Making Connections

October 2017

Indicators of successful teacher recruitment and retention in Oklahoma rural school districts

Valeriy Lazarev
Megan Toby
Jenna Zacamy
Li Lin
Denis Newman
Empirical Education Inc.

Key findings

- Teachers in Oklahoma rural school districts have a 70 percent chance of achieving tenure (this study's definition of successful teacher recruitment); this rate is slightly lower than the rate for teachers in nonrural school districts.
- From 2006/07 to 2011/12 rural school districts had consistently lower rates of success in recruiting teachers than did nonrural school districts.
- Teachers who are male, those who have a higher postsecondary degree, and those with more teaching experience are harder than others to recruit and retain in rural school districts.
- For teachers in rural school districts, higher total compensation and increased responsibilities in job assignment are positively associated with successful recruitment and retention.

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REL 2018–275

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October 2017

This report was prepared for the Institute of Education Sciences (IES) under Contract ED-IES-12-C-0012 by Regional Educational Laboratory Southwest administered by SEDL. The content of the publication does not necessarily reflect the views or policies of IES or the U.S. Department of Education, nor does mention of trade names, commercial products, or organizations imply endorsement by the U.S. Government.

Lazarev, V., Toby, M., Zacamy, J., Lin L., & Newman, D. (2017). *Indicators of successful teacher recruitment and retention in Oklahoma rural schools* (REL 2018–275). Washington, DC: U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance, Regional Educational Laboratory Southwest. Retrieved from http://ies.ed.gov/ncee/edlabs.

This report is available on the Regional Educational Laboratory website at http://ies.ed.gov/ncee/edlabs.

Summary

Recruiting and retaining effective teachers are serious concerns throughout Oklahoma. The Oklahoma State School Boards Association (2016) reported 500 teacher vacancies at the beginning of the 2015/16 school year, according to a survey of school districts, and 53 percent of respondents said the teacher shortage was worse than in the previous year. For years, Oklahoma rural school district administrators have reported difficulty retaining teachers who could cross state lines for higher pay and lower class sizes or seek employment in other industries (Oklahoma State School Boards Association, 2016).

In 2013 the Oklahoma State Superintendent of Public Instruction established the Oklahoma Educator Workforce Shortage Task Force to recommend measures to alleviate the "significant and widespread shortages" of classroom teachers (Oklahoma State Department of Education, 2014, p. 3). The task force was succeeded in September 2015 by the Teacher Shortage Task Force, which was established to identify and recommend successful strategies for curbing the statewide teacher shortage crisis (Oklahoma State Department of Education, 2015d) and which recommended several strategies for placing highly qualified teachers in all Oklahoma classrooms.

More than 70 percent of Oklahoma districts are rural. This rural school context—including isolation, limited access to professional development, and the need for many teachers to teach a wider range of subjects—presents additional challenges to recruitment and retention. Small budgets and scale of operation in smaller rural schools and districts typically mean lower compensation for teachers and difficulty providing resources for students with special needs or with limited English skills. Smaller rural schools also tend to have fewer highly trained and highly experienced teachers (Monk, 2007).

The state's teacher shortage, as well as the unique context of rural schools in Oklahoma, led members of the Regional Educational Laboratory Southwest Oklahoma Rural Schools Research Alliance to seek information about factors associated with successful teacher recruitment and retention in Oklahoma. The goal was to develop effective strategies for recruiting and retaining teachers in rural schools.

In response, this study identified factors that can support teacher recruitment and retention, particularly malleable factors that can be controlled through policies and interventions. This report refers to these factors as indicators of the characteristics of teachers or districts that predict successful teacher recruitment and retention. While associations between indicators and outcomes cannot be interpreted as causal—a specific indicator is not necessarily the cause of a related outcome—the results from this study can be used to pinpoint potential problems and inform future policies. The results can also provide a rationale for experimental evaluations of programs aiming to improve teacher recruitment and retention.

To provide context, the study first explores patterns of teacher job mobility in Oklahoma, including teachers' probability of remaining employed in the same district for a given number of years, the proportion of teachers who leave rural school districts and move to another rural school district, the proportion of teachers who receive tenure, and the one-year retention probability for each successive year of employment. Patterns of teacher job mobility are examined for any differences between rural and nonrural school districts.

The study was designed to identify teacher, district, and community characteristics in rural Oklahoma that predict which teachers are most likely to be successfully recruited (defined as having completed a probationary period of three years and obtained tenure in their fourth year of teaching) and retained longer term (defined as the duration of employment of tenured teachers in a given school district). This study covers the 10 school years between 2005/06 and 2014/15 and uses teacher and district data from the Oklahoma State Department of Education, Oklahoma Office of Educational Quality and Accountability, and community characteristics from data in federal noneducation sources and publicly available geographic information systems from Google Maps.

Key findings include the following:

- Teachers in rural school districts in Oklahoma have a 70 percent chance of reaching their fourth year of teaching in the same district and thus of achieving tenure; this rate is slightly lower than the rate for teachers in nonrural school districts.
- Rural school districts had consistently lower rates of success in recruitment than nonrural school districts from 2006/07 to 2011/12.

More important, this study found that certain teacher, district, and community characteristics are associated with successful recruitment and retention in Oklahoma rural schools. Key findings include the following:

- Teachers who are male, those who have a higher postsecondary degree, and those who have more teaching experience are more difficult than other teachers to recruit and retain.
- Higher compensation and increased responsibilities in job assignment are positively associated with successful recruitment and retention.

These findings can inform incentive schemes for retaining certain groups of teachers and increasing retention rates overall. For example, holding other factors constant, $1,080 of extra annual compensation is associated with an estimated 1 percentage point increase in the probability of successfully recruiting a beginning teacher, whereas just $249 of extra annual compensation is associated with an estimated 1 percentage point increase in the probability of retaining a tenured teacher. The results could inform the design of more rigorous studies, such as impact evaluations, of incentive schemes.

The factors explored were limited by the available data. Other factors, such as details of teacher preparation and connections to the district through origin and family ties, may also improve recruitment and retention. All the variables included in the analysis explained just under 18 percent of what leads to successful recruitment and retention. The results should be interpreted within the time period of the study. Although the 10-year study period is sufficient to answer questions about recruitment, it is too short to obtain complete information on the long-term employment dynamics of teachers.

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Why this study?

Recruiting and retaining effective teachers are serious concerns throughout Oklahoma. The Oklahoma State School Boards Association (2016) reported 500 teacher vacancies at the beginning of the 2015/16 school year, despite the elimination of more than 1,500 teaching positions in the previous year, according to a survey of school districts. This number of vacancies does not include positions filled by the more than 300 teachers holding emergency teaching credentials. More than half (53 percent) of the superintendents responding to the survey said that the 2015/16 teacher shortage was worse than in the previous year and that they were expecting to increase class size and decrease course offerings because of the teacher shortage.

Two task forces have tackled the teacher shortage problem. In 2013 the Oklahoma State Superintendent of Public Instruction established the Oklahoma Educator Workforce Shortage Task Force to recommend measures to alleviate the "significant and widespread shortages" of classroom teachers (Oklahoma State Department of Education, 2014, p. 3). The task force was succeeded in September 2015 by the Teacher Shortage Task Force, which was established to identify and recommend successful strategies for curbing the statewide teacher shortage crisis (Oklahoma State Department of Education, 2015d). On the basis of the recommendations of this second task force, several state policies were enacted to try to alleviate the teacher shortage (box 1).

Box 1. Recommendations by the Oklahoma Teacher Shortage Task Force to recruit and retain teachers

In December 2015 the Oklahoma Teacher Shortage Task Force identified 29 strategic recommendations to resolve the statewide teacher shortage crisis (Oklahoma State Department of Education, 2015c). In May 2016 Governor Mary Fallin signed several bills in response to these recommendations, including legislation that:

- Allows a former or retired classroom teacher to serve as a mentor to resident teachers (beginning teachers or teachers working in a new role).
- Eases the ability of the Oklahoma State Board of Education to issue a teaching certificate to a person who has an out-of-state certificate.
- Gives district boards of education the authority to enter into contracts with student teachers and allows districts to pay a stipend or signing bonus to a student teacher.
- Expands the list of those who qualify to pursue a standard certificate through an alternative placement program.
- Increases the maximum number of clock hours an adjunct teacher may teach (the bill defines adjunct teacher as "persons with distinguished qualifications in their field").
- Establishes the Empowering Teachers to Lead Act, which helps districts pursue a framework of teacher career paths, leadership roles, and compensation requirements.
- Creates the Teacher Certification Scholarship Program to assist teacher candidates with the cost of certification exams (Oklahoma State Department of Education, 2016).

The task force stated that "an increase in teacher compensation was central to the short and long term challenges of Oklahoma's teacher shortage" (Oklahoma State Department of Education, 2015c, p. 1). In 2015 Oklahoma's average teacher salary was the third lowest in the nation (Oklahoma State Department of Education, 2015a) and was less than that of surrounding states. In 2015 the Oklahoma State Superintendent of Public Instruction proposed a plan to increase teacher salaries over five years. However, the state's base salary for teachers for the 2015/16 school year remained the same as in 2008/09, the earliest school year for which a teacher salary schedule is posted on the Oklahoma State Department of Education website (Oklahoma State Department of Education, 2015b).

Members of the Regional Educational Laboratory Southwest Oklahoma Rural Schools Research Alliance have emphasized that the state's rural school context (including isolation, limited access to professional development, and the need for many teachers to teach a wider range of subjects) increases the pressure on teachers and presents challenges for recruitment and retention.[1] For years, Oklahoma rural school district administrators have reported difficulty retaining teachers who could cross state lines for higher pay and lower class sizes or seek employment in other industries, such as the oil industry of western Oklahoma, where salaries are twice those of teachers (Oklahoma State School Board Association 2016). (The average starting teacher's salary is $31,600 in Oklahoma, compared with $32,964 in Kansas and $34,234 in Texas; the average teacher's salary is $44,343 in Oklahoma, compared with $46,598 in Kansas and $48,638 in Texas [Oklahoma State Department of Education, 2014]).

Prior research has identified characteristics of rural communities that may make teacher recruitment and retention more challenging, including "small size, sparse settlement, [and] distance from population concentrations" (Monk, 2007, p. 155; see appendix A for a review of the literature on teacher recruitment and retention in rural schools). Small budgets and scale of operations in smaller rural schools and districts typically mean lower compensation for teachers and difficulty providing resources for students with special needs and with limited English skills. Smaller rural schools are also tend to have fewer highly trained and highly experienced teachers (Monk, 2007). The literature review found no rigorous research, such as randomized controlled trials or quasi-experiments, on the effectiveness of teacher recruitment and retention strategies in rural areas; most of the literature consists of descriptive statistics from self-report surveys and case studies.

This study complements other studies on predicted trends in educator supply and demand in Oklahoma by exploring patterns of job mobility and specific teacher, district, and community characteristics related to successful recruitment and retention in rural schools

More than 70 percent of Oklahoma school districts are rural, and these districts employ about a third of the state's teachers (National Center for Education Statistics, 2016). Rural regions in Oklahoma are not a homogeneous environment; they exhibit considerable variability in socioeconomic and racial/ethnic composition, cultural characteristics, and community links to the outside world. For example, communities classified as remote-rural can vary greatly in their proximity (driving time) and access to population concentrations and employment opportunities, institutions of higher education, and cultural and sports facilities. In addition, many rural districts in Oklahoma have a substantial number of American Indian students from 39 tribes and nations with distinct histories and ethnological features.

The state's teacher shortage, as well as the unique context of rural schools in Oklahoma, led alliance members to seek information about factors associated with successful teacher recruitment and retention in order to develop effective strategies for recruiting and retaining teachers in rural schools.[1] This study complements other recent studies on predicted trends in educator supply and demand in Oklahoma (Berg-Jacobson & Levin, 2015) by exploring patterns of job mobility and specific teacher, district, and community characteristics related to successful recruitment and retention in rural schools. The study results could help identify factors that support teacher recruitment and retention in Oklahoma rural schools, specifically factors that can be controlled through policies and interventions.

What the study examined

This study addressed three research questions related to successful recruitment and retention of teachers in Oklahoma rural school districts between school years 2005/06 and 2014/15:

1. What are the patterns of teacher mobility in rural and nonrural school districts in Oklahoma?

2. Which factors predict the successful recruitment (defined as completing a probationary period of employment in a single district for three years and obtaining tenure in the fourth year of teaching) of teachers in rural school districts in Oklahoma?

3. Which factors predict the continued retention of tenured teachers in rural school districts in Oklahoma?

This study examined the relative influence of teacher, district, and community characteristics to identify which are more predictive of successful recruitment and retention in rural school districts in Oklahoma

Understanding teacher recruitment and retention issues

The answers to research question 1 provide context for understanding the teacher recruitment and retention issues. The findings related to this question show:

- Teachers' probability of remaining employed in the same school district in Oklahoma for a given number of years—in other words, the proportion of teachers who remain in the district after one year of employment, two years of employment, and so on.
- The proportion of newly hired teachers who receive tenure (are employed for three full consecutive years and return for a fourth year) and the one-year retention probabilities for each successive year of employment after reaching tenure.
- The proportion of teachers who leave rural school districts who go on to teach in another rural district and the proportion who become employed by a nonrural school district.

The analyses related to research question 1 explore differences by locale (for example, rural versus nonrural schools and within rural locales).

Research questions 2 and 3, which consider only rural school districts, constitute the primary focus of the study. The distinction between the two questions is driven by the different objectives of teachers during their probationary period and after attaining tenure. During the three-year probationary period, school districts evaluate the new hires and may choose to discontinue their employment. A district's recruitment effort is considered successful once a teacher attains tenure. Once teachers attain the security of tenure (which makes it more difficult for teachers to lose their job and is not transferable between districts), the retention effort begins. Changing local conditions may play more of a role in a teacher's decision to stay or leave than they did when the teacher started his or her career in a given district. Therefore, different factors may motivate teachers to stay or leave during these two periods of employment. This study also examined the relative influence of teacher, district, and community characteristics to identify which are more predictive of successful recruitment and retention in rural school districts in Oklahoma. This analysis can help determine whether successful recruitment and retention are driven by factors that can be affected by education agency policy or whether they are more related to community characteristics.

Key terms used in this report are defined in box 2.

Box 2. Key terms used in this report

Contextual factor. A measurable value or community characteristic that cannot be modified by a policy or initiative of an education agency (is not malleable) but is either positively or negatively associated with the outcome.

Duration of employment. The number of years between the first and last years of employment for a teacher in a single district.

Full-time equivalent. The equivalent workload of one full-time job.

Indicator. A measurable value or characteristic of a teacher, district, or community that can be modified or compensated for by education policy or practice (is malleable) and is positively or negatively associated with the outcome.

Locale. The National Center for Education Statistics categorizes districts into locale codes, based on U.S. Census Bureau designations, which are a measure of geographic status on an urban continuum that ranges from city-large to rural-remote. In this study rural refers to districts categorized as rural-fringe, rural-distant, or rural-remote. Rural-fringe is defined as a rural territory that is no more than 5 miles from an urbanized area or within 2.5 miles of an urban cluster; rural-distant is defined as a rural territory that is more than 5 miles but 25 miles or less from an urbanized area, or more than 2.5 miles but 10 miles or less from an urban cluster; rural-remote is defined as a rural territory that is more than 25 miles from an urbanized area and more than 10 miles from an urban cluster (National Center for Education Statistics, 2014). Urban is used to refer to city locales in this report. Nonrural refers to districts categorized as city/urban, suburb, or town.

Malleable. A variable (value or characteristic) that can be intentionally changed or indirectly affected by a school, district, or state education agency policy or initiative. Malleable variables are called indicators in this report.

Newly hired teachers. Teachers in their first three years of employment (that is, their probationary period) in a given district. These teachers may have prior teaching experience in another district or may be new to teaching.

Retention. The duration of the employment of tenured teachers in years (as used in research question 3).

Successful recruitment. A new hire in a district who teaches for three consecutive full years and earns nonprobationary status, or tenure (as used in research question 2).

Tenure status. Providing job security to teachers by guaranteeing employment and requiring just cause for termination. Tenure is not transferable between districts. A teacher who is employed for three full consecutive years in the same district and continues teaching in the same district for a fourth year receives tenure.

This study examines a specific set of malleable variables (potential indicators) and nonmalleable variables (contextual factors) that were selected on the basis of evidence from prior research and the recommendation of Oklahoma Rural Schools Research Alliance members and other state stakeholders, as well as on the basis of available data.

Alliance members explained that differences across and within rural communities in Oklahoma are not necessarily captured by data sources commonly used in education research,

such as the data available from the National Center for Education Statistics. For example, variations in income and other factors affecting the resources available to rural families and schools are not fully captured by eligibility for the federal school lunch program (a common proxy for low-income status) because more than 60 percent of Oklahoma students qualify for the lunch program, obscuring any differences in the extent of poverty among them (National Center for Education Statistics, 2017). Furthermore, racial/ethnic minorities in Oklahoma are represented almost entirely by American Indians, but education data do not distinguish among the 39 tribes and nations within that single category. In addition, rural communities vary in terms of industry, from agriculture to oil production to tourism. These characteristics add to the challenge of studying rural schools and developing policies related to teacher recruitment and retention for all rural districts. In response to alliance members' concerns about capturing the heterogeneity of rural schools in Oklahoma, the study team accessed additional data sources, such as U.S. Census data and publicly available geographic information system data mapped to school district boundaries, to incorporate the broad range of community characteristics that might affect recruitment and retention.

In response to concerns about capturing the heterogeneity of rural schools in Oklahoma, the study team accessed additional data sources to incorporate the broad range of community characteristics that might affect recruitment and retention

Variables examined in the study

All potential variables related to recruitment and retention in rural Oklahoma that were identified are included in appendix B. The variables for which data were available and that were examined in this study are included in appendix C. Teacher variables include teacher demographics, teacher workload, years of teaching experience, and total compensation. District variables include student performance and discipline rates, student demographics, teacher characteristics, and parent engagement. Community variables include remoteness, socioeconomic status of community, employment in major sectors, and education level of the population.

The data sources, sample, and methods used in this analysis are shown in box 3.

Box 3. Data sources, sample, and methods

Data sources

The study team used data from three sources. Teacher demographics and employment information were from the Oklahoma State Department of Education School Personnel Records. District data, including student demographics, performance data, and additional contextual characteristics, were from the Oklahoma Office of Educational Quality and Accountability. Additional contextual variables and community characteristics were computed from data in federal noneducation sources (mostly the American Community Survey [five-year estimates] administered by the U.S. Census Bureau) and publicly available geographic information systems from Google Maps. Data were linked across the various sources using school and district identification codes. Data from each source were obtained for a 10-year period (school years 2005/06–2014/15). A complete list of the variables examined, list of data sources, and rationale for the study period are included in appendix C.

