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Arkansas Teacher Supply

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Executive Summary

There have been widespread reports of an impending teacher shortage crisis in the U.S. for more than 30 years. In the U.S., there are claims of a widespread national shortage while research indicates teacher shortages are specific to certain subjects and schools. Part of the reason for the conflicting accounts is how shortage is identified and what information is used to assess it. In this study, we test whether a uniform teacher shortage exists across the state of Arkansas. We hypothesize that, rather than a universal shortage, teacher shortages are more likely to occur in certain regions and subjects. We examine the characteristics of districts with the most favorable teaching supply using descriptive and multivariate analysis of data collected from district surveys along with administrative data. In this study, "supply" is defined as the ratio of applications to vacancies. This is the third study to use application information to identify teacher supply, and the first to assess teacher supply in this way. Results indicate teacher supply is unequally distributed across the state. We find district size, region, and urbanicity appear to drive supply. Teacher supply is most favorable for large districts with student enrollments greater than 3,500, districts in the Northwest, and suburban and city districts.

I. Introduction

In the U.S., there are perceptions of a widespread national teacher shortage while research indicates shortages are specific to certain subjects and schools. Part of the reason for the conflicting accounts is how "teacher shortage" is identified and the information used to assess it. Shortages can be influenced by a number of factors from the supply side (an increasing number of retirees, turnover and attrition, or a decline in enrollment in preparation programs) and the demand side (increasing student enrollment, reductions in class size, or the desire to re-staff schools to pre-recession levels). Many factors can influence the lack of alignment between the demand for, and availability of, teachers in Arkansas as well.

Motivation

The Arkansas Department of Education (ADE) reports statewide teacher shortage areas each school year. The ADE references the decline in the number of enrollees in education preparation programs as particular cause for concern. However, a review of the number of education program "completers" over the past ten years suggests that the trend in program graduates has remained constant and is somewhat positive. It is possible that there could be a shortage in some regions and subjects but a surplus in others. In fact, some types of districts may face no shortage at all but rather a robust supply of teachers for each job opening. With a better understanding of actual teacher supply challenges, policies aimed at addressing these problems have a better chance of success. Continuing to have persistent shortage areas over time suggests there may be an issue with the way in how they are identified and/or the means by which they are addressed.

The state's primary strategy to address shortages has been to increase supply by increasing recruitment into education preparation programs and offering incentives such as

bonuses and loan forgiveness. Arkansas should consider additional information when assessing teaching supply (and demand) and defining shortages. In particular, information on the number of applications and vacancies, should be collected at the district level rather than the state level. This would aid in identifying exactly where the need is and inform strategies to address that need. It is one thing to focus on increasing the overall supply of teachers, it is another thing to get teachers to where they are needed most. In this study, we identify the distribution of teacher supply at the district-level looking at the characteristics of districts in an effort to understand how teacher supply might differ across different settings.

Study Purpose

The purpose of this study is to test whether a uniform teacher shortage exists across the state of Arkansas. If so, there should be similar numbers of vacancies in similar subjects across districts of varying sizes, urbanicity, and regional locations. Rather than a uniform shortage, we hypothesize that teacher shortages are more likely to occur in certain regions and subjects. Additionally we further examine whether there is a surplus of elementary and English/language arts teachers as the literature indicates. We expect to find more applications for elementary teachers than middle or high school, and more for English/language arts than math and science teachers.

We conduct descriptive analyses of the teacher supply in Arkansas to identify where shortfalls are actually occurring. Of particular interest is the teaching supply in districts with greater numbers of low income and minority students. Multivariate regression is used to identify the characteristics of districts with the most favorable teaching supply. The analysis includes data collected from semi-structured phone interviews, online surveys, and district administrative

data which includes demographics, academic performance, and teacher salaries. In this study, we specifically address the following questions:

1. What are the characteristics of districts that have the most favorable teaching supply?
2. Does supply differ by school level or subject?

We examine teacher supply at the district level using vacancy and application information and define "supply" as the ratio of applications to vacancies. This is the third study to use information on the teacher application pool to assess teacher supply. However, this is the first study to define teacher supply in this way. The findings are intended to help inform recruiting and hiring practices of districts around the state and aid the Arkansas Department of Education in identifying current teacher supply.

In Chapter 2, we review the literature looking at the issues related to determining teacher supply, how other states have assessed it, and how it is done in Arkansas. The data and methods are discussed in Chapter 3. In Chapter 4, the results are presented and a discussion of the findings and recommendations are provided in Chapter 5.

II. Determining Teacher Supply

There is widespread belief, fueled by ongoing media reports, of an impending teacher shortage crisis in the U.S. Critical to addressing the problem is clearly analyzing where shortages exist rather than incorrectly assuming there is a global or overall teacher shortage. Shortages can be influenced by a number of factors from the supply side (an increasing number of retirees, turnover and attrition, or a decline in enrollment in preparation programs) and the demand side (increasing student enrollment, reductions in class size, or the desire to re-staff schools to pre-recession levels) in the teacher labor market. Many factors can influence the lack of alignment between the demand for and availability of teachers.

Teacher Shortages?

The national policy debate on whether a national teacher shortage exists is muddled by variation in reporting. There may well be areas of teacher shortage across the country, but to refer to it as a national shortage seems incorrect. Some researchers find support for a universal shortage while others find evidence that teacher shortages are specific to certain subjects and schools. Part of the reason for these conflicting reports is how shortage is being identified and what information is being used to assess it.

Both insufficient supply and excess demand drive the discussion. Insufficient teacher supply is supported by reports that many educator preparation programs have seen declining enrollments in the last decade (Malatras et al., 2017; Sutcher et al., 2016). Specifically, teacher preparation program enrollments have declined by a third and program graduates have declined by almost a quarter, between 2009 and 2014 (Sutcher et al., 2016). Rather than insufficient supply, some researchers argue that teacher shortages are driven by excess demand caused by attrition (leavers) and turnover (movers) (Ingersoll, 2001). However, teacher demand is also influenced

by student enrollments, class size policy, fiscal capacity, and wage levels (Murnane & Steele, 2007).

On the other hand, there is evidence to suggest that there are more than enough teachers produced annually and the demand related to turnover has remained steady. Rather than focusing on education program enrollees, attention is directed toward the examination of program completers. Studies show there has been a steady increase in the number of new teacher candidates since the 1980s (Cowan et al., 2016; Dee & Goldhaber, 2017; Ingersoll, 2003; Russell, 2005). Even though only about half of teachers who complete preparation programs are hired in public schools in a typical year, the supply of new teacher graduates exceeds the number of new hires nationally (Cowan et al., 2016; Dee & Goldhaber, 2017; Ingersoll, 2003). In addition, the "reserve pool", which includes delayed entrants and former teachers who left but later return, also contributes to overall supply (Ingersoll, 2003; Murnane & Steele, 2007). Furthermore, recent research indicates the rate of turnover in education is improving and is less than in other industries (Bureau of Labor Statistics, 2018; Malatras et al., 2017; Papay, n.d.), with reports of fewer teacher shortages in 2011-12 than in 1999-00 (Aragon, 2016; Hussar & Bailey, 2014). How teacher supply and demand are identified varies and can lead to conflicting accounts.

Identification Challenges

Part of the confusion related to this policy debate can be explained by the information being used and how teacher shortage is being identified. In terms of supply, there are differences when using education program enrollee, candidate, or graduate data. The number of students enrolled in education programs will differ depending on whether that information is based on students who have applied and been accepted to education programs or on those who have declared education as their major. Additionally, candidates may have completed the

requirements of licensure but not yet graduated. If supply reflects the number of individuals willing and able to teach (Behrstock-Sherratt, 2016), a surplus of teachers being trained does not mean there are enough graduates produced for each field (Ingersoll, 2003). In other words, the aggregate number of teachers is not as important as the number of teachers per field and geographic area. Furthermore, teacher recruitment will not solve staffing problems if issues related to teacher retention are not addressed (Ingersoll, 2001).

In terms of demand, if demand represents the number of teachers a district wishes to employ (Behrstock-Sherratt, 2016), vacancy information is useful to collect. How a district defines a vacant position and when that information is reported will matter. A vacant position could be any position filled by a new teacher, and include teacher movement within schools. Or a vacant position might only include positions that are advertised, or those left unfilled. Moreover, vacancy rates will differ depending on whether that information is collected before the end of a school year, over the summer, or at the start of the following school year. Districts can define vacancies very differently (Barnum, 2018) and some states like Arizona and Indiana do not even track teacher vacancies (Will, 2016). What's more, it is unclear how many unfilled teaching positions or long-term substitutes are employed by districts at the start of the school year (Murnane & Steele, 2007; Murphy et al., 2003).

Further adding to the confusion is the fact that "teacher shortage" is not clearly or consistently identified or assessed either, and can be indicated by a variety of factors. Determinations of teacher shortages may be based solely on evaluations of decreasing supply, indications of increasing demand, or differences between supply and demand. Estimates for supply could be based on the number of teacher preparation program students enrolled, new teacher certifications, the number of anticipated retirees, the number of unemployed certified

teachers, or the number of applications per vacancy (Behrstock-Sherratt, 2016; Lindsay et al., 2016). Assessments of demand might be derived from the number of vacancies a district has, the number of vacancies to full-time teaching staff, the number of teachers needed to maintain student-teacher ratios, the number of emergency credentials, or the number of teachers leaving the profession (Behrstock-Sherratt, 2016; Lindsay et al., 2016). The methods used to examine teacher supply and demand depend on the questions being asked and the available data sources (Lindsay et al., 2016). Data on vacancies is not readily available and application data is not usually collected at all.

Depending on the information being used to measure teacher shortages, research outcomes and reporting on the issue will vary. For example, if we count program graduates, this approach leads to a very high number in the supply category and would lead researchers to say that there is no shortage. However, if instead we only count applicants, this approach would lead to a lower number and thus we would be more likely to find shortages.

Distribution Considerations

Teachers have historically been inequitably sorted across schools with less-qualified teachers in high-poverty, high-minority, and low-performing schools (Hanushek et al., 2004; Loeb & Reininger, 2004; Murnane & Steele, 2007). High-poverty schools have higher turnover rates than affluent schools (Ingersoll, 2001; Malatras et al., 2017). There are higher turnover rates in schools with higher proportions of minority students (Loeb & Reininger, 2004). Urban schools have more turnover than rural or suburban schools (Ingersoll, 2002). Southern and western states also tend to have greater teacher shortages (Murphy et al., 2003). As the nation's population has grown more diverse, the demographic composition of the teacher workforce has remained predominantly white and less diverse (Ingersoll & May, 2011; Konoske-Graf et al., 2016; Murnane & Steele, 2007; Murphy et al., 2003).

However, we should also consider the inequitable distribution of teachers by geographic area and the distribution of teachers by content area. The demand for STEM (science, technology, engineering, and math) and special education teachers is and has been greater than that for elementary, English, and social studies teachers (Cowan et al., 2016). In fact, National Center for Education Statistics data indicates there have been annual shortages since 1990 (NCES) in special education, science, and English as a Second Language (ESL) in almost every state (Hussar & Bailey, 2014; Malatras et al., 2017). Meanwhile, education programs in many states are overproducing candidates in low-demand subjects (Aragon, 2016; Behrstock-Sherratt, 2016).

Review of State Studies on Teacher Supply and Demand[1]

As this study focuses on the teacher supply in Arkansas, we review other state studies of teacher supply and demand to examine how they have evaluated and reported this information. A summary of the 27 reports found is presented in Table 1. There is a lot of variation in the focus and information used by states to examine teacher supply and demand. One state focused only on the supply side (New York), two states focused only on the demand side (Alaska and Nebraska), and only 16 of the 27 states specifically discussed teacher shortage areas.

To examine teacher supply, most states used information on education program participants (enrollees, candidates, or completers), teacher certification, new hires, and retention. To assess teacher demand, information on teacher turnover, attrition, and student enrollments were used most.

[1] We began with the state evaluations included in the works by Aldeman (2018) and Behrstock-Sherratt (2016), which provided 19 state reports. Next, we conducted a Google search for each of the remaining U.S. states using each state's name, "teacher supply and demand" or "teacher shortage", and ".gov" to find any other reports generated by states. This search yielded eight additional states for a total of 27 state reports addressing teacher supply, demand, supply and demand, and/or shortages.

Table 1: State Reports of Teacher Supply and Demand (Alaska–Delaware)

Author(s)	Year	State	Information Used for Supply	Information Used for Demand	Teacher Shortage Areas	Report Findings
Hill & Hirshberg	2013	Alaska		Turnover rates		Turnover has declined slightly but not significantly; annual turnover rates vary widely among rural districts (7-52%); less turnover of teachers with <10yr experience if trained in state; 80% who leave, leave school system entirely; 64% of teachers hired from outside state
Pfeffer & Servedio	2015	Arkansas	Ed program enrollment, newly licensed, license areas	Long-term substitutes, out of field assignments, retirements, projected retirements	Math, science, SPED, computer science, foreign language, art, ag science, consumer science	About 10% expected retirement, more licenses in non-shortage areas
Suckow & Lau	2017	California	New teacher credentials, ed program enrollment, alt cert enrollment	Estimated teacher hires, waivers issued		Increase in initial teaching credentials; increase in number of teaching permits has decreased number of fully-credentialed teachers (by 1%)
Reichardt et al.	2003	Colorado	Information on existing workforce, new hires, attrition	Enrollment and growth rates, teacher retirement, attrition, transfer rates, ratio of school-age-population-to-teachers by county (similar to a pupil-teacher ratio)	Foreign language, SPED	Enrollment increasing but varies by region; number of teachers increasing faster than enrollment; retirement increasing but attrition steady (11% leavers, 11% movers)
Connecticut State Dept. of Education	2012	Connecticut	Total number of certified positions (past 5 yrs), median number of **applicants,** teacher certification	**Vacancies** - total number of available positions (past 5 yrs), unfilled positions, long-term substitutes	Bilingual, SPED, math, science, speech/language, foreign language	Shortage areas fairly consistent; little change in total number of positions, vacancies; number of vacancies declined somewhat but median number of applicants per position increased
Sherretz et al.	2013	Delaware	New hires and attrition	Attrition, **vacancies**, retirement projections	Foreign language, HS math & science	Teacher hires decreased but hiring occurring earlier; 41% hired are new to teaching; increase in teachers leaving with 7% of teachers expected to retire

Table 1: State Reports of Teacher Supply and Demand (Continued – Florida-Kentucky)

Author(s)	Year	State	Information Used for Supply	Information Used for Demand	Teacher Shortage Areas	Report Findings
Office of Economic and Demographic Research	2000	Florida	Estimated at state level - education program graduates, percentage of graduates from other fields who have entered teaching, and state transfers (assumes no change in relative wages or non-pecuniary factors)	Estimated at county level - enrollment growth, replacement for leavers (assumes no change in class sizes)	Elementary, SPED	State supplies 60% of education program grads, remaining teachers come from out of state; demand appears constant due to increasing retirment and declining enrollment
Stephens et al.	2015	Georgia	Education program completers, alt cert completers, new hires, retention rates, returning to service (reserve pool), attrition	Attrition, mobility, hiring from reserve pool, enrollment, attrition, policy changes		Enrollments increasing; 13% of new teachers leave after 1yr, 44% after 5yrs; HS teacher attrition highest especially in math, foreign language, science; attrition higher in high poverty schools; 25-30% of new teacher hiring from reserve pool; number of ed program completers declining; alt cert and out of state hiring increased
Linder & McHugh	2017	Idaho	Education program completers, teacher certification, attrition	Attrition		33% of teachers licensed annually do not teach; attrition steady at 10% (8% nationally); 76% of attrition due to leavers
Meeks & Koch	2014	Illinois	Retention from previous year, newly certified, re-entering personnel, education program enrollees and completers	Enrollments, unfilled positions	Speech/language, bilingual, Chicago	Retention rates remain high (92.7%); increase in number of certificates issued; decrease in number of re-entries; pipeline indicates "fairly robust" supply; enrollment declining; workforce decreasing
Hicks, M.J.	2015	Indiana	Education program graduates, attrition	Enrollment, turnover, retirement	STEM, SPED	Demand is static or declining with low turnover; excess supply; low attrition (17%)
Ford Seiler et al.	2012	Kentucky	Education program completers, teacher certification, new hires, retention, attrition	Attrition and mobility rates, enrollment, unfilled positions, emergency certification	HS science, ELL	Teacher shortages declining (unfilled and emergency cert are <0.5%); emergency cert decreasing while alt cert increasing (1/5 of new teadhers); education degree areas disproportionate to demand

Table 1: State Reports of Teacher Supply and Demand (Continued – Maryland-New Hampshire)

Author(s)	Year	State	Information Used for Supply	Information Used for Demand	Teacher Shortage Areas	Report Findings
Maryland State Dept. of Education	2017	Maryland	New hires, teacher attrition, projected education program graduates, candidates, and enrollees, retired/rehired	School age population, enrollment, attrition	ELL, foreign language, math, science	Enrollment declined; teacher-student ratio steady; attrition increased (7%) at/below nation; early career retention improved; ed program grads is constant (though enrollment decreasing); conditional certifications decreased
Levin et al.	2015	Massachusetts	New hires, transfers, retention	Enrollment, teacher-student ratios		Enrollment decreasing; slower expected rate of decline in supply (<2%) leading to eventual surplus; new teachers decreased but teacher transfers (across districts, out of state) increased
Nguyen & Onstad	2017	Minnesota	New licenses, transfers, retention from previous year, returning to service, attrition	Enrollment, teacher-student ratios, attrition, **vacancies**		Increase in number of full-time teachers; enrollment increased; retirements increased; 15% leave after 1 yr, 26% after 3 yrs
Katnik, P.	2017	Missouri	Teacher certification	Enrollment and attrition based on national data, unfilled positions	SPED, elementary, speech/language, math, science, ELL, foreign language	Initial certifications decreasing; teaching assignments increasing due to increasing enrollment; shortages in certain subjects and geographic areas
Watson et al.	2017	Montana	Education program graduates	Projected ed workforce supply-demand gap		Oversupply of elementary and MS teachers; undersupply of HS teachers and counselors
Nebraska Dept. of Education	2018	Nebraska		Enrollment, unfilled positions	ELA, science, SPED, speech/language, foreign language	Most unfilled positions in the SE (27%) and largest districts (>10,000); main reasons for unfilled positions - no appplicants, no qualified applicants
Cook Smith & Mackin	2006	New Hampshire	Education program completers, teacher certification, attrition	Attrition	Math and science, SPED	Workforce relatively stable; more novice teachers; most new teachers come from state programs; increases in alt cert; supply appears to be adequate in elementary and social studies though few seeking credentials in critical need areas

Table 1: State Reports of Teacher Supply and Demand (Continued – New York-South Carolina)

Author(s)	Year	State	Information Used for Supply	Information Used for Demand	Teacher Shortage Areas	Report Findings
Engage NY	2013	New York	Education program completers (not those already working as teachers), alt cert		Bilingual, ELL, foreign language, math, reading, science, SPED	Decrease in ed program completers; decrease in new teachers hired; most new hires in charters; half of completers in elementary
Zagorsky et al.	2013	Ohio	New teacher license holders	Enrollment, **reduced FTE**, retirement, posted **vacancies**		Fewer teachers needed due to declining birth rates; high levels of retirement will continue but level off; over 25% of new teachers licensed in early childhood or P-3, few in math & science; 1/6 with ed degrees never licensed
Berg-Jacobson & Levin	2015	Oklahoma	Education program completers, certification areas	Enrollment, teacher-student ratio, teacher mobility	ELA, social studies, science; HS more than MS	Ed program completers most commonly elementary, early childhood, ELA; alt certs declined while emergency certs increased; out of state hires constant; reserve pool has increased; leavers have increased; expect completers to decline; demand expected to grow minimally (due to enrollment and teacher-student ratio increases); supply expected to vary by region
Oregon Dept. of Education	2015	Oregon	Education program completers, first time licenses	Job postings, hiring fairs, provisional licenses	Varies by subject, region	Decrease in ed program completers but increase in first-time licenses (attributed to out of state) has led to surplus; low rate of provisional licenses
Garrett, J.	2018	South Carolina	New teachers entering, attrition	Attrition, unfilled positions		Increasing vacancies and departures; decreasing hires from ed programs (-25%); increasing hires from alt cert and out of state; increase in unfilled positions; attrition and movers about same; 22% leavers are first year teachers

Table 1: State Reports of Teacher Supply and Demand (Continued – Tennessee-Wisconsin)

Author(s)	Year	State	Information Used for Supply	Information Used for Demand	Teacher Shortage Areas	Report Findings
Bruce et al.	2009	Tennessee	Retention, attrition, reserve pool	Enrollment and teacher-student ratio (by grade groups - K-3, 4-8, 9-12, per LEA), mobility, attrition	ELL, music/art, grade 8, vocational	Teachers with higher salaries more likely to stay; teachers with less than Master's degree more likely to stay; more experienced teachers less likely to move but more likely to leave (retirement); enrollments expected to grow
Chastain et al.	2017	Washington	Education program graduates, attrition	Enrollment, K-3 class size reduction policy, emergency certification, out of field assignments, attrition		Emergency certification increasing; out of field teaching mostly decreasing but still high in math, science, ELA, elementary; full-day kindergarten and K-3 class size reduction drives elementary need; enrollment increasing; ed program graduates decreasing, yet number of novice teachers increasing
Goff et al.	2018	Wisconsin	Education program completers and enrollees, average number of **applicants** for each vacancy classification rank ordered, applicant origin, attrition	**Vacancies**, emergency credentials, mobility, attrition, duration on job market		High attrition among low-supply positions; there are 2 external appicants for every 1 internal applicant for most positions, but more 1:1 for low-supply positions; increase in emergency credentials (even with high-supply positions)

Of the 27 states, only Connecticut and Wisconsin included applicant information in their measurement of teacher supply. Wisconsin used the average number of applicants for each vacancy classification and then rank ordered positions as low-, medium-, and high- supply (Goff et al., 2018). Additionally they examine mobility and attrition across the supply categories, and the origin of applicants (whether internal - from within the state, or external - from outside the state). Four states incorporated vacancy information (Delaware, Minnesota, Ohio, and Wisconsin) as part of the evaluation of teacher demand, and only Ohio used full-time equivalent (FTE) teaching position information as well. These exceptional cases are noted in the tables in red font. Delaware used vacancy information to understand when positions were advertised and how many were filled internally (Sherretz et al., 2013), and Minnesota identified unfilled positions with their vacancy information (Nguyen & Onstad, 2017). In Ohio, vacancies are used to track changes in employment trends and FTE is used to track the reduction in the number of teaching positions each year (Zagorsky et al., 2013). Wisconsin used vacancy information to determine the three supply classifications (Goff et al., 2018).

