that travel distance remains close to zero and statically insignificant for the entire range of distances for non-Vermont residences. In contrast, travel distance is negative associated with employers making offers to Vermont residences from about 0-200 miles.

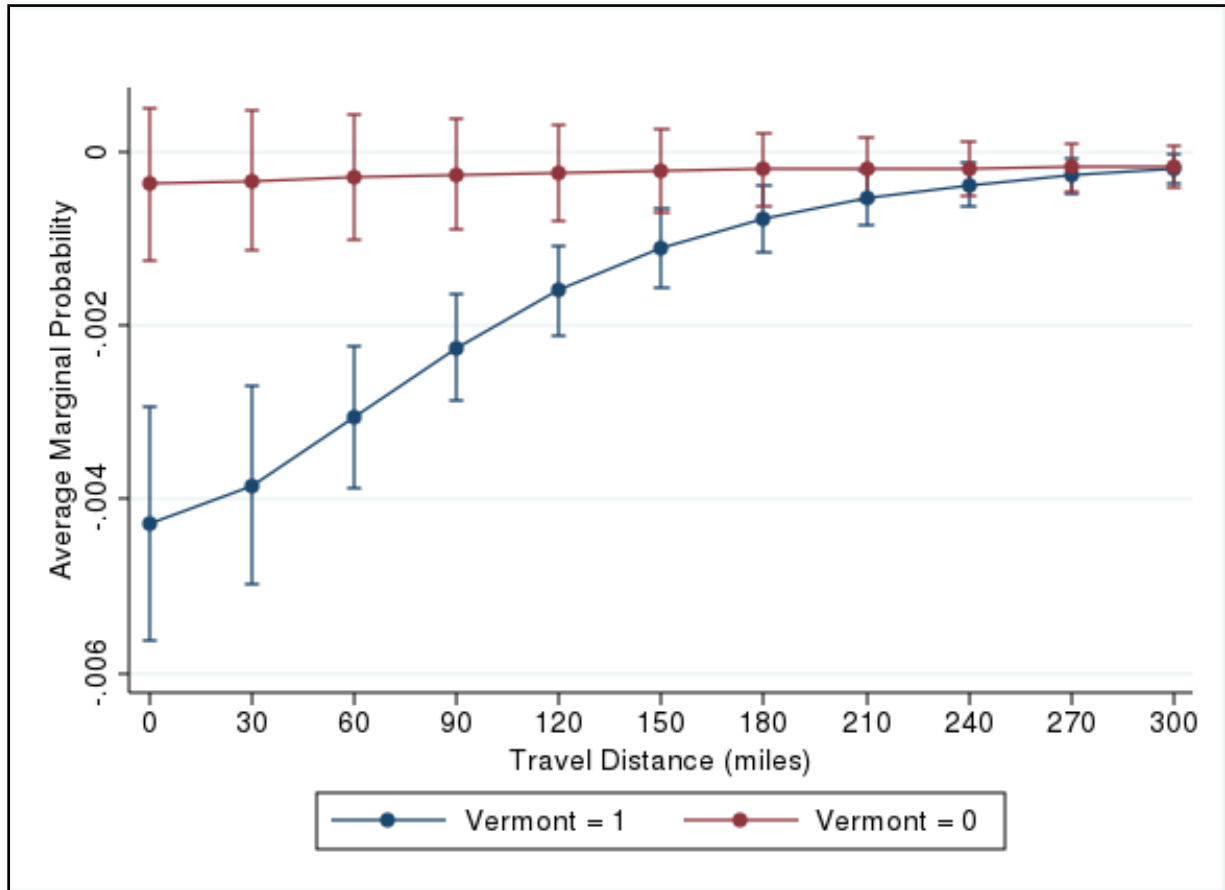


Figure 7c: Average Marginal Probability Estimates of the Effect Travel Distance on the Likelihood of Making an Offer of Employment by Grade Level

Fig. 7c. portrays evidence of variation in travel distance estimates by job characteristics. The largest interaction with distance is for school level. Distance appears to matter little for high schools but more for middle schools and even more for elementary schools.