Sample

The study sample includes data for all teachers who were employed in Oklahoma during the study period, regardless of when they began teaching. The study sample includes at least

(continued)

Box 3. Data sources, sample, and methods *(continued)*

three years of data for seven consecutive cohorts of new teacher hires. Research question 1 includes data on 79,596 unique teachers from 521 school districts in Oklahoma who were employed at any time between school years 2005/06 and 2014/15. The distribution of districts and teachers by regional locale is provided in table C1 in appendix C. About 75 percent of the districts in the sample were rural, and 6 percent were urban or suburban. Research questions 2 and 3 focus on rural teachers only. To address research question 2, the study team examined each teacher who was hired in a rural district in any year from 2005/06 to 2011/12 (8,984 observations). (Because teachers may have been hired or achieved tenure more than once over the study period, these may not all be unique teachers; thus, the term "observations" is used.) The sample used to address research question 3 includes all tenured teachers who were employed in a rural school district in Oklahoma at any time during the study period (14,825 observations).

Methodology

The patterns of teacher job mobility (research question 1) were determined using descriptive statistics and methods of analysis suitable for duration data (that is, the length of time a teacher remains in a job). This analysis is called survival analysis, and it is typically used to determine the expected amount of time until an event happens. In this study survival analysis is used to analyze the duration of employment of teachers in Oklahoma or the probability of reaching a certain number of years of employment in the same district. Because many teachers were still teaching in the last year of the dataset and the study team did not know their "true" duration of employment, analysis methods were used to adjust for this. The proportions of teachers who changed jobs after one year of employment, two years of employment, and so on were established. Then duration data were analyzed to determine the probability that teachers at different points in their careers (that is, teachers who have been employed in a given district for particular durations of time) would remain in their current positions. Differences were compared by district locale type.

To answer research question 2, Oklahoma State Department of Education teacher history records were used to determine whether each teacher who was hired in a rural district in any year from 2005/06 to 2011/12 was successfully recruited.

Regression analysis was used to estimate the strength of association between various characteristics (teacher, district, and community) and specific teacher outcomes—the probability that teachers were successfully recruited (reached tenure; research question 2) and the duration of employment in a district for tenured teachers (research question 3). For research question 2, analyses were conducted for all teachers (new hires to a district regardless of prior experience) and for beginning teachers (those new to the teaching profession). The study team then examined the relative influence of each group of factors (teacher, district, and community characteristics) to identify which groups of factors are predictive of teacher recruitment and retention. In addition to showing the direction of the association, the study team quantified the relationship in terms of incremental changes in each variable. A more detailed description of the study data sources, sample, and methodology is given in appendix C.

What the study found

To provide context, this section first highlights key findings of the patterns of teacher job mobility in rural and nonrural Oklahoma, including the duration of employment, probability of being successfully recruited (reaching tenure), and the proportion of rural teachers who leave their district and are rehired in rural school districts or in nonrural school districts (research question 1). It then presents key findings of the relationship between the teacher, district, and community characteristics and successful teacher recruitment and retention in rural Oklahoma (research questions 2 and 3).

Teachers in rural school districts in Oklahoma have a shorter duration of employment than teachers in nonrural school districts

The median duration of employment is 14 years for teachers in rural school districts—significantly shorter than the 19 years for teachers in towns and the 16 years for teachers in suburban/urban school districts

Teachers in rural school districts have a significantly shorter median duration of employment (14 years) than do teachers in towns (19 years) and in suburban/urban school districts (16 years; table 1).

Within rural school districts, there is no difference in the median duration of employment (14 years) for teachers across fringe, distant, and remote rural school districts.

Teachers in rural school districts have a 70 percent chance of reaching tenure

Teachers in rural school districts have a 70 percent chance of reaching their fourth year of teaching in the same district and thus of achieving tenure, the study's measure of successful recruitment (figure 1). They have an 87 percent chance of being employed after their first year and a 49 percent chance of reaching their 14th year in the same rural district. By 50 years of employment the probability of remaining employed in the same rural school district approaches 0 percent (see tables D1 and D2 in appendix D for detailed probabilities of duration of employment by locale).

Teachers in town school districts in Oklahoma have a 74 percent chance of reaching their fourth year in the same district and an 88 percent chance of remaining employed in the same district after one year. Teachers in suburban/urban school districts have a 71 percent chance of remaining employed in the same district for four years and an 87 percent chance of remaining employed in the same district after one year (see figure 1).

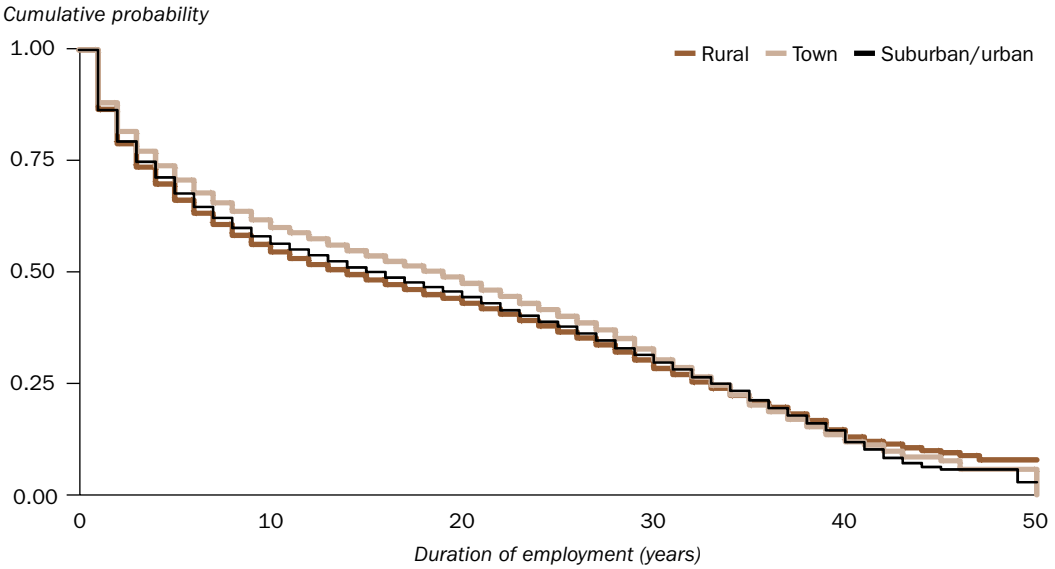
Table 1. Median duration of teacher employment in Oklahoma, by locale, 2005/06–2014/15

Locale	Median years of employment	Lower–upper 95 percent confidence intervals
Rural	14	13–15
Town	19	18–19
Suburban/urban	16	15–16

Note: Differences in duration of employment for teachers in rural and town districts, rural and suburban/urban districts, and town and suburban/urban districts are each statistically significant at $p < .05$. Duration of employment is reported in whole years because teacher employment data are reported as such. In most cases teachers are employed for the whole academic year; if a teacher taught for only a fraction of a year, that information would not be reported.

Source: Authors' analysis of data from Oklahoma State Department of Education School Personnel Records, 2005/06–2014/15.

Figure 1. Teachers in rural school districts in Oklahoma have a lower probability of being retained in the same district than do teachers in nonrural school districts, 2005/06–2014/15



Note: Log-rank tests show that differences in the retention probabilities of teachers in rural, town, and suburban/urban districts are statistically significant at $p < .01$.

Source: Authors' analysis of data from Oklahoma State Department of Education School Personnel Records, 2005/06–2014/15.

Teachers in rural school districts have a 70 percent chance of reaching their fourth year of teaching in the same district and thus of achieving tenure, the study's measure of successful recruitment

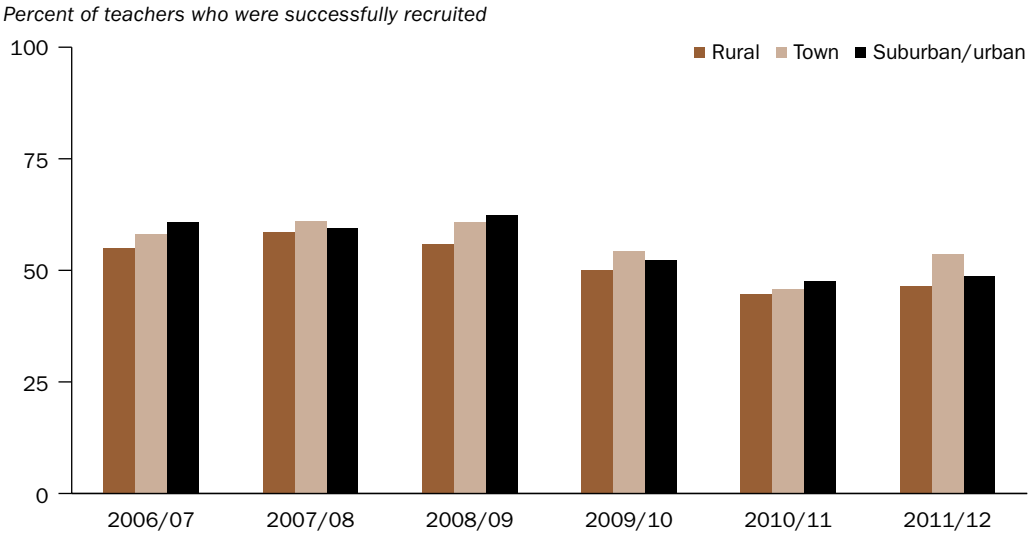
The highest probability of teachers in rural Oklahoma leaving their position occurs in their first year. The probability of "surviving" the first year is 87 percent. After the first year the probability of remaining employed in the same district for an additional year (the one-year probability of remaining employed) increases to more than 90 percent. This pattern, in which the one-year probability of remaining employed increases after the first year, is consistent across nonrural schools as well.

Rural school districts successfully recruited a lower percentage of teachers than did nonrural school districts from 2006/07 to 2011/12

Across each of the six years examined, a lower percentage of teachers were successfully recruited (reached tenure) in rural districts than in nonrural districts (town or suburban/urban districts; figure 2). The differences between rural and nonrural districts ranged from 1 to 7 percentage points and were statistically significant. The percentage of Oklahoma teachers who were successfully recruited in rural school districts ranged from 45 percent (in the 2010/11 cohort of new hires) to 59 percent (in the 2007/08 cohort). The percentage of teachers who were successfully recruited into districts declined in all locales from 2008/09 to 2010/11.[2]

In rural school districts there were differences in successful recruitment rates by sublocale. Successful recruitment rates were higher among teachers in rural-fringe districts (rural areas closest to suburban/urban areas) than among teachers in distant or remote rural districts (table 2).

Figure 2. In every year from 2006/07 to 2011/12 a lower percentage of teachers were successfully recruited (reached tenure) in rural districts in Oklahoma than in nonrural districts



Note: The differences between rural and nonrural districts are statistically significant at $p < .01$.

Source: Authors' analysis of data from Oklahoma State Department of Education School Personnel Records, 2006/07–2011/12.

Table 2. Comparison of successful recruitment in rural school districts in Oklahoma, by sublocale, 2006/07–2011/12

	Teachers successfully recruited	
Rural sublocale	Number	Percent
Rural-fringe	1,191	55.8
Rural-distant	2,191	51.9
Rural-remote	1,341	51.0

Note: The difference between rural-fringe and both distant and remote rural districts was statistically significant at $p < .001$. The difference between distant and remote rural districts was not statistically significant ($p \geq .05$).

Source: Authors' analysis of data from Oklahoma State Department of Education School Personnel Records, 2006/07–2011/12.

Most teachers in rural school districts who left their position but were rehired in the state were rehired in another rural district

Of the 18,182 teachers in rural school districts who left their position during the study period, 3,091 teachers (17 percent) were rehired in the state. Of these, 53 percent were rehired in another rural school district, 28 percent moved to a town school district, and 19 percent moved to a suburban/urban school district. Of the teachers in rural school districts who left the Oklahoma public school system during the study period, 83 percent had no information in their records about their next designation (that is, whether they left the state, left teaching but remained in the state, became employed in a nonpublic school, retired, or died).

Successful recruitment of teachers in rural school districts in Oklahoma is related more to malleable teacher indicators than to district or community characteristics

To answer research question 2, regression analysis was used to estimate the strength of the association between various teacher, district, and community characteristics and the probability that teachers were successfully recruited. Analyses were conducted for all new teachers to a district (that is, new hires to a district regardless of prior experience) and for beginning teachers (that is, those new to the teaching profession). Next, the relative influence of each group of factors (teacher, district, and community) was examined to identify which might predict teacher recruitment in rural school districts. In addition to the direction of the association, calculations included the marginal effects to quantify the relationship in terms of incremental changes in each variable. Each indicator and contextual factor examined and indications of which ones are significantly related to successful recruitment are presented below and in table E1 in appendix E. Detailed results from each statistical model are also in appendix E.

There is a strong positive association between recruitment and the similarity between the teacher's race/ethnicity and that of students in a district: a 12 percentage point increase in the probability of successful recruitment per percentage point on a similarity scale

Several teacher indicators are positively associated with successful recruitment in rural school districts in Oklahoma. Men are less likely than women to be successfully recruited. With all other factors controlled, male teachers are 18 percentage points less likely than female teachers to be successfully recruited (see table E2 in appendix E). Although a teacher's race/ethnicity is not associated with the probability of being successfully recruited, there is a strong positive association between recruitment and the similarity between the teacher's race/ethnicity and that of students in a district: a 12 percentage point increase in the probability of successful recruitment per percentage point on a similarity scale.[3] Additionally, a teacher's age at the time of being hired is positively associated with recruitment, with a 0.3 percentage point increase in the probability of successful recruitment for each year of age.

Teachers with a higher degree are 13 percentage points less likely to remain through tenure, and those with prior teaching experience are 3 percentage points less likely to remain than other teachers. Teachers who receive a degree from a college outside of Oklahoma are 6 percentage points less likely to be successfully recruited in a rural district than are teachers who receive a postsecondary degree from a college in Oklahoma. Graduates of Oklahoma University or Oklahoma State University are 4 percentage points less likely to be successfully recruited than are graduates of regional Oklahoma colleges.

Teachers with a larger workload (those with a higher full-time equivalent value; see box 2) are more likely to be successfully recruited. Also, teachers whose workload consists of both teaching and nonteaching assignments are more likely to be successfully recruited than teachers with the same full-time equivalent value whose workload includes teaching responsibilities only. Having a mix of teaching and nonteaching assignments is associated with a 28 percentage point increase in the probability of successful recruitment (compared with having teaching responsibilities only). Hypothetically, one full-time equivalent difference in workload would result in a 63 percentage point difference in the probability of recruitment. Typically, teachers who take on nonteaching assignments fulfill administrative roles, whereas some teachers with a higher full-time equivalent value work simultaneously as full-time teachers and as part-time coaches or counselors. These additional responsibilities likely increase a teacher's total compensation, but the positive effects of higher full-time equivalent and nonteaching assignments are present even after compensation is

controlled for, which may indicate more engagement and involvement with the students and school. Higher total compensation is also positively related to successful recruitment, increasing recruitment by 0.5 percentage point for every $1,000 annual increase.

Teachers in rural school districts with larger student enrollment, higher student performance, and a more experienced teaching workforce are more likely to be successfully recruited. The number of students in a district is positively associated with successful teacher recruitment: a district with twice the enrollment of another district but similar in every other respect would have a 14 percentage point higher probability of successfully recruiting a teacher (see table E2 in appendix E).[4] Additionally, teachers hired in districts with higher average student performance are more likely to be successfully recruited: a 1 percentage point difference in the proportion of students performing at the satisfactory level or better on state tests is associated with a 0.3 percentage point difference in the probability of successful recruitment between otherwise similar districts. Furthermore, successful recruitment is more likely in rural school districts where the teaching workforce is more experienced: a one-year difference in average years of experience is associated with a 1 percentage point difference in probability of successful recruitment.

The number of students in a district is positively associated with successful teacher recruitment: a district with twice the enrollment of another district but similar in every other respect would have a 14 percentage point higher probability of successfully recruiting a teacher

Some factors are negatively associated with recruitment. Successful teacher recruitment is less likely in the highest grade levels offered in a district, suggesting that it is more difficult to recruit teachers into high schools than into lower grade levels. Each rising grade level is associated with a 4 percentage point lower probability of successfully recruiting teachers, which translates into an approximately 15 percentage point higher chance of successful teacher recruitment in a typical elementary school district (where grade 8 is the highest level offered) than in a unified district (where grade 12 is the highest).

The analysis did not show a statistically significant relationship between successful recruitment and student–teacher ratio, staff–teacher ratio, district financial standings, student demographics in the district (except for the homogeneity between the teachers' and students' race/ethnicity), student suspension or absenteeism rates, or parent engagement (as measured by the percentage of participation in parent–teacher conferences).

Few community characteristics were found to be associated with successful recruitment of teachers in rural school districts. Districts categorized as rural-fringe locales, which are closest to urban centers, are less likely than rural-distant or rural-remote districts to successfully recruit teachers (by 5 percentage points on average). The economic profile of the community (that is, the type of employment sectors represented in the district boundaries) has a weak effect on the probability of successfully recruiting teachers. Only the proportion of employment in tourism and services sectors (trade, entertainment, recreation, accommodation, and food services industries) is associated with lower probability of successful teacher recruitment. One extra percentage point in employment in this sector is associated with a 3 percentage point lower probability of successful recruitment. Finally, the probability of successful recruitment is higher in communities with a larger proportion of students in the total community population.

In general, the indicators that predict successful recruitment in rural school districts for all teachers are similar for beginning teachers. Notable differences include that the percentage of students of the same race/ethnicity as the teacher in a school district is not related to successful recruitment for beginning teachers (see table E3 in appendix E). The

effects of higher total compensation and the teacher's age (being an older teacher) at the time of being hired are stronger for beginning teachers than for experienced teachers.

Teacher indicators are more important to successful recruitment than district or community characteristics are. The results described previously show that teacher indicators tend to have higher significance than district and community characteristics do. Additional analysis was conducted to compare the contribution of groups of malleable and nonmalleable factors. Two alternative statistical models that used subsets of variables were compared with the full model used in the previous analysis (table 3). One alternative model removed the community variables but left in the district factors. The other model left only teacher variables in place. The proportions of total variance explained by each of those models and by the full model were then compared. This comparison was used to distinguish the contributions of the different kinds of factors in explaining successful recruitment in rural districts.

