ECON 398: Advanced Econometrics
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Effects of Teacher Retention on Student Performance

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I. Introduction:

Teacher shortages have been an important issue of interest in the discussions on the United States educational system, especially concerning its stature in the world stage. After the Great Recession, an increasing demand for teachers met with deteriorating supply not only due to previous layoffs and retirements, but a significant rate of attrition of 8% compared to well-performing countries like Finland and Canada with 3-4% (Sutcher, 2016). Unattractive pay and lack of incentives often leads to fewer qualified individuals entering or continuing an education career. While temporary market conditions are to blame for this crisis, many systematic problems exist. Temin (2002) have argued that the current market for teachers, coupling inflexible union regulations and decreases in funding from the government, is at a static equilibrium that would continue and worsen the educational quality nationwide if there are no radical shifts in how it is organized.

Concurrent and symptomatic of these trends are the high turnover rates in schools with 13.% annual turnover nationwide and 30% of new teachers leaving the profession within five years, and both hovering at higher rates for high-poverty, urban and low-performing schools (García and Weiss, 2019). There has been plenty of evidence relating teacher turnover rate with student performance, with the majority showing that high turnover affects student achievements negatively and decrease the overall faculty quality (Jackson and Bruegmann 2009; Sorensen and Ladd 2020; Ronfeld 2013). Therefore, in order to understand the teacher shortages and how it affects the quality of education, this research project aims to examine how the retention of teachers in grade schools affect the educational quality of the institution, more specifically students' academic performance, with the goal to contribute to the economic discourse on hiring, spending, and organizational practices in public education.

Discussions in the literature on this topic have different approaches on determining the trends and causes of this correlation. A popular approach is the "compositional" one that points the disparity in performance to the quality of the teachers leaving and coming in, which influence the effect of the change in teacher quality whether it is negative or positive in the same direction.

Looking through this lens, García and Weiss (2019) show that compared to those who stay, smaller shares of those who left (for other schools or another profession) are qualified in almost every category, which means that generally schools are not losing quality because of attrition alone. This does not necessarily mean the replacements would be of better quality, which is the case in high poverty schools across the nation. Improving on this measure of compositional quality after turnover, Sorensen and Ladd (2020) analyze the composition of North Carolina schools' teachers through examining net effects of in-out flows, resulting in a negative correlation between turnover rates and rate of better-qualified teachers. A resulting policy recommendation of this approach - targeted increase in pay to the better performers in schools with difficulty retaining teachers - have seen success in the case of selective retention bonuses in Tennessee for high performing teachers in poor schools (Swain, et. al. 2019). By only focusing on the compositional changes in teachers, however, these researches leave out significant effects of turnovers on performance other than that of teacher characteristics, empirically demonstrated by Ronfeld et. al (2013) and theoretically examined by Ingersoll (2001).

The main alternative to the "compositional" approach focuses on these so-called "disruptive" effect of turnovers that are not necessarily explained by change in quality, such as the decrease in institutional knowledge and relationships (Jackson and Bruegmann 2009), and the costs of replacements and transitions placed on schools, teachers and students (Sutcher, 2016). Looking into a sample of more than 1 million grade 4 and 5 students in New York, Ronfeld (2013) shows that even when controlling for indicators of teacher quality, experience, and the outcome of students switching teachers, there are still lingering negative effects of turnover rate that might be related to more structural changes to schools caused by the disruption. This effect is especially salient for low-performance schools, as the students are more deeply affected by the same rate of change, and the schools' turnover rate is often higher as well. While these signals point towards a 'disruptive' effect on performance, there has not been many significant research inferring endogeneity between turnover-induced performance shift and any number of single disruptors, with Jackson and Bruegmann (2009) showing only that peer-spillover effects should not be assumed away, not that it is an endogenous factor in student performance.

