Examining the Relationship between School Inputs and Test Performance in Texas' Elementary and Middle School

[redacted]

Professor Sean Corcoran

APSTA.GE.2001, Fall, 2016

New York University

Introduction

Any number of factors play a role in determining students' educational outcomes. In Texas, the Academic Excellence Indicator System (AEIS) collects data on students' performance on the state's standardized test, the Texas Assessment of Knowledge and Skills (TAKS), and on other school factors—e.g., total enrollment and class size. The goal of this analysis is to determine which factors have the strongest correlations with test performance and racial/ethnic achievement gaps. Here, we examine AEIS data from all of Texas' public elementary and middle schools from the 2007-2008 academic year.

Texas public schools must adhere to the Texas Essential Knowledge and Skills (TEKS) state-mandated curriculum. The TAKS is the assessment used to measure how well students perform when tested in the subject areas of that curriculum. The test is administered to public school children in grades 3-11; however, our analysis is only concerned with elementary and middle schools' performance on the test and, therefore, only looks at test proficiencies for grades 3-8. It is important to note that not every subject area is tested every year. Children in grades 3-8 are tested in math and reading every year, but are only tested in science in grades 5 and 8 and are only tested in social studies in grade 8. Our analysis concerns math, science, social studies, reading, and overall test scores. Students are also periodically tested in writing, but writing performance is not considered in this analysis.

My analysis is based on data from all 6354 elementary and middle schools (of which, 271 are charters) supporting grades K-8. These schools cater to any imaginable grade range of students; however, the most popular ranges are EE-5 (1001 schools), PK-5 (895), and PK-6 (224), K-5 (509), K-6 (168), 6-8 (966), 7-8 (281). Some schools that teach at the elementary and

middle school levels also teach high school students—e.g., 49 schools teach all grades from K-12. Variables in this dataset concern teacher and student characteristics, school characteristics, test score proficiency rates, and more.

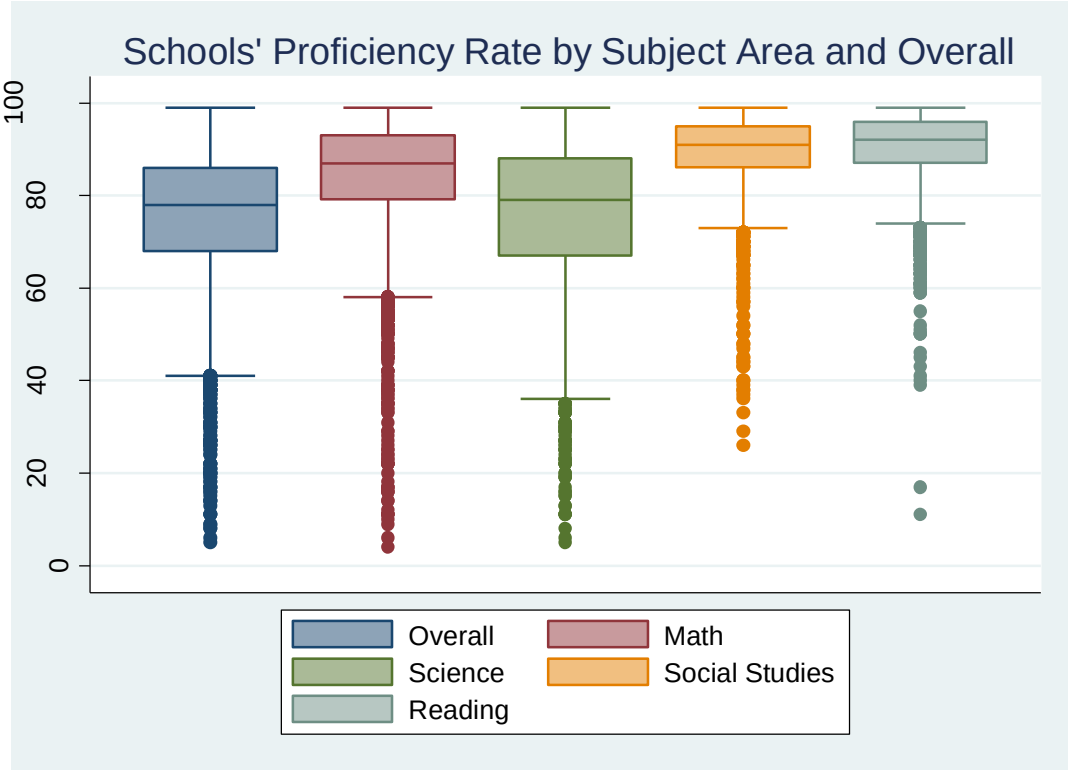
This analysis is based on the assessment of a broad range of data and only goes so far as to suggest areas of concern that policymakers may consider as a starting point for improving Texas' public schools. I conclude that the following should be the top three areas for concern for policymakers: the poor math and science performance (as determined by TAKS pass rates), the black/white and Hispanic/white achievement gaps, and the strong negative correlation between economic disadvantage and test performance.

