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Estimating the Firm's Labor Supply Curve in a "New Monopsony" Framework: School Teachers in Missouri

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Abstract

In the context of certain dynamic models of monopsony, it is possible to infer the elasticity of labor supply to the firm from the elasticity of the quit rate with respect to the wage. Using this property, we estimate the average labor supply elasticity to public school districts in Missouri. We take advantage of the plausibly exogenous variation in pre-negotiated district salary schedules to instrument for actual salary. Instrumental variables estimates lead to a labor supply elasticity estimate of about 3.65, suggesting the presence of significant market power for school districts, especially over more experienced teachers. This is partially explained by institutional features of the teacher labor market.

I. Introduction

There have been few attempts to estimate the labor supply elasticity to individual firms. In their survey of monopsony in the labor market, Boal and Ransom (1997) discussed only four studies that examine the question. Manning's (2003) recent book mentions another three, more recent papers, none of which has yet been published. This dearth of research is somewhat surprising, as the elasticity of the labor supply curve has important implications for labor market policies, such as the minimum wage.

Though this small pool of research partly reflects the technical difficulty of estimating the firm's labor supply curve (due in part to a lack of convincing natural experiments or instruments to solve the inherent endogeneity problem) a deeper explanation may lie in the skepticism about the Robinsonian model of single-firm monopsony (1969), which was thought to be of limited empirical relevance. However, recent theoretical models of the labor market suggest that individual firms may face upward sloping labor supply curves even in markets with many competing firms. For example, Bhaskar and To (1999) propose a model of monopsonistic competition. In an alternative approach, Manning (2003) develops the implications of a search model that also yields upward sloping labor supply curves to firm, even when there are many firms in the labor market.

We posit a dynamic model of labor market monopsony. In a model of the sort that Manning proposes, the elasticity of labor supply to the firm can be described in terms of the elasticity of quits to the wage, providing a very convenient way to estimate the firm's labor supply elasticity. We adopt this approach to examine the labor supply elasticity for school teachers to school districts in Missouri during the 1980s.

Our estimates suggest that school districts in Missouri have a large degree of monopsony power. Using elements of predetermined wage schedules as instruments we find firm labor supply elasticities of 3.65. We also discuss institutional features of the teacher labor market in Missouri that might be a source of market power for school districts.

II. Dynamic Monopsony and Labor Supply to the Firm

At least two recent approaches to modeling the labor market suggest mechanisms by which relatively small employers may wield monopsony power. Bhaskar and To (1999) develop a model of monopsonistic competition in which workers have heterogeneous preferences over some non-wage characteristic of potential jobs. In their particular example this preference is over a measure of distance to the job (closer is better). Since the distance characteristic is predetermined for the potential job offers, workers facing equal wage offers accept the closer offer. Thus each employer has some market power to lower the wage without losing all employees due their valuation of distance. Similarly, to increase firm size beyond the closely located employees, the firm will have to offer a higher wage. Another model of monopsony power that also incorporates the idea of distance is presented by Staiger, Spetz and Phibbs (1999), who posit that hospitals face more intense competition for nurses from their nearest neighbors than other hospitals in the area.

Boyd et. al. (2005) find that teachers are much more likely to end up in a job located close to the high school they attended, a fact they link to strong locational preference, a finding that lends interesting empirical support to the Bhaskar-To model.

Another class of models that produce monopsony implications for small firms follow the general equilibrium search model of Burdett and Mortensen (1998). In the Burdett-Mortensen model, market power accrues to employers because of search frictions. Currently employed workers constantly search for jobs. As job offers arrive, an employee leaves his current employer if offered a higher wage. An employer who offers a higher wage will lose fewer employees to higher-paying competitors and will have greater success in recruiting. Thus a higher wage will yield a larger work force.

Regardless of the source of the market power, in any dynamic monopsony model, equilibrium implies that the flow of recruits to the firm must balance the flow of those who leave. Thus if the size of the firm at time t is defined in terms of labor units N_t, with a separation rate of $s(w_t)$, and a recruitment function $R(w_t)$ both depending on the wage, the firm's size in the next period will be:

$$N_t = [1 - s(w_t)]N_{t-1} + R(w_t),$$

It follows that in a steady state,

$$s(w)N(w) = R(w), \text{ or}$$

$$N(w) = R(w)/s(w), \tag{1}$$

which can be interpreted as the long-run labor supply function to the firm, since it is based on a steady-state equilibrium. In elasticity terms, this dynamic labor supply function can be written as:

$$\varepsilon_{Nw} = \varepsilon_{Rw} - \varepsilon_{sw}. \tag{2}$$

This provides a basic framework from which the elasticity of labor supply to the firm might be estimated. However, as Manning (2003, p. 97) points out, estimating the elasticity of recruits with respect to the wage is conceptually difficult. Fortunately, the Burdett-Mortensen-Manning model provides a powerful insight into the relationship between the recruitment and separation elasticities. In that model, the recruit to one firm is the separation from another. The number of recruits that a firm might gain by increasing its offered wage is exactly the same magnitude as the number of quits that would be deterred. Thus, the recruitment elasticity is simply the negative of the separation elasticity. [See Manning (2003, p. 97) for a formal derivation of the result.] Therefore, the elasticity of labor supply to the firm can be written as:

$$(3) \qquad \varepsilon_{Nw} = \varepsilon_{Rw} - \varepsilon_{sw} = -2\varepsilon_{sw}.$$

This result makes it possible to estimate the firm's labor supply elasticity only from information on the firm's separations, a straightforward task if the necessary data are available.