Variation in community characteristics is not substantially associated with differences in the community's attractiveness to new hires, and the predictive power of the teacher variables constitutes more than three-quarters of the predictive power of the full model

Comparing the model that includes all variables (the full model) to models where different sets of variables have been removed (first community characteristics and then both community and district characteristics) shows that the teacher variables explain the largest amount of variance in successful recruitment. In the full model the explained variance in successful recruitment was .176. Removing the community characteristics made little difference in the explained variance (.171 versus .176). This result shows that variation in community characteristics is not substantially associated with differences in the community's attractiveness to new hires. The second alternative model—in which district characteristics are also removed, leaving only teacher characteristics—reduces the explained variance from .176 to .137. This change indicates that the predictive power of the teacher variables constitutes more than three-quarters of the predictive power of the full model —that is, the explained variance of the model that includes teacher variables only (.137) is 78 percent of the explained variance in the full model (.176). Thus teacher indicators dominate among the predictive factors.

However, all variables included in the analysis explained just under 18 percent of the total variance, which means that most of what leads to successful recruitment is explained by unmeasured variables. These unmeasured variables may include teacher characteristics for which data are unavailable (for example, individual preferences and experiences).

Table 3. Alternative models for analysis related to successful teacher recruitment in Oklahoma rural school districts, 2006/07–2011/12

Variable group	Full model	Model without community variables	Model with teacher variables only
Teacher	Yes	Yes	Yes
District	Yes	Yes	No
Community	Yes	No	No
Explained variance, R^2	.176	.171	.137

Source: Authors' analysis of data from Oklahoma State Department of Education School Personnel Records, data from the Oklahoma Office of Educational Quality and Accountability, and publicly available data, 2006/07–2011/12.

A closer look at teacher indicators of successful recruitment using marginal effects. Using information on the marginal effects makes it possible to compare the predicted outcomes of different policies. Full-time equivalent value, a measure of whether the teacher is employed full or part time, has the largest marginal effect (.628; see table E2 in appendix E). The range of variation in full-time equivalent value for the study sample is narrow: almost three-quarters of teachers are employed full time (1.0 full-time equivalent). Teachers working part time work on average three-quarters time (0.74 full-time equivalent). Less than 1 percent of teachers have extra duties beyond one full-time equivalent; with a few exceptions, these extra duties do not exceed an additional 0.25 full-time equivalent. The average for the sample of new hires is 0.93 full-time equivalent. As noted, the marginal effect of nonteaching duties is .276 (the higher probability of successful recruitment for new hires with nonteaching duties). The marginal effect of total compensation is about 0.5 percentage point per $1,000, which translates into an estimated 1 percentage point increase in the probability of successful recruitment per $1,991 of extra annual compensation.

Using this information, researchers and policymakers can estimate the effect of changes in a teacher's duties. For example, adding 20 percent (0.2 full-time equivalent) of nonteaching duties (such as administrative duties) to a teacher's workload paid at the average rate for new hires ($37,000) is associated with an estimated 44 percentage point increase in the probability of successful recruitment (from 55 percent to 99 percent).[5] The effect is the same for beginning teachers.[6]

Replacing a portion of a new hire's teaching duties with nonteaching assignments (without extra pay or change in full-time equivalent value) could increase the probability of successful recruitment by 28 percentage points, more than offsetting the lower probability associated with having a higher degree

Teacher indicators fall into two groups: those with a negative relationship with successful recruitment (male gender, prior experience, higher degree, and out-of-state education) and those with a positive relationship with successful recruitment (full-time equivalent value, nonteaching duties, and total compensation). Compensation and assignment may offset effects associated with individual characteristics, depending on the magnitude of these malleable factors. For example, having a higher degree (having a master's degree as opposed to a bachelor's degree) is associated with a 13 percentage point lower probability of successful recruitment. Offsetting this with higher pay alone would require an unrealistic salary increase of $24,852 a year. However, the study results suggest that replacing a portion of a new hire's teaching duties with nonteaching assignments (without extra pay or change in full-time equivalent value) would increase the probability of successful recruitment by 28 percentage points, more than offsetting the lower probability associated with having a higher degree. Similar calculations can be made for the quantitative effects associated with hiring men or graduates of out-of-state colleges.

Teacher indicators are more important than district and community characteristics to retention of tenured teachers, but there are important differences in the factors associated with retention, including teacher workload

To answer research question 3, regression analysis was used to estimate the strength of associations between groups of variables (teacher, district, and community) and the duration of tenured teachers' employment in a district. The relative association between each group of variables was examined to identify which predict teacher retention in rural school districts. The marginal effects were calculated to quantify the relationship in terms of incremental changes in each variable, as well as the direction of the association.

The results of the retention analysis are consistent in many respects with the results of the analysis of successful recruitment (detailed results of the teacher retention analysis are in appendix F). Teacher indicators contribute most to the explained variance, and the same teacher indicators have the greatest statistical significance. Community characteristics contribute less to predicting duration of employment. But there are some important differences. Full-time equivalent value, one of the most important teacher variables positively associated with successful recruitment, has a negative effect on retention of tenured teachers: a one full-time equivalent difference changes the probability that a teacher will leave a district in a given year by a factor of 2.08.

Of all the variables included in the analysis, the teacher variables explained the greatest amount of variance in retention. In the teacher retention analysis, teacher indicators contributed 58 percent to the explained variance (.099 is 58 percent of .170; table 4), whereas they contributed 78 percent to the explained variance for recruitment. As with the recruitment results, the full model for teacher retention, which includes all variables, explained 17 percent of the total variance, again pointing to unmeasured variables explaining most of the employment decisions.

The results of the retention analysis are consistent in many respects with the results of the analysis of successful recruitment. Teacher indicators contribute most to the explained variance, and the same teacher indicators have the greatest statistical significance. But there are some important differences

Finally, because the retention results are based on more observations than the recruitment results, the estimated effects of more indicators are statistically significant, including several district indicators and community characteristics (see table F1 in appendix F). Effects of district and community variables present a complex pattern that is impossible to evaluate on the basis of the results of a single exploratory study. Some effects, such as negative effects of crime rate and student discipline metrics or positive effects of district financial resources, are easy to interpret. Other effects, such as the negative effects of average student performance or median household income in the community, seem counterintuitive. It is possible that those effects result from the diversity of rural community types and differences in the relationship among variables across community types, or they may reflect unmeasured indicators of match between the teacher and the community and district policies. In any case, the data suggest that socially and economically disadvantaged rural districts are not necessarily penalized by lower teacher retention rates.

A closer look at teacher indicators of retention using marginal effects. The potentially most influential of all teacher indicators is higher total compensation, and it is more important in retaining teachers than in recruiting them. A 1 percentage point increase in the one-year probability of retention is associated with an increase in annual compensation

Table 4. Alternative models for analysis related to successful teacher retention in Oklahoma rural school districts, 2005/06–2014/15

Variable group	Full model	Model without community variables	Model with teacher variables only
Teacher	Yes	Yes	Yes
District	Yes	Yes	No
Community	Yes	No	No
Explained variance, R^2	.170	.150	.099

Source: Authors' analysis of data from Oklahoma State Department of Education School Personnel Records, data from the Oklahoma Office of Educational Quality and Accountability, and publicly available data, 2005/06–2014/15.

of just $249. Results of the recruitment analysis imply that it takes an annual increase of $1,991 to gain a 1 percentage point increase in recruitment for new hires. This means that tenured teachers' decisions to continue to teach in the same district are more strongly associated with pay increases. Although retention is negatively associated with workload (a higher full-time equivalent value), this can be outweighed by the strong positive association with higher pay. Using a hypothetical 0.2 full-time equivalent increase yields an estimate of a 15 percentage point increase in the probability of a tenured teacher leaving the district because of the negative association between retention and working more hours. However, assuming an annual salary of $50,000 (the average annual salary in the retention analysis sample) the corresponding $10,000 pay increase for the additional 0.2 full-time equivalent is associated with a 33 percentage point increase in the probability of retention, resulting in a net increase of 18 percentage points in the probability of retention. In addition, an extra nonteaching assignment is associated with an increase in the probability of retention by a factor of 1.197. Thus, having an increased workload, especially if resulting from nonteaching assignments, is associated with an increase in the probability of retention.

Implications of the study findings

The study examined differences in patterns of job mobility for teachers in rural and nonrural school districts in Oklahoma. That these differences favor nonrural school districts suggests a need to focus recruitment and retention policies on rural school districts. The study found that successful recruitment and retention of teachers in rural school districts are related more to teacher indicators than to district or community characteristics.

For example, the results show that teachers in rural school districts who are male, those who have higher postsecondary degrees, and those who have more teaching experience are more difficult to successfully recruit and retain. Job assignment (as measured by full-time equivalent value and additional nonteaching assignments) and total compensation are associated with recruitment and retention. This finding is encouraging because it means that successful recruitment is not determined mostly by nonmalleable community characteristics. Rather, the factors identified in this study as associated with better recruitment rates can be improved or supported by initiatives that target individual or subgroups of teachers. Identifying these malleable indicators could inform future efforts to study and evaluate new recruitment and retention policies.

That job assignment and total compensation are associated with recruitment and retention is encouraging because it means that successful recruitment is not determined mostly by nonmalleable community characteristics. The factors identified in this study as associated with better recruitment rates can be improved or supported by initiatives that target individual teachers or subgroups of teachers

Identifying community characteristics could help policymakers focus on districts that would benefit from additional resources. For example, providing additional resources to districts in rural-fringe locales—rural districts closest to urban centers—may help them compete with suburban and urban districts in hiring and retaining teachers. In addition, the study's findings can provide valuable information for school districts to consider when deciding whether to adopt or broaden recruitment and retention initiatives.

This study may also inform Oklahoma's Teacher Shortage Task Force's recommendations, as well as the recommendations of other stakeholders in the state, and the resulting strategy shifts, by providing insight into which factors are related (and how) to rural teacher recruitment and retention in Oklahoma. The task force was formed to identify and recommend successful strategies for curbing the statewide teacher shortage crisis by researching and testing methods aimed at addressing the shortage (Oklahoma State Department of Education, 2015d).

Moreover, because the study used data that many states routinely collect or that are publicly available, other states might begin to explore their own datasets to identify similar relationships among indicators of teacher recruitment and retention.

Limitations of the study

This study has several limitations. Data were not available on some potential indicators of teacher recruitment and retention identified in the literature or by the Oklahoma Rural Schools Research Alliance. The data limitations at the teacher level are considerable. For example, although teacher participation in an induction program may be related to teacher retention, data for this indicator were not available for this study. Research suggests that many types of teacher variables (such as details of teacher preparation and effectiveness and connections to the district through origin and family ties) may predict successful recruitment and retention; however, data on many of these variables were not available for this study. This limits the predictive power of the models developed for this study, which may bias the estimates of the effects of particular indicators and possibly understate the importance of factors related to the match between teacher and district. All variables included in the analysis explained just under 18 percent of the total variance, which means that most of what leads to successful recruitment is explained by unmeasured variables.

All variables included in the analysis explained just under 18 percent of the total variance, which means that most of what leads to successful recruitment is explained by unmeasured variables

Although sufficient to answer questions about nontenured teachers through three years, the 10-year timespan of the dataset is too short to get complete information on the long-term employment dynamics of teachers and to produce reliable estimates of variance in retention rates over time. It may also result in understating the relative weight of community characteristics because their variability over time is not accounted for. Therefore, results should be interpreted as applicable only to the decade-long time period of the study.

Any study of indicators provides guidance based on precise estimates from statistical models, but it can in no way suggest that making changes in indicators or providing support in the face of negative community characteristics would be effective policy. In other words, the study's nonexperimental design means that it cannot determine cause and effect. Finding an association between an indicator and a teacher outcome (effect), even when statistically significant, does not mean that that indicator will cause the predicted outcome and should not be interpreted as such. The study's findings reveal only the strength of the associations between specific indicators and outcomes. These associations can then be used to pinpoint potential problem areas and provide some evidence of promising avenues for administrators to pursue. The findings from this study generate hypotheses that can be tested through experimental evaluations of programs aiming to improve teacher recruitment or retention.

Appendix A. Literature review

To provide a theoretical basis for this study, the study team conducted a literature review to search for factors associated with recruiting and retaining rural teachers. This appendix includes a narrative of the literature review findings. The review covered studies published between 2000 and 2015.

In examining the relevant studies, the study team focused on a list of potential variables developed from a preliminary scan of the literature and through discussions with alliance members and other stakeholders (table A1). Not every potential factor has research support (and therefore is not in the literature review), but because this study is exploratory, the study team relied on the expertise and experience of alliance members as well as on the research literature in developing the list.

The factors are organized by teacher indicators, school or district factors, and community characteristics. Unless explicitly stated, all research is specific to rural districts. Within each section, potential factors supported by consistent findings across multiple studies are listed first, followed by potential factors with mixed evidence, and then potential factors with limited supporting evidence. Consistent evidence means that more than one study showed a positive relationship between the variable and outcome, and no studies were found that contradicted this finding. Mixed evidence signifies that at least one study provided supporting evidence and at least one study did not provide evidence linking the variable to outcomes. Limited evidence indicates that only a single study providing evidence was found on the topic or that the literature discussed the factor as a tool for recruitment and retention but did not provide results linking the variable to outcomes.

Potential teacher indicators

The potential teacher indicators of successful recruitment or retention with the most evidence in recent research include whether a teacher is originally from a rural area and the grade level taught. The study team found mixed evidence with regard to whether teacher participation in a mentoring or induction program is related to recruitment or retention and limited evidence regarding years of teaching experience.

Teacher has a rural background (consistent evidence). Because so many rural districts struggle to attract and keep teachers, many have invested in the "homegrown" approach of recruiting and training local residents to become teachers. Several studies review show a relationship between teaching in a rural setting and growing up in a rural area or enjoying the rural lifestyle. One factor that can influence a teacher's decision to accept and remain in a rural teaching position is the location of the individual's home and family relative to the workplace; teachers who live in rural locations take positions in rural schools (Davis, 2002; Huysman, 2008; Sundeen, & Wienke, 2009). In a study of rural special education teacher preparation, teachers who were recruited from the community stayed after graduation because of personal and family ties (Tyler, Cantou-Clarke, Easterling, & Klepper, 2003). Research on the Prairie Teachers Project, a support program for new teachers, reported that 78 percent of teachers who returned to their home communities to teach stayed for more than one year, whereas only 61 percent of teachers new to the community stayed that long (Harris, Holdman, Clark, & Harris, 2005).

Table A1. Variables included in literature review

Variable	Evidence found in literature review
Teacher indicators	
Whether teacher has a rural background	Yes
Grade levels taught by teacher	Yes
Participation in teacher mentoring or induction program	Yes
Years of teaching experience (prior to employment in a rural district)	Yes
National Board for Professional Teaching Standards certification (incentives offered for certification)	Yes
Teacher effectiveness rating	No
Similarity of student and teacher demographics	No
Type of teaching certification (for example, alternative, emergency)	No
Participation in teaching incentive programs (for example, to hire local residents or to teach in a lower-performing school)	No
Teaching assignment matches certification or prior teaching experience	No
Grade level the teacher has the most experience with	No
School or district factors	
School climate	Yes
Salary/compensation (district mean or mean starting salaries, if available)	Yes
Opportunities for professional learning	Yes
Student–teacher ratio	Yes
Additional incentives: housing assistance, signing bonus	Yes
Principal effectiveness rating	No
Teacher effectiveness rating (district mean)	No
Student–noncertified staff ratio	No
Certified staff–all staff ratio	No
School size (number of teachers and students)	No
Distance learning program	No
School discipline levels	No
School average achievement	No
Access to Internet or technology (in the school or district)	No
Success of extracurricular activities (for example, sports teams)	No
Community characteristics	
Remoteness (for example, driving times to nearest institution of higher education or school of education and major cities)	Yes
Availability of housing	Yes
Socioeconomic status of community (ratio of median income to poverty level)	No
Crime rate	No
Average wages and other compensation in the community	No
Sources of income in the community (structure of employment)	No

Source: Authors' analysis based on literature review, 2000–15.

In a study of rural teacher satisfaction, the most negatively rated aspects of job satisfaction (compensation, company policies, advancement, and recognition) were shown to be significantly influential in transplanted teachers' decisions to leave a rural district; however, these same factors had a negligible influence on homegrown teachers. For these teachers, job satisfaction played little role in decisions to leave the district because the teachers felt invested in the community (Huysman, 2008). When teachers in Montana rural schools were asked to rank their reasons for accepting and remaining in their current teaching

positions, they ranked enjoyment of the rural lifestyle as their first choice for accepting the position and as their second choice for remaining in the position (Davis, 2002). Another study, based on principals' reports, found that hiring local graduates or other people from the geographic area (who would therefore be comfortable in the rural environment) led to a greater success in recruiting and retaining rural teachers (Beesley, Atwill, Blair, & Barley, 2008).

Grade level taught (consistent evidence). In research studies supporting a link between grade level taught and teacher recruitment and retention in rural schools, evidence has suggested that rural schools are specifically challenged in recruiting highly qualified teachers for higher grades. Data from the National Survey of Rural Superintendents, with 603 respondents, suggest that rural schools have the most difficulty staffing high school positions and the least difficulty staffing elementary school positions (Hammer, Hughes, McClure, Reeves, & Salgado, 2005). In a national survey on implementation of requirements stipulated by the No Child Left Behind Act of 2001, Zhang (2008) found a similar statistic: rural districts reported having the hardest time staffing secondary school science and math positions.

Teacher participation in a mentoring or induction program (mixed evidence). Teacher induction and mentoring programs, which aim to provide support and guidance to teachers entering the profession, were mentioned in several studies examined in the literature review, although with mixed results. One study found that insufficient mentoring was negatively associated with teacher retention in a rural setting (Goodpaster, Adedokun, & Weaver, 2012). Teachers without such support may feel unprepared and overwhelmed by the job and may be more inclined to leave the profession. Therefore, many districts and schools are using induction and mentoring programs to recruit and retain highly qualified teachers in rural areas (Schwartzbeck, Prince, Redfield, Morris, & Hammer, 2003; Zhang, 2008). A study of one program designed to support rural special education teachers while they work toward full certification reported that 85 percent of credentialed program graduates remained as special education teachers in the same region and 94 percent remained in the field overall. In addition, all credentialed teachers in the study who served as peer coaches to intern teachers remained as special education teachers in the region (Cegelka & Alvarado, 2000). These findings suggest that mentoring and induction programs may be advantageous in retaining experienced teachers and that placing teachers in mentoring roles may be beneficial to retention.