Analysis

Comparing Overall Combined Score and Subject Area Proficiency

I begin my analysis by looking at the distribution of schools' overall proficiency levels—i.e., percent of students who meet or exceeded the standard for passing—in each of these four areas and overall. *Figure 1* shows the distributions of proficiency on the TAKS overall as well as in each of the four subject areas. (*Appendix Table 1* provides a more detailed summary and the numeric values of central tendency and dispersion for each of distribution.)

Figure 1



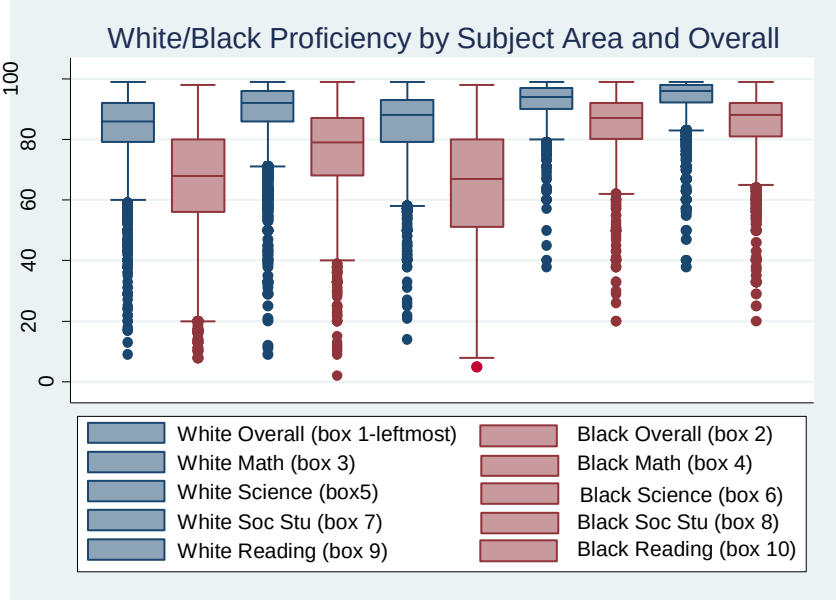
Students appear to have performed very well in reading and social studies and worse in math and science. On average, 90.5% of students in a school met the reading standard (median: 92%) and 88.8% of students met the social studies standard (median: 91%). Students performed relatively worse in math (mean: 84.5%, median: 87%) and, worse still, in science (mean: 76.2%, median: 79%). Additionally, pass rates for social studies (IQR: 9) and reading (IQR: 9) have substantially less variability than for math (IQR: 14) and science (IQR:21). All distributions are negatively skewed.

The average pass rate for a school on the combined measure is 76% with a median pass rate of 78%. This overall measure has relatively high variability, with an IQR (18) and SD = 14.07. This distribution is also negatively skewed.

Comparing Black/White and Hispanic/White Student Proficiency

Figure 2 compares the distributions of achievement on the overall combined test and in individual subject areas between black and white students. The proportion of white students in a school who met the standard on the exam exceeds the proportion of black students who met the standard—as suggested by both the mean and median—in *all* subject areas *and* overall (see *Appendix Table 2* for values). After calculating confidence intervals (α=0.05) for percent proficient for black and white students in each of the subjects and overall, I conclude that in *all* cases the two groups perform significantly different from one another (see *Appendix Table 2).* The mean difference in percent proficient is greatest in science (μ_d = 21.7%) and smallest in reading (μ_d = 7.74%) (see *Appendix Table 7).* Not only is there a substantially larger difference in percent proficient for science between black and white students than for the other subjects (the second largest difference was in math (12.94%), science also has the greatest variability (SD = 15.27%).