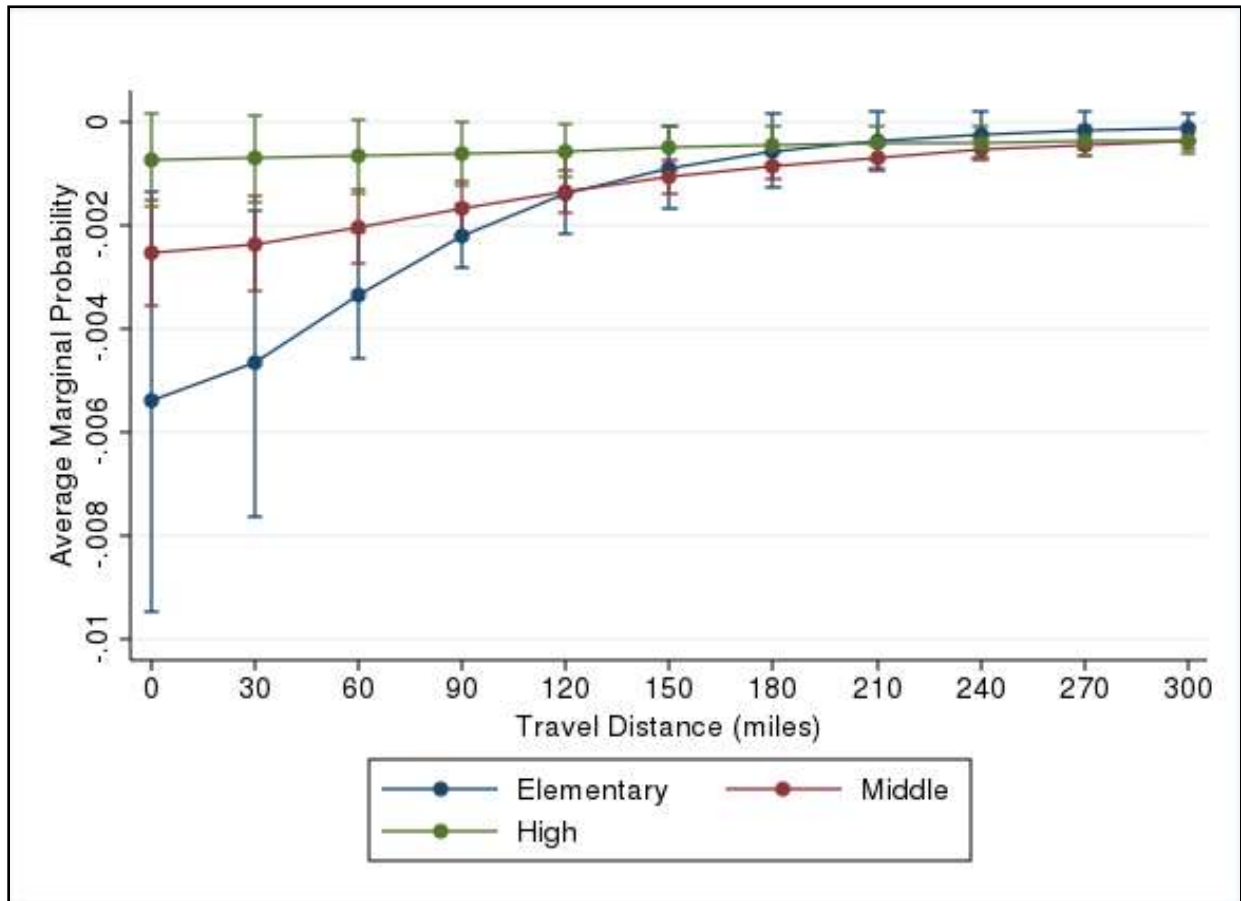


Figure 7d: Average Marginal Probability Estimates of the Effect Travel Distance on the Likelihood of Making an Offer of Employment by District Enrollment

Fig. 7d. also provides evidence of variation in travel distance estimates by job characteristics. We find some differences by district enrollment and by the proportion of poor students in the district. Distance matters less in smaller districts and in districts with fewer poor students.