Contrary to these findings, a study comparing rural and nonrural participants in Project Launch, an induction program, reported that only 50 percent of rural participants stayed in their first-year teaching positions, compared with 80 percent of nonrural participants. However, the percentage of teachers who left the profession after one year was not higher for rural than for nonrural teachers, and the study authors cited many other successes of the program (Harris et al., 2005). In a surprising finding from a survey of 83 members of the American Council on Rural Special Education, consisting mainly of college professors and special education administrators, not one respondent identified induction or mentoring programs as being associated with teacher recruitment or retention (Williams, Martin, & Hess, 2002). However, one should not infer from this finding that induction programs were not used in those districts.

In interviews with principals whose schools had been successful in recruiting and retaining teachers, six of seven principals said that their school or district offered induction programs for new teachers, but not all of the principals said they thought the induction programs helped with retention (Beesley et al., 2008). Therefore, some of the research points to induction and mentoring as being related to successful teacher recruitment and retention, and some does not. Retention may also depend on the type of induction program used.

Years of teaching experience (limited evidence). The research literature suggests that, in rural areas, the turnover of teachers who are relatively new to the profession is higher than that of experienced teachers. The results from an analysis of national survey data focusing on math and science teachers show that, in rural districts, new teachers (that is, those with three or fewer years of teaching experience) were predicted to have roughly a 40 percent probability of staying in their same schools the next year, whereas experienced teachers (that is, those with more than three years of teaching experience) were predicted to have a 74 percent probability of staying in their same schools the next year (Tai, Liu, & Fan, 2007). The authors of the study explained that this finding might lead readers to the conclusion that districts should "poach" experienced teachers from other districts. If that were to happen, then districts and students overall would suffer. Although this study only followed teachers over two years, the findings may suggest that an upfront investment in the first few years of a teacher's entry into the professional could provide long-term gains in retention.

Potential school or district factors

This section discusses school- or district-level variables for which any previous research was found. A positive school climate has been associated with teacher recruitment and retention. Evidence was mixed for salary and compensation and opportunities for professional learning, and limited evidence was found for student–teacher ratio and other financial incentives.

School climate (consistent evidence). Studies mentioning school climate in relation to teacher recruitment and retention were found throughout the research literature. School climate had not previously been identified for this study as a potential factor. A safe school environment was listed as being positively associated with a teacher's decision to accept and remain in a teaching position in a rural school (Davis, 2002; Goodpaster et al., 2012). A supportive environment—including a supportive staff, superintendent, parents, and community—was identified as a way to retain teachers (Davis, 2002; Goodpaster et al., 2012; Schwartzbeck et al., 2003). Because of the prevalence of studies discussing school climate in relation to teacher recruitment and retention, this variable was added to the study list for exploration.

Salary and compensation (mixed evidence). Most of the literature on the topic identified teacher salary and compensation as relevant to rural teacher recruitment and retention, but the results were somewhat mixed. Several studies found that low salaries are associated with rural teachers' reasons for leaving. One study found that dissatisfaction with salaries and benefits was a challenge associated with rural teaching, as well as a negative aspect associated with rural attrition and retention (Goodpaster et al., 2012). A nationwide survey of rural superintendents found that the most commonly cited obstacle to attracting and retaining teachers was low salaries (Schwartzbeck et al., 2003). Additionally, teachers

have rated compensation as the element they were least satisfied with, and compensation has been found to be significantly influential in transplanted teachers' decisions to leave rural districts (Huysman, 2008). As a result, low salaries have been seen historically as an obstacle, and raising salaries is seen as a recruitment incentive. A survey of college professors and special education administrators (Williams et al., 2002) reported the use of salary incentives, increments, and benefits as common strategies for enhancing rural teacher recruitment and retention.

In contrast, two studies pointed to salaries not being linked to retention. In one, teachers in rural Montana reported not being strongly influenced by salary or benefits when deciding whether to accept or remain in their teaching positions (Davis, 2002). The second study by Berry, Pétrin, Gravelle, and Farmer (2011) found that although rural administrators commonly cited salary and benefits as a reason for teachers leaving, less than 6 percent of rural teachers who were planning to leave their positions cited salary or benefits as their reason for leaving.

Opportunities for professional learning (mixed evidence). Professional learning opportunities—a factor suggested by members of the Oklahoma Rural Schools Research Alliance—has some support in the research literature. Studies suggest that rural school districts are investing in professional development as a teacher recruitment and retention tool. Zhang (2008) found that a majority of the districts in the study used content-driven professional development to recruit and retain teachers in rural areas, and that 35 percent of rural districts reported that No Child Left Behind requirements for highly qualified teachers had resulted in more sustained and long-term professional development for teachers. Schwartzbeck et al. (2003) found that superintendents mentioned strong professional development programs as an incentive for recruitment and retention. Professors and special education administrators (Williams et al., 2002) reported the use of onsite professional development opportunities to enhance teacher recruitment and retention in rural schools.

Some instances of success have been documented in rural school districts that use professional development for recruitment and retention. Goodpaster et al. (2012) found that opportunities for professional development benefitted rural teacher retention. In another study, 24 percent of rural special education teachers reported lack of support as a reason for planning to leave their district. Specifically, with regard to professional development, the teachers requested further learning regarding special education processes, technology, and general curriculum content, as well as additional training in specific disability categories (Berry et al., 2011). A study of the Prairie Teachers Project found that teachers were slightly more likely to remain in their first positions when employed at schools that belonged to teacher centers, provided professional leave, or reimbursed travel to professional meetings (Harris, 2001). Contrary to these findings, Davis's (2002) survey of rural Montana teachers found they were not strongly influenced by professional development opportunities when accepting their current positions and actually ranked professional development opportunities last out of 14 identified factors for remaining in teaching.

Student–teacher ratio (limited evidence). Rural schools often have smaller class sizes and lower student–teacher ratios than nonrural schools, and this fact is often referenced as one of the benefits of rural teaching but lacks evidence of effectiveness. Therefore, it follows that some rural school districts attempt to attract teachers by advertising small class sizes (Zhang, 2008). However, in a survey of rural Montana teachers, Davis (2002) showed that

teachers in the study ranked small class size as sixth out of 13 possible factors for accepting the job and seventh out of 14 for remaining in the job.

Other financial incentives (limited evidence). Alternative financial incentives may be another way to increase teacher recruitment and retention in rural areas, although the literature review did not provide any studies examining the effectiveness of these incentives. In a survey of rural superintendents, Schwartzbeck et al. (2003) found that tuition assistance and bonuses for national board certified teachers were common incentives for attracting and retaining teachers. In addition, a case study of nine rural schools with school improvement grants reported that three schools were using the grant money to offer signing bonuses to incoming teachers (Rosenberg, Christianson, Angus, & Rosenthal, 2014). Although both studies described the use of alternative financial incentives as recruitment and retention strategies, neither reported on the success of the measures.

Because of the monetary constraints many rural districts face, financial incentives are not always a viable option. Beesley et al. (2008) reported that the rural districts they studied seldom used incentives such as signing bonuses; relocation assistance; finder's fees; or subsidized housing, transportation, or meals. In fact, the schools that did use signing bonuses were associated with unsuccessful teacher retention. Although several principals reported offering tuition reimbursement or generous health and retirement benefits, they attributed successful retention largely to other approaches outlined elsewhere in this report. Hammer et al. (2005) reported limited reliance on targeted incentives and housing and relocation assistance, and Zhang (2008) found that only 7 percent of districts offered signing bonuses to recruit rural teachers.

Potential community characteristics

Mixed evidence was found regarding whether remoteness is negatively associated with recruitment and retention. Limited evidence was found citing a lack of available housing as an obstacle.

Remoteness (mixed evidence). The literature review identified geographic and social isolation as an obstacle to teaching in rural areas, although the evidence is mixed. In several studies, isolation and remoteness were cited by administrators as challenges to recruitment and retention (Beesley et al., 2008; Berry et al., 2011; Hammer et al., 2005; Rosenberg et al., 2014; Schwartzbeck et al., 2003). In contrast, one study noted that although administrators cited a remote location as a reason for teachers leaving, fewer than 6 percent of teachers in the same study cited this reason for leaving (Berry et al., 2011). In one survey of rural teachers, access to recreational activities was ranked low as a reason to take or remain in a teaching position (Davis, 2002). However, teacher education programs in rural areas have reported the hardship of not having access to shopping, cultural events, or sporting events in preparing rural teachers (Williams et al., 2002; Zhang, 2008). Lack of access to a university has been identified by teachers and teacher preparation programs as a negative aspect, mostly with regard to professional preparation and growth (Goodpaster et al., 2012; Williams et al., 2002).

A case study of one rural district that contains both rural towns and remote areas described how teachers tend to move to a rural town after having gained initial teaching experience in a more remote area. In other words, teachers take a job in a remote area, complete their

certification and then move on to a more populated area (Zhang, 2008). To address long teacher commutes and isolated communities, some schools offer direct support for teacher commutes, such as gas stipends or commuter vans (Rosenberg et al., 2014).

Availability of housing (limited evidence). Housing availability was identified as a potential variable related to rural teacher recruitment and retention. The literature review found one study relating the limited availability of housing in rural areas to recruiting and retaining new teachers. In this study, 36 percent of the superintendents surveyed reported that a lack of adequate housing was an obstacle to teacher recruitment and retention (Schwartzbeck et al., 2003).

Summary and conclusions from the literature review

The literature review uncovered no rigorous research, such as randomized control trials or quasi-experiments, with regard to the effectiveness of teacher recruitment and retention strategies in rural areas. The research base consists of descriptive statistics from surveys, case studies, and self-reports on what participants think influences recruitment and retention rather than what has actually been shown to be associated with recruitment or retention. Teacher factors, such as whether a teacher is originally from a rural area and the grade level taught, have sufficient support in the literature to confirm their importance as possible factors in recruitment and retention. At the school or district level, school climate was the only potential factor found by this literature review with consistent evidence regarding recruitment and retention. Additional variables across all three levels were supported by mixed or limited evidence.

In addition to the variables supported by evidence in the literature review, the research team examined other variables identified by members of the Oklahoma Rural Schools Research Alliance and other stakeholders. Again, the overall lack of research regarding factors related to teacher recruitment and retention in rural school districts highlights the need for the current study to link variables of interest to outcome data.

Appendix B. Variables potentially related to teacher recruitment and retention in Oklahoma rural school districts identified and examined in this study

This study examines a specific set of variables potentially related to recruitment and retention that were selected on the basis of supporting evidence from prior research as identified in the literature review in appendix A, the recommendation of Oklahoma Rural Schools Research Alliance members and other state stakeholders, and availability of data. All variables that were identified, along with an indication of how they were identified, are included in table B1. The availability of data determined which variables were examined in this study.

Table B1. Variables potentially related to teacher recruitment and retention in Oklahoma rural school districts

Variable	How was the variable identified?			Data available for use in this study
	Recommended by members of the Oklahoma Rural Schools Research Alliance and other state stakeholders	Supported by prior research	Included in available data from state or publicly available source	
Teacher				
Teacher demographics (age, gender, race/ethnicity)	No	No	Yes	Yes
Whether teacher is from a rural background	Yes	Yes	No	No
College or university where teacher received degree	No	No	Yes	Yes
Degree level	No	No	Yes	Yes
Type of teaching certification	Yes	No	Yes	No
Participation in teacher induction program	Yes	Yes	No	No
Participation in teaching incentive programs (for example, to hire local residents or to teach in a lower performing school)	Yes	No	No	No
National Board for Professional Teaching Standards certification (incentives offered for certification)	No	Yes	No	Yes
Nonteaching assignment (teacher had nonteaching duties in any year during this period of employment)	No	No	Yes	Yes
Teaching workload (teacher average full-time equivalent during this period of employment)	No	No	Yes	Yes
Teaching assignment matches certification or prior teaching experience	Yes	No	Yes	No
Highly qualified teacher	Yes	No	No	No
Current grade levels taught by teacher (elementary, middle, secondary)	No	Yes	Yes	No
Years of teaching experience (at time of hire in a given district, if new or experienced teacher)	Yes	Yes	Yes	Yes
Total compensation	Yes	Yes	Yes	Yes

(continued)

Table B1. Variables potentially related to teacher recruitment and retention in Oklahoma rural school districts *(continued)*

Variable	How was the variable identified?			
	Recommended by members of the Oklahoma Rural Schools Research Alliance and other state stakeholders	Supported by prior research	Included in available data from state or publicly available source	Data available for use in this study
District				
Principal effectiveness rating	Yes	No	No	No
Teacher effectiveness rating (district mean)	Yes	No	No	No
Student–teacher ratio	No	Yes	Yes	Yes
Staff–teacher ratio	No	No	Yes	Yes
District size	Yes	No	Yes	Yes
Length of school week (four or five days)	Yes	No	No	No
District financial information	Yes	Yes	Yes	Yes
Opportunities for professional learning	Yes	Yes	No	No
Distance learning program	Yes	No	No	No
Additional incentives (for example, housing assistance and signing bonus)	No	Yes	No	No
School climate	Yes	Yes	No	No
School discipline levels	Yes	No	Yes	Yes
Average student performance	No	No	Yes	Yes
Average student demographics	No	No	Yes	Yes
Average teacher characteristics	No	No	Yes	Yes
Similarity of student and teacher demographics	Yes	No	Yes	Yes
Access to Internet and technology in the school and district	Yes	No	No	No
Success of extracurricular activities (for example, sports teams)	Yes	No	No	No
Highest grade offered in district	No	No	Yes	Yes
Parent engagement	No	No	Yes	Yes
Community characteristic				
Remoteness (for example, driving times to nearest institution of higher education or school of education and major cities)	Yes	Yes	Yes	Yes
Socioeconomic status of community	Yes	No	Yes	Yes
Availability of housing	No	Yes	Yes	Yes
Juvenile crime rate	No	No	Yes	Yes
Average wages or median income	Yes	No	Yes	Yes
Employment in major sectors such as agriculture, mining, tourism and services, government	Yes	No	Yes	Yes
Unemployment rate	Yes	No	Yes	Yes
Family composition (proportion of “family,” “complete family,” and “extended-family” households)	No	No	Yes	Yes
Education level of community	No	No	Yes	Yes
School-age children born in Oklahoma	No	No	Yes	Yes

Source: Authors’ compilation based on discussions with the Oklahoma Rural School Research Alliance, literature review, and data collection and processing.

Appendix C. Study methodology

This appendix describes the study sample, the data sources, and the study methodology.

Sample selection

The study sample includes data on all public school teachers in Oklahoma for whom the Oklahoma State Department of Education (OSDE) has data and spans the 2005/06–2014/15 school years. The study start date was chosen for two reasons. First, the study relies heavily on data originating from the American Community Survey, which was implemented in 2006. Second, around 2005, school districts in Oklahoma adopted an online system for submitting teacher records to OSDE, which makes accessing teacher record data much simpler. The study end point—the 2014/15 school year—was chosen because it was the latest period for which the required data were available at the time of data collection.

The 10-year study sample includes data for all teachers who were employed in Oklahoma during this period, regardless of when they began teaching. The study sample includes at least three years of data for seven consecutive cohorts of new teacher hires. In addition, choosing a timespan that includes several periods of changing labor market conditions —including the 2008–11 recession and the expansionary periods before and after it— provides greater variability in socioeconomic data, likely increasing the reliability and generalizability of the results.

For research question 1, data on all teachers employed at any time during this period were used. This sample includes 79,596 unique teachers from 521 school districts in Oklahoma, who were employed at any time between school years 2005/06 and 2014/15. Unique teachers may have multiple records if they taught in multiple districts during the study years. The distribution of districts and teachers by locale is provided in table C1. About 75 percent of the districts in the sample were rural, and 6 percent were urban or suburban.

Only rural teachers were included in the analysis for research questions 2 and 3. For research question 2, only teachers newly hired into district between school years 2006/07 and 2011/12 were included in the analysis. The range for hire date began in 2006/07 in order to determine whether the teacher had prior teaching experience (that is, during the 2005/06 school year) and ended in 2011/12 to ensure that the records included at least four years of postemployment data to determine whether the teacher reached tenure. The

Table C1. Number and percentage of Oklahoma school districts and teachers used in analysis, by locale, 2005/06–2014/15

Locale	Number of districts	Percentage of districts in the state	Number of teachers	Percentage of teachers in the state
Rural	393	75.4	24,537	30.8
Town	97	18.6	21,651	27.2
Urban or suburban	31	6.0	33,408	42.0
Total	521		79,596	

Source: Authors' analysis of data from Oklahoma State Department of Education School Personnel Records, 2005/06–2014/15.

sample for research question 2 included 8,007 unique teachers (8,984 total employment records), 3,679 of whom were new to teaching during this period. For research question 3, only data on teachers who obtained tenure between school years 2005/06 and 2014/15 were included in the analysis. The sample for research question 3 included 14,391 unique teachers (14,825 total employment records).

Data sources and collection methods

Data for the study are collected from three sources: the OSDE, the Oklahoma Office of Educational Quality and Accountability (OEQA), and publicly available data.

Oklahoma State Department of Education. The Oklahoma State Department of Education (OSDE) teacher records contain the following data for all teachers in Oklahoma for the 2005/06–2014/15 school years. If a teacher had more than one job assignment (for example, teacher and athletic coach), there is a separate record for each:

- Teacher year of birth.
- Teacher gender and race/ethnicity.
- Year began teaching in a school in Oklahoma.
- Year began teaching in current district.
- Years of teaching experience prior to current employment.
- Teacher degree, year when they received first bachelor's degree, and name of postsecondary institution attended.
- National Board for Professional Teaching Standards certificate description, grade level, and year.
- Current workload (full-time equivalent, grade level or levels taught by teacher, and current subject description).
- District in Oklahoma where teacher was employed.
- Job assignment (teacher, principal, or other administration).
- Teacher compensation.
- Teacher cause of termination (if terminated from a district that year).

Oklahoma Office of Educational Quality and Accountability. The study used district-level data, including data on student characteristics and additional contextual characteristics. OEQA publishes these statistics annually on its website in individual school and district reports. OEQA provided the study team with the following data in one dataset per year for all schools and districts:

- Student demographic characteristics (race/ethnicity, eligibility for the federal school lunch program).
- U.S. Census data (district population, poverty rate, unemployment rate, average household income, single-parent families).
- Suspension–student ratio and juvenile crime rate.
- Classroom and administration characteristics: number of teachers, number of students (total, English learner designation, special education designation).
- Student performance on standardized assessments.