Strictly, equation (3) depends on a very abstract model of the labor market. Many of the predictions of the Burdett-Mortensen model are clearly inconsistent with known facts about the labor market. Kuhn (2004) provides a thoughtful argument against the Burdett-Mortensen-Manning model as a basis for this type of analysis. While we recognize such criticism, we still believe that there is at least strong intuitive support for estimating the labor supply elasticity to the firm by equation (3).

Our approach relies entirely on two crucial results, both of which we argue are likely to hold outside the strict Burdett-Mortensen framework. The first is that dynamic labor supply to the firm may be upward sloping, a result consistent with much more general versions of the search model, such as Mortensen (2003) or Bontemps, Robin and van den Berg (1999), as well as alternative models of monopsony such as Bhaskar and To (1999).

The second essential result is that recruitment and separation elasticities are equal in absolute value. The insight that one firm's quit is another firm's recruit has strong intuitive appeal. Those who quit must (usually) end up working for another employer who provides a better job. It is hard to imagine how the size of one employer's gain from offering a higher wage can be much different that the size of the loss suffered by another because it offers a lower wage.

For the sake of argument, however, consider the possibility that the recruitment and separation elasticities are different. For example, in this context, one might believe that the heterogeneous teacher preferences which led candidates to their current district may lead to an observational separation rate that is less elastic than the recruitment rate with respect to the wage. This could be due to the tighter distance tying of current teachers than potential teachers who might include, for example, market entrants. This divergence could be even more likely if we consider possible lock-in mechanisms for teachers such as non-portable pensions. Thus, like many steady state results, the equality between recruitment and separation elasticities might be better viewed as an approximation.

III. Data

The analysis makes use of data from four sources. The data about individual school teachers as well as some district characteristics comes from the Missouri Department of Elementary and Secondary Education (MSDESE) census of teachers. For the 1988-89 and 1989-90 school years this provides the actual salary, fraction of time employed (full-time equivalent), years total teaching experience, years seniority in current district, and highest educational degree held, along with a unique identification number for each teacher.

Most school districts in Missouri have established a salary “schedule” — a rule that defines the salary in terms of the teacher’s highest degree and seniority, and in some cases, teaching experience in other districts. Each year the Missouri State Teachers Association (MSTA) surveys districts in the state and collects salary schedules from those that respond to their survey. From this survey we obtain the salary point for a teacher with a bachelors degree and no experience, referenced hereafter as the “base salary.” (In fact, many of the schedules define a given salary simply in increments above this base.) Not all districts respond to the MSTA survey, and not all districts that do respond have a salary schedule in place, but most districts (451 of 540) provided base salary information for the 1988-89 year (which will be the primary focus of this analysis). Additional characteristics of Missouri school districts such as student averages for race, ethnicity, IEP status, and free lunch eligibility as well as per pupil spending data for the 1989-1990 school year come from the National Center of Education Statistics Core of Common Data.

The final source for data is the 1990 Decennial Census of the United States from which we have obtained variables that measure the urban status and economic situation of the district area. These variables include the percentage of the population of a school district that lives in a rural area, and a measure of population density, as well as the median household income in each district. These data have been aggregated from census geographical units to match the school district boundaries by the Office of Social and Education Data Analysis of the Missouri State Census Data Center.

There were a total of 49,874 teachers in the MSDESE data for the 1988-89 school year, of which 177 had a full-time equivalent of zero or missing. Of the remaining 49,697, there were 340 teachers working at less that 50 percent FTE, and these have been excluded from the sample. (This number represents less than 0.7 percent of the sample.) Table 1 summarizes this individual-level data.

A "separation" occurs if a teacher who was present in the 1988-89 school year is not present in the 1989-90 school year, or if the teacher works for a different district in the latter year. The overall separation rate is just less than 10 percent. Average full-time-equivalent salary is $25,856 for 1988, though the data indicate a range from $505 to $91,692. Both these extremes are likely the result of some sort of clerical error as there are only twenty-three recorded salaries below $5,000 and one above $65,000. The following analysis includes all observations but results are not sensitive to omitting these twenty-four outliers.

Slightly more than 50 percent of all teachers work for districts located in the St. Louis or Kansas City metropolitan areas. The average teacher teaches in a district that contains about 10,000 students, although the number of students in a district ranges in value from 14 to 46,128 and is highly skewed in distribution.