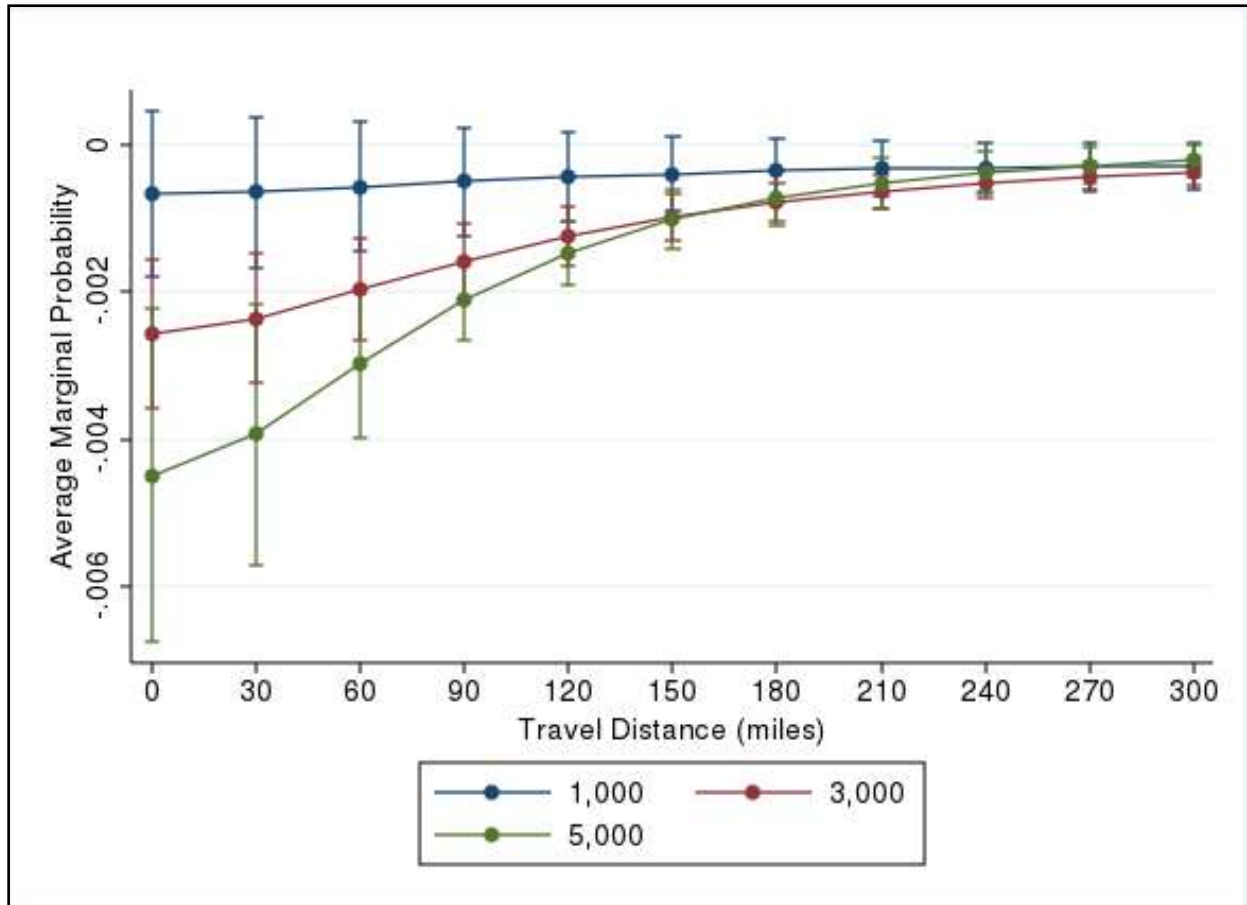
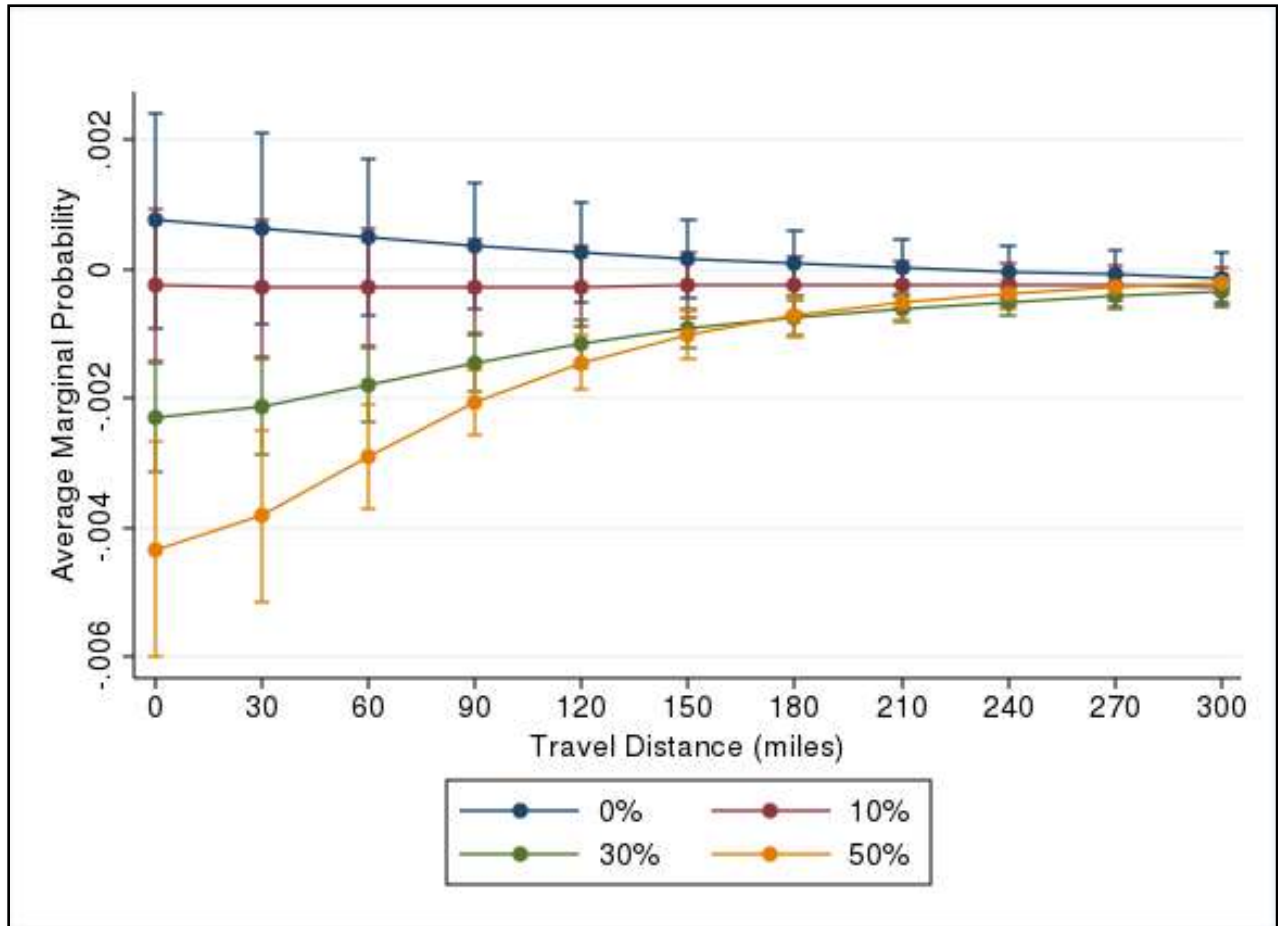