Findings from these state reports indicate a lot of variation in their scope and outcomes for supply and demand. Several states found decreases in education program completers (Georgia, New York, Oklahoma, Oregon, and Washington) and Maryland found the supply of program graduates to be constant. Maryland found increasing attrition, while Indiana found attrition to be decreasing, and Colorado and South Carolina found attrition to be steady. However, with regard to teacher shortage areas, there do appear to be some consistent trends. Among the states that evaluated teacher shortages, there appear to be consistent shortages in math, science, SPED, ELL, and foreign language. The variation in supply and demand reported

by states and the relative consistency of teacher shortage subject areas across states aligns with the research previously discussed.

Arkansas's Method of Identifying Teacher Supply and Demand

Turning to the local context of this study, we examine how Arkansas identifies teacher supply, demand, and shortage areas. The Arkansas Department of Education (Pfeffer & Servedio, 2015) uses its own supply and demand formula to identify shortage areas. Teacher supply focuses on the pipeline of incoming teachers and uses the number of students enrolled in educator preparation programs[2] as well as the number of first time licenses issued (Pfeffer & Servedio, 2015). Using 2015 data, the most recent Arkansas Educator Preparation Performance Report indicates greater decreases in the number of program enrollees than program completers, with 36.3% fewer teachers enrolled in traditional and alternative education programs (ADE, 2016b; 2017a). For demand, the ADE uses the number of classes taught by long-term substitutes or teachers out of their area of licensure, and the number of teachers who retired in the previous year or who have the potential to retire in the near future (Pfeffer & Servedio, 2015). Shortage area scores are calculated, based on the supply and need factors, and shortage areas identified if the score for need is greater than supply (Pfeffer & Servedio, 2015). The following critical academic shortage areas were identified for the 2016-17 school year: agriculture science and technology, art, computer science, family and consumer science, French, library media, mathematics, physical science (chemistry, physics), Spanish, and special education (ADE, 2016a; Cross, 2016; Pfeffer & Servedio, 2015).

[2] Educator preparation programs include both traditional and alternative certification routes.

This method for identifying teacher shortages does not make use of all the relevant information affecting both supply and demand. For supply, the ADE should consider using the number of education program completers, which more accurately reflects those able to fill vacant positions, rather than focusing on the number of program enrollees, which can fluctuate depending on when and what information is being used. For demand, student enrollment rates and teacher turnover should be included as well. In particular, demand calculations appear only to account for teacher replacement and do not factor in growing enrollments (Pfeffer & Servedio, 2015). Student enrollment in public elementary and secondary schools in Arkansas is projected to increase by 1.6% by 2022, with most of the growth expected in grades 9-12 (Hussar & Bailey, 2014). Between 2004-05 and 2014-15, student enrollment in the state grew by 4.5% while the total number of certified teachers employed grew by 3.4% (ADE, 2016b). Without factoring in growing enrollments, teacher need will remain higher than estimated. In addition, non-retirement attrition and turnover are not factored into demand, even though approximately 15% of teachers leave the profession after the first year, 31% after three years, and 36% after five years (ADE, 2016b).[3]

Arkansas reflects trends seen at the national level. As with the rest of the nation, not all education program graduates in Arkansas receive a teaching license or actually end up teaching (Office for Education Policy, 2005). The number of teachers produced each year falls short of the number hired in Arkansas public schools (ADE, 2017a). Of those enrolled in education programs, only 63% were preparing for licenses in critical shortage areas (ADE, 2016b). The

[3] District level retention does not factor in teacher movement between schools within a district (ADE, 2016b).

biggest factor contributing to teacher shortages in Arkansas appears to be teachers teaching out of their licensure area, leaving the state, or not teaching at all (Office for Education Policy, 2005). Furthermore, teachers seem to be concentrated in urban areas or college towns around the state, near to where they received their training (Barnett & Blankenship, 2005).

Policies implemented to address teacher shortages in the state are primarily focused on attracting teachers (increasing supply) rather than retaining teachers (decreasing demand). Most superintendents believe greater resources (funds) are needed to attract highly-qualified teachers (Barnett & Blankenship, 2005). As some schools are more concerned with filling vacancies than with the quality of the candidates, with administrators finding themselves in the position to have to hire whoever applies, focusing on increasing (and possibly redistributing) the teaching supply in the state makes sense (Maranto & Shuls, 2012). Incentives to attract teachers to critical shortage areas have included grants and student loan forgiveness programs (ADE, 2016b; Office for Education Policy, 2005). Additional incentives are offered to draw teachers to hard-to-staff areas and can include moving expenses for particular regions (geographic areas), bonuses for working in high-priority districts, and bonuses for teaching in STEM fields (ADE, 2016b). However, new strategies to address teacher retention are identified as part of Arkansas' Every Student Succeeds Act Plan (ADE, 2017b). These strategies include providing advanced licensure levels to retain effective teachers and personalized mentoring support related to the teacher evaluation system (ADE, 2017b; Howell, 2017).

III. Methods

In this study, we conduct descriptive analyses on the teacher supply in Arkansas, using collected data along with administrative data. We use multivariate regression to identify the characteristics of districts with the most favorable teaching supply. In this chapter, we present the data and methods used in detail, describe the analytic sample, and discuss the limitations.

The research questions we aim to answer about teacher supply in Arkansas include:

1. What are the characteristics of districts that have the most favorable teaching supply?
2. Does supply differ by school level or subject?

Data

Sources of data for this study include interviews with district superintendents, an online survey given to all districts to identify the number of vacancies and applications for grade and subject level positions, and state administrative data on district enrollment, demographics, academic achievement, and finances.

Interviews

As a first step in developing the online survey, we conducted semi-structured interviews with district superintendents from across the state to begin to identify the level of teacher need statewide, where shortages or surpluses may be occurring, and how that need is being met. In an effort to gather information from districts in a variety of settings, we purposefully selected districts based on location (and somewhat on size). Seventeen districts were identified, of which eight agreed to participate in interviews. Of the eight superintendents, two were from districts located in the Northwest, four from the Central region, one from the Southwest, and two from

the Southeast. Two of the eight were superintendents of charter organizations. Interviews were semi-structured and all but one was conducted over the phone in February and March 2017. Interview questions specifically asked about the numbers of vacancies and applications by grade and/or subjects, teacher attrition and movement, and hiring practices. From the interview process and responses, we refined questions for the online survey that was sent out to all districts.

Online Survey

Through this survey, we aimed to gather information on the level of teaching supply statewide and where shortfalls or surpluses may be occurring. Informed by our discussions with superintendents, we developed the online survey to ask the appropriate questions that district human resource representatives could feasibly answer.[4] The survey specifically asked about the number of vacancies by grade level and subjects, the number of applications for those vacancies, whether all vacancies were filled and how that need was met for unfilled positions, recruitment strategies, sources for new hires, teacher preparation program partnerships, incentives, and reasons for attrition. Of particular interest for this study are the responses regarding the number

[4] Three different surveys were created based on district size (small, midsize, and large) to accommodate the variation in range of possible responses. For example, when asking about the number of applicants per school level and subject (i.e. number of middle school math and science position applicants) small districts were provided a survey with a 0-50 range for responses while large districts were provided a survey with a 0-200 range for responses. The same questions were asked in each of the surveys. The only difference between the surveys was the number ranges provided for responses. "Small" districts were identified as those with student enrollments less than 1,500 students, "Midsize" districts included those with student enrollments between 1,500–3,500 students, and "Large" districts were those with student enrollments greater than 3,500. In addition to providing a more tailored survey to districts of varying sizes, this also allowed me to monitor response rates by district size to ensure representative participation. A shorter/condensed survey was also created in the last two weeks of data collection to induce more districts to respond.

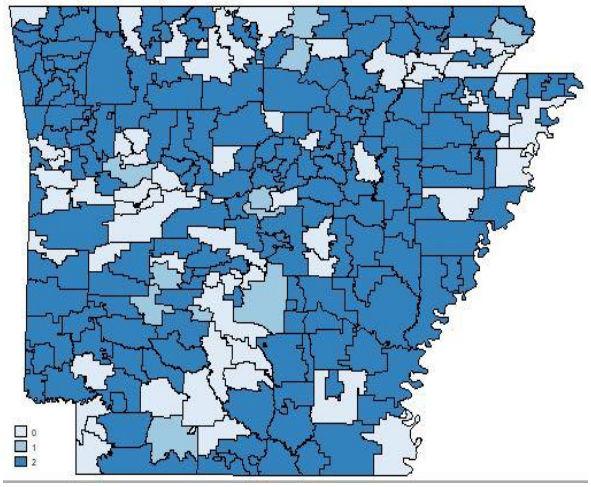
of vacancies and applications as this information is directly tied to the way in which we define and measure teacher supply. We define teacher supply as the ratio of applications to vacancies.

Surveys were emailed to every district in April 2017 and collected through early June 2017. Paper versions of the surveys were available but never requested. Email reminders and requests were sent weekly and personal phone calls made to districts June 1-2, 2017. Of the 262 districts surveyed, the overall response rate was 74.4%. Table 2 shows response rates by district size/survey. Figure 1 displays which districts around the state responded to the survey.

Table 2: Survey Response Rates

	Survey Type				
	Small	Midsize	Large	Short	Total
N of Districts	179	53	30	104	262
N of Responses	106	32	20	37	195
Response Rate	59.2%	60.4%	66.7%	35.6%	74.4%

Note: A shorter survey was created and sent to the 104 districts that had not completed the survey by the initial deadline.



Notes: 0 = No survey; 1= Incomplete survey; 2= Completed survey.
Does not include/reflect charter school districts. (Source: U.S. Census Bureau, 2016)

Figure 1: Map of Arkansas School District Respondents

Administrative Data

From the Office for Education Policy (OEP) website, we compiled district administrative data in May 2017. Data collected included: information on enrollment and demographics (race/ethnicity, free and reduced price lunch (FRL) status) for school years 2012-13 through 2016-17; educational success information based on academic achievement and graduation rates (ACT Aspire data for school years 2015-16 and 2016-17, Grade 11 ACT data for school years 2015-16 and 2016-17, graduation rate for school years 2014-15 and 2015-16); and the most recent district finance data available (for teacher salary, FTE classroom positions for the 2015-16 school year). From the National Center for Education Statistics, we downloaded the most recent urbanicity designation information (2014-15) in August 2017. Information on the state education regions (used by the OEP) comes from the Arkansas Association of Educational Administrators.

Variables of Interest

The categorical variables of interest include district size, urbanicity, and region. A categorical variable is used for district size, as the underlying distribution of enrollment is not believed to be linear. We use the same district size categories[5] used for developing and administering the online survey, with "Small" districts as those with enrollment less than 1,500 students, "Midsize" districts as those with enrollment between 1,500 and 3,500 students, and "Large" districts as those with enrollment greater than 3,500 students. Urbanicity is determined by the NCES urban-locale framework (2017b) and identifies districts as city, suburb, town, or

[5] Size categories are informed by the distribution of district enrollments.

rural. There are five education regions in the state identified as the Northwest, Northeast, Central, Southwest and Southeast by the Arkansas Association of Educational Administrators (2017).

The continuous variables of interest include district demographics and achievement, as well as a composite measure of educational success, beginning teacher salary for new teachers, and a district growth measure. The educational success composite includes district percent proficiency on the ACT Aspire math and reading assessments (state assessment), district graduation rate, and average district math and reading score on the 11th grade ACT exams. All items are standardized (with mean = 0, standard deviation = 1) and a composite created in which one quarter weight is given to each - the average ACT Aspire math score, the average ACT Aspire reading score, the graduation rate, and a composite of the 11th grade ACT reading and math scores.[6] The final educational success indicator has a mean of 0.05 standard deviation units with a standard deviation of 0.71. The educational success indicator is only reported for districts with all information required to create the variable. For teacher salary, we use the district reported salary for new teachers with a Bachelor's degree and no experience.[7] The district growth measure was created to account for changes in student enrollment over a 5-year period from 2012-13 to 2016-17, relative to the first year (2012-13). Differences in enrollment between years is averaged, divided by enrollment in 2012-13, and converted to percent. The district

[6] Prior to standardizing, the mean percent proficient on the ACT Aspire math was 43%, the mean percent proficient on the ACT Aspire reading was 38%, the mean high school graduation rate was 88%, and the mean 11th grade ACT score in math and reading were both 18.

[7] Salary not reported for Arkansas School of the Blind, Arkansas School of the Deaf, Division of Youth Services Schools, Arkansas Virtual Academy, and Quest Middle School of Pine Bluff.

growth measure is expressed in equation 1. Mean district growth for the state over the five-year period was 0.69%.

$$\delta = \left\{ \frac{\sum Enrollment_{(t2\text{-}t1)} + Enrollment_{(t3\text{-}t2)} + Enrollment_{(t4\text{-}t3)} + Enrollment_{(t5\text{-}t4)}}{4} \right\} \div Enrollment_{t1} * 100 \quad (1)$$

Where,

δ represents district growth, and

t represents an enrollment year.

Analytic Sample

Overall, it appears the districts included in the sample are representative of districts statewide. In Tables 3 and 4 we compare districts that responded to the survey to those that did not. We find significant differences between districts in the sample and non-respondents for districts in the Southeast region, and marginally significant differences for rural districts. There are no significant differences found for any other district characteristics. Overall, districts included in the sample appear to be reasonably representative of districts statewide.

Table 3: Analytic Sample Equivalency (Categorical Variables)

(Categorical Variables)	**Analytic Sample**	**Non-Respondents**	**Difference**	**p-value**
Number of Districts	195	67	128	
% of All Districts (n=262)	74%	26%	49%	
District Size				
1- Small (< 1,500)	69%	67%	2%	0.766
2- Mid-size (1,500-3,500)	19%	22%	-3%	0.733
3- Large (> 3,500)	12%	10%	1%	0.930
Urbanicity (CCD Indicator)				
1- Urban	12%	10%	2%	0.877
2- Suburb	5%	9%	-4%	0.131
3- Town	23%	28%	-5%	0.245
4- Rural	57%	49%	8% *	0.091
Region				
1- NW	29%	34%	-6%	0.390
2- NE	26%	24%	2%	0.714
3- Central	19%	24%	-4%	0.445
4- SW	14%	16%	-3%	0.828
5- SE	12%	1%	10% **	0.034
Charter	8%	13%	-6%	0.735

Notes: *** p<0.01, ** p<0.05, * p<0.1. Most recent urbanicity data from NCES (2014-15) does not include seven districts included in this analysis (2016-17). Of the 7 districts, 5 are included in the analytic sample, 2 are included in non-respondents. The most recent NCES district urbanicity information from 2014-15 identifies 290 districts in the state including charter schools. There were 262 districts in the state in the 2016-17 school year. Of the 290 districts identified in 2014-15, 255 include demographic information in 2016-17 and are represented here.

Table 4: Analytic Sample Equivalency (Continuous Variables)

(Continuous Variables)	**Analytic Sample**	**Non-Respondents**	**Difference**	**p-value**
Number of Districts	195	67	128	
Number of Charter Schools	15	9	6	
Mean District Enrollment	1,943	1,468	475	0.247
% FRL	66%	63%	3%	0.187
% White	69%	71%	-3%	0.529
Educational Success Indicator (sd)	0.04	0.08	(0.04)	0.703
% District Growth (over 5 years)	0.79%	37%	-36%	0.676
Base Teacher Pay (BA, 0-yrs)	$34,058	$33,909	$149	0.740
Classroom Teachers FTE	152	114	38	0.231
Graduation Rate	88%	90%	-2%	0.273
% Proficient ACT Aspire Math	43%	43%	1%	0.742
% Proficient ACT Aspire Reading	38%	38%	0%	0.981
Mean Grade 11 ACT Math	18.03	18.28	(0.25)	0.235
Mean Grade 11 ACT Reading	18.32	18.66	(0.34)	0.219

Note: *** p<0.01, ** p<0.05, * p<0.1

Descriptive Analysis

We first examine the raw relationships between the factors of supply (applications to vacancies) and the variables of interest (district size, urbanicity, region, poverty rate, racial/ethnic diversity, educational success, beginning teacher salaries, and district growth). District size is presented in deciles of enrollment as well as a categorical variable, urbanicity and region are described by category, and the remaining variables are provided by quintile.

Multivariate Analysis

As many of the variables of interest are correlated with each other, we turn to multivariate analysis to disentangle these relationships and provide more information as to what is driving teacher supply.

Outcome Measures (Dependent Variables)

The dependent variable of interest for supply is directly derived from the district survey responses about the number of vacancies and applications for grade level and subject positions. We define teacher "supply" as the ratio of applications to vacancies, expressed in equation 2.

Y_1= Supply Ratio = reported applications/reported vacancies (2)

Often, measures of teacher supply focus on the teacher pipeline and the number of education program graduates entering the workforce. There are two issues with using this method as the primary measure of supply: 1) it tends to focus on teacher supply statewide and not at the district level; and 2) having an adequate number of new teachers statewide does not mean they are filling positions in districts that need them most, nor does having an overall inadequate state supply reflect surpluses that may still occur in more desirable districts. By examining the ratio of applications to vacancies at the district level, we get a more direct, localized, measure of teacher supply and can investigate the relationship district characteristics may have on supply.

In addition to examining overall teacher supply, we also investigate teacher supply by school level and subject area in the same way. For teacher supply by school level we use application and vacancy information for elementary (K-4), middle school (5-8), and high school (9-12) levels. For teacher supply by subject we focus on the number of applications and vacancies reported for math and science, and language arts (and social studies) subjects.