Publicly available data. Additional contextual factors and community characteristics pertaining to school district geographic boundaries were computed from data in federal noneducation sources (mostly the American Community Survey administered by the U.S. Census Bureau) and publicly available geographic information systems from Google Maps.

The U.S. Census Bureau recommends using five-year estimates from the American Community Survey data when precision, which results from the increased sample in multiyear estimates, is more important than how recent data are and when examining smaller geographies for which one-year and three-year estimates are not available (U.S. Census Bureau, 2008). The goals of this study, which focus on the specifics and diversity of conditions in which rural schools operate, largely conform to this description. For this reason, this study was limited to the five-year estimates from 2008 to 2012. District locale codes were obtained from the National Center for Education Statistics.

The following data were used:

- Remoteness (driving times to nearest institution of higher education/school of education and major cities).
- Employment in major sectors: agriculture, mining, tourism and services, government.
- Unemployment rate.
- Proportion of "family," "complete family," and "extended-family" households.
- Availability of housing (ratio of median housing prices to average teacher compensation; home ownership rate).
- Average wages and other compensation in the community.
- Locale codes ranging from city-large to rural-remote.

Definition, format, and sample means and distributions of variables used in this study

Outcome variable construction. The study team worked with administrative data provided by OSDE to create two primary outcome variables. For research questions 1 and 3 the outcome variable is the duration of continuous employment in a particular district calculated from teacher employment records. This outcome variable was used in conjunction with the censoring indicator—that is, a binary variable denoting whether the true duration of employment is observed or only a portion of it. The censoring indicator was set to 1 for teachers still employed in the last year covered by the data or if the employment ended due to death or disability. For research question 2 the outcome variable is the binary indicator of successful recruitment: a new hire completed a probationary period of three years and obtained tenure status.

The OSDE teacher history record enabled the study team to count the duration of employment in each district in a sequence of career steps. Linking district information to the National Center for Education Statistics database of school districts allows establishing which of those districts were rural and whether the teacher, after quitting, moved to another rural district in Oklahoma, moved to a nonrural district in Oklahoma, died, retired, or left the system. OSDE records carry no postemployment information and thus do not allow distinguishing among teachers who quit the profession, moved to another state, or were on leave by the end of the period covered by the dataset. All these cases are referred to as "out of system." The records allowed the study team to count the number of years a teacher had worked in a rural school district in Oklahoma and to determine whether a teacher's career had begun in an Oklahoma rural school district and, if not, whether the teacher had had prior experience at rural schools in other states. In addition, these data were used to construct the ratio variables used to address the additional analyses for research question 1.

To examine newly hired teachers who reached tenure (and, thus, can be considered successfully recruited), the study team used the proportion of new teachers retained in the fourth year of their career in the district where they started. To examine the findings related to whether teachers who leave rural school districts go on to teach in another rural district or become employed by a nonrural district, the study team used the proportion of rural teachers hired by another rural school district in Oklahoma in year $N + 1$ after they leave their jobs among all teachers who left their rural jobs after year N. To examine the retention rates of tenured teachers by duration of employment, the study team used the proportion of teachers employed in year $N + 1$ in the same district where they were employed in year N among all teachers employed in year N. For the analysis of successful recruitment (research question 2), the study team used the teacher history records to create a binary indicator of successful recruitment for each teacher who was hired in a rural district in any year from 2005 to 2011. A setting of 1 indicates that the teacher was employed for three full consecutive years after being hired and returned for a fourth consecutive year (received tenure). For example, a teacher hired by district X in summer 2005 and reported as still employed by that district as of fall 2008 (or later) was considered a case of successful recruitment, and the indicator was set to 1. If a teacher with the same start date was last employed in spring 2008 (or earlier), the indicator was set to 0.

For the analysis of retention (research question 3), the study team recorded the duration of employment for each teacher in a rural school district who had achieved tenure by the start of the 2005/06 school year or any later year covered by the data. The duration of employment was recorded as an integer number of years.[7] Duration data were right censored in the records; that is, many teachers were teaching in the last year in the dataset. For this reason a censoring indicator was added and set to 1 if the record is censored (teacher is employed in 2014/15) and set to 0 otherwise (employment terminated before the end of the 2014/15 school year).

The study team created a separate record for each new hire in the data subset for the analysis of successful recruitment and a separate record for each tenured teacher in the data subset for the analysis of retention. Thus, the same teacher may appear more than once in each of the two subsets if the teacher changed districts. Similarly, a teacher appearing in the recruitment subset will also appear in the retention subset of the dataset. The full list of variables analyzed in this study is described in table C2.

Sample means and distributions of variables used in the analysis are provided in tables C3–C5.

Table C2. Variables used in the study, with sources and formats

Variable	Data source	Variable format and construction
Data used to construct outcome variables		
Year teacher started teaching in a rural school district in Oklahoma	OSDE:SPR	Year (integer)
Year teacher left position in a rural school district in Oklahoma (if applicable, indicator of continuing employment otherwise)	OSDE:SPR	Year (integer)
Teacher		
Teacher age (at time of hire and when received degree)	OSDE:SPR	Age in years at time of hire; age in years when received degree
Teacher gender	OSDE:SPR	Male or female
Teacher race/ethnicity	OSDE:SPR	American Indian or Alaska Native, Asian, Black or African American, Native Hawaiian or Pacific Islander, White, Multiple (two or more races/ethnicities), Hispanic
Type of college attended	OSDE:SPR	Categorized into out-of-state, major Oklahoma school (University of Oklahoma or Oklahoma State University), or other Oklahoma college
Degree level	OSDE:SPR	Categorized into no college or some college, bachelor's degree, master's degree, advanced degree (higher than master's)
Degree year	OSDE:SPR	Year
Nonteaching assignment (teacher had nonteaching duties in any year during this period of employment)	OSDE:SPR	For example, administrative role, support specialist, athletic coach
Teacher workload	OSDE:SPR	Teacher average full-time equivalent during study period of employment
Total compensation	OSDE:SPR	Annual compensation (includes salary, benefits, retirement pay, extra pay for additional responsibilities)
Years of teaching experience (at time of hire in a given district)	OSDE:SPR	Years of teaching in Oklahoma, by district (these data are used to construct years of teaching experience prior to employment in rural district)
District		
Student–teacher ratio	OEQA	Number of students and teachers; converted to appropriate ratios
Staff–teacher ratio	OEQA	Number teachers, staff, administrators; converted to appropriate ratios
District size	OEQA	Number of students in district
District financial information	OEQA	Per pupil expenditure, district property value per student, debt service per student
School suspension rates	OEQA	Suspension rate
Absenteeism rate	OEQA	Absenteeism rate
School average achievement	OEQA	Percentage of students scoring proficient on Oklahoma Core Curriculum tests across all subjects
Average student demographics	OEQA	Percentage in each racial/ethnic category, percentage in special education
Average teacher characteristics	OEQA	Average years of experience, percent of teachers with advanced degree
Similarity of student and teacher characteristics	OEQA	Percentage of students of the same race/ethnicity as the teacher (on a 0–1 scale) constructed from student and teacher demographic data
Highest grade offered in district	OEQA	Highest grade offered in district
Parent engagement	OEQA	Percentage of participation in parent–teacher conferences (it is not known if this is regularly scheduled conferences, such as back-to-school night, or a conference for any other reason)

(continued)

Table C2. Variables used in the study, with sources and formats *(continued)*

Variable	Data source	Variable format and construction
Community characteristics		
Remoteness (driving times to nearest institution of higher education; length of commute)	Google mapping data and location information from Oklahoma websites	Google Maps application programming interface was used to locate relevant objects and calculate distances. A list of colleges was obtained from OSDE website.
Remoteness (fringe, number of students per square mile of district area)	ACS	Fringe, number of students per square mile of district area
Socioeconomic status of community	ACS	Ratio of median household income to poverty level
Availability of housing	ACS	Ratio of median housing prices to average teacher compensation; home ownership rate
Juvenile crime rate	OEQA	Ratio of the number of incidents involving juvenile offenders reported to police to middle and high school enrollment
Median household income	ACS	Median household income
Employment in major sectors (within the rural population): agriculture, mining, tourism and services, government	ACS	Percentage in labor force, per sector (major sectors identified as those in which the majority of the rural population are employed)
Unemployment rate	ACS	Percentage unemployed; percentage not in labor force
Proportion of family households	ACS	Percentage of families (across all households)
Proportion of complete family households	ACS	Percentage of families with two parents and children (across all families)
Proportion of extended-family households	ACS	Percentage of families with other relatives living in household (across all families)
Education level of community	ACS	Percentage without high school diploma; percentage with an associate's degree or higher
Proportion of students in community population	OEQA	Percent of students in total community population
School-age children born in Oklahoma	ACS	Percentage of school age (6–17) born in state of residence
Age of housing	ACS	Median age of housing structures in the community

ACS is American Community Survey. OEQA is Oklahoma Office of Educational Quality and Accountability. OSDE is Oklahoma State Department of Education. SPR is School Personnel Records.

Source: Authors' analysis.

Table C3. Oklahoma rural school district means for variables used in this study, 2005/06–2014/15

Variable	Sample mean
District	
Number of rural school districts	393
Student–teacher ratio	13.7
Staff–teacher ratio	0.2
District size: total number of students in district	469.8
District financial information: per pupil expenditure ($)	8,922.64
District financial information: district property value per student ($)	45,928.72
District financial information: debt service per student ($)	286
Student suspension rate (percent)	2.5
Student absenteeism (average number of days per student)	8.6
Average student performance (percentage of students scoring proficient/ satisfactory on the Oklahoma Core Curriculum Tests	76.0
Student race/ethnicity: percentage of Hispanic students	6.2
Student race/ethnicity: percentage of American Indian students	28.3
Student race/ethnicity: percentage of Asian/Pacific Islander students	0.6
Student race/ethnicity: percentage of Black students	2.4
Student demographics: percentage of students in special education	18.1
Teacher characteristics: average years of teaching experience	13.2
Teacher characteristics: percentage of teachers with advanced degree	24.2
Parent engagement (percentage of participation in parent–teacher conference)	68.1
Community characteristic	
Remoteness: number of students per square mile of district area	6.1
Remoteness: percentage of all workers with a long commute	8.4
Remoteness: driving time to nearest college (hours)	0.5
Socioeconomic status of community: percentage under poverty level	16.5
Owner occupied housing (of all occupied; percentage of occupied housing occupied by owner)	0.8
Median value of housing units ($)	85,207.16
Juvenile crime rate (per 1,000 students)	8.4
Median household income ($)	43,626.51
Employment in major sectors: agriculture, forestry, fishing, or hunting (percent)	6.1
Employment in major sectors: mining (percent)	5.4
Employment in major sectors: trade, entertainment, recreation, accommodation, or food service (percent)	18.8
Unemployment rate (percent)	6.8
Percentage of population not in the labor force	42.7
Percentage of family households	73
Percentage of complete family households (two parents and children)	79.9
Percentage of extended-family households	4.5
Education level of community: percentage without high school diploma	13.2
Education level of community: percentage with associate's degree or higher	24.1
Proportion of students in community population	20.1
Percentage of school-age children born in Oklahoma	76.8
Age of housing (median year housing built in the community)	1976

Source: Authors' analysis of data from Oklahoma State Department of Education School Personnel Records, data from the Oklahoma Office of Educational Quality and Accountability, and publicly available data, 2005/06–2014/15.

Table C4. Distribution of highest grade levels offered in Oklahoma rural school districts examined in this study, 2005/06–2014/15

Highest grade offered in district	Number of districts	Percent of total districts
Grade 5	1	0.3
Grade 6	7	1.8
Grade 8	82	20.9
Grade 12	303	77.1
Total	393	100

Source: Authors' analysis of data from the Office of Educational Quality and Accountability, 2005/06–2014/15.

Table C5. Sublocales of Oklahoma rural school districts examined in this study, 2005/06–2014/15

Rural sublocale	Number of districts	Percent of total districts
Rural-fringe	52	13.2
Rural-distant	200	50.9
Rural-remote	141	35.9
Total	393	100

Source: Authors' analysis from publicly available data, 2005/06–2014/15.

Analysis methods

This study used a variety of quantitative methods of analysis to address its research questions. Preliminary steps in the analysis were to evaluate the completeness of the data files, establish the number of observations in the dataset, and document whether each of the proposed variables was available and usable (the sample sizes in the dataset in rural districts are shown in table C6). Data cleaning and merging of data files allowed for an assessment of missing data for each variable.

Missing data were treated in a number of ways depending on the origin of a variable in the analysis. District-level data and community characteristics originate from the OEQA records and U.S. Census datasets and have practically no missing data. However, a few districts were merged during the study period. In these cases, the teacher may have changed district assignment without changing jobs or have been laid off as a result of the merger. The data may not have been explicit about such cases; therefore, those districts and all related teacher records were removed from the study dataset.

Missing values of categorical teacher variables were coded as such ("unknown college" or "gender unknown"). Rates of missing data for teacher variables are shown in table C7. The missing values of continuous variables, including teaching experience at the time of employment and at the time their bachelor's degree was awarded, were replaced with sample means, and a corresponding dummy variable indicating missingness was created.

An important element in this preliminary phase of the study was the identification of statistically "censored" observations. Accounting for the censoring of duration data is a precondition for producing unbiased estimates of related statistical quantities. As is typical for studies involving duration variables, a large proportion of observations were right-censored; that is, the data may show that a teacher was still employed in the last year covered by the

Table C6. Sample sizes in dataset for Oklahoma rural school districts

Sample	Number	Percent
Total observations in dataset (periods of employment with a single district)	29,053	na
Unique teachers in dataset	24,537	na
Unique teachers with a single observation (was employed in a single district during the study years of 2005/06 and 2014/15)	20,877	85[a]
Unique teachers with two observations (was employed in two districts during the study years of 2005/06 and 2014/15)	2,989	12[a]
Unique teachers with three or more observations (was employed in three or more districts during the study years of 2005/06 and 2014/15)	671	3[a]
Right-censored observations (research question 1) (employed in the same district in 2014/15 as in one or more preceding years or started a new job in 2014)	15,032	52[b]
Observations used in research question 2	8,984	31[b]
Successfully recruited (teacher remained employed with same district for 3 years and, therefore, attained tenure)	4,723	53[c]
Unsuccessful recruited (teacher did not remain employed with same district for 3 years and, therefore, did not attain tenure)	4,261	47[c]
Observations in research question 3	14,825	51[b]
Right-censored observations (research question 3)	8,115	55[d]

na is not applicable.

a. Percentage of number of unique teachers in dataset.

b. Percentage of total observations in dataset.

c. Percentage of observations used in research question 2.

d. Percentage of observations used in research question 3.

Source: Authors' analysis of data from Oklahoma State Department of Education School Personnel Records, 2005/06–2014/15.

Table C7. Rate of missing data of teacher characteristics in Oklahoma rural school districts, 2005/06–2014/15

Missing or inconsistent teacher data	Percentage of total observations
Gender	0.90
Degree	0.01
Age	7.2

Source: Authors' analysis of data from Oklahoma State Department of Education School Personnel Records, 2005/06–2014/15.

dataset, but the actual duration (time until future job termination) is unknown. In addition to identifying observations censored due to the temporal limits of the available data, the study team (by using teacher record data on the cause of job termination) identified censoring due to intervening circumstances (death, disability, and retirement).[8] As a result, a single dummy variable indicating right censoring for any reason was created.

In answering research question 1 (What are the patterns of teacher mobility in rural and nonrural school districts in Oklahoma?), the research team used descriptive statistics and methods of analysis of distribution suitable for duration data.

Examining the distribution of the duration of employment called for establishing the frequencies (probabilities) of duration of employment in years. In other words, the study team

established what proportion of teachers (empirical probability) change jobs after one year of employment, two years of employment, and so on. Because many of the observations were right-censored, the study team used a conventional approach to analyze the distribution of duration metrics in the presence of censored observations—the Kaplan-Meier estimate. This estimate presents the unconditional probabilities of reaching a certain duration (the duration of employment in a single district, in this case) and is illustrated using a special type of diagram, wherein one annual step represents the probability of quitting in a given year and the vertical coordinate represents the cumulative probability—probability of staying in a position for *n* years.

The statistical results obtained in answering the distribution of the duration of employment provided input for addressing the proportion of newly hired teachers who stay long enough to obtain tenure and, thus, can be considered successfully recruited and the retention rates for tenured teachers by duration of employment. For the first analysis the study team calculated the cumulative probability of a newly hired teacher staying with the hiring district for three consecutive full years (normal time to tenure). For the second analysis the study team calculated the one-year retention probability for each successive year of employment and presented this information as the median duration of employment.[9]

Examining the proportion of teachers in rural school districts in Oklahoma who leave their jobs and are rehired by another rural school district in Oklahoma, as opposed to moving to a nonrural school district in Oklahoma, involved calculation of probabilities (proportions) of employment in the same type of job after job termination.

Using the log-rank test, the distributions of duration data (that is, the Kaplan-Meier curves) were compared for various district location types (using U.S. Census Bureau classification of urbanicity and remoteness) for each analysis listed as part of research question 1. The log-rank test provides a summative measure of the significance of differences between two curves or, in other words, tests the hypothesis that one-year probabilities of retention are higher for one group than the other at every duration of employment. In addition, the study team provided aggregate metrics, which are easier to interpret, such as the average duration of employment and differences in the successful recruitment rates between groups of districts.

Analyses used to address research question 2 (Which factors predict the successful recruitment [defined as completing a probationary period of employment in a single district for three years and obtaining tenure in the fourth year of teaching] of teachers in rural school districts in Oklahoma?) and research question 3 (Which factors predict the continued retention of tenured teachers in rural school districts in Oklahoma?) involved methods of regression analysis appropriate for the type of outcome metrics used. Both questions relied on the same groups of variables and were answered using the same steps:

- Estimation of base (full) models on the full sample.
- Estimation of full models on the subsamples of interest.
- Model refinement and estimation of reduced models.
- Analysis of the results for substantively important findings.

Research questions 2 and 3 refer to two substantially different stages in teachers' careers. For this reason, they use different outcome measures—binary indicator of reaching tenure

(successful recruitment) and duration of employment (retention)—and appropriately structured models:

- Research question 2: logistic regressions for indicators of successful recruitment to estimate marginal probabilities of reaching tenure associated with certain covariates.
- Research question 3: discrete-time survival analysis model (a variety of Cox regression) for retention of tenured teachers to identify hazard rates (that is, annual probabilities of job termination) associated with specific indicators.