Figure 7e: Average Marginal Probability Estimates of the Effect Travel Distance on the Likelihood of Making an Offer of Employment by District Poverty

Fig. 7e. also provides evidence of variation in travel distance estimates by job characteristics. We find some differences by district enrollment and by the proportion of poor students in the district. Distance matters less in smaller districts and in districts with fewer poor students.



References

- Boyd, D., Lankford, H., Loeb, S., & Wyckoff, J. (2013). Analyzing determinants of the matching of public school teachers to jobs: Disentangling the preferences of teachers and employers. *Journal of Labor Economics*, 31(1), 83-117.
- Boyd, D., Lankford, H., Loeb, S., Ronfeldt, M., & Wyckoff, J. (2011a). The role of teacher quality in retention and hiring: Using applications-to-transfer to uncover preferences of teachers and schools. *Journal of Policy Analysis and Management*, 30(1), 88-110.
- Boyd, D., Lankford, H., Loeb, S., Rockoff, J., & Wyckoff, J. (2011b). The effect of school neighborhoods on teacher retention decisions. In G. Duncan & R. Murnane (Eds.), *Social Inequality and Educational Disadvantage* (pp.377-396). New York: Russell Sage Foundation Press.
- Boyd, D., Grossman, P., Ing, M., Lankford, H., Loeb, S., & Wyckoff, J. (2011c). The influence of school administrators on teacher retention decisions. *American Education Research Journal*, 48(2), 303-333.
- Boyd, D., Lankford, H., Loeb, S. & Wyckoff, J. (2005a). Explaining the short careers of high-achieving teachers in schools with low-performing students. *American Economic Review*, 95(2), 166-171.
- Boyd, D., Lankford, H., Loeb, S. & Wyckoff, J. (2005b). The draw of home: How teachers' preferences for proximity disadvantage urban schools. *Journal of Policy Analysis and Management*, 24(1), 113-132.
- Cannata, M. (2010). Understanding the teacher job search process: Espoused preferences and preferences in use. *Teachers College Record*, 112(12), 2889-2934.
- Cannata, M. (2011). The role of social networks in the teacher job search process. *The Elementary School Journal*, 111(3), pp. 477-50.
- Darling-Hammond, L. (1999). *Teacher Quality and Student Achievement: A Review of State Policy Evidence*. Center for the Study of Teaching and Policy, University of Washington
- Engel, M., Finch, M., and Huff, J. (2012). "Staffing the classroom: How urban principals find teachers and make hiring decisions." Working Paper.
- Goldhaber, D., Brewer, D., and Anderson, D.J. (1999). A three-way error components analysis of educational productivity. *Education Economics*, 7(3), 199-208.
- Grissom, J. A., Nicholson-Crotty, J., & Keiser, L. (2012). Does my boss's gender matter? Explaining job satisfaction and employee turnover in the public sector. *Journal of Public Administration Research and Theory*, 22(4), 649-673.
- Grissom, J. A. (2011). Can good principals keep teachers in disadvantaged schools? Linking principal effectiveness to teacher satisfaction and turnover in hard-to-staff environments. *Teachers College Record*, 113(11), 2552-2585.