Independent Variables

There are several independent district characteristics that may influence the extent to which school districts have a greater or lesser supply of teachers than other districts, which will in turn be related to teacher shortages. Independent variables included in the regression model include: district enrollment (size), urbanicity, region, poverty rate (FRL), race/ethnicity (white), educational success indicator (composite), teacher salary (BA, 0-years), and district growth measure (5-year average). Regression analyses statistically control for any minor differences in demographic characteristics. District enrollment (by size), region, and urbanicity are categorical indicator variables.

Multivariate Regression Model

We conduct Ordinary Least Squares (OLS) regression analysis to determine the characteristics of districts associated with teacher supply. The fully specified models is defined in equation 3 below. In total, there are nine models presented for supply. Initially, simple models are run for district enrollment (using the categorical variable district size), urbanicity, and region separately without variables controlling for demographics, educational success, teacher salary, or district growth. Next, models that include both district enrollment (district size) and region are run, both with and without control variables. Finally, models including both region and urbanicity are run, with and without control variables. The same models are used for the additional school level and subject analyses.

OLS Regression Models (Supply).

$$Y_1 = \beta_0 + \beta_1\gamma + \beta_2\theta + \beta_3 X + \beta_4\varphi + \beta_5\lambda + \beta_6\delta + \varepsilon \quad (3)$$

Where,

- Y_1 represents a given outcome of interest (overall supply, supply by school level, or supply by subject area),
- γ is an indicator for district size (or urbanicity),
- θ is an indicator for region,
- X represents district demographic characteristics (FRL status, race/ethnicity),
- φ represents district educational success,
- λ represents beginning new teacher salary,
- δ represents district growth, and
- ε represents the error term.

Limitations

Limitations to the study include concerns regarding the accuracy and reliability of the self-reported responses on the superintendent survey. While some districts were likely very thoughtful and thorough in their responses regarding the number of vacancies and applications provided, it is expected many districts offered best estimates rather than exact numbers. In addition, not all surveys were fully completed. Of the 195 districts included in the sample and subsequent analyses, 11 provided incomplete surveys.

There may also be concerns regarding the inclusion of charter school responses. It could be argued that charter school districts' needs and hiring practices are different and should not be included. We would argue that charter districts are competing to attract teachers the same as traditional public school districts and that many fully licensed and certified teachers find positions in charter districts as well.[8] In addition, there are relatively few charter school districts

[8] However, licensure and certification often is not required of public charter school teachers.

included (15 of the 195).[9] In favor of being more inclusive and using as much of the data available as possible, charter schools and incomplete survey responses are kept in the sample.

Finally, this is a descriptive study with the purpose of determining the association between certain district characteristics and teacher supply in the state of Arkansas. Causal inferences cannot be determined. The findings of this study are unique to the Arkansas context for the 2016-17 school year.

[9] Additional analyses were conducted which excluded charter schools. There was no effect on the outcomes or changes in significance to the findings.

IV. Results

The purpose of this study is to test whether a uniform teacher shortage exists across the state of Arkansas. We hypothesize that, rather than a uniform shortage, teacher shortages are more likely to occur in certain regions and subjects. We further examine whether there is a surplus of elementary and English/language arts teachers as the literature indicates. We expect to find more applications for elementary than middle or high school teachers, and more English/language arts than math and science teachers.

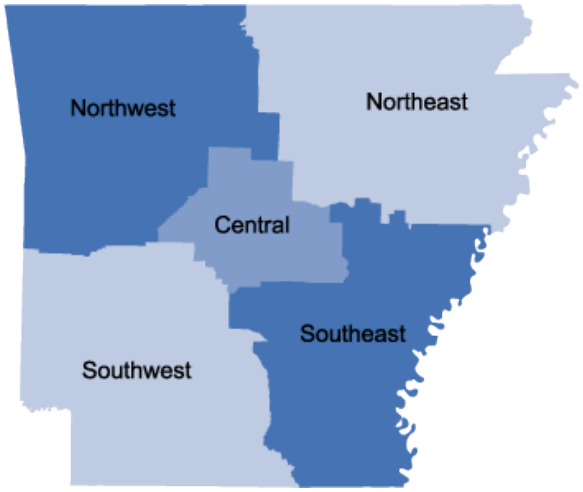
Research Question 1. What are the characteristics of districts that have the most favorable teaching supply?

Descriptive Analysis

Which district factors drive supply? When examining the characteristics of districts that might contribute to teacher supply, the literature suggests that district size, urbanicity, poverty, and racial/ethnic diversity will be factors to consider (Aragon, 2016; Dee & Goldhaber, 2017; Ingersoll, 2001; 2003; Murnane & Steele, 2007; Murphy et al., 2003). From the 2017 district survey, we define "supply" as the ratio of applications over vacancies.[10] As district size and urbanicity are strongly correlated with each other and certain regions in the state are more urban than others, we will examine these factors separately and not place them in a model simultaneously. It is also likely that schools in different regions face different levels of teacher supply due to the relative attractiveness of each region. For reference, the five education regions in the state referred to are displayed in Figure 2. Therefore, we examine the extent to which

[10] The mean unit of supply across the state is approximately 6 applicants per vacancy.

teacher supply is related to these factors as well as district poverty rate, racial/ethnic diversity, academic educational success, beginning teacher salaries, and district growth as these may also influence teacher supply. As many of these district characteristics may be related to each other (e.g. district size and teacher salary, district racial/ethnic diversity and region), we present correlations in Table 15. Initially, we present the descriptive relationships, however, any of these relationships might be confounded by other factors. Subsequently, we follow up using regression analyses to determine which consistent independent relationships remain.



(Source: Arkansas Association of Educational Administrators, 2017)

Figure 2: Education Regions of Arkansas

How is teacher supply related to district size (enrollment)? It is likely that larger districts will have more positions than smaller districts due to the fact that larger districts have more amenities and more opportunities for employment. For enrollment, we first present district enrollment by decile and then as a categorical variable using the same district size categories as those used for developing and administering the online survey. "Large" districts are defined as

those with enrollment greater than 3,500 students, "Midsize" districts are those with enrollment between 1,500 and 3,500 students, and "Small" districts are those with enrollment less than 1,500 students.

Examining district enrollment by decile in Table 5, as expected we find the largest districts, in decile 10, have the greatest teacher supply (8.0), which is nearly twice as much as any other decile. Districts with enrollments of between 900-1,000 students (decile 6) have the least teacher supply at 2.9. This means that the largest districts receive 8 applications for every vacant position while districts with 900-1,000 students get about 3 applications. Note that the mean unit of teacher supply statewide is approximately 5 applications for every vacancy. Districts in the remaining deciles have similar teacher supply ranging from 3.0-4.6, with most (60%) having fewer than 4 applications per vacancy. Figure 3 shows the relationship between the average numbers of district applications to vacancies for districts in each decile.

In addition to examining district size by enrollment decile, we also use the categorical variable for district size in Table 6 and find similar results. Here, "large" districts again have the greatest supply of teachers (7.9), almost double that of "small" districts (4.0) and more than double that of "midsize" districts (2.8). In other words, when a vacancy is posted in a large school district, there are roughly 8 applications for the position, while there are fewer than 4 applications in small districts and fewer than 3 in midsize districts. Figure 4 illustrates the relationship between the average numbers of district applications to vacancies for each type of district. While the relationship between teacher supply and district size exists in bivariate analyses, it could be confounded by the fact that large districts will be concentrated in more urban areas and those areas are concentrated in certain regions of the state. As both enrollment

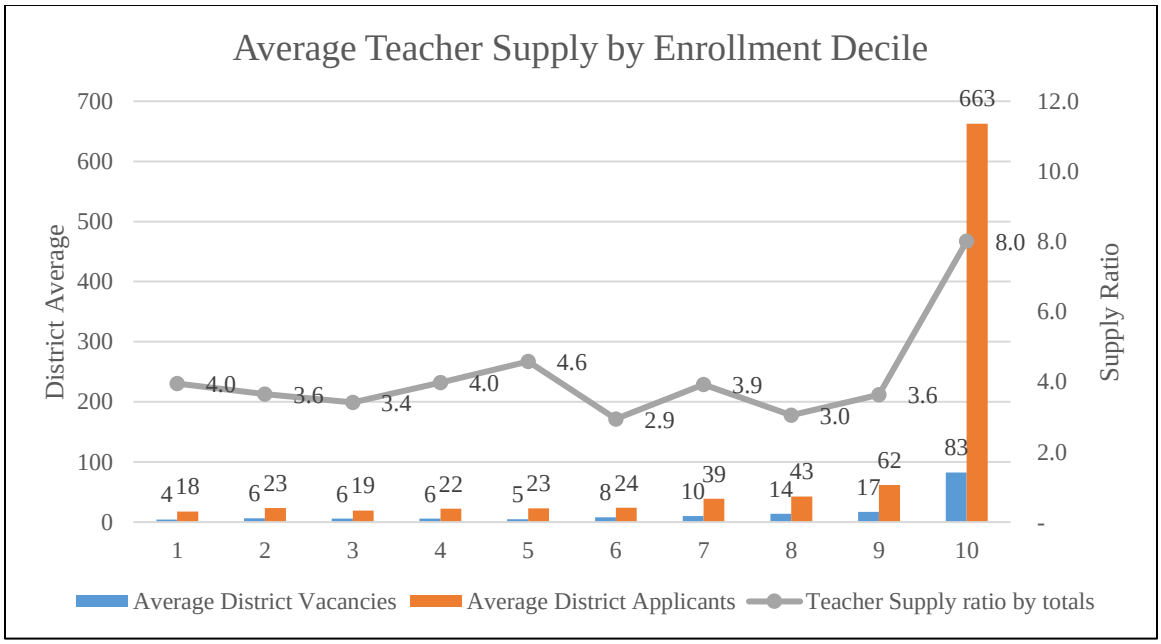
by decile and by category are similar, and enrollment does not appear to be linear, we use the categorical variable in multivariate analysis.

Table 5: Teacher Supply by Enrollment Decile[11]

Decile range		Decile	N of districts	N responses	Total Vacancies	Total Applicants	Teacher Supply ratio by totals
56-371	smallest	1	27	18	80	316	**4.0**
384-487		2	26	17	108	394	**3.6**
493-599		3	26	21	119	406	**3.4**
614-779		4	26	17	96	382	**4.0**
781-905		5	26	20	100	458	**4.6**
908-1,180		6	27	15	122	359	**2.9**
1,188-1,567		7	26	23	229	898	**3.9**
1,583-2,111		8	26	19	267	814	**3.0**
2,248-3,693		9	26	16	272	989	**3.6**
3,829-22,759	largest	10	26	18	1,489	11,930	**8.0**
		Total	262	184	2,882	16,946	**5.9**

Note: Mean enrollment for 2016-17 = 1,821

[11] Survey response rates for deciles 1, 4, 6, and 9 were between 56-67%, while at least 73% of districts in the remaining deciles provided information on the survey for this factor.



Note: Decile 1 = Smallest, Decile 10 = Largest

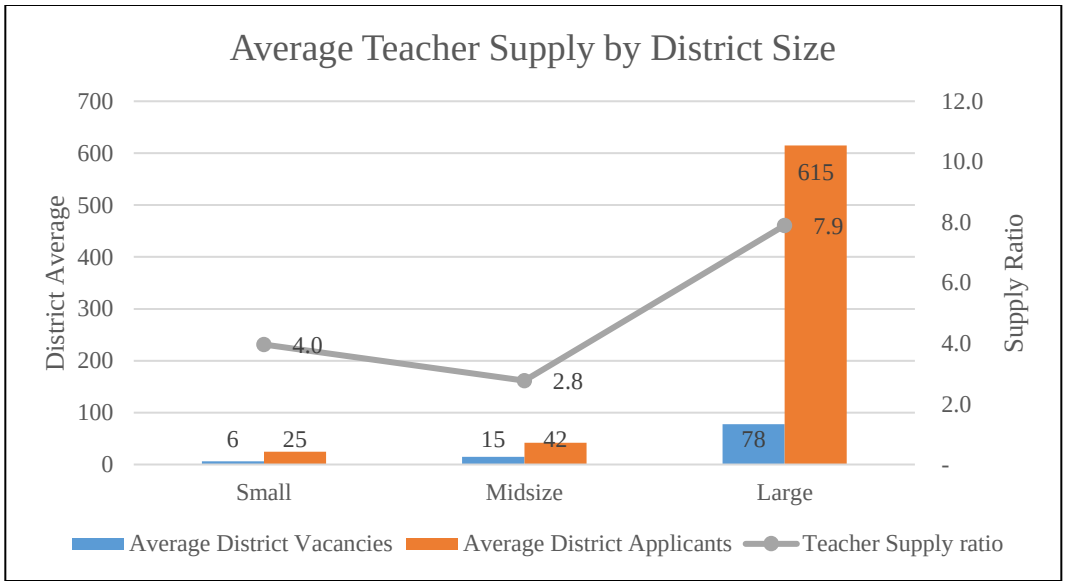
Figure 3: Average Teacher Supply by Enrollment Decile

Table 6: Teacher Supply by District Size[12]

Size range	District Size	Type	N of districts	N of responses	Total Vacancies	Total Applicants	Teacher Supply ratio
< 1,500	Small	1	181	128	793	3,145	**4.0**
1,500-3,500	Midsize	2	51	36	541	1,499	**2.8**
> 3,500	Large	3	30	20	1,557	12,302	**7.9**
	Total		262	184	2,891	16,946	**5.9**

Note: Mean Enrollment 2016-17 = 1,821

[12] Sixty seven percent of large districts and more than 70% of small and midsize districts provided information on the survey for this factor.



Note: Small district is <1,500, Midsize is 1,500-3,500, Large is >3,500

Figure 4: Average Teacher Supply by District Size

How is teacher supply related to urbanicity? The urbanicity of a district may also influence teacher supply (Aragon, 2016; Dee & Goldhaber, 2017; Ingersoll, 2001; 2002; 2003; Malatras et al., 2017; Murphy et al., 2003; Will, 2016). More urban districts will be able to attract more teachers as more people want to live in urban areas that offer more attractions and activities. In addition, there are more educator preparation programs offered in and around the urban areas of the state.

Urbanicity is another way to consider and measure district size, as it is related to the population of a particular area. Using the NCES (2017b) urban-locale framework[13], there are four basic urbanicity designations for school districts: "City", "Suburb", "Town", and "Rural". A "City" is defined as an urban area with a population of around 100,000 or more. Fayetteville

[13] The most recent NCES district urbanicity information from 2014-15 identifies 290 districts in the state including charter schools (NCES 2017a). There were 262 districts in the state in the 2016-17 school year.

School District would be an example of a district designated as “City”, as would the capital city of Little Rock. A “Suburb” is outside a city but still within an urban area. An example of a district designated as “Suburb” would include Farmington School District. A “Town” is approximately 10-35 miles from a city/suburb, and Mountain Home School District would be an example of a “Town” district. “Rural” is considered at least five miles from a city/suburb and approximately 10 miles from a town. An example of a “Rural” district would include West Fork School District.

In Table 7, as expected, city districts have the largest supply of teachers (8.3), more than double that of districts in towns (3.8) and almost double that of rural districts (4.0). That is to say, for every vacancy in city school districts, there are an average of approximately 8 applications for the position, while there are fewer than 4 applications in town and rural districts. Figure 5 illustrates the relationship between average district vacancies and applications by urbanicity. While this simple analysis points to a relationship between urbanicity and teacher supply, it is certainly correlated with the fact that the majority of rural districts (74%) are small districts, and most of the rural and small districts are concentrated in the Northwest region.

Table 7: Teacher Supply by Urbanicity[14]

NCES Urban-Locale Designation	Type	N of districts	N of responses	Total Vacancies	Total Applicants	Teacher Supply ratio
City	1	36	23	985	8,171	**8.3**
Suburb	2	20	10	287	1,771	**6.2**
Town	3	75	42	675	2,550	**3.8**
Rural	4	159	104	632	2,542	**4.0**
	Total	290	179	2,579	15,034	**5.8**

Note: The most recent NCES district urbanicity information from 2014-15 identifies 290 districts in the state including charter schools (NCES 2017a). There were 262 districts in the state in the 2016-17 school year.

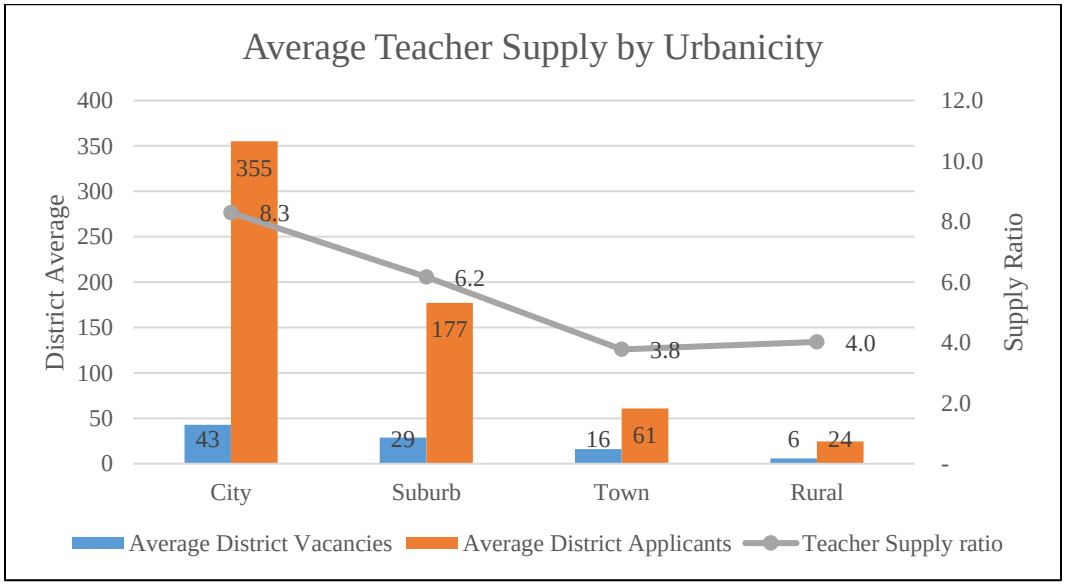


Figure 5: Average Teacher Supply by Urbanicity

[14] More than 64% of city and rural districts, and more than 50% of suburban and town districts provided information on the survey for this factor.

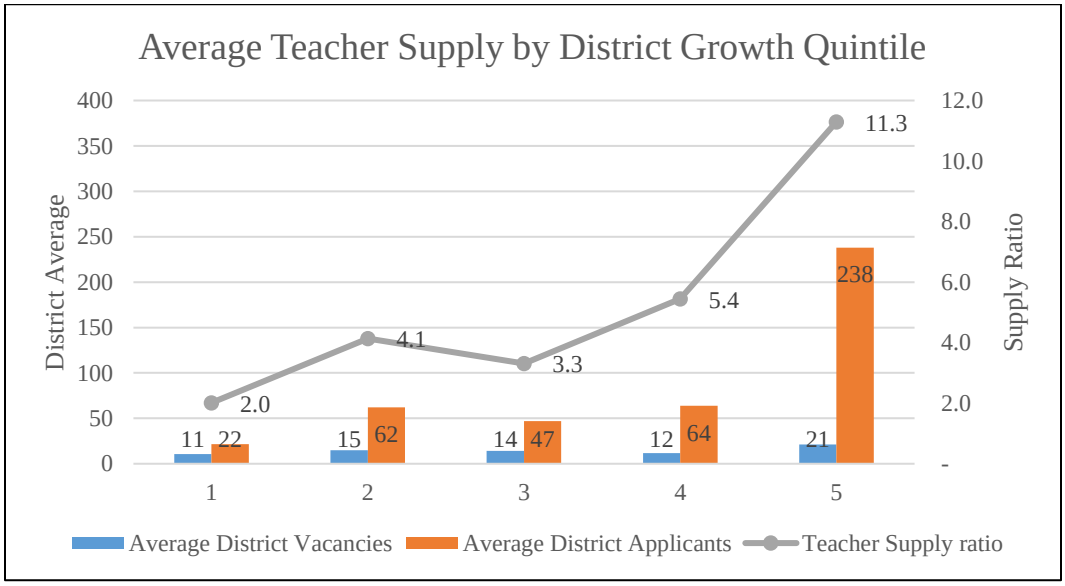
How is teacher supply related to district growth? It is reasonable to assume that increases or decreases in student enrollment in a district over time will influence the number of vacancies a district has (Lindsay et al., 2016; Murnane & Steele, 2007; Murphy et al., 2003). It may also be an indicator as to the desirability of a particular region. One would expect that districts with more growth would have more vacancies and, thus, more applications. In contrast, districts with decreasing student enrollments would have fewer vacancies and likely fewer applications. It is not clear, therefore, whether the supply should go up or down related to growth. To evaluate this, a district growth measure was created to account for changes in student enrollment over a 5-year period from 2012-13 to 2016-17, relative to the first year (2012-13).