The two models are similar, differing primarily in the assumed distribution of the outcome variable: logistic in the first case and exponential in the second. The results of both models are reported as regression coefficients (effects). For models in research question 2 the study team produced marginal effects on probability of success—the estimated change in the probability of reaching tenure associated with different levels of a categorical indicator variable or a unit change in a continuous indicator.

Modeling the probability of successful recruitment (research question 2). The study team fit a series of logistic regression models.[10] Data were transformed using the log odds of successful recruitment (staying for three years to reach tenure status) for teacher *i* in district *j:*

$$u_{ij} = P(Y_{ij} = 1) \text{ using the logit link } n_{ij} = \log\left(\frac{u_{ij}}{1 - u_{ij}}\right)$$

The above transformed variable becomes the outcome in a series of models with covariates identified at the teacher and school and district levels.

The underlying full (reference) model includes the following: teacher-level variables (x_{kij}), a series of district-level variables (z_{pj}), community-level contextual factors (pertaining to district boundaries) (w_{qj}), and interactions between teacher-level variables and community-level contextual factors (v_{qj}):

$$\eta_i = \beta_0 + \sum_k \beta_k x_{kij} + \sum_p \lambda_p z_{pj} + \sum_q \alpha_q w_{qj} + \sum_q \gamma_q v_{qj} + u_i$$

Teacher variables (x_{kij}), district variables (z_{pj}), and interactions between teacher and community contextual factors (v_{qj}) are taken at the first year of employment. Contextual variables are multiyear averages considered indicators of persistent characteristics.

Modeling retention of tenured teachers. The team used the discrete-time survival analysis model (Singer & Willett, 1993), a variation of the Cox proportional hazard model, to estimate differences in hazard rates associated with individual indicators. This model has the benefit of removing the dependence of the hazard rate on time by expressing it as a product of a baseline time-dependent hazard rate and a function that expresses the dependence of the hazard rate on other covariates. The exponential function is often used for the latter quantity, as it has the advantage of letting regression coefficients take on any value while ensuring that the hazard rate stays positive.

$$h(t|x) = h_0(t)r(x,\beta_x) = h_0(t)\exp(x\beta_x)$$

The covariate effect of x is the ratio between hazard rates:

$$HR = \frac{h(t \mid x_2)}{h(t \mid x_1)} = \frac{h_0(t)\exp(x_2\beta_x)}{h_0(t)\exp(x_1\beta_x)} = \exp(\beta_x(x_2 - x_1))$$

The reference model for this analysis includes the same components as the underlying equation of the logistic model described above: teacher-level variables (x_{kij}), a series of district-level variables (z_{pj}), community characteristics or contextual variables (pertaining to school district boundaries) (w_{qj}), and interactions between teacher-level indicators and community-level contextual factors (v_{qj}). In this model, however, x, z, v, and w are considered time-variant and are measured at the time period of job termination (or the end-of-series for censored observations). In addition, this model includes changes in the values of those variables over the whole employment period, denoted here as D terms.[11] Therefore, the study team expresses the hazard rate as follows:

$$h(t \mid x) = h_0(t)\exp(x\beta_x) =$$
$$h_0(t)\exp\left(\beta_0 + \sum_k \beta_k x_{kij} + \sum_p \lambda_p z_{pj} + \sum_q \alpha_q w_{qj} + \sum_q \gamma_q v_{qj} + \sum_q \gamma_d D_{dij}\right)$$

The function $\exp(\beta_x) - 1$ represents the proportion change in the hazard rate associated with a one-unit increase in x_{kij} conditional on the other effects in the model. Thus, the full model allowed the study team to estimate the difference in the probability of retention in a given time interval associated with a one-unit increase in a given indicator variable, assuming retention up to that point. The coefficients associated with other variables have a similar interpretation.

Model comparisons. An important goal of the study is to identify the contributions of malleable and nonmalleable characteristics that are predictive of teacher retention in rural school districts in Oklahoma. The study team identified variables that have a robust association with outcomes (variables that predict outcomes even after accounting for the effects of stable characteristics of teachers and contexts). Additionally, the study aims to understand the role of individual teacher–district matching represented by interaction terms in the models described earlier. For this reason, each of the two models was estimated in three alternative specifications: the full model, the model without community variables, and the model with teacher variables only. Similarity of student and teacher race/ethnicity is included in the full model only. For each model the study team reported side by side the estimates of effects (regression betas) for each included regression term and a metric of goodness of fit that provides a comparison of the contributions of each group of factors.

The groups of variables that are included in each type of model are displayed in table C8. Comparing results across models is critical for understanding the predictive capacity of specific groups of variables. The comparisons involve removing a group of variables and assessing the variance explained by the reduced model in comparison with the full model. The study team used Nagelkerke's pseudo-R^2 as a measure of explained variance applicable for generalized linear models such as used in this study (Nagelkerke, 1991).

It is also of interest to compare the estimated effects of variables in the recruitment (logistic) versus retention (survival) models. Although a rigorous comparison is impossible because the models are not nested, it is important to find out whether the same variables

Table C8. Composition of alternative models

Variable group	Models					
	Recruitment (logistic)			Retention (survival)		
	Full model	Without community variables	Teacher only	Full model	Without community variables	Teacher only
Teacher	Yes	Yes	Yes	Yes	Yes	Yes
District	Yes	Yes	No	Yes	Yes	No
Community	Yes	No	No	Yes	No	No

Note: For each type of model variance, components were estimated both for purposes of completeness and for the extent to which specific types of variables account for differences among upper-level units in the outcomes.

Source: Authors' composition.

are likely to explain both successful recruitment and retention over time or whether the influential factors vary.

Model refinement. Once the model comparisons were completed and the study team was able to identify the best of the alternatives for each model (for example, by establishing that the inclusion of interaction—"job match"—terms does not result in a better model), a model refinement and assessment of the robustness of the models was undertaken.

First, the study team attempted to produce more compact final models (one for recruitment and one for retention) by repeatedly removing the least significant terms and comparing the levels of Akaike information criterion for the sequential models to establish the most efficient model. The primary goal of this procedure is to produce the model that will have an adequate predictive power (measured by pseudo-R^2) while requiring the lowest possible quantities of data inputs. Such a model could become an important tool for policymakers as long as it can produce reliable predictions on the basis of a modest amount of readily available data.

Second, to ensure that associations between variables and outcomes were not model artifacts, the strength of the associations between the variables and the outcomes were tested by modifying model specifications. The focus of these tests is on contextual factors, for which the statistical reliability is known approximately (American Community Survey-based variables) or not known (most variables from OSDE sources). By excluding variables from this group (in particular, those that were estimated as significant covariates), the study team assessed the extent to which the model (estimates for other covariates) depends on the model assumptions and reliability of underlying data. The study team reported statistics for model comparisons (likelihood ratios) and pointed to potential problems if contextual variables that may significantly affect the results are identified.

Third, the study team assessed potential limits to the model homogeneity and generalizability of the results by testing the effects of year of entry and locale type. Specifically, the study team attempted to test the effects of interactions between each of these variables (separately) and covariates that were identified as significant in the main analyses.

Effect of year of entry. This analysis included a variable that indicates in which year a teacher began teaching in a rural school district in Oklahoma for the first time. The effects of interactions between the year of entry and indicators were tested for joint significance.

If joint significance was found, then the indicator effects were considered nonrobust to when a teacher entered a nonrural school district in Oklahoma.

Effect of locale type. This analysis included variables that indicate the locale type, including town/rural classification (National Center for Education Statistics, 2014), remoteness, and presence of a substantial American Indian population. Each of these dichotomous or categorical variables was tested for significant interactions with indicator variables. If significant interactions were found, then the indicator effects were considered nonrobust to the tested community variables.

Analyzing the results for substantively important findings. With large samples, such as Oklahoma teacher records data, variables may be significantly related to outcomes even if the substantive association between them is small. That is, the effects might be statistically significant even when the variables do not discriminate well among teachers who are successfully retained and those who are not. Therefore, the final prediction models were used to calculate regression-adjusted marginal probabilities of teachers achieving the desired outcome for each indicator. The difference in the probability of achieving the desired outcome for individuals at different points in the distribution of a given variable was calculated. For dichotomous variables, this step involved comparing probabilities for the two levels of the variable. For continuously distributed variables, this step involved comparing the change in probability for individuals at one and two standard deviations below and above the mean of the distribution of the variable. Whether specific change in the value of a variable translates into a substantively important difference in probability of success on the outcome is not a statistical question. However, the outcome will allow readers to decide whether a variable is sufficiently discriminating to make a substantive difference in the results.

Appendix D. Detailed results of patterns of job mobility in Oklahoma

This appendix provides the detailed results of the analysis of patterns of job mobility in Oklahoma. The probability of duration of employment for teachers in rural, town, and suburban/urban school districts is shown in table D1. The probability of duration of employment for teachers in rural-fringe, rural-distant, and rural-remote school districts is shown in table D2.

Table D1. Probability of duration of employment (Kaplan-Meier estimate) for teachers in Oklahoma for rural, town, and suburban/urban school districts

	Rural school districts		Town school districts		Suburban/urban school districts	
Year of employment	One year probability	Cumulative probability	One year probability	Cumulative probability	One year probability	Cumulative probability
1	.866	.866	.881	.881	.865	.865
2	.911	.789	.927	.817	.919	.794
3	.934	.737	.946	.772	.943	.749
4	.948	.699	.958	.740	.953	.713
5	.948	.662	.957	.707	.950	.677
6	.955	.633	.959	.679	.956	.647
7	.960	.608	.967	.656	.962	.623
8	.960	.583	.971	.637	.964	.600
9	.965	.563	.970	.618	.969	.581
10	.970	.546	.972	.601	.971	.564
11	.973	.531	.980	.589	.977	.551
12	.975	.518	.978	.576	.977	.538
13	.978	.506	.975	.561	.975	.525
14	.978	.495	.977	.549	.973	.511
15	.976	.483	.979	.537	.980	.501
16	.978	.472	.977	.525	.975	.488
17	.977	.461	.981	.515	.978	.478
18	.976	.450	.977	.503	.977	.467
19	.982	.442	.974	.490	.979	.457
20	.974	.431	.971	.475	.973	.445
21	.972	.418	.968	.460	.969	.431
22	.970	.406	.970	.446	.963	.415
23	.964	.392	.964	.430	.971	.403
24	.970	.380	.968	.416	.966	.389
25	.964	.366	.964	.401	.972	.378
26	.963	.353	.963	.386	.959	.363
27	.957	.337	.959	.371	.957	.347
28	.952	.321	.948	.351	.949	.329
29	.945	.303	.933	.328	.955	.315
30	.937	.284	.925	.303	.946	.298
31	.952	.270	.943	.286	.947	.282
32	.937	.254	.928	.265	.938	.264
33	.944	.239	.929	.246	.945	.250
34	.933	.223	.912	.225	.935	.234
35	.929	.207	.897	.202	.910	.213
36	.950	.197	.926	.187	.917	.195
37	.924	.182	.908	.170	na	na
38	.919	.167	.903	.153	na	na
39	.873	.146	.882	.135	na	na
40	.890	.130	.882	.119	na	na

na is not applicable.

Note: Cumulative probability refers to the probability of being employed for at least *N* years. One-year probability refers to the probability of remaining in the district in the next school year (that is, once a teacher has reached *N* years, the one-year probability refers to the probability of being employed *N* + 1 years).

Source: Authors' analysis of data from Oklahoma State Department of Education School Personnel Records, 2005/06–2014/15.

Table D2. Probability of duration of employment (Kaplan-Meier estimate) for teachers in Oklahoma rural-fringe, rural-distant, and rural-remote districts

	Rural fringe		Rural distant		Rural remote	
Year of employment	One year probability	Cumulative probability	One year probability	Cumulative probability	One year probability	Cumulative probability
1	.860	.860	.868	.868	.868	.868
2	.921	.792	.909	.789	.906	.787
3	.931	.737	.935	.738	.933	.734
4	.946	.698	.949	.701	.949	.696
5	.945	.659	.949	.665	.949	.661
6	.954	.629	.953	.634	.960	.634
7	.959	.603	.961	.609	.960	.609
8	.958	.578	.959	.584	.961	.585
9	.967	.559	.963	.563	.968	.567
10	.971	.543	.968	.545	.972	.550
11	.969	.526	.974	.531	.973	.535
12	.973	.512	.977	.519	.971	.520
13	.979	.501	.976	.506	.981	.510
14	.980	.492	.978	.495	.978	.499
15	.976	.480	.976	.483	.975	.486
16	.972	.466	.979	.472	.979	.476
17	.972	.453	.976	.461	.981	.467
18	.973	.441	.975	.450	.977	.457
19	.982	.433	.980	.440	.985	.450
20	.980	.424	.977	.430	.968	.435
21	.966	.410	.972	.418	.974	.424
22	.968	.397	.973	.407	.967	.410
23	.958	.380	.969	.394	.962	.395
24	.966	.368	.975	.385	.963	.380
25	.958	.352	.967	.372	.965	.367
26	.961	.338	.960	.357	.968	.355
27	.939	.318	.958	.342	.963	.342
28	.951	.302	.948	.324	.958	.328
29	.928	.280	.944	.306	.955	.313
30	.941	.264	.931	.285	.941	.295
31	.964	.254	.952	.271	.946	.279
32	.905	.230	.932	.253	.962	.268
33	.947	.218	.939	.238	.948	.254
34	.914	.199	.941	.224	.931	.237
35	.925	.184	.948	.212	.905	.215
36	.938	.173	.948	.201	.958	.206
37	.897	.155	.953	.192	.896	.184
38	.942	.146	.913	.175	.918	.169
39	.795	.116	.870	.152	.924	.156
40	.846	.098	.882	.134	.930	.145

Note: Cumulative probability refers to the probability of being employed for at least *N* years. One-year probability refers to the probability of remaining in the district in the next school year (that is, once a teacher has reached *N* years, the one-year probability refers to the probability of being employed *N* + 1 years).

Source: Authors' analysis of data from Oklahoma State Department of Education School Personnel Records, 2005/06–2014/15.

Comparison of duration of employment in rural school districts

The median duration of employment for teachers in rural-fringe, rural-distant, and rural-remote school districts is shown in table D3.

Table D3. Comparison of duration of employment in Oklahoma rural school districts, by locales of districts, across all years, 2005/06–2014/15

Rural sublocale	Median years of employment	95 percent confidence interval
Rural-fringe	14	12–15
Rural-distant	14	13–15
Rural-remote	14	13–15

Source: Authors' analysis of data from Oklahoma State Department of Education School Personnel Records, 2005/06–2014/15.

Proportion of newly hired teachers who are successfully retained

The number and percentage of Oklahoma teachers who were successfully recruited (reached tenure) over 2006/07–2011/12, by locale, are shown in table D4. The chi-square test of Oklahoma teachers who were successfully recruited (reached tenure), by locale, is shown in table D5.

Table D4. Number and percentage of Oklahoma teachers who were successfully recruited (reached tenure), by locale, 2006/07–2011/12

	Teachers in rural districts		Teachers in town districts		Teachers in suburban/urban districts	
Year	Number	Percent	Number	Percent	Number	Percent
2006/07	993	55	801	58	1,500	61
2007/08	914	59	807	61	1,330	60
2008/09	935	56	765	61	1,380	62
2009/10	767	50	639	54	993	52
2010/11	414	45	316	46	676	48
2011/12	732	47	644	54	1,048	49

Source: Authors' analysis of data from Oklahoma State Department of Education School Personnel Records, 2006/07–11/12.

Table D5. Chi-square test of Oklahoma teachers who were successfully recruited (reached tenure), by locale

Locale	Chi-square value	*p*-value
Rural versus town	31.9	<.01
Rural versus nonrural	46.3	<.01

Note: Nonrural includes town, suburban, and urban school districts.

Source: Authors' analysis of data from Oklahoma State Department of Education School Personnel Records, 2006/07–11/12.

Appendix E. Detailed results of the variables related to successful recruitment of teachers in rural school districts in Oklahoma

The variables examined related to successful recruitment are shown in table E1. The results of the marginal effects on probability of successful recruitment (full model) are shown in table E2 for all teachers. The results of the marginal effects on probability of successful recruitment (full model) are shown in table E3 for new hires. Additional detailed tables, including logistic regression coefficients and reduced models, are available from the authors upon request.

Successful recruitment for all teachers

Table E1. Variables related to successful recruitment for all teachers in Oklahoma rural school districts, full model

Variable	Related to teacher recruitment	Significance indicator
Teacher		
Teacher age at time of hire	+	***
Teacher age when bachelor's degree received	ns	ns
Teacher gender: male	–	***
Teacher gender: unknown	–	*
Teacher race/ethnicity	ns	ns
Similarity of student and teacher demographics (proportion of students of the same race/ethnicity, scale of 0–1)	+	**
Attended a regional college in Oklahoma	+	*
Attended an out-of-state college	–	*
Degree level when hired[a]	–	***
National Board for Professional Teaching Standards certified prior to being hired	ns	ns
Nonteaching assignments (teacher had nonteaching duties in any year during this period of employment)	+	***
Teacher workload (average full-time equivalent during this period of employment)	+	***
Total compensation	+	***
Whether teacher is experienced at time of hire	–	*
District		
Student–teacher ratio	ns	ns
Staff–teacher ratio	ns	ns
District size: total number of students in district	+	***
District financial information: per pupil expenditure	ns	ns
District financial information: district property value per student	ns	ns
District financial information: debt service per student	ns	ns
Student suspension rate	ns	ns
Student absenteeism	ns	ns
Average student performance	+	**
Student demographics: percentage of Hispanic students	ns	ns
Student demographics: percentage of American Indian students	ns	ns
Student demographics: percentage of Asian/Pacific Islander students	ns	ns
Student demographics: percentage of Black students	ns	ns

(continued)

Table E1. Variables related to successful recruitment for all teachers in Oklahoma rural school districts, full model *(continued)*

Variable	Related to teacher recruitment	Significance indicator
Student demographics: percentage of students in special education	ns	ns
Teacher characteristics: average years of teaching experience	+	***
Teacher characteristics: percentage of teachers with advanced degree	ns	ns
Highest grade offered in district	–	***
Parent engagement (percentage of participation in parent–teacher conference)	ns	ns
Community characteristics		
Remoteness: fringe	–	*
Remoteness: number of students per square mile of district area	ns	ns
Remoteness: percentage of all workers with a long commute	ns	ns
Remoteness: driving time to nearest college	ns	ns
Socioeconomic status of community: percentage under poverty level	ns	ns
Owner occupied housing (of all occupied)	ns	ns
Median value of housing units	ns	ns
Juvenile crime rate (per 1,000 students)	ns	ns
Median household income	ns	ns
Employment in major sectors: agriculture, forestry, fishing, or hunting	ns	ns
Employment in major sectors: mining	ns	ns
Employment in major sectors: trade, entertainment, recreation, accommodation, or food service	–	*
Unemployment rate	ns	ns
Proportion of population not in the labor force	ns	ns
Proportion of family households	ns	ns
Proportion of complete family households (two parents and children)	ns	ns
Proportion of extended-family households	ns	ns
Education level of community: percentage without high school diploma	ns	ns
Education level of community: percentage with associate's degree or higher	ns	ns
Proportion of students in community population	+	***
Proportion of school-age children born in Oklahoma	ns	ns
Age of housing (median year housing built in the community)	ns	ns

* Significant at $p < .05$; ** significant at $p < .01$; *** significant at $p < .001$. ns is not significant.