- Grissom, J. A., & Keiser, L. (2011). A supervisor like me: Race, representation, and the satisfaction and turnover decisions of public sector employees. *Journal of Policy Analysis and Management*, 30(3), 557-580.
- Guarino, C. M., Santibanez, L., & Daley, G. A. (2006). Teacher recruitment and retention: A review of the recent literature. *Review of Educational Research*, 76(2), 173-208.
- Hanushek, E. and Rivkin, S. (2003). Does public school competition affect teacher quality? In C. Hoxby (Ed.), *The Economics of School Choice* (pp. 23-47). Chicago: University of Chicago Press.
- Hanushek, E. A., Kain, J., and Rivkin, S. G. (2004). Why public schools lose teachers. *The Journal of Human Resources*, 39(2), 326-354.
- Harris, D. N., S.A. Rutledge, W.K. Ingle, & C.C. Thompson. (2010). "Mix and Match: What Principals Really Look for when Hiring Teachers." *Education Finance and Policy* 5 (2), 228-246.
- Ladd, H.F. (2011). Teachers' perceptions of their working conditions: How predictive of planned and actual teacher movement? *Educational Evaluation and Policy Analysis*, 33, 235-261.
- Lankford, H., Loeb, S., & Wyckoff, J. (2002). Teacher sorting and the plight of urban schools: A descriptive analysis. *Education Evaluation and Policy Analysis*, 24(1), 37-62.
- Loeb, S., Darling-Hammond, L., & Luczak, J. (2005). How teaching conditions predict teacher turnover in California schools. *Peabody Journal of Education*, 80(3), 44-70.
- Miller, L. C. (2012). Understanding rural teacher recruitment and the role of community amenities. Curry Working Paper Series #2. Retrieved 1/10/2013 from http://curry.virginia.edu/uploads/resourceLibrary/2_Miller_CEPWC_Rural_Recruitment.pdf
- Nye, B., Konstantopoulos, S. & Hedges, L.V. (2004). How large are teacher effects? *Educational Evaluation and Policy Analysis* 26(3), 237-57.
- Reininger, M. (2012). Hometown disadvantage? It depends on where you're from: teachers' location preferences and the implications for staffing schools. *Educational Evaluation and Policy Analysis*, 34(2), 127-145.
- Rivkin, S. G., Hanushek, E. A., & Kain, J. F. (2005). Teachers, schools, and academic achievement. *Econometrica*, 73(2), 417-458.
- Rockoff, J. (2004). The impact of individual teachers on student achievement: Evidence from panel Data. *American Economic Review*, 94(2), 247-252.
- Strauss, R. P., L.R. Bowes, M.S. Marks, and M.R. Plesko. 2000. Improving teacher preparation and selection: Lessons from the Pennsylvania experience. *Economics of Education Review* 19, 387-415.

Table 1: Descriptive Statistics of Teacher Candidates

Variable	All Candidates		Shortage Area Candidates	
	N	Mean	N	Mean
Out of State	9602	0.45	3723	0.33
Graduate Degree	9602	0.51	3723	0.54
Candidate Experience: Less than a year	9602	0.13	3723	0.10
Candidate Experience: 1-3 years	9602	0.29	3723	0.27
Candidate Experience: 4-9 years	9602	0.30	3723	0.33
Candidate Experience: 10+ years	9602	0.22	3723	0.26
Standard Certification	9602	0.44	3723	0.42
High Qualified Teacher Certification	9602	0.36	3723	0.38
National Board Certification	9602	0.02	3723	0.02
Speaks Spanish	9602	0.03	3723	0.01
Female	9602	0.49	3723	0.50
Gender Not Reported	9602	0.27	3723	0.25
White	9602	0.59	3723	0.59
Black	9602	0.01	3723	0.01
Asian	9602	0.01	3723	0.02
Hispanic	9602	0.01	3723	0.01
Other Race	9602	0.01	3723	0.01
Race Not Reported	9602	0.37	3723	0.36

Table 2: Descriptive Statistics of Teaching Positions

Variable	All Jobs			Jobs in Shortage Areas		
	N	Mean	Std. Dev.	N	Mean	Std. Dev.
Number of Applications	3445	23.03	27.90	1412	12.61	10.79
Math	3445	0.11	--	1412	0.26	--
Special education	3445	0.21	--	1412	0.52	--
Science	3445	0.11	--	1412	0.27	--
Graduate Degree Preferred	3445	0.08	--	1412	0.11	--
Experience Required (Years)	3445	0.73	1.23	1412	0.86	1.28
Pre-K	3445	0.00	--	1412	0.01	--
Elementary	3445	0.30	--	1412	0.26	--
Middle	3445	0.59	--	1412	0.58	--
High	3445	0.37	--	1412	0.45	--
Travel Distance (miles)	3445	133.72	93.56	1412	120.84	93.86
Number of Schools in District	3445	5.69	2.34	1412	5.79	2.37
Number of District Staff	3445	321.29	156.66	1412	331.37	158.58
District Enrollment: Total	3445	1853.15	992.09	1412	1912.84	997.19
District Enrollment: % Native American	3445	0.48	1.18	1412	0.53	1.27
District Enrollment: % Asian	3445	1.46	1.75	1412	1.51	1.83
District Enrollment: % Black	3445	1.60	2.16	1412	1.62	2.14
District Enrollment: % Hispanic	3445	1.02	0.66	1412	1.01	0.65
District Enrollment: % White	3445	94.19	5.21	1412	94.04	5.18
District Enrollment: % Poor	3436	29.40	13.06	1405	29.43	13.21
District Enrollment: % LEP	3229	0.94	2.38	1315	0.92	2.36
District Enrollment: % Special Education	3058	8.99	6.16	1255	8.94	6.23
City	3445	0.05	--	1412	0.05	--
Suburban	3445	0.18	--	1412	0.19	--
Small Town	3445	0.31	--	1412	0.32	--
Rural	3445	0.46	--	1412	0.44	--

Note: a position can be at more than one school level.