Looking at the quintiles of district growth in Table 8,wefind that districts with the most positive growth (quintile 5 at 11.3) had five times more teacher supply than districts with the most negative growth (quintile 1 at 2.0). In other words, districts with the most growth saw an average of 11 applications for each advertised vacancy. Meanwhile, districts with the greatest decreases in enrollment saw an average of 2 applications per vacant position. Figure 6 illustrates the relationship between average district vacancies and applications by district growth.

Table 8: Teacher Supply by District Growth (5-year) Quintile[15]

Quintile range		Quintile	N of districts	N of responses	Total Vacancies	Total Applicants	Teacher Supply ratio
(-7.3) - (-1.84)	most -	1	50	39	420	846	**2.0**
(-1.81) - (-0.63)		2	50	33	495	2,047	**4.1**
(-0.61) - 0.302		3	50	40	568	1,883	**3.3**
0.309 - 1.48		4	50	30	351	1,911	**5.4**
1.49 - 79.8	most +	5	50	35	737	8,323	**11.3**
		Total	250	177	2,571	15,010	**5.8**

Notes: Mean District Growth 2012-13 to 2016-17 = 0.69%. Average growth over five years relative to the first year, 2012-13.

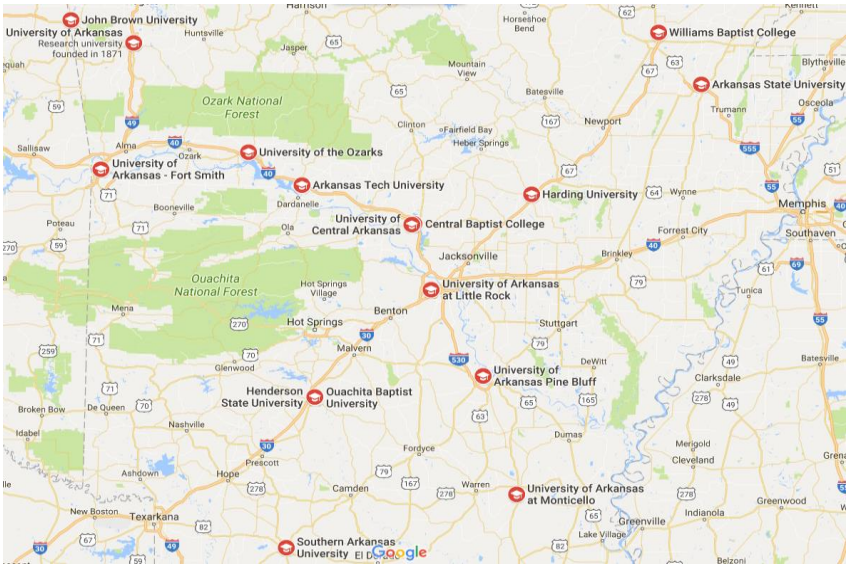


Note: Quintile 1 = Least growth, Quintile 5 = Most growth.

Figure 6: Average Teacher Supply by District Growth (5-year) Quintile

[15] More than 60% of districts in quintiles 2 and 4, and at least 70% of districts in the remaining quintiles provided information on the survey for this factor.

How does teacher supply vary by region? Different regions of the state may be more attractive or may have more opportunities available for teachers looking for positions, which may influence the number of applications. Additionally, the literature suggests that many teachers find positions close to home and/or in proximity to their training institutions (Barnett & Blankenship, 2005; Boyd et al., 2005; Goldhaber et al., 2014; Krieg et al., 2016). Therefore, it is likely that there would be increased teacher supply (driven by more applicants) in the Northwest region, as that is where the state's flagship university is located, and in the Central region, as there is a concentration of teacher education institutions located there. Figure 7 illustrates the concentration of teacher preparation institutions in these areas of Arkansas.



(Source: Google, 2017)

Figure 7: Arkansas Teacher Preparation Programs

In Table 9, as hypothesized, we find that districts in the Northwest have the greatest supply of teachers (10.1), far more than any other region. However, districts in the Central region (4.5) do not share the same teacher supply advantage. Districts in the Southeast (1.4) and the Southwest (2.5) have the lowest teacher supply. Districts in the Northeast have supply similar to the state average (5.9). In other words, for a vacancy posted in Northwest school districts, there are an average of 10 applications for the position, while there are fewer than 2 applications in districts in the Southeast and fewer than 3 in Southwest districts. Figure 8 illustrates the relationship between average district vacancies and applications by region. While there appears to be a relationship between region and teacher supply, it is not consistent and may be correlated with the fact that the Northwest and Central regions are the most urban areas with 73% of large districts located there.

Table 9: Teacher Supply by Region[16]

Region	Type	N of districts	N of responses	Total Vacancies	Total Applicants	Teacher Supply ratio
NW	1	79	55	796	8,079	**10.1**
NE	2	67	48	519	3,048	**5.9**
Central	3	54	33	1,080	4,887	**4.5**
SW	4	38	25	212	522	**2.5**
SE	5	24	23	284	410	**1.4**
	Total	262	184	2,891	16,946	**5.9**

[16] More than 70% of districts in the Northeast, Central, and Southeast, and more than 61% of districts in the Northwest and Southwest provided information on the survey for this factor.

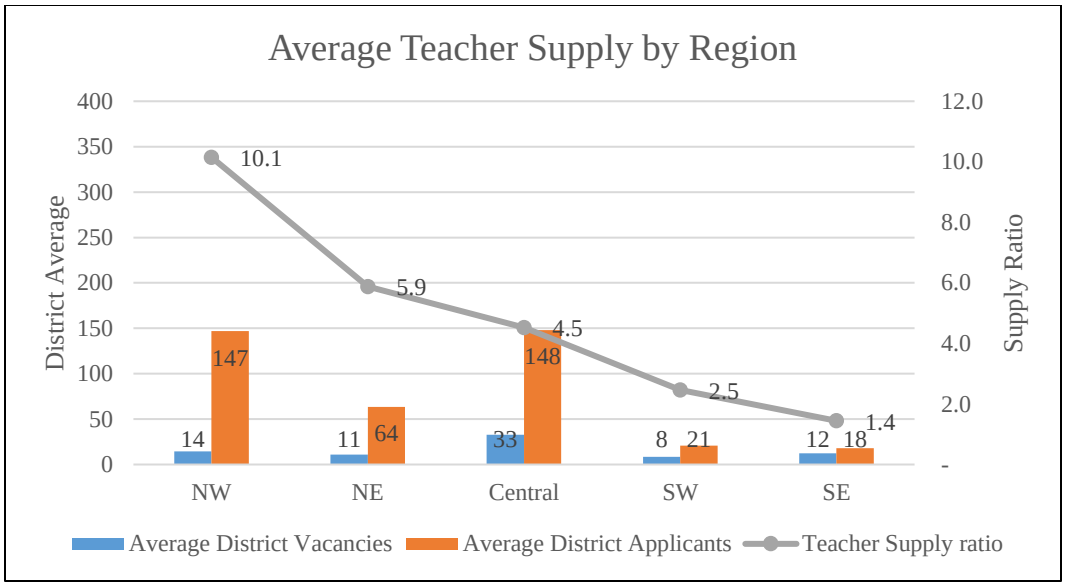


Figure 8: Average Teacher Supply by Region

How is teacher supply related to district poverty rate? The literature shows that highly disadvantaged schools and districts (i.e. more poor, more minority) often have more vacancies and new teachers due to difficulties in attracting and retaining teachers (Aragon, 2016; Dee & Goldhaber, 2017; Ingersoll, 2001; 2003; Malatras et al., 2017; Murnane & Steele, 2007; Murphy et al., 2003). As such, one would expect that districts with lower poverty rates would have greater teacher supply due to the increased number of applicants wanting to teach in these districts. Put plainly, more people would prefer to work in more affluent areas than in poor areas.

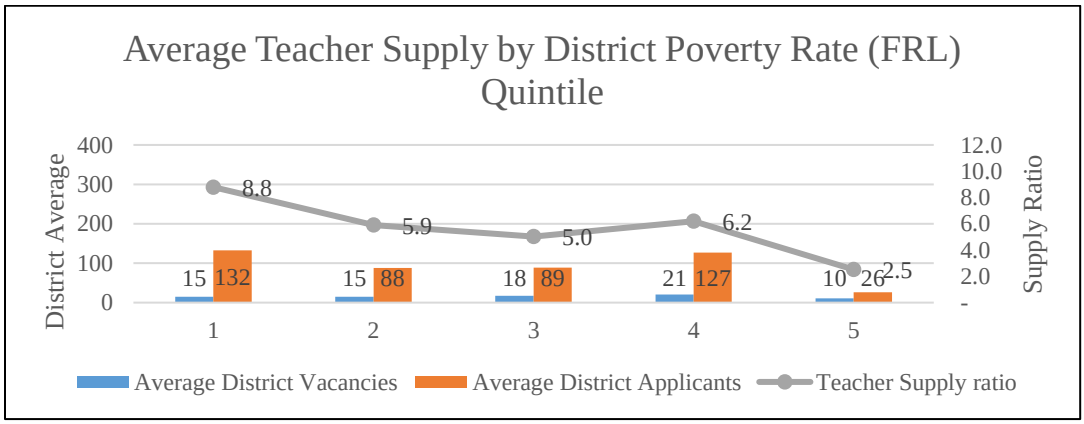
District poverty rate is based on the federal free and reduced price lunch status and is reported by quintile in Table 10. As anticipated, we find that districts with the highest percentage of FRL students (the poorest) have the lowest teacher supply (2.5) while the least poor districts have the highest teacher supply (8.8). This means that the wealthiest districts have

nearly 9 applications per vacant position while the poorest districts have between 2 and 3 applications per vacancy. Figure 9 illustrates the relationship between average district vacancies and applications by poverty quintile. While the initial analysis indicates a relationship between district poverty level and teacher supply, high poverty is often associated with very urban or very rural areas.

Table 10: Teacher Supply by District Poverty Rate (FRL) Quintile[17]

Quintile range		Quintile	N of districts	N of responses	Total Vacancies	Total Applicants	Teacher Supply ratio
0-0.54	least poor	1	56	36	542	4,763	**8.8**
0.55-0.64		2	52	35	521	3,077	**5.9**
0.64-0.71		3	51	37	652	3,276	**5.0**
0.72-0.76		4	53	38	781	4,833	**6.2**
0.77-1	most poor	5	49	37	388	976	**2.5**
		Total	261	183	2,884	16,925	**5.9**

Note: Mean %FRL 2016-17 = 65%. Poverty rate for Northwest Classical Academy not reported.



Note: Quintile 1 = Least poor, Quintile 5 = Most poor

Figure 9: Average Teacher Supply by District Poverty Rate (FRL) Quintile

[17] More than 64% of districts in quintiles 1 and 2, and at least 72% of districts in the remaining quintiles provided information on the survey for this factor.

How is teacher supply related to district racial/ethnic diversity? Highly disadvantaged schools and districts not only have higher poverty rates but also tend to have higher percentages of minority students (Aragon, 2016; Dee & Goldhaber, 2017; Loeb & Reininger, 2004; Murnane & Steele, 2007; Murphy et al., 2003). As with poverty, it is probable that there would be greater teacher supply in districts with less racial/ethnic diversity. That is, more diverse districts will have fewer applicants. However, in Arkansas, there is an interesting dynamic where some of the poorest districts in rural areas serve nearly all white students. Thus, the relationship in this case is unclear.

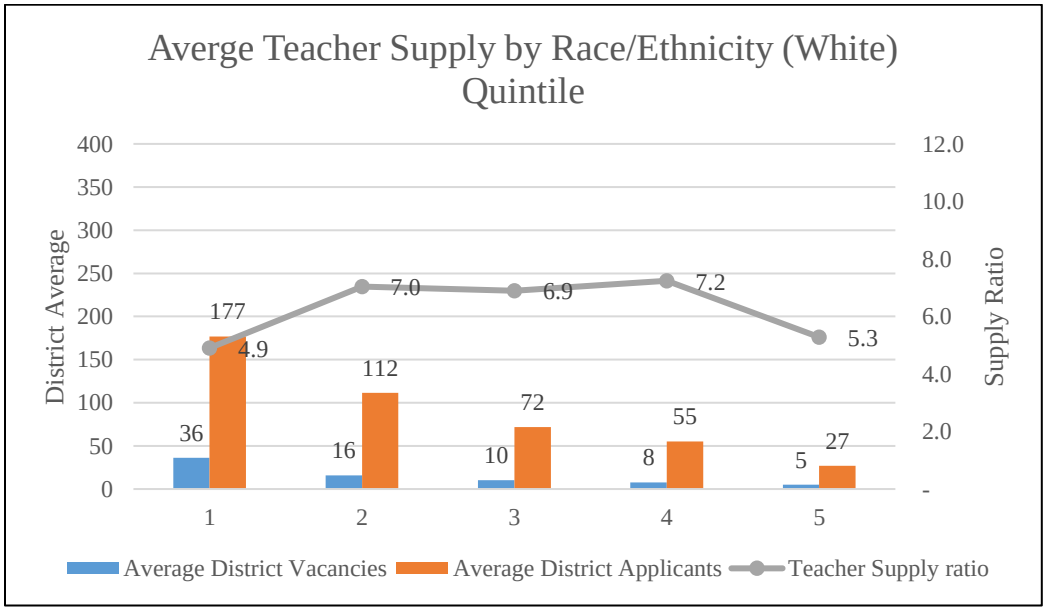
Using the percent of white students in a district as a measure of diversity,[18] presented in quintiles, in Table 11,wefind that districts with the lowest percentage of white students (quintile 1) have the lowest teacher supply (4.9), however, districts with the highest percentage of white students (quintile 5) have similar teacher supply (5.3). In other words, the least white districts and the whitest districts both have approximately 5 applications for each vacant position. Figure 10 illustrates the relationship between average district vacancies and applications by white quintile. Further analysis indicates that both the whitest and least white districts are also among the smallest districts in the state. [19] Additionally, we find that the largest districts in the Northwest are also the whitest. These reasons likely contribute to the similar rates of teacher supply. Moreover, some of the urban districts in central Arkansas have relatively high levels of teacher supply and serve large percentages of minority students.

[18] Further examination of teacher supply by the district percentage of Hispanic and black students is presented in Appendix A. Teacher supply is greatest in districts that are more than 10% Hispanic (even when excluding districts in the Northwest region), and in districts that are 0.01-0.10% black.
[19] A table summarizing the race/ethnicity (white) quintiles by small districts is included in Appendix B.

Table 11: Teacher Supply by District Race/Ethnicity (White) Quintile[20]

Quintile range		Quintile	N of districts	N of responses	Total Vacancies	Total Applicants	Teacher Supply ratio
0-0.44	least white	1	54	41	1,479	7,254	**4.9**
0.47-0.71		2	53	36	571	4,018	**7.0**
0.72-0.87		3	51	35	365	2,517	**6.9**
0.88-0.93		4	60	43	328	2,375	**7.2**
0.94-0.98	most white	5	44	29	148	782	**5.3**
		Total	262	184	2,891	16,946	**5.9**

Note: Mean %White 2016-17 = 70%



Note: Quintile 1 = Least White, Quintile 5 = Most White

Figure 10: Average Teacher Supply by District Race/Ethnicity (White) Quintile

[20] More than 66% of districts in quintiles 2, 3, and 5, and more than 72% of districts in quintiles 1 and 4 provided information on the survey for this factor.

How is teacher supply related to district educational success? As teachers seek vacant positions, it is possible they may look to apply to higher achieving schools and districts assuming higher achieving students would be easier to teach (Aragon, 2016; Hanushek et al., 2004; Loeb & Reininger, 2004). However, it is also possible that student achievement may be higher in districts with a steady supply or surplus of teachers. While we cannot determine the particulars or the direction of the relationship, we can look at the association between district student educational success and teacher supply.

To examine how teacher supply might be related to educational success, we created a district educational success indicator that includes district percent proficiency on the ACT Aspire math and reading assessments (state assessment), district graduation rate, and district average math and reading score on the 11th grade ACT exams. All items were standardized and a composite created in which one quarter weight was given to each of the average ACT Aspire math score, ACT Aspire reading score, graduation rate, and composite of the 11th grade ACT reading and math scores.[21] The final composite has a mean of 0.05 standard deviation units with a standard deviation of 0.71. Using this measure, we examine the extent to which the "overall success" of a district (based on student achievement and graduation rate) is related to teacher supply.

In Table 12, we find the relationship does not appear to be perfectly linear. Districts with the highest educational success (quintile 5 at 10.0) have almost four times more teacher supply

[21] Prior to standardizing, the mean percent proficient on the ACT Aspire math was 43%, the mean percent proficient on the ACT Aspire reading was 38%, the mean high school graduation rate was 88%, and the mean 11th grade ACT score in math and reading were both 18.

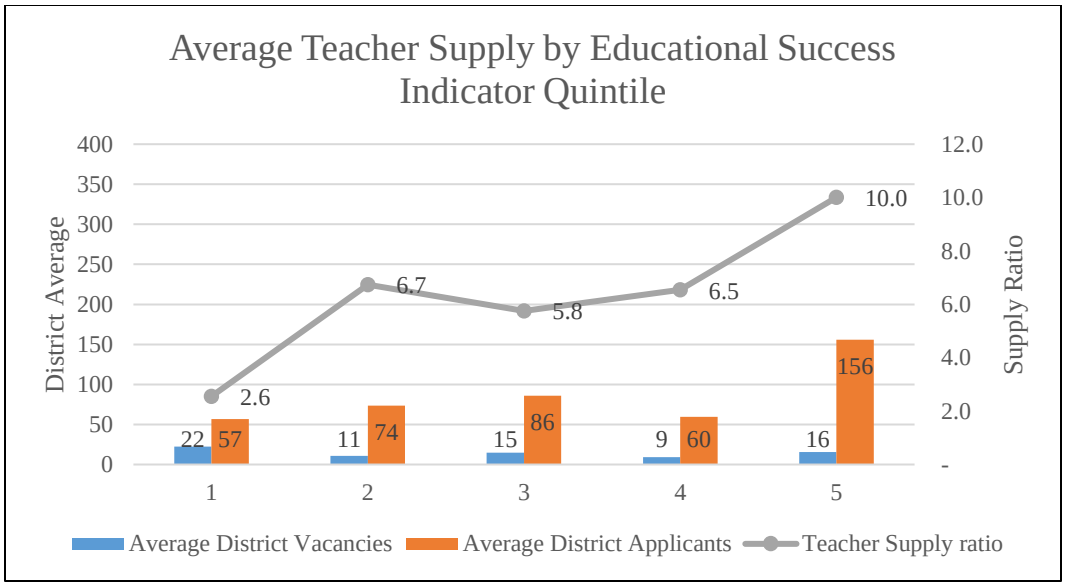
than districts with the lowest educational success (quintile 1 at 2.6). That is to say, for every vacant position in the highest achieving districts, there are an average of nearly 10 applications for the position, while there are fewer than 3 applications per position in the lowest achieving districts. Figure 11 illustrates the relationship between average district vacancies and applications by educational success. While there appears to be a relationship between educational success and teacher supply, educational success is also often related to socioeconomic advantage and urbanicity.