Table 2 presents the district aggregate data. Column (1) considers all districts in the sample. The separation rate for the average district is about 14 percent. This reflects the skewness of the size of school districts. Smaller districts tend to have higher separation rates, and most districts are small. Similar patterns are also visible in other variables, such as the number of pupils in the district, or the metropolitan area dummies. The average district has only about 1,500 students, while the average teacher is employed by a district that has about 10,000 students! All of these results reflect the fact that the majority of the districts in the state are small and rural, while there are a few very large districts. Column (2) considers the subsample of districts for which base salary data is available. A comparison of the columns does not reveal any striking (or indeed statistically significant) differences in most characteristics, but it shows a number of small differences consistent with the fact that the smallest school districts, those with less than 25 teachers, are less likely to have a salary schedule.

IV. Estimating the Elasticity of Labor Supply to the Firm

A. Background

The task at hand is to estimate the elasticity of separations with respect to the wage. There is already a large literature in labor economics that examines separations. Much of this literature concentrates on the relationship between demographic characteristics and the likelihood of quitting or being laid off, and although these issues are related to this study, they are not particularly relevant to the analysis. This literature is surveyed, for example, in Farber (1999).

More germane are a number of studies that examine the sensitivity of quits to wages, such as Pencavel (1972), and Parsons (1973). In fact the Pencavel model has some search-theoretic elements, including the "monopsonistic" idea that the firm can influence the turnover rate by choosing a high or low wages. However, most of this literature focuses on the question of specific human capital, since turnover is particularly costly for firms and workers in industries where there is a large amount of specific training. District or school specific human capital is probably relatively unimportant in the market for public school teachers, as most states set the curriculum, and what an instructor teaches in one school she could just as well teach in another.

Although these previous papers do not address the issue of the labor supply to the firm directly, a couple more recent studies that apply a similar approach to estimate labor supply to the firm. Ransom and Oaxaca (2008) examine the differences in the labor supply behavior of women and men at a large chain of grocery stores, while Manning's (2003) book contains extensive empirical analyses, some of which are comparable to the analysis presented here.

B. Estimation

The primary obstacle to estimating a separation elasticity and hence an elasticity of labor supply to the firm is likely to be an identification issue. To see this, consider the estimation of a regression of teacher separation on salary and related controls for both individual and district characteristics. Given the nature of the data, available controls are unlikely to proxy well for unobservable salary correlates that also affect separation rates, leading to bias in the parameter estimates. We address this problem with an instrumental variables strategy that uses the district base salary from the salary schedule as an instrument for actual salary. This provides an identified parameter estimate to create the separation elasticity if the base salary is correlated with actual salary and if base salary is properly excludable from the relationship of interest

Because we will be using district level variation in base salary levels to identify our separation elasticity, working with district level observations seems sensible. However, we still wish to account for the fact that individual teacher level characteristics are likely to have an important role in explaining separations and salary levels. Consequently we begin by estimating:

(4) $$S_{i,d} = \alpha + X_{i,d}\lambda + \delta_d + \eta_{i,d}$$

via a linear probability model. $S_{i,d}$ is a dummy variable equal to one if the teacher leaves his or her district after the 1988-89 school year, $X_{i,d}$ is a vector of teacher characteristics including experience, time with current employer, sex, and education level, and δ_d is a district fixed effect. We then form district average residuals from this regression, $\widehat{S}_d$ for each district. We use a similar methodology to produce a district level regression adjusted log salary residual, $\ln \widehat{W}_d$. Regression coefficients for these models are reported in Table A1.

The regression adjustment allows us to easily see the relationship between salaries $\ln \widehat{W}_d$ and separations $\widehat{S}_d$ at a district level, presented as figure 1. Note that the separation rate is declining with increases in salary as expected, although the slope does not appear particularly steep. Also, it appears that several districts had very few separations during this year, and that one of the districts experienced a full turnover of 100 percent of their teachers. (That district had only 30 students and 3 teachers in 1988).

Though the graphical evidence is encouraging, there is little reason to believe a simple slope line through the data will provide us with a convincing parameter estimate. Consider a generalized regression form of the data in figure 1.

$$\text{(5)} \qquad \widehat{S}_d = \beta \ln\left(\widehat{W}_d \big/ C_d \right) + X_d \gamma + \varepsilon_d = \alpha + \beta \ln \widehat{W}_d - \beta \ln C_d + X_d \gamma + \varepsilon_d$$

where $\widehat{S}_d$ and $\ln \widehat{W}_d$ remain as previously defined, while C_d is a district level cost of living index and X_d is a vector including district characteristics that may affect teacher salaries. In this formulation, the firm's elasticity of separations with respect to the wage may be calculated as β/S_d. An "average" elasticity is $\beta/\overline{S}$, where $\overline{S}$ is the sample mean separation rate. Although the model does suggest the possibility of identifying different elasticities for teachers or districts with particular characteristics, we initially confine our interest to estimating the average elasticity.