Table 3: Discrete Choice Model of Decision to Apply to Teaching Position

Job Characteristics	Odds Ratio		Average Marginal Probability (Candidate FE = 0)	
	(1)	(2)	(1)	(2)
Travel Distance (10 miles)	0.7527*** [0.0026]	0.7568*** [0.0026]	-0.0286*** [0.0001]	-0.0360*** [0.0020]
Travel Distance ²	1.0030*** [0.0001]	1.0029*** [0.0001]		
Math		1.3510*** [0.0514]		0.0490*** [0.0064]
Science		1.3616*** [0.0567]		0.0503*** [0.0069]
Elementary		1.1491*** [0.0433]		0.0228*** [0.0062]
Middle		1.1358*** [0.0203]		0.0209*** [0.0030]
Preferred Degree: Graduate		0.8685*** [0.0245]		-0.0233*** [0.0047]
Number of Positions Open		1.1494*** [0.0103]		0.0228*** [0.0016]
Experience Required: 1-3 years		0.9310*** [0.0183]		-0.0117*** [0.0033]
Experience Required: More than 3 years		0.8401*** [0.0369]		-0.0287*** [0.0073]
District Enrollment (1,000 students)		1.1017*** [0.0117]		0.0159*** [0.0018]
% White Students		1.0168*** [0.0028]		0.0027*** [0.0004]
% Poor Students		1.0059*** [0.0008]		0.0010*** [0.0001]
City		1.6111*** [0.0890]		0.0775*** [0.0071]
Suburban		1.3432*** [0.0422]		0.0486*** [0.0044]
Small Town		1.1935*** [0.0275]		0.0294*** [0.0036]
N	629,000	629,000	629,000	629,000
Pseudo R ²	0.068	0.074		

+ p<.10, * p<.05, ** p<.01, *** p<.001

Table 4: Discrete Choice Model of Decision to Apply to Teaching Position with Job Characteristic Interactions

Job Characteristics	Odds Ratio			Average Marginal Probability (Candidate FE = 0)
	Main Effect	Distance Interaction	Distance ² Interaction	
Travel Distance (10 miles)	0.7364*** [0.0336]			-0.0391*** [0.0010]
Travel Distance ²	1.0029*** [0.0006]			
Math	1.1202* [0.0555]	1.0338*** [0.0061]	0.9997*** [0.0001]	0.0568*** [0.0074]
Science	0.9472 [0.0511]	1.0674*** [0.0066]	0.9993*** [0.0001]	0.0629*** [0.0100]
Elementary	1.2822*** [0.0674]	0.9845* [0.0063]	1.0001+ [0.0001]	0.0237*** [0.0067]
Middle	1.1359*** [0.0292]	1.0008 [0.0029]	1 [0.0000]	0.0216*** [0.0031]
Preferred Degree: Graduate	0.8443*** [0.0334]	1.0006 [0.0046]	1 [0.0001]	-0.0260*** [0.0049]
Number of Positions Open	1.1686*** [0.0133]	0.9963+ [0.0022]	1 [0.0000]	0.0218*** [0.0020]
Experience Required: 1-3 years	0.8754*** [0.0245]	1.0110*** [0.0033]	0.9999*** [0.0000]	-0.0114** [0.0036]
Experience Required: More than 3 years	0.8558* [0.0538]	0.995 [0.0072]	1.0001 [0.0001]	-0.0304*** [0.0075]
District Enrollment (1,000 students)	1.1415*** [0.0175]	0.9929*** [0.0018]	1.0001*** [0.0000]	0.0153*** [0.0019]
% White Students	1.0128*** [0.0039]	1 [0.0004]	1 [0.0000]	0.0023*** [0.0005]
% Poor Students	1.0009 [0.0012]	1.0008*** [0.0001]	1.0000*** [0.0000]	0.0010*** [0.0002]
City	1.5866*** [0.1196]	0.9982 [0.0092]	1.0001 [0.0001]	0.0790*** [0.0095]
Suburban	1.3059*** [0.0568]	1.0043 [0.0055]	0.9999 [0.0001]	0.0495*** [0.0057]
Small Town	1.2447*** [0.0439]	0.9897** [0.0038]	1.0002*** [0.0000]	0.0284*** [0.0039]
N				629,000
Pseudo R ²				0.076

+ p<.10, * p<.05, ** p<.01, *** p<.001

Table 5: Discrete Choice Model of Decision to Apply to Teaching Position with Candidate Characteristic Interactions