Therefore, further examinations of the non-individual characteristics within teacher turnover can be useful in isolating its effects on student performance. The previous literature

suggests that having a favorable teaching environment is negatively correlated with the turnover rate (Ingersoll 2001; Perrachione 2008). The teaching environment can be measured by general school conditions, student behavioral measures, and with consideration of teachers, students and staff's perceptions, which García and Weiss (2019) have touched on in a comprehensive nationwide report. The picture is grim, with large portions of the teachers reporting unprepared and ill-supported students, safety concerns, lack of voice and influence in job practices and materials. This leads to a high degree of dissatisfaction with their schools, especially in the high-poverty and underserved ones that need greater quality and retention the most. While teacher turnover has not been widely explored in terms of organizational conditions and traits, employee turnover theory can be applied as schools are often classified as relying on "uncertain and nonroutine technology" that can be disrupted by changes in the dynamics and composition of the working environment, which in turn leads to change in effectiveness (Ingersoll, 2001). Similarly, the environment and fit of teaching and school characteristics are shown to be significantly related to satisfaction and retention rates in a survey of Missouri public elementary teachers, while job concerns such as salary and workload are considered more minor factors (Perrachione, 2008). This is pertinent with the observation in the New York analysis of better teachers being reluctant to transfer even with lower income, lower performance schools (Ronfeldt, 2013). However, as Kraft et. al. (2016) point out, past research which has looked into the effects of environment on turnover and achievement either does not contain longitudinal data, which let time-invariant factors between schools or districts to affect the results, or only looks at one aspect of teaching environment. The researchers then proceed to analyze panel data on New York city schools, concluding that administrator's leadership and a safe, orderly environment are closely related to turnover and student achievement.

This research, building on these existing findings and methods, use a panel dataset on public schools in Massachusetts to demonstrate the interrelationships between teacher turnover, student performance, and the educational environment including safety and order, administrator turnover, and in-district funding. When controlling for the teachers' quality through the net compositional flow of teachers, the student's characteristics, and school fixed effects, it examines whether measures of school environment contribute to a significant relationship between low turnover rates and good school performance. By looking into a wide range of factors, both compositional and disruptive, across a period of time, hopefully the research can

bring value to the policy debates on how to improve schools with limited resources and shortage of quality teachers.

II. Empirical Methodology:

1. Conceptual Model:

This paper examines teachers' turnover in grade schools and aims to understand how teacher turnover affects student achievement. Using panel data on some Massachusetts school districts, we hope to provide more evidence to suggest that when controlling for the teachers' quality and the student's characteristics, changes in school environment contribute to a significant relationship between low turnover rates and good student performance when controlling for the teacher cohort's quality and student compositions.

The existing literature proposes two mechanisms driving this relationship, one based on the change in the compositional makeup of the teachers, while another accounts for the disruptive effects on performance even with comparable teaching cohorts. The model here, while also controlling for certain measures of teacher quality, includes year and school fixed effects so as to account for time-invariant school characteristics and school-invariant shocks over time. We aim to further isolate the effects of teacher retention on students by controlling for other variables affecting specific schools over time than teacher retention, in this case including many variables of teaching environment such as leadership turnover, changes in class or student characteristics, and financial support.

2. Data:

We use a longitudinal data from the Massachusetts Department of Elementary and Secondary Education accessed through their School and District Profiles online reports. The data includes 360 observations representing 90 school districts in Massachusetts yearly, over a four-year period from the 2012-2013 school year to 2015-2016 school year. For each observation, the data includes information within 19 variables regarding district staff retention, rate of students disciplined for serious offenses, Mathematics class size, composition, and teacher quality, Mathematics MCAS exam results, and monetary data regarding teacher salary and funding for schools in the district. Table 1 provides the descriptions and summary statistics for the variables included in the data:

Table 1

Variable	Obs	Unique	Mean	Min	Max	Label
distname	360	91	.	.	.	District Name
distcode	360	90	4564222	10000	9150000	District Code
year	360	4	2014.5	2013	2016	Year of interest
retperc_p	360	29	81.52528	0	100	Principal % Retained
retperc_t	360	133	89.3875	76.4	97.9	Teacher % Retained
classsize	360	105	17.35361	9.6	22.8	Average Class Size
stfemale	360	124	48.4225	31.4	71.5	Female %
ellperc	360	80	2.001944	0	14.1	English Language Learner %
poorperc	360	258	22.88361	1.8	83.7	Economically Disadvantaged %
cpi	360	197	85.13278	66.3	98.6	CPI for MCAS Math
sgpmed	360	59	51.24306	23.5	78	Median SGP for MCAS Math
licensed	360	38	99.31556	60.4	100	% of Teachers Licensed in Teaching Assignment
corequality	360	52	98.92389	55	100	% of Core Academic Classes Taught by Teachers Who are Highly Qualified
discp	360	360	4.455818	0.08312	21.2707	% of students disciplined any offenses
sdiscp	360	356	1.646699	0	8.05687	% of students disciplined for drugs, violent or criminal-related offenses
lwage	360	360	11.19982	10.9505	11.4585	Log of Average Teacher Salary
lin_exppp	360	360	9.586814	9.14334	10.7464	Log of In-District Expenditures per Pupil
ltot_exppp	360	360	9.617603	9.21668	10.4286	Log of Total Expenditures per Pupil

Most of the variables' values are as anticipated, with wide variations and some skewness – examples are discipline, ELL/poverty rates skewing right, and the two quality measures *licensed* and *corequality* which skews left. The former two is predictable as certain schools are more segregated than the mean, and there are enough samples at the tails to include in the analysis. Meanwhile, the two quality variables have more extreme skews, which means that different groups are to be tested separately.

However, there are certain limitations in the data that might be obstacles to effectively estimating models. Firstly, there are not sufficient data and organization on schools and at each grade, thus the data are for the districts and at all grades. Not only are grouping all the grades and schools in a district detrimental to the significance of the results, the models also cannot separate the effects caused by the dynamics of turnover at each school. Moreover, the teacher salaries and expenditures measures are not for Mathematics specifically, which might mean unrealistic changes attributable to other subjects' teachers or aspects of the school budget. Finally, having data from more years would be useful in studying longer-term effects of sustained low retention.

3. Model Specifications:

Our dependent variables, which are the variables indicating student performance, are measures from the Mathematics MCAS results for each school district each year. This includes *cpi*, which is the average value of points, over 100, earned on the MCAS tests by students in that district. Another measure is *sgpmed*, which indicates the district median SGP value over 100, which is the change in a group of students' Mathematics MCAS achievement over time, with values below 30 indicating decline and values above 50 as being on target. For each of these outcome variables, we have our regression equation as below:

$$Outcome_{is} = \beta_1 (retperc\_t)_{is} + \beta_2 X_{is} + \gamma_s + \delta_i + \epsilon_{is}$$

$Outcome_{is}$ can be either of the two measures *cpi* and *sgpmed* at district *i* at year of interest *s*. $(retperc\_t)_{is}$ is our explanatory variable of interest, the percentage of teachers retained from the previous year in a district *i* at year of interest *s*. X_{is} is a vector of time-varying characteristics of the school districts, while γ_s, δ_i are the school and year fixed effects. By using the fixed effects in the model, we can control for time-invariant factors and time-varying shocks to all the districts and estimate the coefficient of interest β_1 with only the time-varying, district-specific variations. The controls vector X_{is} in the model include Math class composition variables (*classsize, stfemale, ellperc, poorperc*), teacher quality (*licensed, corequality*), funding measures (*lwage, lin_exppp* or *ltot_exppp*), principal retention (*retperc_p*), and disciplinary measures (*discp* or *sdiscp*). Information on the variables in this equation are available in Table 1.

For the coefficient of interest β_1, we can interpret its estimations as the net effects of increasing the retention rate of teachers in a district by one percentage point on the Math MCAS performance of the same district the next year. There has been plenty of evidence relating teacher turnover rate with student performance, with the majority showing that high turnover affects student achievements negatively (Sorensen and Ladd 2020; Ronfeld 2013). Even as district and year fixed effects are included, the negative relationship is likely to hold due to other disruptive effects of teacher change in a school such as peer spill-over effects or other dynamic factors (Jackson and Bruegmann 2009). Certain variables already controlled in the model can have a quite significant coefficient, however, as Sorensen and Ladd (2020) summarized from past research significant relationships of the variables of interest with factors of teacher credentials, class size, and student discipline as well.