Table 12: Teacher Supply by District Educational Success Indicator Quintile[22]

Quintile range		Quintile	N of districts	N of responses	Total Vacancies	Total Applicants	Teacher Supply ratio
(-2.5) - (-0.47)	lowest	1	49	35	779	1,991	**2.6**
(-0.45)- (-0.07)		2	49	36	393	2,648	**6.7**
(-0.06) - 0.254		3	48	31	463	2,667	**5.8**
0.257 - 0.542		4	49	34	310	2,028	**6.5**
0.548 - 3.5	highest	5	48	36	560	5,604	**10.0**
		Total	243	172	2,505	14,938	**6.0**

Notes: Mean for 2016-17 = 0.05 SD. Educational Success = (0.25) ACT Aspire Math + (0.25) ACT Aspire Reading + (0.25) Grad rate + (0.25) Gr.11 ACT Math-Reading Composite. Total number of districts reflects those with all the data required to create an Educational Success Indicator (composite). Districts missing graduation rate or assessments are not included.

[22] More than 65% of districts in quintiles 3 and 4, and at least 71% of districts in the remaining quintiles provided information on the survey for this factor.



Note: Quintile 1 = Lowest, Quintile 5 = Highest

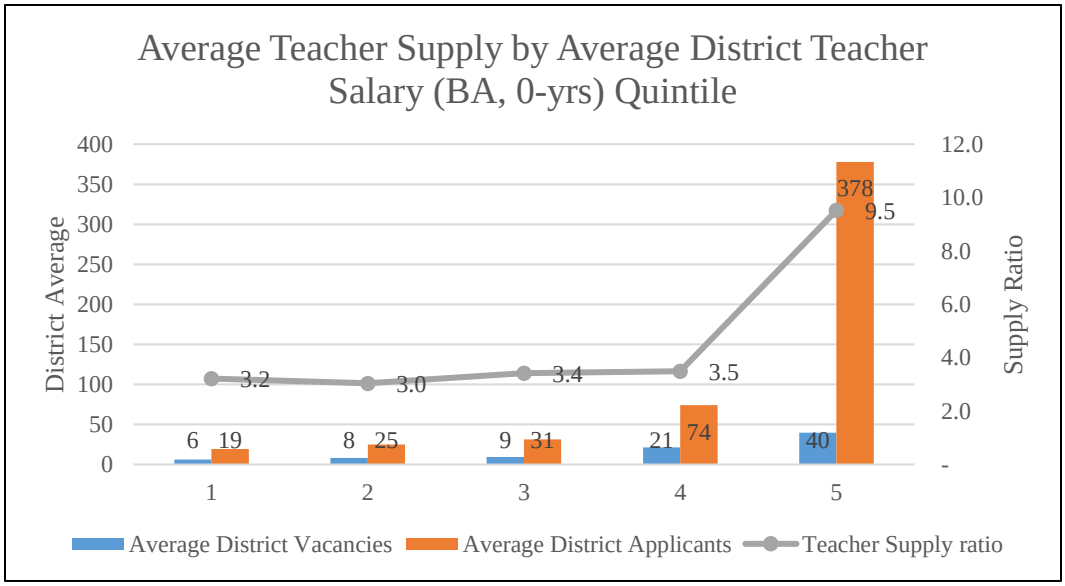
Figure 11: Average Teacher Supply by District Educational Success Indicator Quintile

How is teacher supply related to salary offered to new teachers? Variation in teacher salaries among districts may also influence teacher supply, with higher paying districts attracting more applicants (Hanushek et al., 2004; Loeb & Reininger, 2004). As such, one would expect the highest paying districts to have the greatest teacher supply. Looking at beginning teacher salary (Bachelor's degree with no experience) by quintile in Table 13, as expected, districts with the highest teacher salary have by far the greatest teacher supply. In fact, quintile 5 (the highest at 9.5) has almost three times more teacher supply than the remaining quintiles (between 3.0 – 3.5). This means that the highest paying districts have between 9 and 10 applications per vacant position on average while districts in the remaining quintiles have about 3 applications per vacancy. Figure 12 illustrates the relationship between average district vacancies and applications by beginning teacher salary.

Table 13: Teacher Supply by Average District Teacher Salary (BA, 0-years) Quintile[23]

Quintile range		Quintile	N of districts	N of responses	Total Vacancies	Total Applicants	Teacher Supply ratio
$29,000 - 31,400	lowest	1	52	36	216	695	**3.2**
31,440 - 32,250		2	51	34	277	843	**3.0**
32,305 - 33,508		3	52	30	275	941	**3.4**
33,774 - 36,832		4	51	36	763	2,663	**3.5**
36,886 - 47,016	highest	5	51	30	1,191	11,337	**9.5**
		Total	257	166	2,722	16,479	**6.1**

Notes: Mean Teacher Salary (BA, 0yrs) 2016-17 = $34,020. Salary not reported for Arkansas School of the Blind, Arkansas School of the Deaf, Division of Youth Services Schools, Arkansas Virtual Academy, and Quest Middle School of Pine Bluff.



Note: Quintile 1 = Lowest salary, Quintile 5 = Highest salary

Figure 12: Average Teacher Supply by District Average Teacher Salary (BA, 0-years) Quintile

[23] More than 71% of districts in quintile 4 and between 58-69% of districts in the remaining quintiles provided information on the survey for this factor.

To recap the descriptive relationships thus far, we categorize districts as those with the least favorable teaching supply (supply ratio less than 1.5), average teaching supply (ratio between 1.5 and 7.0), or most favorable teaching supply (ratio greater than 7.0).[24] In Table 14 below, we find 26% of districts in the sample represented in the least favorable teaching supply category. Relative to the state, over-represented in the least favorable category are small districts with student enrollments of less than 1,500, districts in towns, districts in the Central and Southeast regions, poorer districts, more racially diverse districts, the lowest achieving districts, and districts with the most growth. In the most favorable teaching supply category, we find 25% of districts in the sample represented. Relative to the state, it appears large districts with enrollments greater than 3,500, urban and suburban districts, districts in the Northwest, wealthier districts, whiter districts, the highest achieving districts, higher paying districts, and districts with the least growth are over-represented in the most favorable category. As many of these factors are related to each other we turn to multivariate analysis to disentangle these relationships.

[24] Categories determined by percentile ranking with 1.5 at the 25th percentile and 7.0 at the 75th percentile.

Table 14: Summary of Teacher Supply Indicators

Indicators	Least Favorable Teacher Supply (<1.5)	Average Teacher Supply	Most Favorable Teacher Supply (>7)	Sample Total	State Total
N of Districts	48	89	46	183	262
% of Sample	26%	49%	25%	100%	
Supply Range	0 - 1.45	1.5 - 6.8	7 - 42.4	0 - 42.4	
Mean Supply	0.55	3.37	13.28	5.7	
District Size					
% Small (< 1,500)	69%	74%	61%	69%	68%
% Midsize (1,500 - 3,500)	21%	19%	15%	19%	20%
% Large (> 3,500)	10%	7%	24%	12%	11%
Urbanicity					
% City	13%	11%	15%	13%	14%
% Suburb	4%	3%	11%	5%	8%
% Town	31%	18%	22%	22%	29%
% Rural	52%	64%	48%	57%	61%
Region					
% NW	15%	24%	54%	29%	30%
% NE	25%	26%	24%	25%	26%
% Central	25%	21%	11%	20%	21%
% SW	13%	18%	9%	14%	15%
% SE	23%	11%	2%	12%	9%
Mean Enrollment	1,487	1,608	3,184	1,972	1,822
Mean % FRL	71%	67%	61%	66%	65%
Mean % White	58%	70%	76%	68%	70%
Mean Educational Success (sd)	-0.30	0.04	0.37	0.03	0.05
Mean Beginning Teacher Salary (BA, 0-yrs)	$33,903	$33,374	$35,666	$34,092	$34,020
Mean % District Growth	1.00%	0.92%	0.47%	0.83%	0.69%

Notes: Supply categories determined by percentile ranking with 1.5 at the 25th percentile and 7.0 at the 75th percentile. Sample Total includes all districts with supply ratios (with both application and vacancy information). Educational success Indicator is in standard deviation units.

Multivariate Analysis

What is driving teacher supply? Based on the descriptive analyses presented above and correlations in Table 15 below, it appears teacher supply is likely predicted by district size, urbanicity, district poverty level, and district racial/ethnic diversity. We find that district enrollment, educational success, new teacher starting salary, percent white and district size are significantly positively correlated with supply while poverty level is significantly negatively correlated with supply. Urbanicity is significantly correlated with many factors including the components of supply (significantly negatively correlated with applications and vacancies) but not directly with supply.[25] District growth does not appear to be correlated with any other factors.

To unpack these effects multivariate analysis is needed. Multivariate models will be able to provide more information as to what is driving teacher supply. Highly correlated variables will impact regression models which include both, and make it difficult to determine impacts separately. To avoid such issues of multicollinearity, urbanicity and district size will be included in separate models as they are likely driving the same variation. Enrollment and region are somewhat related, but there is enough variation in enrollment within regions that we will include both variables in the same models. Therefore, several models will be presented and discussed.

[25] Urbanicity is included in the correlation matrix as it is a more ordinal than categorical variable.

Table 15: Correlations: Variables Associated with Supply

	Supply	Total Vacancies	Total Applicants	Enrollment	District Growth	Achievement	Tsalary Ba0Yrs	FRL	White	District Size	Urbanicity
Supply	1										
Total Vacancies	0.06	1									
Total Applicants	0.51***	0.77***	1								
Enrollment	0.29***	0.73***	0.73***	1							
District Growth	0.01	0.03	0.01	0.01	1						
Educational Success	0.31***	-0.03	0.16**	0.11*	0.28***	1					
Tsalary Ba0Yrs	0.36***	0.43***	0.55***	0.61***	0.23***	0.25***	1				
FRL	-0.30***	-0.02	-0.15**	-0.19***	-0.23***	-0.66***	-0.44***	1			
White	0.14*	-0.29***	-0.15**	-0.18***	0.01	0.62***	-0.19***	-0.39***	1		
District Size	0.16*	0.63*	0.50*	0.82*	0.21*	0.13	0.58*	-0.32*	-0.31*	1	
Urbanicity	-0.12	-0.54*	-0.38*	-0.66*	-0.04	0.13	-0.49*	0.06	-0.47*	0.48***	1

Note: *** p<0.01, ** p<0.05, * p<0.1

Multivariate Regression Models

There are three types of multivariate regression analysis models presented in Table 16: 1) separate models for district enrollment (using the categorical variable district size), urbanicity and region, without variables controlling for demographics, educational success, teacher salary, or district growth; 2) models with both district enrollment (district size) and region, with and without control variables; and 3) models with both region and urbanicity, with and without control variables. Results for nine regression models in total are presented.

Results of Multivariate Regression

The descriptive data suggests the main drivers of teacher supply are district enrollment (using the categorical variable), urbanicity, and region. In Table 16, we examine separately simple models for each (models 1-3). The first three individual models confirm the descriptive results.[26] Model 1 examines the association between teacher supply and district enrollment (by size) and shows that large districts receive roughly 6 more applications than small districts and 5 more applications than midsize districts. Model 2 looks at the relationship between teacher supply and urbanicity. Results indicate that suburban districts are more advantaged, receiving about 6 more applications than rural districts, 2 more applications than city districts, and 4 more

[26] The descriptive supply (and need) ratios are based on weighted averages for each group while the simple regressions are based on unweighted averages (treat districts in an unweighted way). Therefore, the descriptive ratios and simple regression coefficients show slightly different relationships. See Appendix C for an example of the descriptive and regression supply comparisons.

applications than town districts.[27] Model 3 focuses on teacher supply and region and reveals that districts in all regions receive fewer applications than districts in the Northwest. In fact, districts in the Southeast receive the fewest applications with 6 fewer than districts in the Northwest, 2 fewer than those in the Southwest and Central regions, and 3 fewer applications than districts in the Northeast.[28] Standing alone, the individual models confirm what we find in the descriptive relationships.

As a reminder, enrollment and urbanicity are highly correlated and as both are measures of district size, we do not include them in models together. The remaining six models combine region with each measure of district size; models 4-6 include enrollment and region, models 7-9 include region and urbanicity. When either measure of district size (enrollment or urbanicity) and region are included in models together, it appears the influence of district size persists. In models 4 and 7, while the coefficients change slightly the relationships do not. In model 4, large districts continue to have a supply advantage. In model 7, suburbs have the best advantage followed by city and town districts. In both models, the supply disadvantage in the Northeast no longer matters, dependent on district size.

[27] There are 20 districts identified as suburban statewide, only 10 of those are included in the analyses.
[28] The variation in teacher supply by region is presented in Appendix D.

Table 16: Predictors of Supply

VARIABLES	(1) Enrollment (Categorical)	(2) Urbanicity	(3) Region	(4) Enrollment & Region (no controls)	(5) Enrollment & Region (w/demo controls)	(6) Enrollment & Region (w/all controls)	(7) Region & Urbanicity (no controls)	(8) Region & Urbanicity (w/demo controls)	(9) Region & Urbanicity (w/all controls)
Midsize districts (1,500-3,500)	0.900			0.921	-0.294	-0.367			
	(1.119)			(1.056)	(1.043)	(1.263)			
Large districts (> 3,500)	5.674**			6.574***	5.505***	4.631*			
	(2.319)			(2.366)	(2.054)	(2.368)			
City (urbanicity 1)		3.284					5.122*	6.969**	8.188**
		(2.218)					(2.640)	(2.973)	(3.534)
Suburb (urbanicity 2)		5.798**					6.342**	5.572**	5.736**
		(2.711)					(2.804)	(2.767)	(2.881)
Town (urbanicity 3)		1.347					1.825*	2.269*	2.026
		(1.078)					(1.082)	(1.274)	(1.351)
NE (Region 2)			-2.447*	-1.946	-1.435	-0.843	-1.634	-1.250	-0.672
			(1.416)	(1.327)	(1.262)	(1.297)	(1.333)	(1.275)	(1.273)
Central (Region 3)			-4.577***	-5.863***	-6.313***	-5.388***	-6.144***	-6.131***	-4.780***
			(1.191)	(1.261)	(1.448)	(1.610)	(1.789)	(1.780)	(1.726)
SW (Region 4)			-4.018***	-3.440***	-2.905**	-2.179*	-2.904**	-1.892	-1.321
			(1.260)	(1.195)	(1.162)	(1.259)	(1.140)	(1.202)	(1.291)
SE (Region 5)			-5.884***	-5.086***	-4.408***	-3.738***	-5.120***	-3.329***	-2.755**
			(1.206)	(1.091)	(1.065)	(1.023)	(1.124)	(1.239)	(1.211)
District %FRL					-10.99***	-7.440		-6.474	-3.234
					(4.200)	(6.765)		(4.604)	(6.364)
District %White					-1.866	-1.994		2.810	0.967
					(1.655)	(2.519)		(2.493)	(2.667)
Educational Success						1.226			1.928*
						0.166			0.102
Teacher Salary BA, 0-yrs (in $1,000s)						(0.202)			(0.201)
						0.166			0.102
District Growth						(0.202)			(0.201)
						(0.203)			(0.179)
Constant	4.277***	3.999***	7.916***	6.908***	15.65***	7.203	6.240***	7.881	3.088
	(0.393)	(0.346)	(0.986)	(0.803)	(4.021)	(8.750)	(0.809)	(4.966)	(8.672)
Observations	183	178	183	183	182	165	178	177	165
R-squared	0.089	0.069	0.116	0.222	0.271	0.295	0.202	0.258	0.328

Notes: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; Constant: Small districts, NW = Region 1, Rural. Mean unit of supply = 5.12 (equivalent to 5 applicants per vacancy).

Models where measures of district size (enrollment or urbanicity) are combined with region are preferred. It appears that region and district size matter separately and when combined in models together the results change somewhat but the relationships are not undermined. Adding region and measures of district size in models together adds more variation, provides better estimates, and increases significance.

In models 5 and 8, we examine the extent to which including student characteristics such as race and poverty in the combined models influence the estimates. In these models, again the coefficients change somewhat but the relationships do not. However, we find that poverty matters more when using enrollment rather than urbanicity, and the supply disadvantage in the Southwest no longer matters in the model using urbanicity. While we find the coefficient on poverty is in the predicted direction in both models, it is not consistently significant. Race does not appear to matter in either model. It may be that controlling for region also controls for race as the racial compositions of regions differs a lot (see Table 9).

Finally, in models 6 and 9, we examine whether including educational success, teacher salary,[29] and district growth affect the estimates. Adding these new indicators reduces many of the coefficients as more variation is shared. These models hint at a relationship between district educational success and supply as both models are nominally positive but only one is significant. Poverty points in the right direction but is no longer significant. Again, race does not matter in either model.

[29] Analyses using a categorical variable of teacher salary are included in Appendix E. Teacher salary remains insignificant whether using the continuous or categorical variable.

The results of the regressions support the theme that region and district size matter, regardless of how district size is operationalized. We consistently see the following relationships influencing teacher supply:

- large districts have a supply advantage relative to small and midsize districts;
- suburban and city districts have a supply advantage relative to rural and town districts; and
- districts in the Northwest and Northeast have greater supply than districts in the other regions.

Other indicators included in the models mostly move in the predicted direction but some do not, perhaps because they are sharing the same variation. The key drivers of teacher supply are district size and region.

Research Question 2. Does supply differ by school level or subject?

How does supply vary by subject and grade level? The literature indicates that teacher supply will vary by school level and subject (Behrstock-Sherratt, 2016; Cowan et al., 2016; Cross, 2016; Dee & Goldhaber, 2017; Ingersoll, 2001; 2003; Malatras et al., 2017; Murnane & Steele, 2007; Murphy et al., 2003). Therefore, we examine teacher supply by elementary, middle, and high school levels defined by the grades used in the online survey. Teacher supply for elementary includes all applications and vacancies for kindergarten through grade 4, middle school includes those for grades 5 through 8, and high school includes grades 9 through 12. Per the literature, we expect to find greater teacher supply at the elementary level and more evidence of shortages at the secondary level.

In addition to school level, we look at teacher supply by subject, in particular, math and science compared to language arts (and social studies).[30] On the survey, questions about vacancies and applicants were asked about general subject areas rather than specific class types. The subjects in the survey presented here included: middle school math and science[31]; high school math and science; middle school English/language arts and social studies; and high school English/language arts. We expect to find greater teacher supply in language arts than in math and science.

Contrary to expectations, we find greater teacher supply associated with the middle school level (Table 17 and Figure 13). In fact, in Table 17, we find elementary and high school have the same teacher supply while there appears to be 2 more applications per vacancy at the middle school level.

Table 17: Teacher Supply by School Level (Raw Differences)

School Level	N of responses	Total Vacancies	Total Applicants	Teacher Supply ratio
Elementary	156	1,406	6,149	**4.4**
Middle School	137	884	5,827	**6.6**
High School	163	1,226	5,367	**4.4**

[30] We assumed positions available at the middle school level would be advertised as both 'math and science' or 'language arts and social studies' together. At the high school level, we assumed math, science, language arts, and social studies positions would be advertised separately.

[31] Grade 5 may or may not be included in the middle level subjects' responses. On the survey, questions related to grade 5 positions were asked as if those would have had a self-contained core classroom teacher. Math and science does not include computer science or career technical education (CTE) courses.