Figure 2

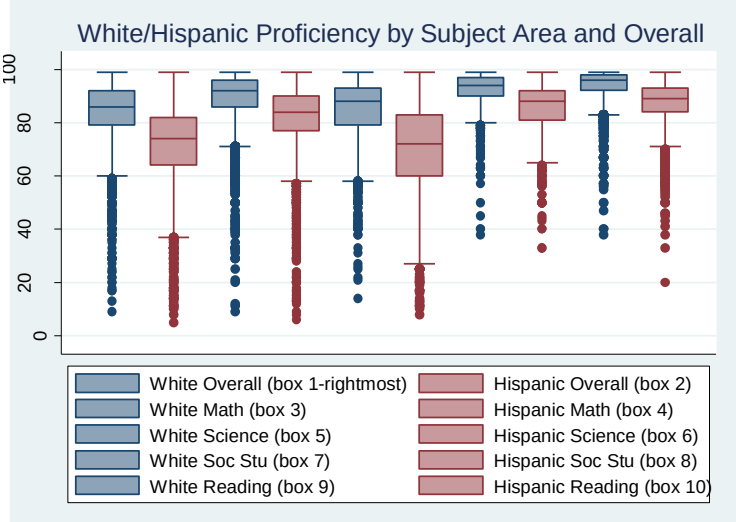


The simple least squares regression line for the relationship of the difference between black and white students in percent proficient on the TAKS overall and average years of teacher experience(AYE) predicts the

difference in percent proficient within a school ($\hat{y}$) as: $\hat{y} = 12.95 - 0.38(AYE)$. This equation suggests that (1) when average years of teacher experience within a school is 0, the percent of black students who meet the TAKS standard is 12.95 less than the percent of white students who meet the standard and (2) for each additional year of teacher experience, the difference in proficiency decreases by 0.38%. While the slope is small, it is at least in the expected direction—i.e., we would hope that more experienced teachers would be better able to help close the black/white achievement gap.

Figure 3 presents the distributions of white and Hispanic students' proficiency rates overall and for each of the four subject areas. Just as we saw in the black/white test proficiency comparison, white students have higher proportions of proficiency than Hispanic students in every area and overall as indicated by both the mean and median percentages (see *Appendix Table 3).* Again, as we saw in the comparison between black and white student proficiency, a calculation of confidence intervals (α=0.05) allows us to conclude that in *all* cases the two groups are significantly different from one another (see *Appendix Table 3).* The mean difference in percent proficient is greatest in science (μ_d = 15.75%) and smallest in reading (μ_d = 5.21%) (see *Appendix Table 8).* Th mean difference in percent proficient in science (15.75%) is substantially larger than for other subjects;

Figure 3

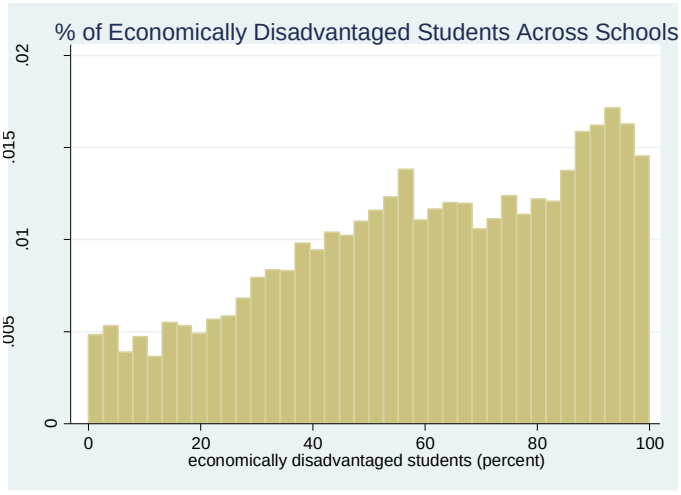


however, it is not as large as the difference in percent proficient between black and white students in science. (The second largest difference was in social studies at 7.62%.)

Characteristics of Students in Texas Schools

Appendix Table 4 provides summary statistics of a few characteristics of the population of students in Texas elementary and middle schools. On average, the racial composition of these schools is as follows: Hispanic students (μ=46.2%, median=39.5%), white (μ=36.8%, median=33.7%), and black (μ=14.0%, median=6.9%). My analysis also indicates that these schools often have high rates of economically disadvantaged students (μ=60.2%, median=62.6%). While the average percent of economically disadvantage students within a school ranges from 0% to 100%, more schools have a higher proportion of disadvantaged students than a lower proportion. 45 schools deemed 100% of their students economically disadvantaged and a quarter of the schools considered 84% or more of their student population as such (see *Appendix Table 5)*. *Figure 4* provides a more detailed depiction of the distribution of economic disadvantage in the schools.