III. Results:

Table 2 shows the two-way district and year fixed effects regression results with the same outcome of interest as the growth index for student performance at the Math MCAS but using five different modifications. The independent variable of interest is the percentage of teachers retained from the previous year and is included in all five models. Model 2 and 3 add compositional controls and environmental controls, respectively, while Model 4 and 5 have similar specifications to the former two but also including a 'poor' district dummy and its interaction term with the teacher retention variable.

According to Model 1, with the district and time fixed effects, a 1 percentage point increase in teacher retention rate means a .172 decrease in the student performance growth index with 10% significance. When controlling for the compositional variables, the effect is enlarged to a .181 decrease and improve in significance to satisfy the 5% level. Model 3 further controls for disruptive factors and sees a minor increase in magnitude to a .183 drop in the growth index for each 1 percentage point of teachers retained. Thus, we can infer that for the districts observed, high retention likely points to lower gains in student performance, and that compositional factors of student cohort and teacher quality might produce an upward bias on the coefficient of interest while environmental factors bring an upward bias to a lesser degree. However, as all of these factors aside from current student performance are not correlated with the dependent variable, it is inconclusive whether any of them cause omitted variable bias, including the current performance variable due to insignificant results in correlation test with retention. While the trend of bias from the compositional and environmental factors on the relationship of interest is consistent if not robust, the majority of literature suggests that high turnover affects student achievements negatively (Sorensen and Ladd 2020; Ronfeld 2013), but some have made the case for turnover being useful in providing better fit and necessary attrition (Temin 2002; Hanushek and Rivkin 2010).

Model 4 and 5 compares the effects of retention on performance in schools of different poverty levels. While the coefficients on the 'poor' district dummy and the interaction term are not statistically significant, the relationship of interest showed a downward bias (-.181 in Model (2) to -.176 in (4), -.183 in (3) to -.169 in (5)) produced by these factors. Unlike in Model 2 and 3, there is a downward change in the effect of retention when adding disruptive controls, from a decrease of .176 to a decrease of .169 and losing significance, which is partly due to the decrease

in the interaction term coefficient from 0.0023 to -0.0112. Additionally, as this coefficient is not statistically significant, it is difficult to estimate a reliable result. While these findings cannot reaffirm the literature, which considers poorer schools as particularly benefiting from lower retention (Ronfeld 2013), the shift from a significant, negative relationship between retention and performance to a more ambiguous one points to a similar direction.

Table 2: Regression results:

	Dependent variable: Student growth in performance index				
Independent variables	(1)	(2)	(3)	(4)	(5)
Teacher retention	-0.172*	-0.181**	-0.183**	-0.176*	-0.169
	(0.0917)	(0.0860)	(0.0871)	(0.103)	(0.104)
Environment controls:					
Principal retention			0.00429		0.00419
			(0.00923)		(0.00884)
Serious offence rates			-0.0882		-0.0528
			(0.404)		(0.366)
Compositional control:					
Quality instructor rates		-0.0638	-0.0642	-0.0897	-0.0945
		(0.0543)	(0.0581)	(0.0658)	(0.0682)
Current performance		1.807***	1.810***	1.795***	1.800***
		(0.258)	(0.260)	(0.241)	(0.243)
Student poverty rates		0.0824	0.0882	0.0827	0.0922
		(0.0545)	(0.0560)	(0.0557)	(0.0571)
Female student rates		-0.326	-0.322	-0.330	-0.326
		(0.213)	(0.215)	(0.217)	(0.220)
'Poor' dummy				2.696	3.891
				(16.27)	(16.13)
Retention and poor interaction term				0.00230	-0.0112
				(0.184)	(0.181)
Constant	67.13***	-65.58***	-66.00***	-63.78***	-64.81***
	(8.218)	(23.84)	(24.99)	(21.15)	(22.45)
District fixed effects	Y	Y	Y	Y	Y
Year fixed effects	Y	Y	Y	Y	Y
Observations	360	360	360	360	360
R-squared	0.066	0.347	0.347	0.362	0.362
Number of district codes	90	90	90	90	90