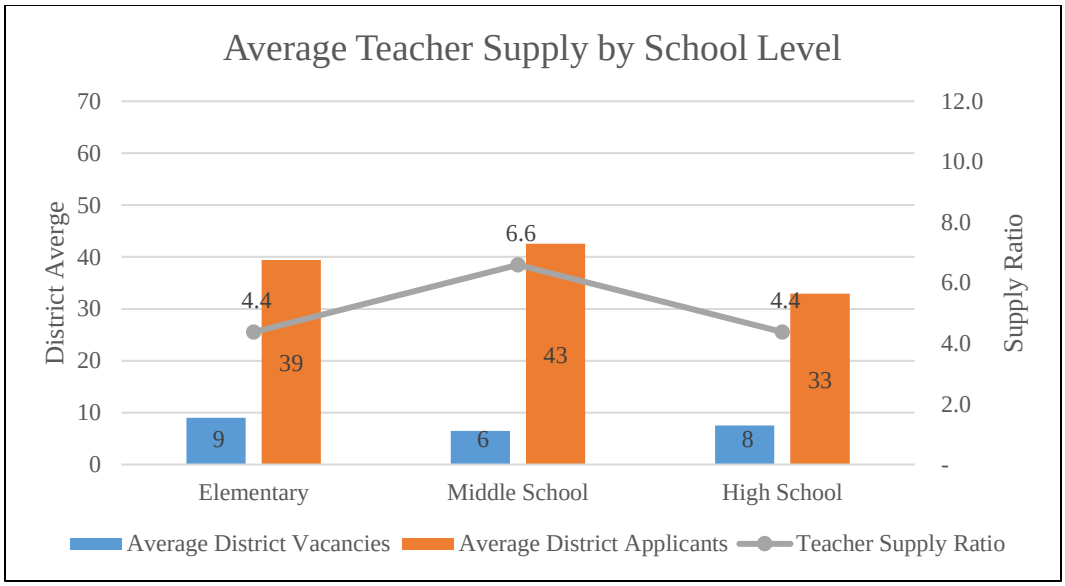


Figure 13: Average Teacher Supply by School Level (Raw Differences)

Multivariate analyses included in Appendix F, examine the predictors of teacher supply by school level as well. We find similar results to those in the overall analysis of teacher supply presented above. In particular, there is a consistent teacher supply advantage for larger districts, particularly at the middle level (Appendix Tables F1-F3). The teacher supply advantage for suburban districts persists at the middle and high school levels, but not at the elementary level. Again it appears that districts in the Central, Southwest, and Southeast regions are at a consistent disadvantage, with a greater disadvantage at the middle level. For example, large districts have almost 8 more middle level applications per position relative to small districts, suburban districts have 9 more middle level applications per vacancy relative to rural districts, and districts in the Southeast have 7 fewer middle level applications relative to those in the Northwest.

Turning to the relationship between subject area and teacher supply, as expected, we find greater teacher supply associated with English/language arts than with math and science, particularly at the middle school level (Table 18 and Figure 14). Table 18 shows the middle school level has a teacher supply advantage over the high school level in these subjects. In fact,

we find middle school English/language arts (and social studies) has the largest teacher supply at 10.1 while high school math and science has the lowest teacher supply at 2.8. In other words, for every middle school English/language arts and social studies position there are an average of 10 applications while there are fewer than 3 applications per high school math and science vacancy.

Table 18: Teacher Supply by Subject Area (Raw Differences)

Subject	N of responses	Total Vacancies	Total Applicants	Teacher Supply ratio
MS Math & Science	61	174	992	**5.7**
HS Math & Science	82	270	751	**2.8**
MS ELA & SS	52	138	1,391	**10.1**
HS ELA	57	124	841	**6.8**

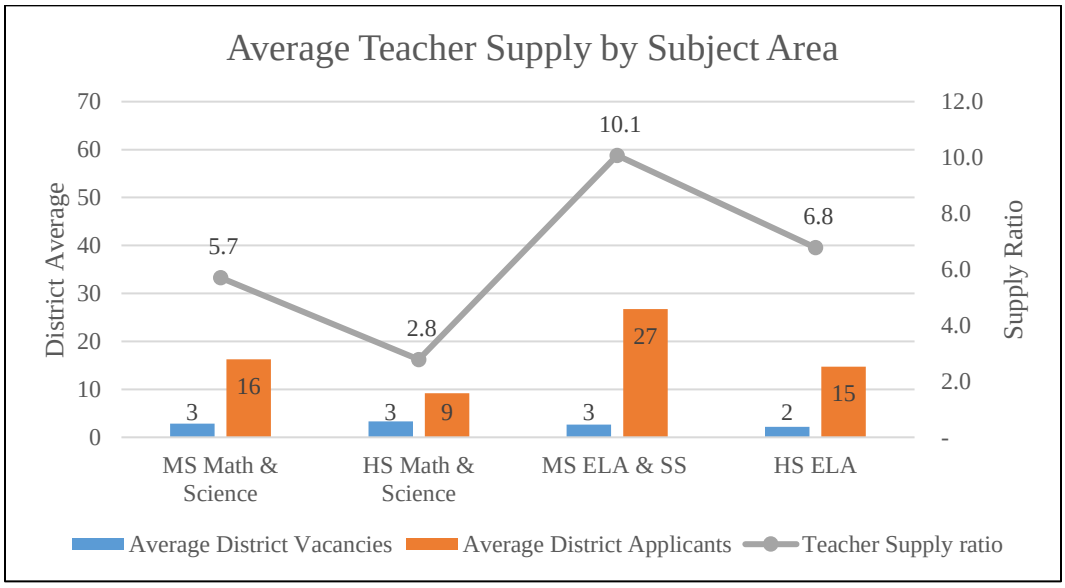


Figure 14: Average Teacher Supply by Subject Area (Raw Differences)

The multivariate analyses included in Appendix F, further examine the predictors of teacher supply by subject area. As with the examination of teacher supply by school level, we find a teacher supply advantage for large districts, however, this advantage is not significant in middle school math and science (Appendix Tables F4-F7). Suburban districts appear to have

greater teacher supply, but it is not significant in middle school math and science. Middle school subjects appear to have a greater teacher supply disadvantage than high school subjects in all regions, relative to the Northwest. In particular, districts in the Northeast, Southwest, and Southeast see a larger significant teacher supply disadvantage for middle school math and science. The supply disadvantage for districts in the Central, Southwest, and Southeast regions for English/language arts and social studies is much larger at the middle school level. The teacher supply disadvantage in the Southeast is the greatest and persists across subjects and levels. For example, relative to small districts, large districts have almost 13 more applications per position in the area of middle school English/language arts and social studies. Similarly, suburban districts have 12 more applications per vacancy relative to rural districts, and districts in the Southeast have 15 fewer applications relative to those in the Northwest for these positions (Appendix Table F6).

In sum, these results indicate that teacher supply is positively associated with the middle school level, which is not what was expected based on the literature. Teacher supply is also positively associated with English/language arts (and social studies), as expected. The supply advantages appear to be greater for large districts while the supply disadvantages seem to vary somewhat depending on subject and region.

Summary

We find that district size, urbanicity, and region have the most influence on teacher supply across Arkansas. In particular, districts that have the most favorable teaching supply are larger districts with enrollments greater than 3,500. Districts in the Northwest appear to have a significant advantage in attracting teachers, as do urban and suburban districts. Districts that face a greater challenge in attracting teaching supply are those in the Central, Southwest, and Southeast regions

and those in rural areas. Examining teacher supply by school level and subject area, we find the middle school level and English/language arts have a significant advantage in attracting teachers.

V. Conclusion

The purpose of this study was to test whether a uniform teacher shortage exists across the state of Arkansas. The literature is muddled on whether a national teacher shortage exists depending on the information used and how it is assessed. Additionally, we examine whether there is a surplus of elementary and English/language arts teachers as indicated by the literature. We hypothesized that rather than a global shortage, teacher shortages are more likely to occur in certain regions and subjects. However, we expected to find more elementary teachers than middle or high school teachers, and more English/language arts teachers than math and science teachers.

To address these issues, we examined the characteristics of districts with the most favorable teaching supply using descriptive and multivariate analysis. To do so, we used data on the number of vacancies and applications for positions by grade and subjects collected from surveys of districts along with administrative data. This is the third study to use applicant pool information to assess teacher shortages and the first to identify teacher supply in this way. In this study, "supply" is defined as the ratio of applications to vacancies.

Discussion of Findings

We find that teacher supply is unequally distributed across the state and that district size, region, and urbanicity appear to drive supply. Teacher supply is most favorable for large districts with student enrollments greater than 3,500, districts in the Northwest, and suburban and city districts. Examining teacher supply by school level and subject, it appears that the middle school level, not the elementary level, has the greatest supply of teachers. Moreover, English/language arts positions have a significant advantage attracting teachers, as expected.

Policy Implications/Recommendations

To address issues of teacher shortage, supply (and need) must first be identified. The steps taken to address the issues will vary based on what information is being used. The remedies may either address overall supply, overall need, a combination of both, or look at localized supply and how the issues related to particular types of districts might be addressed. To that end, we hope this study further informs the discussion and policies related to addressing the issue.

This way of identifying supply focuses more on the overall intended (future) supply, not on the current supply districts experience with the number of applications they receive. Issues related to district level teacher supply may be different and must also be considered. It is one thing to have a large supply of teachers overall, it is another thing to get them to where they are needed most. As this study finds an unequal distribution with regard to the supply of teachers to districts statewide, rather than focusing on overall supply, Arkansas should consider examining teacher supply at a more localized level and examine ways to better match prospective teachers to positions. To that end, we suggest the following recommendations:

- To better understand how teacher supply is distributed across districts, the state should consider collecting application and vacancy information at the district level.
- To make it easier for applicants to find district vacancies and districts to find applicants, a statewide online application process could be used.
- Starting the hiring process earlier, especially for low-supply districts, could increase both the quantity and quality of candidates.
- Examining ways to purposefully place student teachers in districts, and developing more district-university partnerships where they are limited or may not exist, would also facilitate getting teachers to where they are needed.

To continue to have persistent shortage areas identified by the state suggests that either the ways in which shortages are identified and/or the means by which they are being addressed may not be working. Rather than focus on overall supply, Arkansas should consider addressing supply at a more localized level.

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Appendices

Appendix A: Supply by District Percent Hispanic, Black Students
Supply by District Percent Hispanic

Table A1: Teacher Supply by District Race/Ethnicity - Hispanic (Quintile)

Quintile range		Quintile	N of districts	N of responses	Total Vacancies	Total Applicants	Teacher Supply ratio
0-0.02	lowest%	1	59	41	316	1,085	**3.4**
0.03-0.04		2	71	50	404	1,392	**3.4**
0.05-0.06		3	41	29	322	1,262	**3.9**
0.07-0.10		4	40	27	764	3,295	**4.3**
0.11-0.61	highest%	5	51	37	1,085	9,912	**9.1**
		Overall	262	184	2,891	16,946	**5.9**

Note: Mean %Hispanic 2016-17 = 8.1%

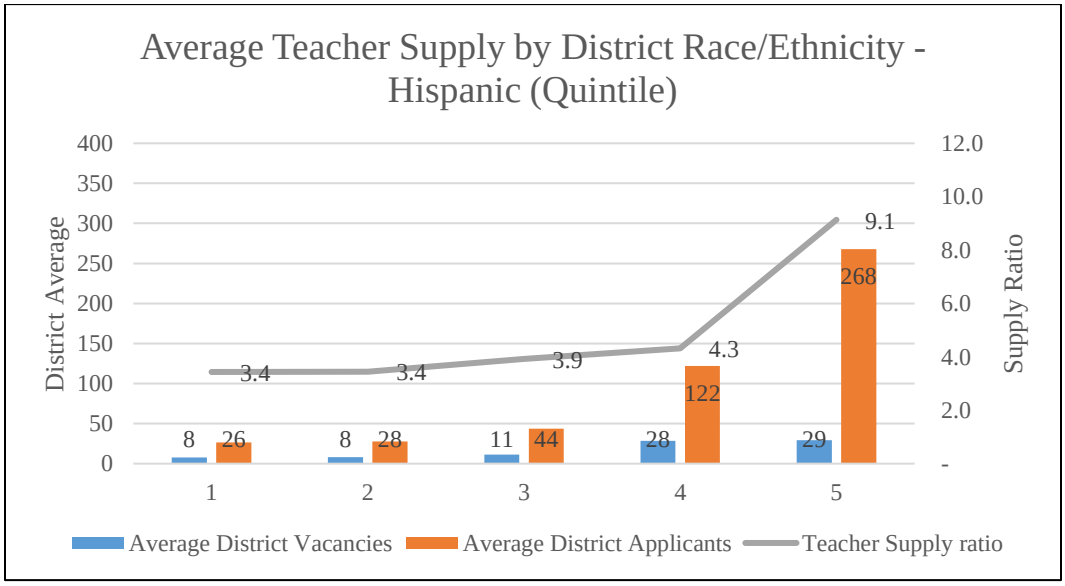

Figure A1: Average Teacher Supply by District Race/Ethnicity - Hispanic (Quintile)

Table A2: Teacher Supply by District Race/Ethnicity - Hispanic (Quintile), Excluding Northwest Region Districts

Quintile range		Quintile	N of districts	N of responses	Total Vacancies	Total Applicants	Teacher Supply ratio
0-0.02	lowest%	1	59	29	264	688	**2.6**
0.03-0.04		2	71	36	328	1,085	**3.3**
0.05-0.06		3	41	25	300	976	**3.3**
0.07-0.10		4	40	16	664	2,628	**4.0**
0.11-0.61	highest%	5	51	23	539	3,490	**6.5**
		Overall	262	129	2,095	8,867	**4.2**

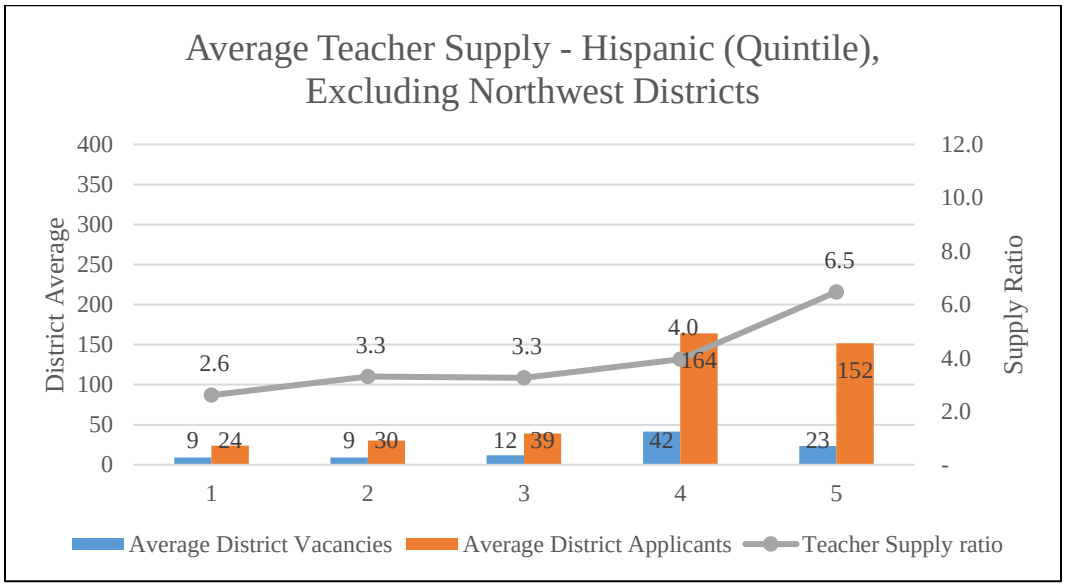

Figure A2: Average Teacher Supply by District Race/Ethnicity - Hispanic (Quintile), Excluding Northwest Region Districts

Supply by District Percent Black

Table A3: Teacher Supply by District Race/Ethnicity - Black (Quintile)

Quintile range		Quintile	N of districts	N of responses	Total Vacancies	Total Applicants	Teacher Supply ratio
0	lowest%	1	56	32	176	917	**5.2**
0.01		2	53	41	259	2,044	**7.9**
0.02-0.09		3	49	33	702	6,130	**8.7**
0.10-0.38		4	53	39	520	2,464	**4.7**
0.39-0.98	highest%	5	51	39	1,234	5,391	**4.4**
		Overall	262	184	2,891	16,946	**5.9**

Note: Mean %Black 2016-17 = 18.5%

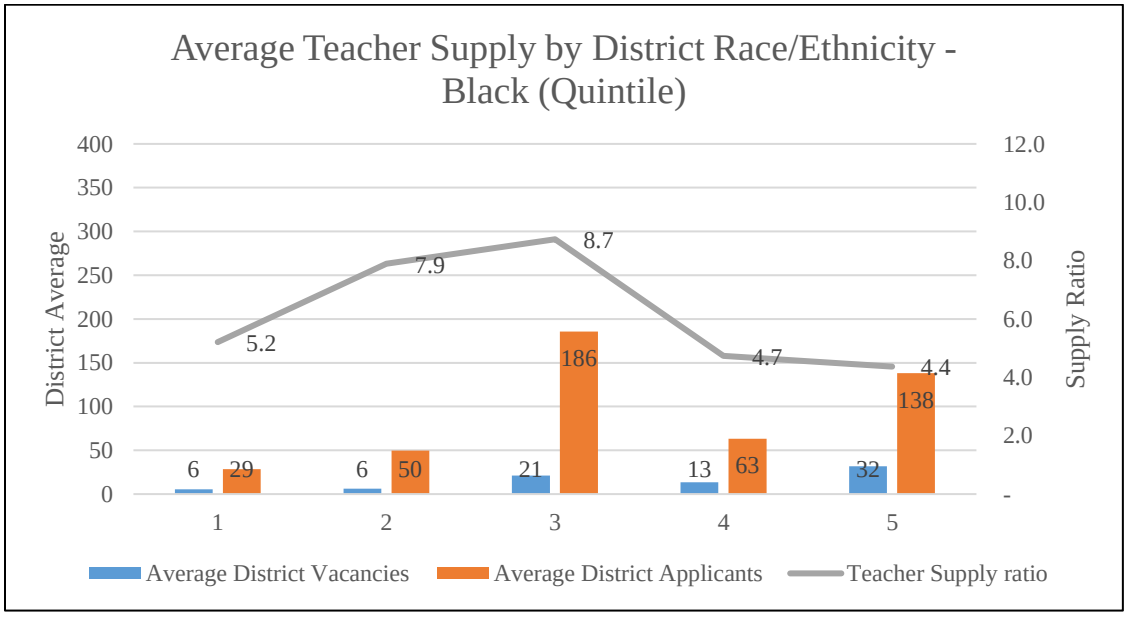

Figure A3: Average Teacher Supply by District Race/Ethnicity - Black (Quintile)

Table A4: Teacher Supply by District Race/Ethnicity - Black (Category)

Category range		Category	N of districts	N of responses	Total Vacancies	Total Applicants	Teacher Supply ratio
0	lowest%	1	56	32	176	917	**5.2**
0.01-0.10		2	108	77	1,070	9,137	**8.5**
0.10-0.50		3	62	46	706	3,496	**5.0**
0.51-0.98	highest%	4	36	27	939	3,396	**3.6**
		Overall	262	182	2,891	16,946	**5.9**

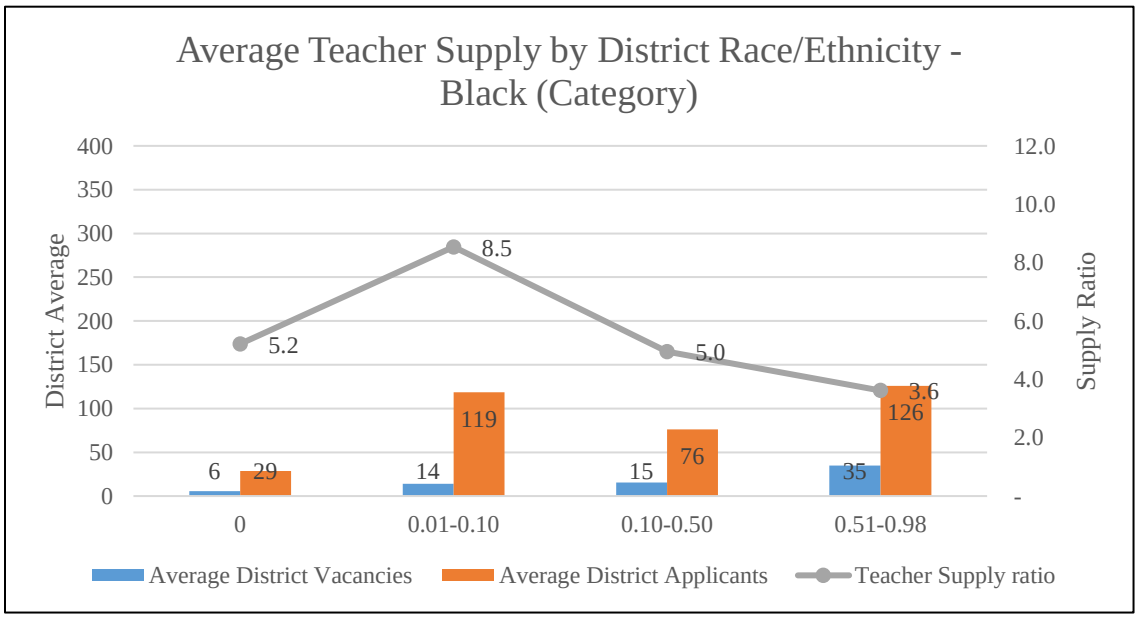

Figure A4: Average Teacher Supply by District Race/Ethnicity - Black (Quintile)

Appendix B: Race/Ethnic Diversity (%White) of Small Districts

Table B1: District Race/Ethnicity (White) Quintile for Small Districts Relative to All Districts

		All Districts					Small Districts				
Quintile range		**Quintile**	**N of districts**	**Mean % White**	**Min**	**Max**	**N of Small Districts**	**Mean % White**	**Min**	**Max**	**% of Small Districts in Quintile**
0-0.44	least white	1	54	0.23	108	22,759	30	0.16	108	1,462	0.56
0.47-0.71		2	53	0.61	62	15,399	32	0.60	62	1,419	0.60
0.72-0.87		3	51	0.81	336	16,609	39	0.81	336	1,454	0.76
0.88-0.93		4	60	0.91	325	10,290	38	0.91	325	1,314	0.63
0.94-0.98	most white	5	44	0.96	56	1,661	42	0.96	56	1,383	0.95
		Total	262	0.70	56	22,759	181	0.69			

Appendix C: Comparison of Descriptive Ratios and Simple Regression

Table C1: Example Comparison of Descriptive Supply Ratios and Simple Regression Coefficients - District Size

Size range	District Size	N of responses	Teacher Supply Ratio (weighted)	N of responses	Mean Teacher Supply (unweighted)	Simple Regression Coefficients	Sum of Coefficients and Reference Group
< 1,500	Small	128	**4.0**	128	**4.28**	4.28	(reference group)
1,500-3,500	Midsize	36	**2.8**	33	**5.18**	0.90	**5.18**
> 3,500	Large	20	**7.9**	22	**9.95**	5.67	**10.85**
	Total	184	**5.9**	183	**5.12**		

Note: Simple regression coefficients added to the reference group coefficient are approximately equivalent to the unweighted mean teacher supply.