Figure 4



Upon further examination of the relationship between economic disadvantage and students' overall performance on the achievement measures in math, science, social studies, and reading (see *Table 1*, below), I find consistently strong negative correlations

(also see scatterplot, *Appendix Figure 1*). *Table 1* lists a number of other student characteristics and, interestingly, only two have consistently *positive* correlations with these four achievement measures: percent of white students and percent of gifted/talented students within a school. Mobility also appears to be a noteworthy characteristic. A student is considered mobile if he/she has missed 6+ weeks at a school in which he/she is enrolled. This characteristic, as one may expect, has very strong negative correlations with proficiency rates in the four subject areas. Proportion of bilingual education and Hispanic students also tends to correlate negatively with the proficiencies—with a very strong negative correlation in reading.

Table 1

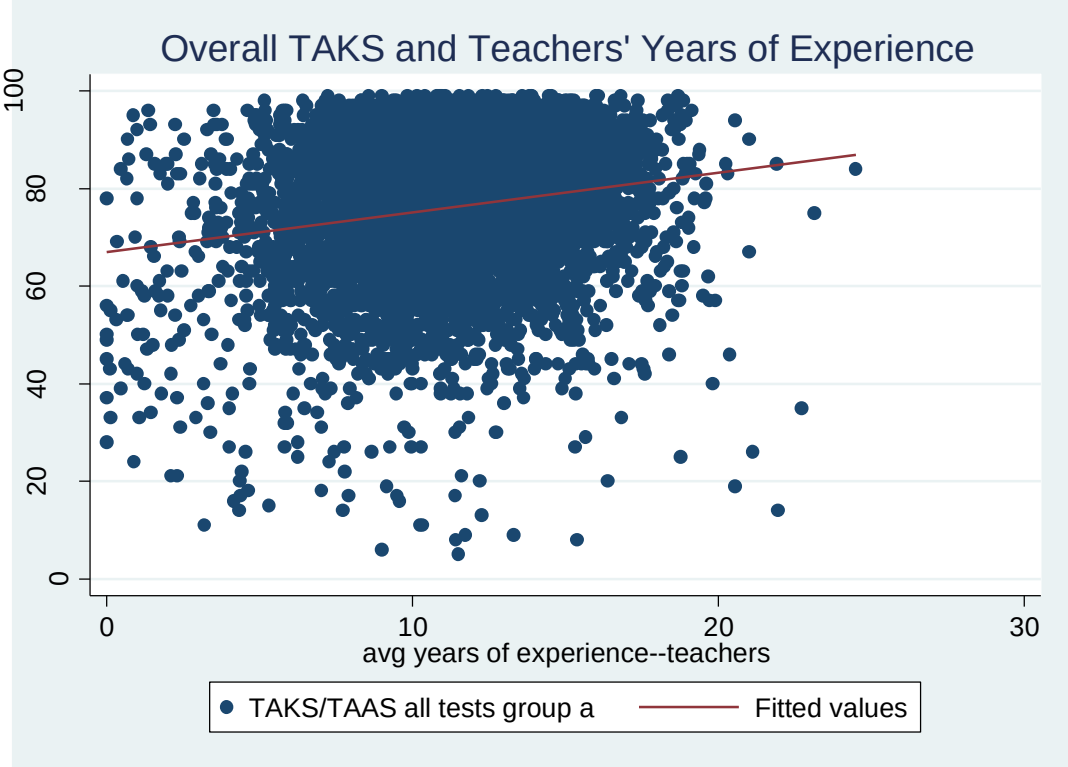
	Overall Math	Over Science	Overall SocStud	Overall Rdng
Mobility	-0.59	-0.44	-0.57	-0.51
Bilingual Education	-0.09	-0.08	-0.19	-0.38
Black	-0.26	-0.22	-0.23	-0.25
Economically Disadvantaged	-0.44	-0.43	-0.39	-0.61
Gifted/Talented	0.18	0.12	0.28	0.23
Hispanic	-0.23	-0.24	-0.18	-0.40
Special Education	-0.21	-0.23	-0.26	-0.1
White	0.35	0.33	0.28	0.52

Characteristics of Texas School Teachers

On average, 35.3% (see Appendix *Table 6*) of Texas elementary and middle schools' staff are minority (African American, Hispanic, Asian/Pacific Islander, and Native American). Teachers within these schools typically have an average of 11.1 years of experience (the distribution is fairly normal around the mean—see *Appendix Figure 2*). After constructing a scatterplot (*Figure 5)* to examine the relationship between teachers' average years of experience and students' overall proficiency rate on the TAKS, there does not appear to be appear much of a

linear relationship between the two. The Pearson correlation coefficient (ρ=0.17) supports this observation, for the relationship it recognizes can be considered, at best, weak.