– indicates a negative correlation; + indicates a positive correlation.

Note: Each effect assumes other factors are held constant. For example, the effects of age and experience may seem to contradict each other but, the effect of teaching experience is the effect of teaching experience given that all other characteristics remain the same, including age.

a. Degree level was recorded on a four-point scale: 0 = no college or some college, 1 = bachelor's degree, 2 = master's degree, and 3 = advanced degree. However, only 1.3 percent of teachers belonged to the two extreme categories (0 or 3) combined, so the 12.5 percentage point marginal effect is, for practical purposes, the effect of having a master's degree at the time of hire as opposed to having a bachelor's degree.

Source: Authors' analysis of data from Oklahoma State Department of Education School Personnel Records, Office of Educational Quality and Accountability data, and publicly available data, 2006/07–2011/12.

Table E2. Variables related to successful recruitment: Marginal effects on probability of successful recruitment for all teachers in Oklahoma rural school districts, full model

Variable	Estimate	Standard error	*z*-test
Teacher			
Teacher age at time of hire	0.003***	0.001	4.222
Teacher age when bachelor's degree received	0.000	0.001	0.035
Teacher gender: male	–0.177***	0.014	–12.554
Teacher gender: unknown	–0.127**	0.048	–2.623
Teacher race/ethnicity: Asian or Pacific Islander	0.021	0.096	0.223
Teacher race/ethnicity: Black or African American	0.029	0.064	0.455
Teacher race/ethnicity: Hispanic	0.048	0.058	0.840
Teacher race/ethnicity: American Indian	0.007	0.020	0.325
Teacher race/ethnicity: multiple races/ethnicities	0.036	0.036	0.988
Similarity of student and teacher demographics (proportion of students of the same race/ethnicity, scale of 0–1)	0.124**	0.041	2.988
Attended a regional college in Oklahoma	0.039*	0.016	2.388
Attended college in another state	–0.055*	0.023	–2.424
Degree level when hired[a]	–0.125***	0.017	–7.387
National Board for Professional Teaching Standards certified prior to be hired	0.005	0.068	0.076
Nonteaching assignments (teacher had nonteaching duties in any year during this period of employment)	0.276***	0.020	13.820
Teaching workload (average full-time equivalent during this period of employment)	0.628***	0.056	11.244
Total compensation (in thousands of dollars)	0.005***	0.001	8.359
Whether teacher is experienced at time of hire	–0.030*	0.014	–2.175
District			
Student–teacher ratio	0.002	0.005	0.511
Staff–teacher ratio	0.191	0.127	1.507
District size: total number of students in district[b]	0.197***	0.030	6.631
District size: total population in the district	–0.088***	0.024	–3.647
District financial information: per pupil expenditure (in thousands of dollars)	–0.001	0.006	–0.180
District financial information: district property value per student (in thousands of dollars)	0.000	0.000	1.515
District financial information: debt service per student (in thousands of dollars)	–0.003	0.019	–1.594
Student suspension rate	–0.012	0.063	–0.184
Student absenteeism	0.001	0.003	0.163
Average student performance	0.003**	0.001	3.000
Student demographics: percentage of Hispanic students	–0.036	0.116	–0.309
Student demographics: percentage of American Indian students	0.010	0.054	0.187
Student demographics: percentage of Asian/Pacific Islander students	0.413	0.639	0.647
Student demographics: percentage of Black students	0.034	0.105	0.325
Student demographics: percentage of students in special education	0.124	0.147	0.845
Teacher characteristics: average years of teaching experience	0.011***	0.003	4.040
Teacher characteristics: percentage of teachers with advanced degree	0.090	0.061	1.475
Highest grade offered in district	–0.037***	0.007	–5.019
Parent engagement (percentage of participation in parent–teacher conference)	–0.003	0.035	–0.099

(continued)

Table E2. Variables related to successful recruitment: Marginal effects on probability of successful recruitment for all teachers in Oklahoma rural school districts, full model *(continued)*

Variable	Estimate	Standard error	*z*-test
Community characteristics			
Remoteness: fringe	–0.051*	0.020	–2.485
Remoteness: number of students per square mile of district area	–0.001	0.001	–1.104
Remoteness: percentage of all workers with a long commute	–0.072	0.156	–0.460
Remoteness: driving time to nearest college	0.028	0.033	0.856
Socioeconomic status of community: percentage under poverty level	–0.072	0.150	–0.476
Owner occupied housing (of all occupied)	0.151	0.111	1.364
Median value of housing units (in thousands of dollars)	0.000	0.000	0.144
Juvenile crime rate (per 1,000 students)	0.000	0.001	0.184
Median household income (in thousands of dollars)	–0.001	0.001	–1.012
Employment in major sectors: agriculture, forestry, fishing, or hunting	0.225	0.182	1.239
Employment in major sectors: mining	0.042	0.146	0.286
Employment in major sectors: trade, entertainment, recreation, accommodation, or food service	–0.277*	0.140	–1.987
Unemployment rate	0.142	0.205	0.696
Proportion of population not in the labor force	0.013	0.103	0.126
Proportion of family households	0.087	0.139	0.630
Proportion of complete family households (two parents and children)	–0.244	0.139	–1.756
Proportion of extended-family households	0.202	0.276	0.734
Education level of community: percentage without high school diploma	0.007	0.168	0.040
Education level of community: percentage with associate's degree or higher	0.044	0.119	0.375
Proportion of school-age children born in Oklahoma	–0.068	0.052	–1.304
Age of housing (median year housing built in the community)	0.002	0.001	1.416
Control indicators			
First recorded in 2007 for personal record	0.024	0.019	1.248
First recorded in 2008 for personal record	–0.014	0.019	–0.734
First recorded in 2009 for personal record	–0.076***	0.021	–3.676
First recorded in 2010 for personal record	–0.122***	0.023	–5.276
First recorded in 2011 for personal record	–0.127***	0.020	–6.245
Dummy indicator for missing teacher age at time of hire	–0.188***	0.056	–3.377
Dummy indicator for missing teacher age when bachelor's degree received	0.114***	0.032	3.605

* Significant at $p < .05$; ** significant at $p < .01$; *** significant at $p < .001$.

Note: The proportion of students in the community population is not included in these results because the estimation included separate logs of number of students and district total population. Because the log of the proportion of students is the difference of the logs of students and district population, the positive effect of the (log of) student enrollment and negative effect of district population is equivalent to a positive effect of the proportion of students in the population.

a. Degree level was recorded on a four-point scale: 0 = no college or some college, 1 = bachelor's degree, 2 = master's degree, and 3 = advanced degree. However, only 1.3 percent of teachers belonged to the two extreme categories (0 or 3) combined, so the 12.5 percentage point marginal effect is, for practical purposes, the effect of having a master's degree at the time of hire as opposed to having a bachelor's degree.

b. The marginal effect shown is for the natural logarithm of student enrollment, a conventional transformation used in the analysis. It corresponds to the district size factor difference of approximately 2.72.

Source: Authors' analysis of Oklahoma State Department of Education School Personnel Records data, Office of Educational Quality and Accountability data, and publicly available data, 2006/07–11/12.

Successful recruitment for beginning teachers

The results of the marginal effects on probability of successful recruitment for beginning teachers (full model) are shown in table E3.

Table E3. Variables related to successful recruitment: Marginal effects on probability of successful recruitment for beginning teachers in Oklahoma rural school districts, full model

Variable	Estimate	Standard error	*z*-test
Teacher			
Teacher age at time of hire	0.009***	0.002	5.552
Teacher age when bachelor's degree received	–0.002	0.002	–1.021
Teacher gender: male	–0.150***	0.023	–6.662
Teacher gender: unknown	–0.247***	0.071	–3.489
Teacher race/ethnicity: Asian or Pacific Islander	–0.010	0.142	–0.069
Teacher race/ethnicity: Black or African American	0.009	0.100	0.093
Teacher race/ethnicity: Hispanic	0.006	0.084	0.069
Teacher race/ethnicity: American Indian	–0.011	0.032	–0.340
Teacher race/ethnicity: multiple races/ethnicities	0.070	0.055	1.273
Similarity of student and teacher demographics (proportion of students of the same race/ethnicity, scale of 0–1)	0.065	0.065	1.005
Attended a regional college in Oklahoma	0.052*	0.025	2.125
Attended an out-of-state college	–0.060	0.037	–1.596
Degree level when hired[a]	–0.177***	0.038	–4.707
National Board for Professional Teaching Standards certified prior to be hired	–0.014	0.359	–0.038
Nonteaching assignments (teacher had nonteaching duties in any year during this period of employment)	0.274***	0.039	7.015
Teaching workload (average full-time equivalent during this period of employment)	0.496***	0.083	5.942
Total compensation (in thousands of dollars)	0.009***	0.001	7.616
District			
Student–teacher ratio	0.006	0.008	0.717
Staff–teacher ratio	0.056	0.203	0.277
District size: total number of students in district	0.200***	0.046	4.367
District size: total population in the district	–0.083*	0.037	–2.214
District financial information: per pupil expenditure (in thousands of dollars)	–0.004	0.010	–0.414
District financial information: district property value per student (in thousands of dollars)	0.000	0.000	1.124
District financial information: debt service per student (in thousands of dollars)	–0.042	0.031	–1.351
Student suspension rate	0.065	0.111	0.590
Student absenteeism	0.001	0.005	0.146
Average student performance	0.004**	0.001	2.914
Student demographics: percentage of Hispanic students	–0.207	0.181	–1.146
Student demographics: percentage of American Indian students	0.028	0.084	0.337
Student demographics: percentage of Asian/Pacific Islander students	–1.744	1.032	–1.691
Student demographics: percentage of Black students	0.153	0.169	0.906
Student demographics: percentage of students in special education	0.195	0.230	0.848
Teacher characteristics: average years of teaching experience	0.012**	0.004	2.833
Teacher characteristics: percentage of teachers with advanced degree	–0.154	0.096	–1.593
Highest grade offered in district	–0.040***	0.011	–3.584
Parent engagement (percentage of participation in parent–teacher conference)	0.069	0.054	1.278

(continued)

Table E3. Variables related to successful recruitment: Marginal effects on probability of successful recruitment for beginning teachers in Oklahoma rural school districts, full model *(continued)*

Variable	Estimate	Standard error	*z*-test
Community characteristics			
Remoteness: fringe	–0.063	0.032	–1.950
Remoteness: number of students per square mile of district area	–0.000	0.001	–0.015
Remoteness: percentage of all workers with a long commute	0.019	0.241	0.077
Remoteness: driving time to nearest college	0.053	0.051	1.042
Socioeconomic status of community: percentage under poverty level	0.304	0.235	1.296
Owner occupied housing (of all occupied)	0.252	0.174	1.444
Median value of housing units (in thousands of dollars)	–0.001	0.001	–1.762
Juvenile crime rate (per 1,000 students)	0.000	0.001	0.371
Median household income (in thousands of dollars)	0.002	0.002	1.000
Employment in major sectors: agriculture, forestry, fishing, or hunting	0.391	0.285	1.369
Employment in major sectors: mining	–0.098	0.225	–0.435
Employment in major sectors: trade, entertainment, recreation, accommodation, or food service	–0.180	0.221	–0.815
Unemployment rate	–0.199	0.315	–0.630
Proportion of population not in the labor force	0.151	0.162	0.931
Proportion of family households	0.253	0.221	1.144
Proportion of complete family households (two parents and children)	–0.203	0.215	–0.943
Proportion of extended-family households	0.177	0.429	0.411
Education level of community: percentage without high school diploma	–0.308	0.259	–1.191
Education level of community: percentage with associate's degree or higher	–0.009	0.185	–0.050
Proportion of school-age children born in Oklahoma	–0.300***	0.083	–3.632
Age of housing (median year housing built in the community)	0.002	0.002	0.852
Control indicators			
First recorded in 2007 for personal record	0.046	0.031	1.488
First recorded in 2008 for personal record	0.017	0.031	0.548
First recorded in 2009 for personal record	–0.028	0.033	–0.866
First recorded in 2010 for personal record	–0.085*	0.035	–2.457
First recorded in 2011 for personal record	–0.088**	0.033	–2.675
Dummy indicator for missing teacher age at time of hire	–0.467***	0.033	–13.952
Dummy indicator for missing teacher age when bachelor's degree received	0.247***	0.048	5.120

* Significant at $p < .05$; ** significant at $p < .01$; *** significant at $p < .001$.

Note: The proportion of students in the community population is not included in these results because the estimation included separate logs of number of students and district total population. Because the log of the proportion of students is the difference of the logs of students and district population, the positive effect of the (log of) student enrollment and negative effect of district population is equivalent to a positive effect of the proportion of students in the population.

a. Degree level was recorded on a four-point scale: 0 = no college or some college, 1 = bachelor's degree, 2 = master's degree, and 3 = advanced degree. However, only 1.3 percent of teachers belonged to the two extreme categories (0 or 3) combined, so the 12.5 percentage point marginal effect is, for practical purposes, the effect of having a master's degree at the time of hire as opposed to having a bachelor's degree.

Source: Authors' analysis of data from Oklahoma State Department of Education School Personnel Records, Office of Educational Quality and Accountability data, and publicly available data, 2006/07–2011/12.

Appendix F. Detailed results of the variables related to teacher retention in rural school districts in Oklahoma

The variables examined related to successful retention of teachers in rural school districts are shown in table F1. The results of the Cox regression estimates of quit rate effects (full model) are shown in table F2.

Table F1. Variables related to duration of employment for all teachers in Oklahoma rural school districts (full model)

Variable	Related to duration of employment	Significance indicator
Teacher		
Teacher age when bachelor's degree received	ns	ns
Teacher gender: male	–	***
Teacher gender: unknown	–	***
Teacher race/ethnicity: Asian or Pacific Islander	ns	ns
Teacher race/ethnicity: Black or African American	+	*
Teacher race/ethnicity: Hispanic	ns	ns
Teacher race/ethnicity: American Indian	–	**
Teacher race/ethnicity: multiple races/ethnicities	–	*
Similarity of student and teacher demographics (proportion of students of the same race/ethnicity, scale of 0–1)	ns	ns
Attended a regional college in Oklahoma	ns	ns
Attended out-of-state college	–	***
Degree level when hired[a]	+	**
Degree level when left district	ns	ns
National Board for Professional Teaching Standards certified prior to be hired	ns	ns
National Board for professional Teaching Standards certified during period of employment	+	***
Nonteaching assignments (teacher had nonteaching duties in any year during this period of employment)	+	***
Teaching workload (average full-time equivalent during this period of employment)	–	***
Total compensation	+	***
Whether teacher is experienced at time of hire	+	***
District		
Student–teacher ratio	+	***
Staff–teacher ratio	–	*
District size: total number of students in district	+	***
District financial information: per pupil expenditure	+	***
District financial information: district property value per student	+	***
District financial information: debt service per student	ns	ns
Student suspension rate	ns	ns
Student absenteeism	–	***
Average student performance	–	***
Student demographics: percentage of Hispanic students	+	*
Student demographics: percentage of American Indian students	–	***
Student demographics: percentage of Asian/Pacific Islander students	ns	ns

(continued)

Table F1. Variables related to duration of employment for all teachers in Oklahoma rural school districts (full model) *(continued)*

Variable	Related to duration of employment	Significance indicator
Student demographics: percentage of Black students	–	***
Student demographics: percentage of students in special education	+	***
Teacher characteristics: average years of teaching experience	+	***
Teacher characteristics: percentage of teachers with advanced degree	–	*
Highest grade offered in district	–	***
Parent engagement (percentage of participation in parent–teacher conference)	+	***
Community characteristic		
Remoteness: fringe	–	***
Remoteness: number of students per square mile of district area	ns	ns
Remoteness: percentage of all workers with a long commute	ns	ns
Remoteness: driving time to nearest college	–	*
Socioeconomic status of community: percentage under poverty level	+	**
Owner occupied housing (of all occupied)	+	***
Median value of housing units	+	**
Juvenile crime rate (per 1,000 students)	–	***
Median household income	–	***
Employment in major sectors: agriculture, forestry, fishing, or hunting	–	***
Employment in major sectors: mining	–	***
Employment in major sectors: trade, entertainment, recreation, accommodation, or food service	–	**
Unemployment rate	ns	ns
Proportion of population not in the labor force	ns	ns
Proportion of family households	ns	ns
Proportion of complete family households (two parents and children)	ns	ns
Proportion of extended-family households	ns	ns
Education level of community: percentage without high school diploma	ns	ns
Education level of community: percentage with associate's degree or higher	ns	ns
Proportion of students in community population	+	***
Proportion of school-age children born in Oklahoma	ns	ns
Age of housing (median year housing built in the community)	–	***

* Significant at $p < .05$; ** significant at $p < .01$; *** significant at $p < .001$. ns is not significant.

– indicates a negative correlation; + indicates a positive correlation

Note: Each effect assumes other factors are held constant. For example, the effects of age and experience may seem to contradict each other, but in fact, the effect of teaching experience is the effect of teaching experience given all other characteristics are the same, including age. The district and community variables were averaged over a period. The community variables are the 2008–12 average, and the district-level variables were averaged over the period of employment or for the period when data are available (for teachers who were hired before 2005).

a. Degree level was recorded on a four-point scale: 0 = no college or some college, 1 = bachelor's degree, 2 = master's degree, and 3 = advanced degree. However, only 1.3 percent of teachers belonged to the two extreme categories (0 or 3) combined, so the 12.5 percentage point marginal effect is, for practical purposes, the effect of having a master's degree at the time of hire as opposed to having a bachelor's degree.