Equation (5) clearly shows that unobservable differences in cost of living levels represent a threat to identification. In other words, a cost index is necessary because salary differentials likely reflect, in part, the higher cost of living in some areas. Furthermore, to the extent that cost of living differences drive the variation in base salary schedules, our IV specification will fail to consistently estimate β unless we also condition on the cost of living. However, if we can control for differences in the cost of living across districts, the remaining variation in base salary is likely to be due to differential district level demand for teachers, exactly what we require to identify a supply parameter.

Although exact differences in the cost of living depend on the teachers' housing locations, we will assume that housing locations are closely proxied by job location. Thus, we include the census estimated median household income of the school district in our regressions to control for the salary differential due to locational factors. Recognizing the limited nature of any single cost index we also include a population density index for the district and the fraction of the district's residents who live in "rural" areas, since some who live in MSAs actually live in the rural parts of counties. (MSA boundaries follow the boundaries of counties, not necessarily the boundaries of the urbanized area of the city.)

Urban economic models of location choice, such as the "open city" model in Mills and Hamilton (1989, p. 115), explain differences in wages across geographical areas as compensating differences for the higher cost of housing and/or the longer commutes required of those who live in larger cities. Since in locational equilibrium the cost of living is the same for everyone living in the same city, and because all of those living outside of metropolitan areas experience roughly the same cost of living, these models suggest another candidate index for the geographical variation in cost of living can be captured with a set of dummy variables that identify the major cities of the state. In this spirit we also present regressions with dummy variable controls for census Metropolitan Statistical Areas (MSA) of the state (our approximation to these "cities."). Our results indicate that using either or both methods of accounting for cost of living differences produces similar estimates of the labor supply elasticity.

Beyond the cost of living there are other potential omitted variable pitfalls. Although a very high percentage of salary variation among teachers can be explained by observed experience and education measures, there is still a substantial amount of variation that is likely due to non-measurable teacher characteristics. Any unobservable teacher or district characteristic that is positively associated with both separation and salary levels would bias the OLS estimates of β toward zero.[1] Additionally it is likely that the reported salary data are measured with error, leading to attenuation in the estimates of β. Both these factors suggest that an instrumental variables approach is more likely to produce a meaningful estimate of β than simple OLS regression.

We anticipate that our instrumental variables strategy will account for both these sources of bias. An ideal instrument would encapsulate that part of teacher salary that reflects the predetermined wage setting policy of his employer. The salary schedule or base data provides a partial insight into that wage setting policy by giving a differential evaluation of a basic teacher by districts that is predetermined relative to new hires and is uncorrelated with unknown teacher characteristics. Estimation then proceeds via two-stage least squares on equation (5) with the natural logarithm of a district's base salary as the excluded instrument.

Figure 2 illustrates the positive bivariate first-stage relationship between log base salary and our district regression adjusted average salary, $\ln \widehat{W}_d$. It also suggests that the positive relationship between base and actual salary is not confined to large districts. Table 3 provides the regression estimates of the first stage relationship, and shows a strong positive correlation between base and actual salaries. This relationship persists with the addition of numerous control covariates including SMSA fixed effects. The F-statistic on the instrument is close to 100 in all cases suggesting that the analysis is unlikely to suffer from weak instrument issues. Also the base salary and included controls do a good job of explaining cross district salary differences, with a coefficient of variation of 0.88 in one specification.

[1] Beyond this simple consideration, the salary of a particular individual may also represent some match-specific rents. This raises complicated issues that are beyond the scope of this paper, but are discussed, for example, in Altonji and Shakotko (1987).

As a benchmark, Columns (1) – (3) of Table 4 present OLS estimates of the elasticity of separations from equation (5), along with the implied elasticity of the labor supply curve to Missouri school districts. Column (1) includes controls designed to capture differences in the cost of living across districts. The estimates here suggest that it would require almost a 10% increase in average teacher salary to reduce separations by a single percentage point. These coefficient estimates are robust to the addition of other district characteristics in column (2) and the addition of SMSA fixed effects in column (3).[2]

Because of the lack of sensitivity of separations to wage changes, these OLS estimates generate a low implied elasticity of labor supply to the firm, around 1.6. If true, these estimates suggest that Missouri school districts have a great deal power to set wages. A standard measure of monopsony power is Pigouvian "exploitation:"

$$E = \frac{(MRP - w)}{w} = \frac{1}{\varepsilon_{N,w}} . \qquad (6)$$

(See Boal and Ransom, 1997, p. 87 for a discussion.) In a world where monopsony power arises because there is a single employer, an elasticity of less than 2 implies that Missouri teachers are paid less than half the marginal value of output! Of course, in the context of equilibrium search models, the comparison is not quite so straightforward, as the monopsony power arises from imperfect information and other frictions in the labor market. Nevertheless, this is an extremely low elasticity of labor supply to the firm. Furthermore the OLS estimates here are robust to the choice of covariates. The only specification that results in estimated elasticities that are much greater in magnitude is one that eliminates all cost of living controls (including SMSA fixed effects) from the regression.

[2] Furthermore the use of a Probit model produces similar estimated marginal effects of log salary on separations, so we do not believe that model linearity is important in our results.