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

IV. Discussion:

The regression results in the first three models show that for the 90 school districts in Massachusetts observed over a four-year period, having higher teacher retention rates mean that student performance growth from the previous year would decrease. These results are not consistent with the majority of the literature, which suggests that higher turnover harms student achievement due to compositional factors regarding teaching quality and the disruptive effects of faculty change. There are theoretical advantages to turnover, such as allowing for better teacher-school fit and maintain greater competition and thus higher performance, with Hanushek and Rivkin (2010) providing evidence that teachers who stay are often more qualified than those leaving, even in low-income schools. However, a differentiating factor of this study is that the school districts observed are within the Massachusetts K-12 system, which is considered one of the best in the country, with ample funding, stringent accountability measures and relatively healthy supply of qualified teachers (Wong 2016). Thus, the negative effects of turnover such as less effective replacement teachers (compositional) and adverse changes to the school staff dynamics and educational environment (environmental/disruptive) are likely minimized in such a setting. Despite these strengths, there are still issues of achievement gap and segregation that negatively affect poorer schools in the state. As the paper examines the effects of retention on performance dependent on whether a school is low-income, the results show that the relationship of interest declines in both magnitude and significance. This means that allowing high turnover can be more harmful to student performance in more disadvantaged schools, and more effort should be made to retain high-performing teachers.

The paper also contains some limitations that hinder a deeper analysis. Firstly, the individual observations are at the school district level and for all grades, which does not allow for examining the dynamics of a group of teachers at a single school. Secondly, these results are from school districts that chose to report these data, which means that they can be lacking if generalized to apply to the entire state. There are also only four years of data, which restricts from analyzing more long-term effects. Thus, to expand our knowledge of the relationship between turnover and achievement for students, more detailed observations at preferable the individual teacher/student or school level coupled with more years of data would be useful in controlling for and understanding variations. Meanwhile, more variables measuring teacher ability and satisfaction would provide more policy recommendations for increasing the public gains from formal education.

Bibliography

García, E., and E. Weiss. *The Perfect Storm in the Teacher Labor Market*. Economic Policy Institute, 2019. Accessed March 31, 2020.

Hanushek, E., and S. Rivkin, "Constrained job matching: Does teacher job search harm disadvantaged urban schools?": *National Bureau of Economic Research*, Working paper No. 15816 (2010), Cambridge, MA.

Ingersoll, Richard M. "Teacher Turnover and Teacher Shortages: An Organizational Analysis." *American Educational Research Journal* 38, no. 3 (January 2001): 499–534.

Jackson, C. K., and E. Bruegmann. "Teaching Students and Teaching Each Other: The Importance of Peer Learning for Teachers." American Economic Journal: Applied Economics 4, no. 1 (2009): 85–108.

Kraft, M.A., W.H. Marinell, & D. Yee. "School organizational contexts, teacher turnover, and student achievement: Evidence from panel data." *American Educational Research Journal* 53, no. 5 (2016): 1411-1499.

Perrachione, B. A., G. J. Petersen, and V. J. Rosser. "Why Do They Stay? Elementary Teachers' Perceptions of Job Satisfaction and Retention." *Professional Educator* 32, no. 2 (Fall 2008): 25.

Ronfeldt, M., S. Loeb, and J. Wyckoff. "How teacher turnover harms student achievement." *American Educational Research Journal* 50, no. 1 (2013): 4-36.

Sorensen, L. C., and H. F. Ladd. "The Hidden Costs of Teacher Turnover." *AERA Open* 6, no. 1 (2020).

Sutcher, L., L. Darling-Hammond, and D. Carver-Thomas. *A coming crisis in teaching? Teacher supply, demand, and shortages in the U.S.*. Palo Alto, CA: Learning Policy Institute, 2016.

Swain, W. A., L. A. Rodriguez, and M. G. Springer. "Selective retention bonuses for highly effective teachers in high poverty schools: Evidence from Tennessee." *Economics of Education Review* 68 (2019): 148-160.

Temin, Peter. "Teacher Quality And The Future Of America," *Eastern Economic Journal* 28, no.3, (Summer 2002): 285-300.

Wong, Alia. "Why Do Massachusetts Public Schools Lead the Nation?" The Atlantic. Last modified May 23, 2016. https://www.theatlantic.com/education/archive/2016/05/what-are-massachusetts-public-schools-doing-right/483935/.