Job Characteristics	Odds Ratio	Average Marginal Probability (Candidate FE = 0)	Candidate Characteristics	Odds Ratio		Average Marginal Probability (Candidate FE = 0)
				Distance Interaction	Distance ² Interaction	
Travel Distance (10 miles)	0.6496*** [0.0104]	-0.0389*** [0.0033]	Out of State	1.4791*** [0.0163]	0.9862*** [0.0006]	0.2516*** [0.0212]
Travel Distance ²	1.0145*** [0.0007]		Graduate Degree	1.0084 [0.0078]	0.9999 [0.0001]	0.0135 [0.0130]
Math	1.3466*** [0.0518]	0.0520*** [0.0073]	Experience: 1-3 years	0.9908 [0.0144]	0.9998 [0.0002]	-0.0261 [0.0204]
Science	1.3446*** [0.0566]	0.0518*** [0.0079]	Experience: 4-9 years	0.9521*** [0.0138]	1.0003 [0.0002]	-0.0786*** [0.0211]
Elementary	1.1483*** [0.0440]	0.0243*** [0.0069]	Experience: 10+ years	0.9401*** [0.0138]	1.0002 [0.0003]	-0.1205*** [0.0234]
Middle	1.1290*** [0.0205]	0.0213*** [0.0034]	Standard Certification	0.9919 [0.0071]	1.0003+ [0.0001]	-0.0015 [0.0118]
Preferred Degree: Graduate	0.8358*** [0.0241]	-0.0319*** [0.0055]	National Board Certification	0.9904 [0.0287]	1.0002 [0.0004]	-0.0113 [0.0473]
Number of Positions Open	1.1459*** [0.0104]	0.0239*** [0.0021]	White	0.9925 [0.0078]	1.0002 [0.0001]	-0.003 [0.0129]
Experience Required: 1-3 years	0.9202*** [0.0184]	-0.0146*** [0.0036]	Female	0.9792** [0.0074]	1.0002 [0.0001]	-0.0323** [0.0124]
Experience Required: More than 3 years	0.8765** [0.0392]	-0.0232** [0.0080]				
District Enrollment (1,000 students)	1.0801*** [0.0118]	0.0135*** [0.0020]				
% White Students	1.0225*** [0.0028]	0.0039*** [0.0003]				
% Poor Students	1.0072*** [0.0009]	0.0013*** [0.0001]				
City	1.4685*** [0.0824]	0.0665*** [0.0075]				
Suburban	1.2093*** [0.0384]	0.0336*** [0.0048]				
Small Town	1.2205*** [0.0288]	0.0352*** [0.0039]				
N					611,000	
Pseudo R ²					0.087	

+ p<.10, * p<.05, ** p<.01, *** p<.001

Table 6: Discrete Choice Model of Decision to Make an Offer of Employment

Candidate Characteristics	Odds Ratio		Average Marginal Probability (Job FE=0)	
	(1)	(2)	(1)	(2)
Travel Distance (10 miles)	0.941*** [0.010]	0.938*** [0.013]	-0.0121*** [0.0019]	-0.0123*** [0.0025]
Travel Distance ²	1.001*** [0.000]	1.001*** [0.000]		
Out of State		1.067 [0.214]		0.0146 [0.0455]
Graduate Degree		0.899 [0.095]		-0.0242 [0.0239]
Candidate Experience: 1-3 years		1.099 [0.200]		0.0221 [0.0425]
Candidate Experience: 4-9 years		1.079 [0.196]		0.0177 [0.0425]
Candidate Experience: 10+ years		0.625* [0.123]		-0.1056* [0.0424]
Standard Certification		0.987 [0.102]		-0.003 [0.0235]
Highly Qualified Teacher Certification		1.048 [0.111]		0.0107 [0.0240]
National Board Certification		0.993 [0.447]		-0.0016 [0.1020]
Fluent in Spanish		0.43 [0.323]		-0.1738 [0.1336]
Female		1.17 [0.143]		0.0356 [0.0280]
Gender Not Provided		1.152 [0.197]		0.0324 [0.0394]
Black		0.296 [0.303]		-0.2345 [0.1500]
Asian		0.582 [0.275]		-0.117 [0.0952]
Hispanic		1.168 [0.674]		0.0356 [0.1330]
Other Race		1.24 [0.621]		0.0493 [0.1156]
Missing Race		1.262+ [0.165]		0.0533+ [0.0302]
N	6,922	6,922	6,922	6,922
Pseudo R ²	0.023	0.04		

+ p<.10, * p<.05, ** p<.01, *** p<.001

Table 7: Discrete Choice Model of Decision to Offer Employment with Candidate Interactions