In order to provide estimates that will be directly comparable to the instrumental variable regressions, columns (4) – (6) repeat the previous analysis using only those districts that have base salary data available. In each case the effect of salary on separations is not very different from the OLS coefficient obtained from the whole sample, suggesting that the IV results discussed below are not driven by selecting a particular composition of districts.

These instrumental variables estimates are presented in Table 5 whose columns contain specifications that match those of the corresponding column numbers in the preceding table. The estimated coefficient on salary is much larger than that estimated by OLS--only a 4-5 percent salary increase would be required to produce a one percentage point decrease in separation rates. This is likely due to bias in the OLS estimates, perhaps because of some combination of omitted variables and measurement error. These results in turn imply a much higher elasticity of labor supply to the firm, though the implied elasticity is still only about 3.7. Furthermore, the parameter on which the elasticity estimate is based is estimated with relatively high precision, and it is evident that the elasticity of labor supply to the firm is much smaller than the infinity of the perfectly competitive model. Interestingly, the Pigou's E for this estimate is still around 27 percent, which seems rather large. These results indicate that Missouri school districts have a meaningful level of market power.

The IV results are also relatively robust to changes in included covariates.[3] Though the primary identifying assumption of the instrumental variables model, the excludability of base salary from the reduced form regression, is not directly testable, it is hard to construct a plausible story whereby the base salary would act through a channel other than actual salary.

[3] The IV results are also robust to the omission of the two very large districts in the state (St. Louis and Kansas City) or for that matter the omission of all districts in those two MSAs.

C. Discussion

Is the estimated labor supply elasticity to firms too low to be plausibly believed? Is the number really an indication of a shortcoming in the new monopsony model or its lack of applicability to the teacher labor market? While both of those conclusions are certainly possible there are some institutional features of the labor market for teachers that suggest that a high degree of district market power is plausible.

First, there is the Boyd et. al. (2005) evidence on the strong locational preferences of teachers. They show that teacher have strong preference to work in geographical areas near the high school they attended. In their study of teachers in the state of New York, they found that new teachers were four times more likely to accept a teaching position within five miles of their hometown than one more than forty miles away. A second fact that is consistent with district market power is that a substantial fraction of teachers are also second earners within their families which may limit their mobility. An analysis of the 1990 PUMS census data (Ruggles et al. 2004) reveals that almost two-thirds of Missouri school teachers in 1990 were born in Missouri, a fact consistent with strong locational preferences of teachers. If the sample is further restricted to exclude the teachers in the large cities of St. Louis and Kansas City the Missouri natality of teachers is 20 percentage points higher.

A strong preference for employment in a small geographical area is certainly a potential factor in low responsiveness of quit rates to salary differentials. Another possible source of market power is the nature of teacher pensions. Many school districts, including those in Missouri in the late 1980's, offer defined benefit pension plans that vest after some term of employment (3-5 years) but suffer from a lack of portability. Because of their pension situation, job movement could induce a significant financial loss to a Missouri schoolteacher of that period.

If pension lock plays a role in the low responsiveness of teachers to salary differentials, the responsiveness should vary by teacher experience. In order to test this possibility, we separated the teacher pool into experience categories and repeated the analysis. The results for low versus high experience teachers are presented in Table 6. As expected, teachers with fewer than ten years experience were almost 2.5 times as responsive to salary differentials as were teachers with 10-20 years of experience. In fact the suggested labor supply elasticity for a hypothetical district with all less experienced teachers is about 5.65 according to these estimates, suggesting a much lower degree of market power for the district.

The appropriateness of a monopsony model to describe employer behavior might be questionable in the case where employees are represented by unions. However, teachers' unions in Missouri are prohibited by state law from formal collective bargaining. The law requires districts to "meet and confer" with teachers or their representatives. This means that "bargaining" takes place at the discretion of the local school district. Teachers are legally proscribed from striking and cannot enter into a binding collective bargaining contract with local school districts. Nevertheless, a more-or-less formal bargaining process does take place in large St. Louis and Kansas City districts.[4] It is possible that teachers' unions exert some influence in the salary determination process. We ignore this role in our analysis.

[4]This information is based on a discussion with Professor Michael Podgursky, professor of economics at the University of Missouri.

V. Conclusions

Newer models of many-firm monopsony help motivate the notion that the dynamic movement of labor markets may not be frictionless. This framework provides a potential new approach for estimating the elasticity of labor supply to the firm. In this paper we estimate the labor supply elasticity to public school districts in Missouri. Because of the likely presence of measurement error and omitted variables, we adopt an instrumental variables strategy using published salary schedules of the districts as an instrument. Although the IV and OLS results are quite different, both suggest that the process by which teachers and districts are matched results in a substantial amount of wage-setting power for school districts.

In fact, our instrumental variables estimates imply a labor supply elasticity to the firm of about 3.65. This suggests that labor market frictions give employers enough power to reduce wages somewhere in the neighborhood of 27 percent, when compared with a world of perfectly informed and mobile workers. However, certain institutional features of the teacher labor market suggest teachers, especially those with high experience, may have different mobility potential than average workers. Further research is needed to understand how these results apply to firms more generally where workers may not exhibit such strong locational preferences.