Appendix D: Variation in Supply by Region

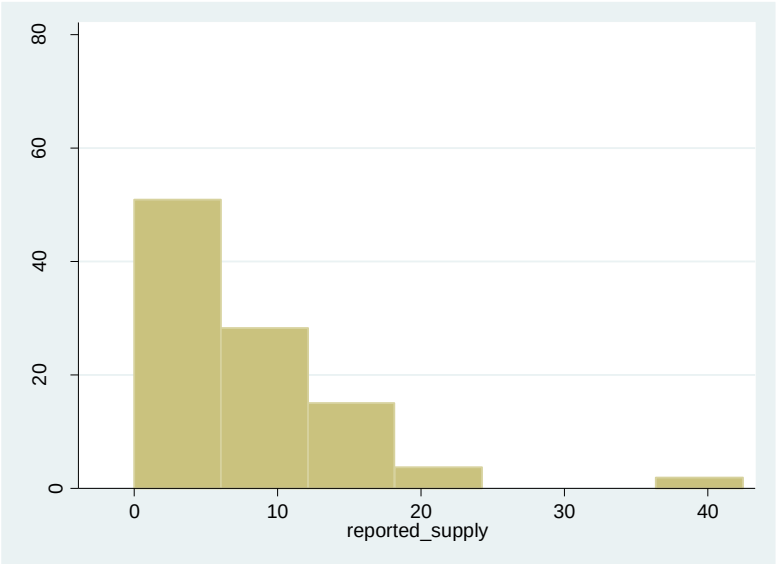

Figure D1: Distribution of Teacher Supply – Northwest Region

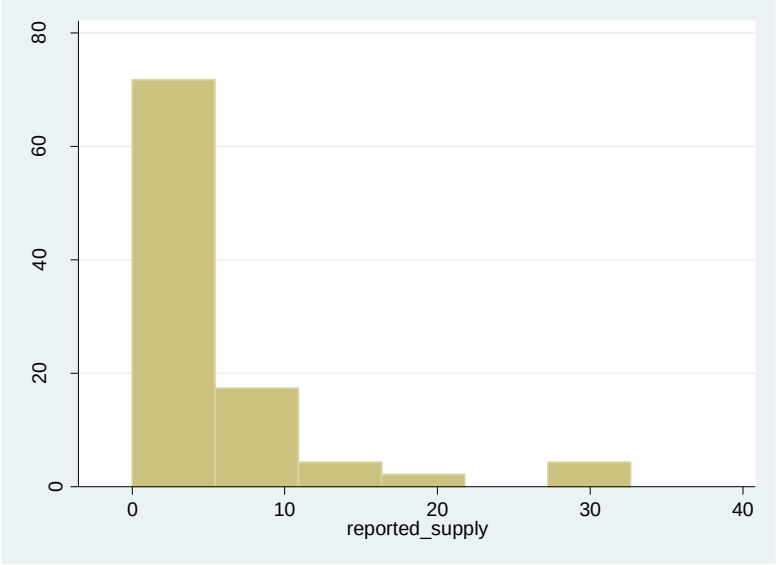

Figure D2: Distribution of Teacher Supply – Northeast Region

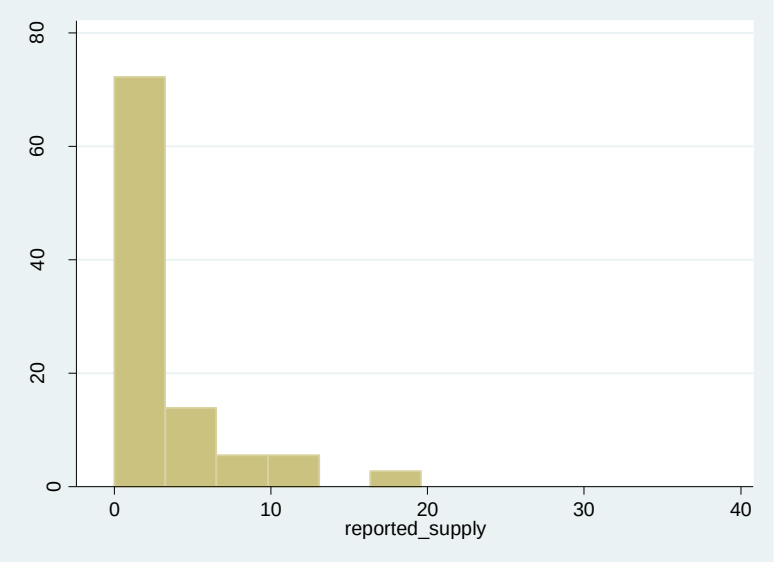

Figure D3: Distribution of Teacher Supply – Central Region

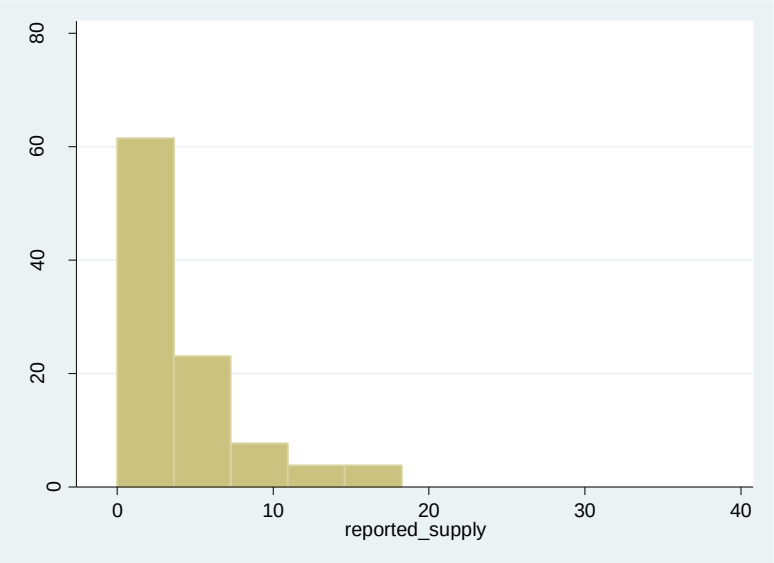

Figure D4: Distribution of Teacher Supply – Southwest Region

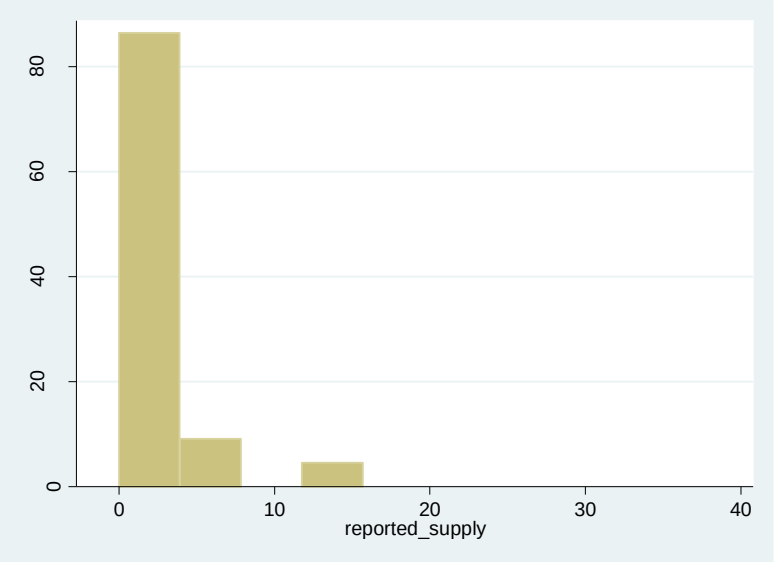

Figure D5: Distribution of Teacher Supply – Southeast Region

Table D1: Mean Teacher Supply by Region (Unweighted)

Region	Mean Teacher Supply (unweighted)	25th %ile	75th %ile	SD
NW	7.92	4.00	11.00	7.15
NE	5.47	1.45	5.66	6.87
Central	3.34	1.10	4.25	4.01
SW	3.90	1.50	5.00	4.02
SE	2.03	0.50	5.00	3.29

Appendix E: Supply Using Teacher Salary (Categorical)

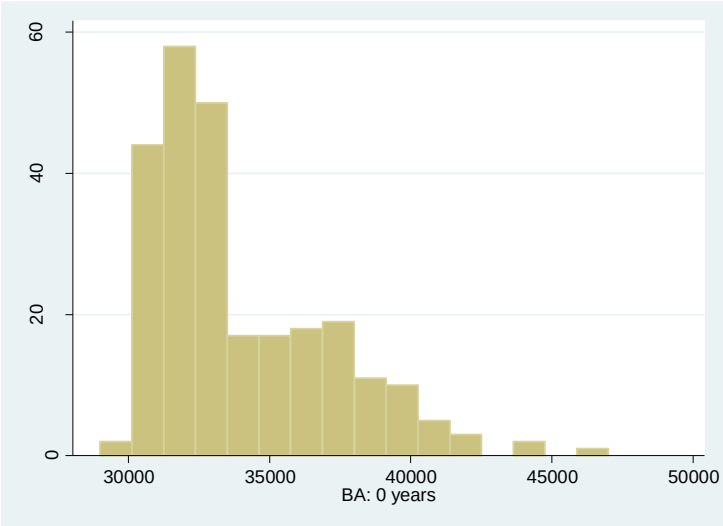

Figure E1: Distribution of Teacher Salary, 2016-17

Table E1: Teacher Supply by Teacher Salary – BA, 0 years (Categorical)

Salary Range	Salary Category	N of districts	N of responses	Total Vacancies	Total Applicants	Average District Vacancies	Average District Applicants	Teacher Supply ratio
< $31,610	Low	64	45	302	1,026	7	23	**3.4**
$ 31,610-36,000	Mid	126	88	1,183	3,634	13	41	**3.1**
> $36,000	High	67	47	1,367	12,277	29	261	**9.0**
	Total	257	180	2,852	16,937	16	94	**5.9**

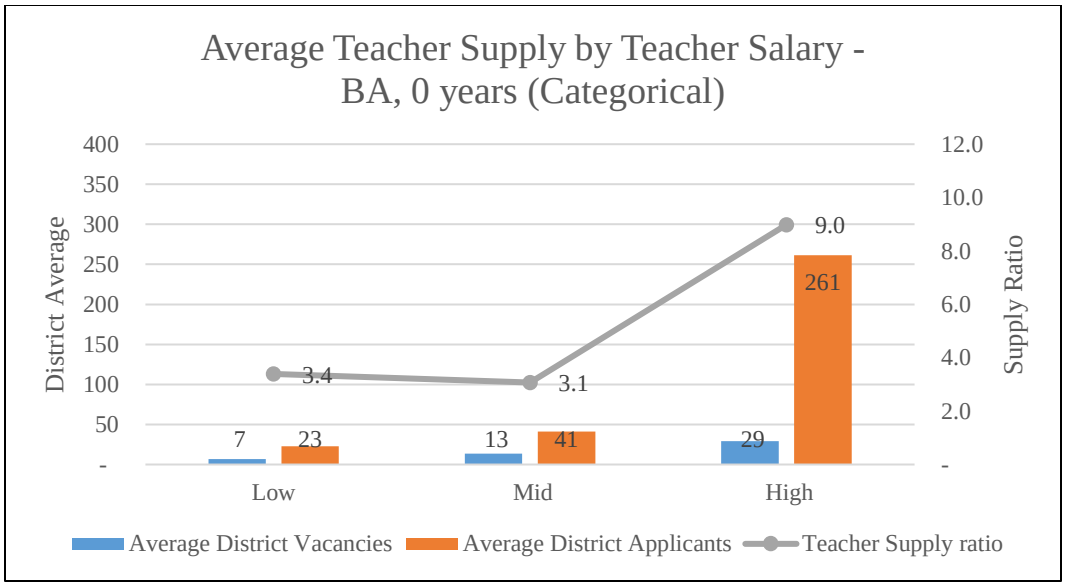

Figure E2: Average Teacher Supply by Teacher Salary – BA, 0 years (Categorical)

Table E2: Predictors of Supply: Continuous vs Categorical Teacher Salary

Teacher Salary Continuous			Teacher Salary Categorical		
	(6)	(9)		(1)	(2)
	Enrollment & Region (w/all	Region & Urbanicity (w/all		Enrollment & Region (w/all	Region & Urbanicity (w/all
VARIABLES	controls)	controls)	VARIABLES	controls)	controls)
Midsize districts (1,500-3,500)	-0.367		Midsize districts (1,500-3,500)	-0.667	
	(1.263)			(1.086)	
Large districts (> 3,500)	4.631*		Large districts (> 3,500)	4.725**	
	(2.368)			(2.297)	
City (urbanicity 1)		8.188**	City (urbanicity 1)		7.845**
		(3.534)			(3.192)
Suburb (urbanicity 2)		5.736**	Suburb (urbanicity 2)		4.766*
		(2.881)			(2.767)
Town (urbanicity 3)		2.026	Town (urbanicity 3)		2.020
		(1.351)			(1.315)
NE (Region 2)	-0.843	-0.672	NE (Region 2)	-0.762	-0.579
	(1.297)	(1.273)		(1.321)	(1.302)
Central (Region 3)	-5.388***	-4.780***	Central (Region 3)	-5.962***	-5.181***
	(1.610)	(1.726)		(1.717)	(1.703)
SW (Region 4)	-2.179*	-1.321	SW (Region 4)	-2.195*	-1.228
	(1.259)	(1.291)		(1.176)	(1.216)
SE (Region 5)	-3.738***	-2.755**	SE (Region 5)	-3.662***	-2.640**
	(1.023)	(1.211)		(1.123)	(1.266)
District %FRL	-7.440	-3.234	District %FRL	-7.166	-2.077
	(6.765)	(6.364)		(6.400)	(6.351)
District %White	-1.994	0.967	District %White	-1.885	1.894
	(2.519)	(2.667)		(2.480)	(2.627)
Educational Success	1.226	1.928*	Educational Success	1.054	1.574
	(0.997)	(0.990)		(1.036)	(0.997)
Teacher Salary BA, 0-yrs (rescaled)	0.166	0.102			
	(0.202)	(0.201)			
			Mid-salary ($31,610-36,000)	-1.353	-1.371
				(0.919)	(0.927)
			High-salary (> $36,000)	1.399	1.416
				(1.453)	(1.478)
District Growth	0.169	0.131	District Growth	0.039	-0.062
	(0.203)	(0.179)		(0.068)	(0.078)
Constant	7.203	3.088	Constant	12.983**	5.447
	(8.750)	(8.672)		(5.977)	(5.931)
Observations	165	165	Observations	170	170
R-squared	0.295	0.328	R-squared	0.298	0.318

Notes: *** p<0.01, ** p<0.05, * p<0.1. Robust standard errors in parentheses.

Appendix F: Supply by Subgroups Analyses
Supply by School Level

Table F1: Predictors of Elementary Teacher Supply

VARIABLES	(1) Enrollment (Categorical)	(2) Urbanicity	(3) Region	(4) Enrollment & Region	(5) Enrollment & Region (w/demo controls)	(6) Enrollment & Region (w/all controls)	(7) Region & Urbanicity	(8) Region & Urbanicity (w/demo controls)	(9) Region & Urbanicity (w/all controls)
Small districts (< 1,500)	-			-	-	-			
Midsize districts (1,500-3,500)	-0.589			-0.390	-0.803	0.493			
	(0.974)			(0.909)	(0.923)	(0.920)			
Large districts (> 3,500)	5.072**			5.882***	5.489**	7.279***			
	(2.117)			(2.105)	(2.259)	(2.624)			
City (urbanicity 1)		1.601					2.271	2.521	3.802
		(1.804)					(2.457)	(2.997)	(3.213)
Suburb (urbanicity 2)		5.443					5.548	5.143	4.984
		(4.240)					(4.498)	(4.518)	(4.268)
Town (urbanicity 3)		0.116					0.672	0.591	0.302
		(1.278)					(1.096)	(1.034)	(0.938)
Rural (urbanicity 4)		-					-	-	-
NW (Region 1)			-	-	-	-	-	-	-
NE (Region 2)			-1.805	-1.195	-1.087	-0.753	-1.019	-1.006	-0.518
			(1.403)	(1.424)	(1.479)	(1.515)	(1.523)	(1.528)	(1.547)
Central (Region 3)			-3.324**	-4.844***	-4.874***	-3.446**	-3.846*	-4.111**	-2.214
			(1.608)	(1.276)	(1.604)	(1.722)	(1.957)	(2.037)	(2.185)
SW (Region 4)			-4.773***	-4.103***	-3.952***	-3.344***	-3.836***	-3.778***	-3.210**
			(1.013)	(1.075)	(1.274)	(1.263)	(1.113)	(1.353)	(1.368)
SE (Region 5)			-4.071**	-3.146	-2.899	-3.122**	-3.248*	-3.111*	-3.107**
			(2.013)	(2.076)	(1.819)	(1.422)	(1.898)	(1.675)	(1.552)
District %FRL					-3.340	2.399		-2.487	3.896
					(3.742)	(5.056)		(3.886)	(5.055)
District %White					-0.285	1.863		-0.282	-0.422
					(2.635)	(2.508)		(2.983)	(3.197)
Educational Success						0.549			1.772
						(1.052)			(1.281)
Teacher Salary BA, 0-yrs (in $1,000s						-0.126			-0.276
						(0.239)			(0.223)
District Growth						0.349*			0.350
						(0.211)			(0.216)
Constant	4.670***	4.646***	7.524***	6.707***	9.218**	7.055	6.335***	8.244*	2.601
	(0.601)	(0.513)	(0.909)	(0.997)	(3.918)	(10.69)	(1.038)	(4.533)	(10.46)
Observations	156	152	156	156	155	144	152	151	144
R-squared	0.077	0.036	0.076	0.160	0.165	0.268	0.101	0.109	0.221

Notes: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1. Constant: Small districts, NW=Region 1, Rural. Mean unit of supply for elementary teachers = 4.37 (equivalent to 4 applicants per vacancy). Overall mean unit of teacher supply = 5.12 (equivalent to ~5 applicants per vacancy).