Candidate Characteristics	Odds Ratio			Average Marginal Probability (Job FE = 0)
	Main Effect	Distance Interaction	Distance ² Interaction	
Travel Distance (per 10 miles)	0.905* [0.040]			-0.0292*** [0.0042]
Travel Distance ²	1.001 [0.001]			
Out of State	0.410** [0.129]	1.172*** [0.041]	0.998*** [0.000]	-0.0589 [0.0445]
Graduate Degree	0.876 [0.113]	1.02 [0.022]	1 [0.000]	-0.0159 [0.0225]
Experience: 1-3 years	1.305 [0.301]	0.953 [0.033]	1.001 [0.001]	0.0182 [0.0406]
Experience: 4-9 years	1.305 [0.298]	0.946+ [0.032]	1.001 [0.000]	0.0082 [0.0401]
Experience: 10+ years	0.738 [0.182]	0.95 [0.038]	1.001 [0.001]	-0.1056** [0.0393]
Standard Certification	1.119 [0.142]	0.950* [0.020]	1.001* [0.000]	-0.0135 [0.0221]
Highly Qualified Teacher Certification	1.044 [0.112]			0.0091 [0.0226]
National Board Certification	1.327 [0.873]	1.008 [0.158]	0.999 [0.006]	0.0339 [0.0937]
Fluent in Spanish	0.385 [0.294]			-0.1743 [0.1141]
Female	1.013 [0.146]	1.032 [0.022]	1 [0.000]	0.0291 [0.0270]
Gender Not Provided	1.119 [0.193]			0.0239 [0.0370]
White		0.949* [0.020]	1.000+ [0.000]	-0.0559** [0.0192]
Black	0.196 [0.203]			-0.2566* [0.1022]
Asian	0.449 [0.226]			-0.1513+ [0.0814]
Hispanic	0.948 [0.554]			-0.0113 [0.1218]
Other Race	1.031 [0.522]			0.0064 [0.1074]
Missing Race	1.034 [0.158]			0.0071 [0.0325]
N			6,922	
Pseudo R ²			0.06	

+ p<.10, * p<.05, ** p<.01, *** p<.001

Table 8: Discrete Choice Model of Decision to Make An Offer of Employment with Job Interactions

Candidate Characteristics	Odds Ratio	Average Marginal Probability (FE=0)	Job Characteristics	Odds Ratio		Average Marginal Probability (Job FE = 0)
				Distance Interaction	Distance ² Interaction	
Travel Distance (10 miles)	1.815+ [0.632]	-0.0148*** [0.0029]	Math	0.991 [0.029]	1 [0.000]	-0.0027 [0.0283]
Travel Distance ²	0.992+ [0.004]		Science	0.933* [0.030]	1.001+ [0.000]	-0.0610* [0.0262]
Out of State	1.136 [0.236]	0.0279 [0.0453]	Multiple Subjects	0.948 [0.078]	1 [0.002]	-0.0609 [0.0541]
Graduate Degree	0.89 [0.095]	-0.0256 [0.0234]	Elementary	0.825* [0.071]	1.002* [0.001]	-0.1372** [0.0439]
Candidate Experience: 1-3 years	1.137 [0.212]	0.0287 [0.0418]	Middle	0.928** [0.022]	1.001** [0.000]	-0.0678** [0.0220]
Experience: 4-9 years	1.094 [0.204]	0.0201 [0.0418]	Preferred Degree: Grad	1.002 [0.035]	1 [0.000]	-0.0007 [0.0321]
Experience: 10+ years	0.645* [0.130]	-0.0954* [0.0424]	#of Positions	0.99 [0.010]	1 [0.000]	-0.0113 [0.0102]
Standard Certification	1.008 [0.106]	0.0018 [0.0230]	Exp: 1-3 yrs	0.982 [0.025]	1 [0.000]	-0.0143 [0.0238]
Highly Qual Cert	1.082 [0.116]	0.0173 [0.0236]	Exp: >3 yrs	1.075 [0.092]	0.998 [0.002]	0.0418 [0.0622]
National Board Certification	0.935 [0.431]	-0.0146 [0.1002]	Enroll /1,000	0.961* [0.015]	1.000* [0.000]	-0.0358** [0.0137]
Fluent in Spanish	0.461 [0.345]	-0.1577 [0.1360]	% White Stdnts	0.996 [0.003]	1 [0.000]	-0.0036 [0.0031]
Female	1.159 [0.144]	0.0323 [0.0273]	% Poor Students	0.996*** [0.001]	1.000** [0.000]	-0.0038*** [0.0011]
Gender Not Provided	1.117 [0.196]	0.0242 [0.0387]	City	1.053 [0.072]	0.999 [0.001]	0.0416 [0.0618]
Black	0.291 [0.300]	-0.2335 [0.1504]	Suburban	0.986 [0.039]	1 [0.001]	-0.002 [0.0339]
Asian	0.587 [0.286]	-0.1123 [0.0966]	Small Town	1.032 [0.032]	1 [0.000]	0.0309 [0.0282]
Hispanic	1.179 [0.682]	0.0362 [0.1279]				
Other Race	1.357 [0.693]	0.0674 [0.1127]				
Missing Race	1.281+ [0.170]	0.0546+ [0.0294]				
N					6,828	
Pseudo R ²					0.056	

+ p<.10, * p<.05, ** p<.01, *** p<.001