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Table 1: Descriptive Statistics – Individual Teachers

Variable	Mean (std dev.)
Separation (=1 if left 1988 job)	0.098 (0.297)
FTE Salary	25,856 (6,863.102)
FTE	0.992 (0.060)
Female	0.749 (0.434)
BA/BS Degree	0.564 (0.496)
MA Degree	0.405 (0.491)
Specialist Degree	0.017 (0.129)
Doctorate Degree	0.004 (0.062)
Years Teaching Experience	13.525 (8.620)
Years Tenure with District	10.627 (7.988)
Number of Pupils in District	10,012 (13,151)
Kansas City MSA	0.198 (0.399)
St. Louis MSA	0.318 (0.466)
St. Joseph MSA	0.021 (0.143)
Springfield MSA	0.049 (0.216)
Columbia MSA	0.020 (0.141)
Joplin MSA	0.028 (0.165)

N= 49,357

Table 2: Descriptive Statistics – District Averages

Variable	All districts (n=540)	Base Salary Districts (n=451)
Separation Rate	0.143	0.136
	(0.114)	(0.098)
District Base Salary	--	16,141.76
		(1,966.18)
FTE Salary	21,125	21,627
	(3,894)	(3,926)
Log Salary	9.935	9.958
	(0.162)	(0.160)
Number of Pupils in District	1,485	1,599
	(3,478.877)	(3,113)
Number of Teachers	91.419	96.8
	(227.009)	(189.7)
District Population Density	0.257	0.288
	(0.912)	(0.937)
District Fraction Rural	0.796	0.763
	(0.337)	(0.352)
Log of Median HH Income	9.964	9.977
	(0.278)	(0.281)
Fraction Free Lunch Elig.	0.285	0.273
	(0.156)	(0.152)
Fraction IEP	0.122	0.119
	(0.054)	(0.048)
Fraction Black Students	0.039	0.043
	(0.114)	(0.118)
Fraction Hispanic Students	0.003	0.003
	(0.009)	(0.007)
Per-Pupil Expenditures	4,242.370	4,134.634
	(1,120.514)	(1,046.272)
Kansas City MSA	0.085	0.093
	(0.279)	(0.291)
St. Louis MSA	0.104	0.118
	(0.305)	(0.322)
St. Joseph MSA	0.015	0.016
	(0.121)	(0.124)
Springfield MSA	0.035	0.033
	(0.184)	(0.180)
Columbia MSA	0.022	0.024
	(0.148)	(0.154)
Joplin MSA	0.011	0.011
	(0.105)	(0.105)

Table 3: First stage estimates of the total and base salary relationship.

	(1)	(2)
Log Base Contract Salary	0.440	0.363
	(0.048)**	(0.036)**
District Population Density	0.002	0.009
	(0.005)	(0.005)
District Percent Rural	-0.068	-0.100
	(0.016)**	(0.013)**
Log of Median HH Income	0.157	0.052
	(0.016)**	(0.017)**
Fraction Free Lunch Elig.	0.002	0.028
	(0.030)	(0.024)
Fraction IEP	-0.138	-0.241
	(0.097)	(0.081)**
Fraction Black Students	0.038	-0.026
	(0.027)	(0.030)
Fraction Hispanic Students	0.221	0.678
	(0.392)	(0.615)
Per-Pupil Expenditures (x1000)	0.001	0.007
	(0.003)	(0.003)*
Kansas City SMSA		0.039
		(0.012)**
St. Louis SMSA		0.058
		(0.016)**
St. Joseph SMSA		0.012
		(0.013)
Springfield SMSA		0.029
		(0.017)
Joplin SMSA		-0.012
		(0.016)
Columbia SMSA		0.046
		(0.025)
R-squared	0.78	0.88

N = 451. The dependent variable is district average of the natural logarithm of teacher salary. All regressions weighted by the number of teachers in the district. Robust standard errors in parentheses. * significant at 5%; ** significant at 1%

Table 4: OLS Estimates of the Labor Supply Elasticity to Missouri School Districts