Source: Authors' analysis of data from Oklahoma State Department of Education School Personnel Records, Office of Educational Quality and Accountability data, and publicly available data, 2005/06–2014/15.

Table F2. Variables related to quit rates and retention for all teachers in Oklahoma rural school districts: Cox regression estimates of quit rate effects (full model)

Variable	Estimate	Effect on probability of retention	Standard error	*z*-test
Teacher				
Teacher age when bachelor's degree received	0.000	1.000	0.002	0.138
Dummy indicator for missing teacher age when bachelor's degree received	–0.321***	1.378	0.038	–8.426
Teacher gender: male	0.605***	0.546	0.030	20.461
Teacher gender: unknown	0.789***	0.454	0.147	5.353
Teacher race/ethnicity: Asian or Pacific Islander	–0.027	1.027	0.275	–0.098
Teacher race/ethnicity: Black or African American	–0.345*	1.412	0.151	–2.279
Teacher race/ethnicity: Hispanic	0.207	0.813	0.149	1.389
Teacher race/ethnicity: American Indian	0.114**	0.892	0.044	2.604
Teacher race/ethnicity: multiple races/ethnicities	0.164*	0.849	0.082	1.999
Similarity of student and teacher demographics (proportion of students of the same race/ethnicity, scale of 0–1)	0.152	0.859	0.093	1.640
Attended a regional college in Oklahoma	–0.007	1.007	0.036	–0.191
Attended an out-of-state college	0.237***	0.789	0.049	4.863
Degree level when hired[a]	–0.150**	1.161	0.054	–2.780
Degree level when left district	0.079	0.924	0.050	1.573
National Board for Professional Teaching Standards certified prior to being hired	–0.107	1.113	0.118	–0.912
National Board for Professional Teaching Standards certified during period of employment	–0.338***	1.402	0.102	–3.322
Nonteaching assignments (teacher had nonteaching duties in any year during this period of employment)	–0.180***	1.197	0.050	–3.605
Teaching workload (average full-time equivalent during this period of employment)	0.736***	0.479	0.150	4.911
Total compensation (in thousands of dollars)	–0.040***	1.041	0.002	–21.150
Whether teacher is experienced at time of hire	–0.628***	1.873	0.043	–14.695
District				
Student–teacher ratio	–0.149***	1.160	0.014	–10.377
Staff–teacher ratio	0.744*	0.475	0.325	2.290
District size: Total number of students in district	–0.572***	1.772	0.068	–8.466
District financial information: per pupil expenditure (in thousands of dollars)	–0.156***	1.169	0.018	–8.727
District financial information: district property value per student (in thousands of dollars)	–0.003***	1.003	0.001	–4.244
District financial information: debt service per student (in thousands of dollars)	–0.061	1.063	0.052	–1.174
Student suspension rate	0.378	0.685	0.241	1.568
Student absenteeism	0.123***	0.885	0.009	13.735
Average student performance	0.041***	0.959	0.002	17.524
Student demographics: percentage of Hispanic students	–0.580*	1.785	0.268	–2.164
Student demographics: percentage of American Indian students	0.710***	0.492	0.128	5.545
Student demographics: percentage of Asian/Pacific Islander students	0.312	0.732	1.616	0.193
Student demographics: percentage of Black students	2.988***	0.050	0.273	10.926
Student demographics: percentage of students in special education	–2.156***	8.641	0.376	–5.740
Teacher characteristics: average years of teaching experience	–0.071***	1.074	0.007	–10.461
Teacher characteristics: percentage of teachers with advanced degree	0.288*	0.749	0.147	1.956
Highest grade offered in district	0.066***	0.936	0.016	4.248
Parent engagement (percentage of participation in parent–teacher conference)	–0.435***	1.544	0.089	–4.889

(continued)

Table F2. Variables related to quit rates and retention for all teachers in Oklahoma rural school districts: Cox regression estimates of quit rate effects (full model) *(continued)*

Variable	Estimate	Effect on probability of retention	Standard error	*z*-test
Community characteristics				
Remoteness: fringe	0.143***	0.866	0.043	3.344
Remoteness: number of students per square mile of district area	–0.001	1.001	0.002	–0.725
Remoteness: percentage of all workers with a long commute	0.117	0.890	0.342	0.342
Remoteness: driving time to nearest college	0.169*	0.844	0.072	2.342
Socioeconomic status of community: Percentage under poverty level	–1.029**	2.799	0.332	–3.099
Owner occupied housing (of all occupied)	–1.208***	3.348	0.256	–4.718
Median value of housing units (in thousands of dollars)	–0.003**	1.003	0.001	–2.619
Juvenile crime rate (per 1,000 students)	0.015***	0.985	0.002	6.992
Median household income (in thousands of dollars)	0.013***	0.987	0.003	4.328
Employment in major sectors: agriculture, forestry, fishing, or hunting	1.829***	0.161	0.397	4.611
Employment in major sectors: mining	1.673***	0.188	0.320	5.223
Employment in major sectors: trade, entertainment, recreation, accommodation, or food service	0.973**	0.378	0.304	3.206
Unemployment rate	–0.382	1.465	0.442	–0.864
Proportion of population not in the labor force	0.047	0.954	0.224	0.212
Proportion of family households	0.542	0.582	0.297	1.825
Proportion of complete family households (two parents and children)	–0.067	1.070	0.313	–0.215
Proportion of extended-family households	–0.114	1.121	0.597	–0.191
Education level of community: percentage with high school diploma	–0.148	1.159	0.365	–0.405
Education level of community: percentage with associate's degree or higher	0.124	0.883	0.260	0.478
Proportion of students in community population	0.313***	0.731	0.056	5.592
Proportion of school-age children born in Oklahoma	0.143	0.867	0.113	1.268
Age of housing (median year housing built in the community)	0.010***	0.990	0.003	3.710

* Significant at $p < .05$; ** significant at $p < .01$; *** significant at $p < .001$.

a. Degree level was recorded on a four-point scale: 0 = no college or some college, 1 = bachelor's degree, 2 = master's degree, and 3 = advanced degree. However, only 1.3 percent of teachers belonged to the two extreme categories (0 or 3) combined, so the 12.5 percentage point marginal effect is, for practical purposes, the effect of having a master's degree at the time of hire as opposed to having a bachelor's degree.

Source: Authors' analysis of data from Oklahoma State Department of Education School Personnel Records, Office of Educational Quality and Accountability data, and publicly available data, 2005/06–2014/15.

Notes

1. The Oklahoma Rural Schools Research Alliance core members represent the following organizations: the Absentee Shawnee Tribe of Oklahoma, Academic Transitions, the American Indian Institute at the University of Oklahoma, the Aurora Learning Community Association, Byng Public Schools, the Chokka' Kilimpi' Division of Education at the Department of Community Services for the Chickasaw Nation, the Public Utilities Division of the Corporation Commission, Elite Research, Frederick Public Schools, the Iowa Tribe of Oklahoma, K–8 Scholars Appreciating Mathematics at Southwestern Oklahoma State University, the K20 Center at the University of Oklahoma, the Madill Early Childhood Center, McAlester Public Schools, McDaniel & Assoc. LLC, the Office of Educational Quality and Accountability, Oklahoma City Public Schools, the Oklahoma State Department of Education, the Oklahoma Technical Assistance Center, the South Central Comprehensive Center at the University of Oklahoma, and Yale Public Schools.
2. This decline may be due to overall budget cuts in the Oklahoma state budget, which decreased from approximately $3.8 billion to $3.4 billion during the period (Oklahoma Office of Management and Enterprise Services, 2016).
3. Similarity between student and teacher race/ethnicity is measured on a scale from 0 to 1 according to the proportion of district students of the same race/ethnicity as the teacher. If all students are of the same race/ethnicity as the teacher, then there is a "perfect" match (1). If there are no such students, then there is no match (0). The difference between "no match" and "perfect match" (integer 1) translates into a 12 percentage point difference in the probability of successful recruitment.
4. The marginal effect shown in table E2 in appendix E is for the natural logarithm of student enrollment, a conventional transformation used in the analysis. Calculating the difference between the two districts in the example in the text requires multiplying the marginal effect of .197 reported in table E2 by the natural logarithm of 2, which is approximately 0.69. This yields a 14 percentage point difference.
5. This is accounted for by a combination of 27.6 percentage points because of the additional nonteaching assignment, 12.6 percentage points because of the full-time equivalent change, and 3.7 percentage points because of the compensation effect.
6. This is due to the higher effect of increased compensation ($1,080 per 1 percent of the rate of successful recruitment) being offset by the lower effect due of employment at 1 full-time equivalent (0.49).
7. OSDE records are submitted once each year and do not allow differentiating between teachers who quit midyear or worked for the whole year. Duration variables thus round the actual duration up to the nearest integer in cases of midyear departures.
8. Job termination due to death, disability, or retirement results in censored duration of employment because this type of event prevents workers from making free employment choices. In the absence of such events, they could choose to stay longer in their last positions.
9. This analysis used an approach that is standard for integer duration data (see Miller, 1981) and is implemented in widely used R/Splus package "survival" (Survival Analysis, Version 2.40–1). The duration of employment is an integer number, by the nature of available data. In most cases, teachers are employed for the whole academic year, and even if they leave midyear, the way teacher employment data are reported to OSDE leaves no room for such information. All results are reported as integers. The Kaplan-Meier curves are not smooth curves but are stepwise lines. In addition,

duration of employment is not distributed normally, and the median in such a situation is a more robust statistic of central tendency than the mean. Confidence limits for the median essentially mark portions of the Kaplan-Meier curve, and by design, they can also be only integer numbers.

10. Whereas the data are inherently two level, with teachers nested in districts, estimation of a two-level logistic model with random district effects as described in the literature (for example, Raudenbush & Bryk, 2002) proved to be computationally infeasible due to the large number of top-level units (nearly 500 districts) and the small number of observations per unit, a single one in many cases.
11. Values at the time of job termination signify implicit comparisons with conditions in other locations (pull factors), whereas changes over time correspond to push factors of mobility. The study team assumed that all teachers have the same information about potential opportunities elsewhere in Oklahoma. Given this assumption, external conditions, constant across observations, were captured in the year effect. Including the calendar year in the model accounts for changing economic conditions in Oklahoma over time. This assumption may be too strong because teachers working in remote districts may be less informed. If this factor is substantial, then it will show in a lower mobility for teachers in remote districts, other things being equal.

References

Beesley, A., Atwill, K., Blair, P., & Barley, Z. (2008). *Strategies for recruitment and retention of secondary teachers in Central Region Schools*. Denver, CO: Mid-continent Research for Education and Learning. Retrieved April 17, 2017, from http://eric.ed.gov/?id=ED544668

Berg-Jacobson, A., & Levin, J. (2015). *Oklahoma study of educator supply and demand: Trends and projections*. Washington, DC: American Institutes for Research. Retrieved October 20, 2016, from http://www.air.org/sites/default/files/downloads/report/Oklahoma-Study-of-Teacher-Supply-and-Demand-September-2015.pdf.

Berry, A. B., Pétrin, R. A., Gravelle, M. L., & Farmer, T. W. (2011). Issues in special education teacher recruitment, retention, and professional development: Considerations in supporting rural teachers. *Rural Special Education Quarterly, 30*(4), 3–11.

Cegelka, P. A., & Alvarado, J. L. (2000). A best practices model for preparation of rural special education teachers. *Rural Special Education Quarterly, 19*(3), 15–29.

Davis, M. S. (2002). Teacher retention and small rural school districts in Montana. *Rural Educator, 24*(2), 45–52.

Goodpaster, K. P. S., Adedokun, O. A., & Weaver, G. C. (2012). Teachers' perceptions of rural STEM teaching: Implications for rural teacher retention. *Rural Educator, 33*(3), 9–22. http://eric.ed.gov/?id=EJ987621

Hammer, P. C., Hughes, G., McClure, C., Reeves, C., & Salgado, D. (2005). *Rural teacher recruitment and retention practices: A review of the research literature, national survey of rural superintendents, and case studies of programs in Virginia*. Charleston, WV: Appalachia Educational Laboratory at AEL. Retrieved April 17, 2017, from http://eric.ed.gov/?id=ED489143

Harris, M. M. (2001). Lessons from prairie teachers. *Action in Teacher Education, 23*(1), 19–26.

Harris, M. M., Holdman, L., Clark, R., & Harris, T. R. (2005). Rural teachers in Project Launch. *Rural Educator, 26*(2), 23–32. http://eric.ed.gov/?id=EJ783823

Huysman, J. T. (2008). Rural teacher satisfaction: An analysis of beliefs and attitudes of rural teachers' job satisfaction. *Rural Educator, 29*(2), 31–38. http://eric.ed.gov/?id=EJ869291

Jovanovic, B. (1979). Job matching and the theory of turnover. *Journal of Political Economy 87*(5), 972–990.

Miller, R. G., Jr. (1981). *Survival analysis*. New York, NY: John Wiley & Sons, Inc.

Monk, D. H. (2007). Recruiting and retaining high-quality teachers in rural schools. *The Future of Children, 17*(1), 155–174.

Nagelkerke, N. J. D. (1991). A note on a general definition of the coefficient of determination. *Biometrika, 78*(3), 691–692.

National Center for Education Statistics. (2014). Common Core of Data. Locale Codes. U.S. Department of Education. Retrieved August 24, 2016, from https://nces.ed.gov/programs/edge/geographicLocale.aspx.

National Center for Education Statistics. (2016). Common Core of Data. Local Education Agency Universe Survey Data, 2013–14. U.S. Department of Education. Retrieved August 24, 2016, from http://nces.ed.gov/ccd/pubagency.asp.

National Center for Education Statistics. (2017). *Number and percentage of public school students eligible for free or reduced-price lunch, by state: Selected years, 2000–01 through 2014–15*. U.S. Department of Education. Retrieved June 20, 2017, from https://nces.ed.gov/programs/digest/d16/tables/dt16_204.10.asp?current=yes.

No Child Left Behind Act of 2001. (2002). Pub. L. No. 107–110, 115 Stat. 1425.

Oklahoma Office of Management and Enterprise Services. (2016). *Budget books: Fiscal years 2004–2017*. Retrieved August 24, 2016, from https://www.ok.gov/OSF/Budget/Budget_Books.html.

Oklahoma State Department of Education. (2014). *Oklahoma Educator Workforce Shortage Task Force: Initial report*. Oklahoma City, OK: Author. Retrieved August 24, 2016, from http://www.ok.gov/sde/sites/ok.gov.sde/files/documents/files/OK_Educator_Workforce_Shortage_Task_Force_Initial_Report.pdf.

Oklahoma State Department of Education. (2015a). *Supt. Hofmeister proposes 5-year plan raising state average teacher pay to regional average*. Oklahoma City, OK: Author. Retrieved August 24, 2016, from http://www.ok.gov/sde/newsblog/2015–01–26/supt-hofmeister-proposes-5-year-plan-raising-state-average-teacher-pay-regional.

Oklahoma State Department of Education. (2015b). *Teacher and school administrator salary information*. Oklahoma City, OK: Author. Retrieved August 24, 2016, from http://ok.gov/sde/state-minimum-teacher-salary-schedule.

Oklahoma State Department of Education. (2015c). *Teacher Shortage Task Force: Preliminary report*. Oklahoma City, OK: Author. Retrieved September 20, 2016, from http://okpolicy.org/wp-content/uploads/Prelim.-report-Dec.-11–2015.pdf.

Oklahoma State Department of Education. (2015d). *Teacher Shortage Task Force will identify real solutions to statewide crisis*. Oklahoma City, OK: Author. Retrieved August 24, 2016, from http://www.ok.gov/sde/newsblog/2015–09–24/teacher-shortage-task-force-will-identify-real-solutions-statewide-crisis.

Oklahoma State Department of Education. (2016). *Hofmeister applauds Governor's approval of bills addressing teacher shortage*. Oklahoma City, OK: Author. Retrieved September 20, 2016, from http://sde.ok.gov/sde/newsblog/2016–05–31/hofmeister-applauds-governor%E2%80%99s-approval-bills-addressing-teacher-shortage.

Oklahoma State School Boards Association. (2016, August). *Oklahoma schools struggle with teacher shortage despite cutbacks*. Oklahoma City, OK: Author. Retrieved August 24, 2016, from http://www.ossba.org/2016/08/22/oklahoma-schools-struggle-with-teacher-shortage-despite-cutbacks/.

Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical linear models: Applications and data analysis methods*. Thousand Oaks, CA: Sage.

Rosenberg, L., Christianson, M. D., Angus, M. H., & Rosenthal, E. (2014). *A focused look at rural schools receiving School Improvement Grants*. *National Center for Education Evaluation and Regional Assistance Evaluation Brief* (NCEE No. 2014–4013). http://eric.ed.gov/?id=ED544784

Schwartzbeck, T. D., Prince, C. D., Redfield, D., Morris, H., & Hammer, P. C. (2003). *How are rural school districts meeting the teacher quality requirements of No Child Left Behind?* Arlington, VA: American Association of School Administrators and Appalachia Educational Laboratory.

Singer, J. D., & Willett, J. B. (1993). It's about time: Using discrete-time survival analysis to study duration and the timing of events. *Journal of Educational Statistics, 18*(2), 155–195.

Sundeen, T. H., & Wienke, W. D. (2009). A model for recruiting and preparing new rural special educators: Mining an untapped potential. *Rural Special Education Quarterly, 28*, 3–10.

Survival Analysis (Version 2.40–1) [Computer software]. Retrieved October 28, 2016, from https://github.com/therneau/survival.

Tai, R. H., Liu, C. Q., & Fan, X. (2007). *Factors influencing retention of mathematics and science teachers in secondary schools—A study based on SASS/TFS*. Raleigh, NC: National Science Education Leadership Association.

Tyler, N. C., Cantou-Clarke, C. D., Easterling, J., & Klepper, T. (2003). Recruitment and retention and special education teacher preparation in rural areas: Diversity, federal funding, and technical assistance considerations. *Rural Special Education Quarterly, 22*(3), 3–11.

U.S. Census Bureau. (2008). *A compass for understanding and using American Community Survey data*. Washington, DC: U.S. Government Printing Office.

Williams, J. M., Martin, S. M., & Hess, R. K. (2002). Personnel preparation and service delivery issues in rural areas: The state of the art. *Rural Special Education Quarterly, 21*(4), 3–12. http://eric.ed.gov/?id=EJ1148502

Zhang, Y. (2008). *Some perspectives from rural school districts on the No Child Left Behind Act*. Washington, DC: Center on Education Policy. http://eric.ed.gov/?id=ED503795

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