Table F2: Predictors of Middle School Teacher Supply

VARIABLES	(1) Enrollment (Categorical)	(2) Urbanicity	(3) Region	(4) Enrollment & Region	(5) Enrollment & Region (w/demo controls)	(6) Enrollment & Region (w/all controls)	(7) Region & Urbanicity	(8) Region & Urbanicity (w/demo controls)	(9) Region & Urbanicity (w/all controls)
Small districts (< 1,500)	-			-	-	-			
Midsize districts (1,500-3,500)	-0.196			0.557	-0.688	-0.808			
	(1.327)			(1.296)	(1.236)	(1.311)			
Large districts (> 3,500)	7.862***			8.907**	7.836**	6.369			
	(2.967)			(3.438)	(3.419)	(3.896)			
City (urbanicity 1)		4.624					5.859	7.675	8.109
		(2.848)					(4.345)	(5.280)	(6.230)
Suburb (urbanicity 2)		9.201***					9.263**	8.453**	8.089*
		(3.331)					(3.822)	(4.217)	(4.266)
Town (urbanicity 3)		1.990					3.026	3.323	3.376
		(1.973)					(2.101)	(2.814)	(3.169)
Rural (urbanicity 4)		-					-	-	-
NW (Region 1)			-	-	-	-	-	-	-
NE (Region 2)			-2.291	-1.342	-0.799	-0.344	-1.187	-0.897	-0.228
			(2.315)	(2.310)	(2.333)	(2.380)	(2.414)	(2.359)	(2.327)
Central (Region 3)			-3.075	-5.868***	-5.555**	-4.487	-5.610*	-5.540*	-3.016
			(1.879)	(2.022)	(2.334)	(2.752)	(3.147)	(3.327)	(3.234)
SW (Region 4)			-5.522***	-4.689***	-3.934**	-3.204*	-4.468**	-3.510*	-2.707
			(1.476)	(1.517)	(1.598)	(1.624)	(1.741)	(1.818)	(1.796)
SE (Region 5)			-7.506***	-6.128***	-5.012***	-3.763**	-6.641***	-4.967**	-3.187
			(1.298)	(1.190)	(1.493)	(1.541)	(1.691)	(2.003)	(1.951)
District %FRL					-9.934**	-2.966		-4.981	6.707
					(4.496)	(7.288)		(6.744)	(8.726)
District %White					-0.500	-1.810		3.128	0.249
					(2.704)	(3.034)		(5.313)	(4.637)
Educational Success						1.363			3.371*
						(1.465)			(1.750)
Teacher Salary BA, 0-yrs (in $1,000s						0.146			0.127
						(0.278)			(0.362)
District Growth						0.677			0.578
						(0.409)			(0.374)
Constant	4.764***	4.140***	8.708***	7.144***	14.09***	5.223	6.330***	6.819	-3.874
	(0.779)	(0.516)	(1.232)	(1.104)	(4.581)	(12.81)	(1.296)	(9.289)	(13.26)
Observations	137	134	137	137	136	127	134	133	127
R-squared	0.111	0.084	0.086	0.197	0.218	0.241	0.169	0.194	0.254

Notes: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1. Constant: Small districts, NW=Region 1, Rural. Mean unit of supply for middle school teachers = 6.6 (equivalent to ~7 applicants per vacancy). Overall mean unit of teacher supply = 5.12 (equivalent to ~5 applicants per vacancy).

Table F3: Predictors of High School Teacher Supply

VARIABLES	(1) Enrollment (Categorical)	(2) Urbanicity	(3) Region	(4) Enrollment & Region	(5) Enrollment & Region (w/demo controls)	(6) Enrollment & Region (w/all controls)	(7) Region & Urbanicity	(8) Region & Urbanicity (w/demo controls)	(9) Region & Urbanicity (w/all controls)
Small districts (< 1,500)	-			-	-	-			
Midsize districts (1,500-3,500)	-0.0863			-0.0623	-0.772	-0.675			
	(0.804)			(0.779)	(0.700)	(0.774)			
Large districts (> 3,500)	5.795**			6.463**	5.770**	4.900			
	(2.598)			(2.882)	(2.846)	(3.341)			
City (urbanicity 1)		3.643					5.405	7.075*	7.419*
		(2.676)					(3.543)	(4.123)	(4.316)
Suburb (urbanicity 2)		4.678**					5.485**	5.304*	4.760*
		(2.295)					(2.670)	(2.903)	(2.697)
Town (urbanicity 3)		0.123					0.492	0.951	0.785
		(0.836)					(1.089)	(1.244)	(1.121)
Rural (urbanicity 4)		-					-	-	-
NW (Region 1)			-	-	-	-	-	-	-
NE (Region 2)			-1.390	-0.741	-0.523	-0.109	-0.295	-0.240	0.226
			(1.514)	(1.559)	(1.560)	(1.591)	(1.743)	(1.686)	(1.712)
Central (Region 3)			-2.888**	-4.242***	-4.666***	-3.528**	-4.734**	-4.838**	-3.152
			(1.136)	(1.171)	(1.409)	(1.662)	(1.965)	(2.044)	(1.945)
SW (Region 4)			-3.337***	-2.716***	-2.549**	-1.893*	-2.024*	-1.559	-0.983
			(0.912)	(0.968)	(1.038)	(1.137)	(1.092)	(1.120)	(1.216)
SE (Region 5)			-4.901***	-3.951***	-3.830***	-2.847**	-3.673***	-2.841**	-2.018
			(0.818)	(0.811)	(0.946)	(1.098)	(1.111)	(1.183)	(1.278)
District %FRL					-6.179**	-0.0551		-1.790	3.362
					(2.642)	(5.301)		(3.424)	(4.938)
District %White					-1.338	-1.486		2.461	-0.0470
					(1.665)	(2.221)		(2.173)	(2.180)
Educational Success						0.785			1.804*
						(0.817)			(0.978)
Teacher Salary BA, 0-yrs (in $1,000s)						0.151			0.120
						(0.161)			(0.174)
District Growth						0.463			0.362
						(0.292)			(0.232)
Constant	3.478***	3.349***	6.164***	5.232***	10.47***	0.961	4.679***	3.717	-2.337
	(0.360)	(0.372)	(0.787)	(0.797)	(2.370)	(8.480)	(0.860)	(3.961)	(8.808)
Observations	163	159	163	163	162	149	159	158	149
R-squared	0.111	0.069	0.080	0.200	0.218	0.235	0.164	0.187	0.250

Notes: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1. Constant: Small districts, NW=Region 1, Rural. Mean unit of supply for high school teachers = 4.38 (equivalent to 4 applicants per vacancy). Overall mean unit of teacher supply = 5.12 (equivalent to ~5 applicants per vacancy).

Supply by Subject Area

Table F4: Predictors of Math & Science Teacher Supply (Middle School)

VARIABLES	(1) Enrollment (Categorical)	(2) Urbanicity	(3) Region	(4) Enrollment & Region	(5) Enrollment & Region (w/demo controls)	(6) Enrollment & Region (w/controls)	(7) Region & Urbanicity	(8) Region & Urbanicity (w/demo controls)	(9) Region & Urbanicity (w/controls)
Small districts (< 1,500)	-			-	-	-			
Midsize districts (1,500-3,500)	0.193			1.730	-3.332	-4.351			
	(2.096)			(1.594)	(4.837)	(5.154)			
Large districts (> 3,500)	12.04			12.07	7.916	2.539			
	(7.597)			(9.558)	(5.851)	(5.828)			
City (urbanicity 1)		9.277					8.448	7.663	4.545
		(9.482)					(12.66)	(12.34)	(15.57)
Suburb (urbanicity 2)		6.348					4.011	-3.224	-4.375
		(7.163)					(4.939)	(5.670)	(6.418)
Town (urbanicity 3)		0.0577					0.0659	-2.048	-3.386
		(2.041)					(1.964)	(3.115)	(3.203)
Rural (urbanicity 4)		-					-	-	-
NW (Region 1)			-	-	-	-	-	-	-
NE (Region 2)			-14.44*	-11.16**	-8.826**	-7.322**	-12.25**	-9.840**	-8.027**
			(7.207)	(4.773)	(3.708)	(3.612)	(4.776)	(3.832)	(3.967)
Central (Region 3)			-10.68	-14.55	-11.93	-9.474	-14.72	-12.95	-9.990
			(7.562)	(10.03)	(9.191)	(9.696)	(11.99)	(10.20)	(11.84)
SW (Region 4)			-14.69**	-12.98**	-9.947*	-8.209*	-11.98***	-8.622***	-7.624**
			(7.212)	(6.449)	(5.228)	(4.763)	(4.259)	(3.123)	(3.252)
SE (Region 5)			-16.24**	-12.25***	-7.415**	-6.886*	-13.53***	-7.075*	-6.240
			(7.166)	(4.332)	(3.622)	(3.684)	(4.141)	(3.725)	(3.976)
District %FRL					-34.23	-30.18		-37.21	-30.65
					(31.12)	(34.11)		(25.83)	(33.22)
District %White					-1.803	-5.737		0.295	-5.529
					(9.119)	(9.409)		(6.257)	(5.684)
Educational Success						2.216			3.330
						(2.055)			(3.031)
Teacher Salary BA, 0-yrs (in 1,000s						0.434			0.358
						(0.632)			(0.701)
District Growth						0.218			-0.0537
						(0.642)			(1.139)
Constant	4.273***	5.052***	17.49**	13.02***	37.25	22.55	14.75***	38.39*	25.45
	(1.093)	(1.392)	(7.160)	(4.173)	(30.19)	(36.67)	(4.503)	(20.97)	(39.45)
Observations	61	60	61	61	61	59	60	60	59
R-squared	0.099	0.053	0.149	0.215	0.268	0.278	0.179	0.262	0.284

Notes: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1. Constant: Small districts, NW=Region 1, Rural. Mean unit of middle school math & science teacher supply = 5.7 (equivalent to ~6 applicants per vacancy). Overall mean unit of teacher supply = 5.12 (equivalent to ~5 applicants per vacancy).

Table F5: Predictors of Math & Science Teacher Supply (High School)

VARIABLES	(1) Enrollment (Categorical)	(2) Urbanicity	(3) Region	(4) Enrollment & Region	(5) Enrollment & Region (w/demo controls)	(6) Enrollment & Region (w/controls)	(7) Region & Urbanicity	(8) Region & Urbanicity (w/demo controls)	(9) Region & Urbanicity (w/controls)
Small districts (< 1,500)	-			-	-	-			
Midsize districts (1,500-3,500)	0.198			0.362	-0.170	-0.00943			
	(0.638)			(0.834)	(0.779)	(0.726)			
Large districts (> 3,500)	4.493**			4.735**	4.330**	3.749			
	(1.722)			(2.057)	(1.942)	(2.349)			
City (urbanicity 1)		2.891					3.813	5.528	3.974
		(1.807)					(2.664)	(3.342)	(3.036)
Suburb (urbanicity 2)		5.459**					7.271***	7.221**	8.105***
		(2.491)					(2.608)	(2.867)	(2.308)
Town (urbanicity 3)		0.553					1.081	1.573	1.467*
		(0.721)					(0.928)	(0.965)	(0.805)
Rural (urbanicity 4)		-					-	-	-
NW (Region 1)			-	-	-	-	-	-	-
NE (Region 2)			-1.435	-0.548	-0.305	-0.288	-0.451	-0.467	-0.262
			(1.389)	(1.668)	(1.701)	(1.610)	(1.721)	(1.686)	(1.624)
Central (Region 3)			-1.445	-2.437**	-2.725**	-2.104*	-3.686**	-3.757**	-2.487*
			(1.148)	(1.146)	(1.319)	(1.254)	(1.615)	(1.670)	(1.328)
SW (Region 4)			-2.678***	-2.030	-1.652	-1.463	-1.767	-1.221	-1.310
			(0.902)	(1.226)	(1.246)	(1.192)	(1.248)	(1.339)	(1.302)
SE (Region 5)			-3.299***	-2.153**	-1.816*	-1.468	-2.478*	-1.679	-1.417
			(0.859)	(1.041)	(1.036)	(1.029)	(1.252)	(1.449)	(1.271)
District %FRL					-5.397***	-0.811		-1.830	2.936
					(1.963)	(4.684)		(2.778)	(4.558)
District %White					-0.454	-0.716		2.413	-1.304
					(1.485)	(2.624)		(1.873)	(2.193)
Educational Success						0.555			1.759**
						(0.793)			(0.803)
Teacher Salary BA, 0-yrs (in 1,000s						0.082			0.022
						(0.218)			(0.204)
District Growth						0.423**			0.479***
						(0.199)			(0.177)
Constant	2.444***	2.374***	4.778***	3.512***	7.487***	1.758	3.326***	2.412	1.108
	(0.274)	(0.227)	(0.819)	(0.834)	(2.028)	(10.49)	(0.916)	(3.654)	(9.428)
Observations	82	81	82	82	81	76	81	80	76
R-squared	0.206	0.150	0.089	0.276	0.315	0.381	0.265	0.317	0.428

Notes: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1. Constant: Small districts, NW=Region 1, Rural. Mean unit of high school math & science teacher supply = 2.78 (equivalent to ~3 applicants per vacancy). Overall mean unit of teacher supply = 5.12 (equivalent to ~5 applicants per vacancy).

Table F6: Predictors of English/Language Arts & Social Studies Teacher Supply (Middle School)

VARIABLES	(1) Enrollment (Categorical)	(2) Urbanicity	(3) Region	(4) Enrollment & Region	(5) Enrollment & Region (w/demo controls)	(6) Enrollment & Region (w/controls)	(7) Region & Urbanicity	(8) Region & Urbanicity (w/demo controls)	(9) Region & Urbanicity (w/controls)
Small districts (< 1,500)	-			-	-	-			
Midsize districts (1,500-3,500)	2.392			5.078	-0.936	1.097			
	(3.526)			(3.268)	(3.510)	(3.411)			
Large districts (> 3,500)	12.77*			13.69*	6.851	8.171			
	(6.535)			(6.946)	(5.467)	(6.180)			
City (urbanicity 1)		12.34*					16.37*	17.09	19.93
		(7.014)					(8.862)	(11.28)	(15.47)
Suburb (urbanicity 2)		18.38					24.01*	19.93	21.85***
		(15.96)					(13.35)	(12.41)	(4.842)
Town (urbanicity 3)		4.688					4.709*	4.012	4.943
		(2.965)					(2.781)	(2.760)	(3.145)
Rural (urbanicity 4)		-					-	-	-
NW (Region 1)			-	-	-	-	-	-	-
NE (Region 2)			-6.784	-6.367	-3.436	-3.589	-7.274	-6.265	-5.300
			(6.792)	(5.072)	(4.828)	(4.198)	(4.479)	(4.130)	(3.758)
Central (Region 3)			-9.605*	-12.38*	-13.14**	-9.470	-17.20**	-15.46**	-10.73
			(5.440)	(6.167)	(5.788)	(6.482)	(8.312)	(6.865)	(6.820)
SW (Region 4)			-10.50*	-11.00*	-8.136	-5.746	-7.897**	-5.836	-2.448
			(5.440)	(5.476)	(5.127)	(5.117)	(3.793)	(3.553)	(3.540)
SE (Region 5)			-15.11***	-12.48***	-11.26***	-6.960	-11.72***	-7.187	-1.518
			(5.031)	(3.540)	(3.603)	(4.166)	(3.409)	(4.890)	(6.782)
District %FRL					-35.17	-24.22		-20.92	-12.13
					(23.64)	(24.88)		(17.42)	(27.59)
District %White					-14.45*	-18.80**		2.606	-6.677
					(8.197)	(9.161)		(10.39)	(9.853)
Educational Success						4.556			7.028*
						(3.451)			(3.680)
Teacher Salary BA, 0-yrs (in 1,000s						-0.685			-1.135
						(0.753)			(0.960)
District Growth						2.184**			2.244***
						(0.869)			(0.494)
Constant	6.108***	4.992***	16.56***	12.23***	46.68**	64.10*	11.60***	22.26	59.48
	(1.187)	(0.950)	(5.021)	(2.961)	(21.99)	(37.94)	(3.068)	(14.91)	(43.65)
Observations	52	51	52	52	52	49	51	51	49
R-squared	0.135	0.151	0.130	0.269	0.324	0.414	0.338	0.380	0.479

Notes: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1. Constant: Small districts, NW=Region 1, Rural. Mean unit of middle school English language arts & social studies teacher supply = 10.08 (equivalent to 10 applicants per vacancy). Overall mean unit of teacher supply = 5.12 (equivalent to ~5 applicants per vacancy).

Table F7: Predictors of English/Language Arts Teacher Supply (High School)

VARIABLES	(1) Enrollment (Categorical)	(2) Urbanicity	(3) Region	(4) Enrollment & Region	(5) Enrollment & Region (w/demo controls)	(6) Enrollment & Region (w/controls)	(7) Region & Urbanicity	(8) Region & Urbanicity (w/demo controls)	(9) Region & Urbanicity (w/controls)
Small districts (< 1,500)	-			-	-	-			
Midsize districts (1,500-3,500)	0.449			-0.254	-1.758	-2.600			
	(1.706)			(1.448)	(1.385)	(2.026)			
Large districts (> 3,500)	11.29**			10.96**	9.658*	6.988			
	(4.961)			(4.744)	(4.892)	(7.955)			
City (urbanicity 1)		6.663					7.154	10.61	9.197
		(4.707)					(4.615)	(6.328)	(7.306)
Suburb (urbanicity 2)		7.938*					9.066**	8.658*	7.274*
		(4.062)					(4.066)	(4.558)	(4.306)
Town (urbanicity 3)		-1.083					-1.872*	-1.255	-0.466
		(1.263)					(1.111)	(1.318)	(1.875)
Rural (urbanicity 4)		-					-	-	-
NW (Region 1)			-	-	-	-	-	-	-
NE (Region 2)			-3.102	-0.805	-0.168	-0.295	-1.338	-1.349	-1.029
			(4.113)	(2.898)	(3.376)	(3.939)	(2.901)	(3.347)	(3.570)
Central (Region 3)			-7.979**	-8.660**	-8.931**	-7.408*	-10.55**	-10.72**	-7.980*
			(3.564)	(3.452)	(3.993)	(4.239)	(4.109)	(4.352)	(4.241)
SW (Region 4)			-9.898***	-6.685***	-6.028**	-6.617*	-6.635***	-5.019*	-5.001
			(3.335)	(1.977)	(2.877)	(3.498)	(2.035)	(2.579)	(3.069)
SE (Region 5)			-10.42***	-7.175***	-5.941*	-5.484	-6.752***	-4.581*	-4.106
			(3.331)	(1.963)	(3.283)	(3.788)	(1.929)	(2.644)	(3.345)
District %FRL					-11.87	-13.43		-5.435	-6.432
					(8.397)	(16.41)		(10.42)	(15.27)
District %White					-0.711	-8.082		4.948	-4.209
					(3.005)	(6.993)		(5.152)	(7.699)
Educational Success						2.096			3.167
						(3.199)			(4.237)
Teacher Salary BA, 0-yrs (in 1,000s						-0.179			-0.142
						(0.532)			(0.534)
District Growth						0.642			0.440
						(0.391)			(0.286)
Constant	4.516***	4.833***	12.04***	8.864***	17.68***	30.55	9.313***	8.625	20.33
	(0.765)	(0.828)	(3.312)	(1.969)	(5.685)	(20.07)	(2.164)	(9.457)	(20.33)
Observations	57	56	57	57	56	53	56	55	53
R-squared	0.228	0.133	0.203	0.395	0.428	0.447	0.337	0.404	0.445

Notes: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1. Constant: Small districts, NW=Region 1, Rural. Mean unit of high school English language arts teacher supply = 6.78 (equivalent to ~7 applicants per vacancy). Overall mean unit of teacher supply = 5.12 (equivalent to ~5 applicants per vacancy).