	All districts			Districts with base salary data (iv sample)		
	(1)	(2)	(3)	(4)	(5)	(6)
Log Salary	-0.114	-0.119	-0.112	-0.116	-0.125	-0.118
	(0.027)**	(0.027)**	(0.031)**	(0.030)**	(0.030)**	(0.033)**
Implied Labor Supply ε	1.594	1.664	1.566	1.706	1.838	1.735
District Population Density	0.007	0.003	0.005	0.008	0.004	0.005
	(0.002)**	(0.002)	(0.003)	(0.002)**	(0.002)	(0.003)
District Percent Rural	0.009	0.016	0.018	0.015	0.020	0.021
	(0.008)	(0.009)	(0.009)*	(0.008)	(0.009)*	(0.009)*
Log of Median HH Income	0.015	0.029	0.034	0.015	0.028	0.031
	(0.009)	(0.011)*	(0.014)*	(0.009)	(0.012)*	(0.014)*
Fraction Free Lunch Elig.		0.023	0.023		0.018	0.017
		(0.023)	(0.023)		(0.025)	(0.025)
Fraction IEP		0.073	0.072		0.058	0.057
		(0.061)	(0.061)		(0.062)	(0.063)
Fraction Black Students		0.016	0.016		0.019	0.020
		(0.016)	(0.016)		(0.016)	(0.016)
Fraction Hispanic Students		0.405	0.349		0.172	0.118
		(0.250)	(0.281)		(0.240)	(0.258)
Per-Pupil Expenditures (x1000)		0.002	0.002		0.003	0.003
		(0.002)	(0.002)		(0.002)	(0.002)
SMSA fe	No	No	Yes	No	No	Yes
Observations	540	540	540	451	451	451
R-squared	0.30	0.32	0.33	0.32	0.34	0.34

Dependent variable is a district separation rate which has been regression adjusted to reflect differences in individual level teacher characteristics. All regressions weighted by the number of FTE teachers in the district. Robust standard errors in parentheses.* significant at 5%; ** significant at 1%. Joint F-tests fail to reject the hypothesis that the collective SMSA fixed effects equal zero.

Table 5: 2SLS Estimates of the Labor Supply Elasticity to Missouri School Districts

	(1)	(2)	(3)
Log Salary	-0.211	-0.243	-0.251
	(0.064)**	(0.069)**	(0.079)**
Implied Labor Supply ε	3.103	3.574	3.691
District Population Density	0.009	0.003	0.004
	(0.002)**	(0.002)	(0.003)
District Percent Rural	0.005	0.009	0.010
	(0.010)	(0.011)	(0.011)
Log of Median HH Income	0.035	0.051	0.049
	(0.015)*	(0.017)**	(0.018)**
Fraction Free Lunch Elig.		0.016	0.012
		(0.026)	(0.027)
Fraction IEP		0.025	0.019
		(0.067)	(0.070)
Fraction Black Students		0.029	0.027
		(0.017)	(0.017)
Fraction Hispanic Students		0.249	0.257
		(0.246)	(0.272)
Per-Pupil Expenditures (x1000)		0.003	0.003
		(0.002)	(0.002)
SMSA fe	No	No	Yes
R-squared	0.31	0.32	0.32

N=451. Dependent variable is the district separation rate. All regressions weighted by the number of FTE teachers in the district. Robust standard errors in parentheses.
* significant at 5%; ** significant at 1%

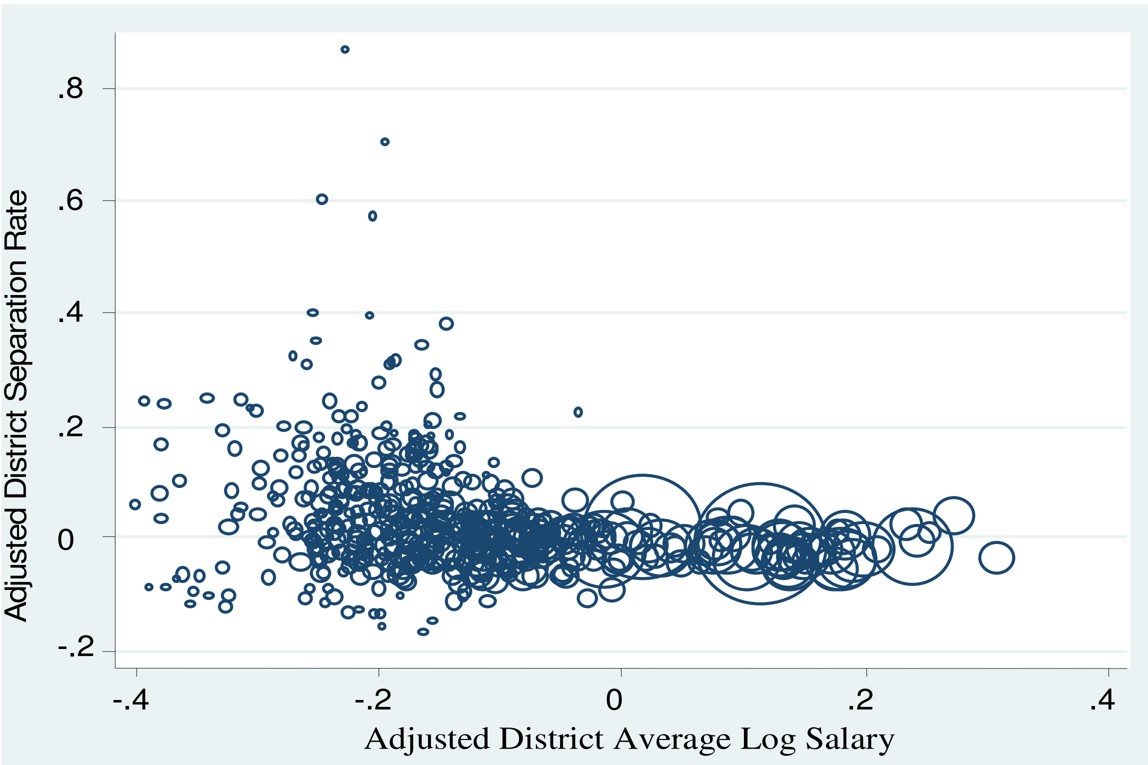
Table 6: Teacher Experience and Separations

	Experience (10 – 20 years) (1)	Experience (<10 years) (2)
Log Salary	-0.171 (0.062)**	-0.418 (0.129)**
	N=446	N=450

Regressions are analogous to Table 5 column (1). The sample is made of district averages across high or low experience teachers respectively. Robust standard errors in parentheses. * significant at 5%; ** significant at 1%

Figure 1

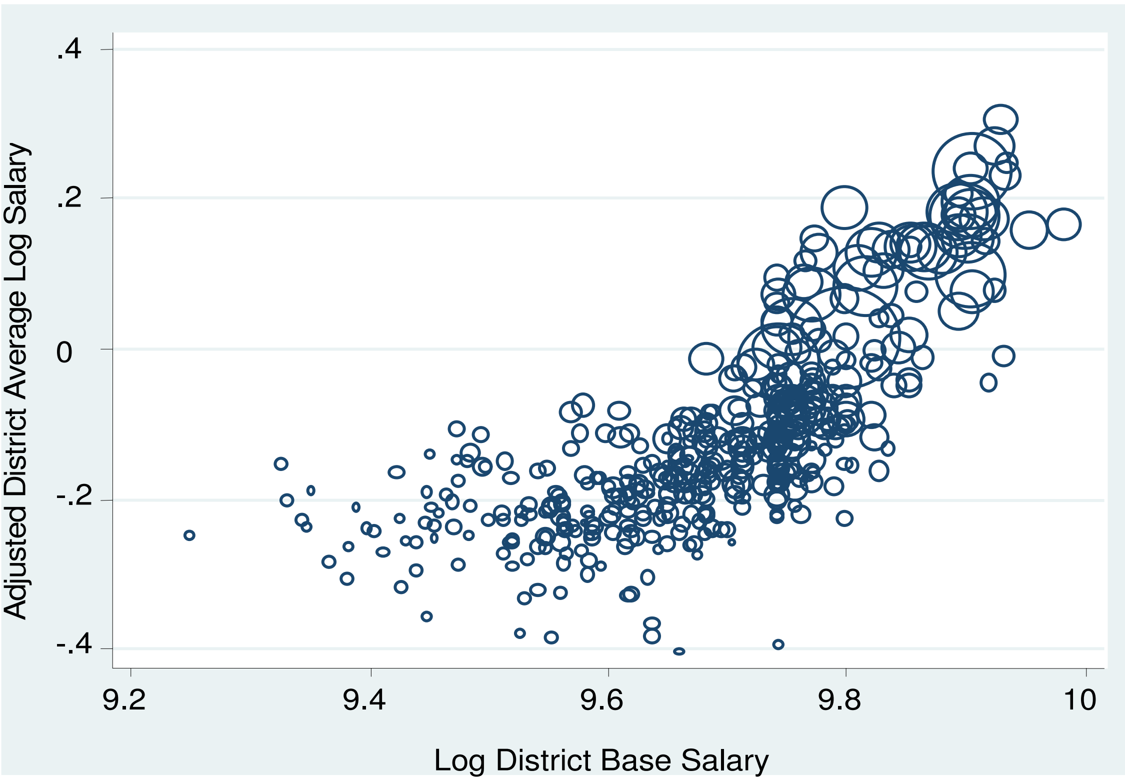
Relationship of District Separation Rate and Average Salary



Notes: Size of the circle is proportional to the number of teachers in the district. Both variables are district averaged residuals from individual level regressions on teacher characteristics.

Figure 2

Relationship of District Base Salary and Actual Average Salary



Notes: The size of the circle is proportional to the number of teachers in the district. Adjusted District Average Log Salary represents district averaged residuals from individual level regressions on teacher characteristics.

Appendix Table A1: Individual determinants of teacher outcomes

	Employment Separation (1)	Log Salary (2)
Teaching Experience	-0.011	0.020
	(0.001)**	(0.000)**
Experience^2 (x100)	0.036	-0.037
	(0.002)**	(0.001)**
Tenure with District	-0.010	0.010
	(0.001)**	(0.000)**
Tenure^2 (x 100)	0.025	-0.012
	(0.003)**	(0.001)**
Female	-0.015	-0.061
	(0.003)**	(0.001)**
MA Degree	0.017	0.116
	(0.003)**	(0.001)**
Specialist Degree	0.019	0.137
	(0.011)	(0.004)**
Doctoral Degree	0.050	0.193
	(0.021)*	(0.008)**
Number of district fe	540	540
R-squared	0.03	0.64

Standard errors in parentheses. N = 49,357. All regressions also include district fixed effects. * significant at 5%; ** significant at 1%.