Figure 5



The simple least squares regression line (which runs through the scatterplot in *Figure 5*) for the relationship between students' overall TAKS proficiency and average years of teacher experience(AYE) predicts percent proficient within a school ($\hat{y}$) as: $\hat{y} = 66.97 + 0.81(AYE)$. This equation suggests that (1) when average years of teacher experience within a school is 0, students who meet the TAKS standard is 66.97% and (2) for each additional year of teacher experience, student proficiency increases by 0.81%. While the slope is small, it is at least in the expected direction—i.e., we would hope that more experienced teachers would have a more positive impact on students' performance or, at very least, a non-negative one.

Table 2 below, shows the correlations for the relationships between four teacher characteristics and schools' proficiency scores on TAKS subjects and overall. Notable among these correlations is the strength of the relationship between percent of minority staff within a school and performance in the individual subject areas and overall. A particularly strong negative correlation exists between percent of minority staff and percent proficient in reading. The correlations between percent of beginning teachers and percent proficient are predictably slightly negative. There does not appear to be any significant relationship between number of students per teacher and TAKS performance.

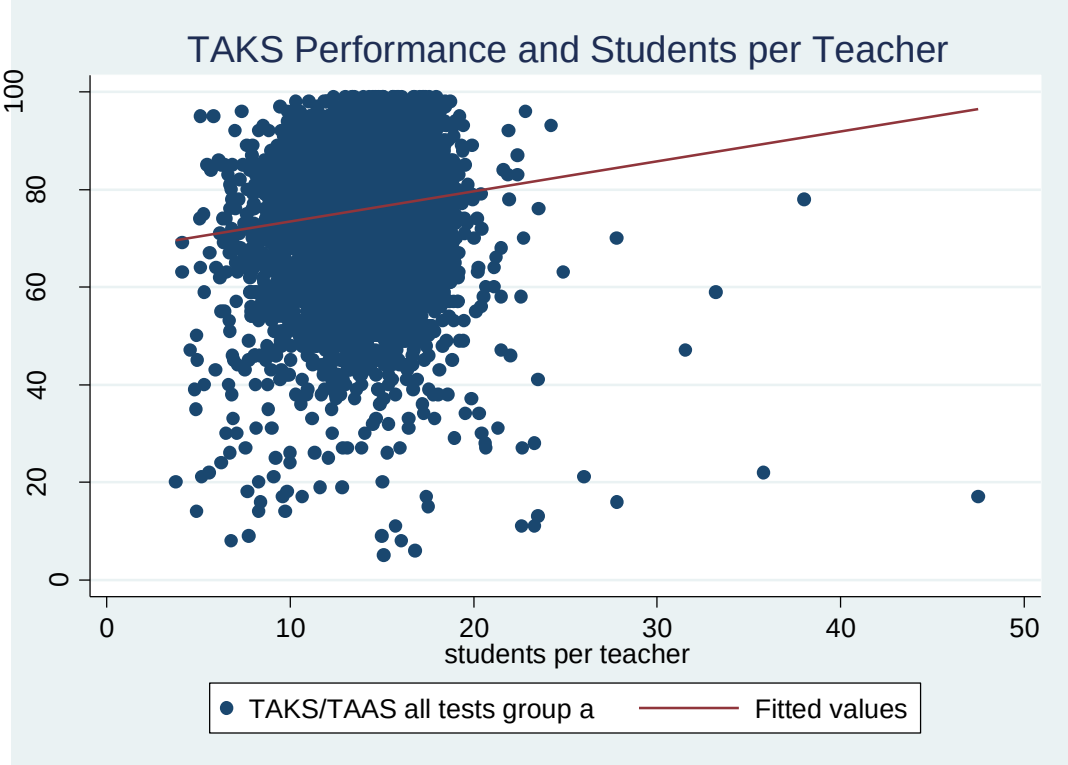
Table 2

	Overall Math	***Over Science***	***Overall Soc Stu***	***Overall Reading***
Minority Staff (%)	*-0.32*	*-0.30*	*-0.30*	*-0.49*
Beginning Teachers (%)	*-0.26*	*-0.23*	*-0.19*	*-0.20*
Average Years of Experience	*0.17*	*0.15*	*0.16*	*0.20*
Students per Teacher	*0.08*	*0.13*	*0.02*	*-0.05*

The simple least squares regression line (see *Figure 6*) for the relationship between students' overall TAKS proficiency and average number of students per teacher (AST) predicts percent proficient within a school ($\hat{y}$) as: $\hat{y} = 67.32 + 0.61(AST)$. This equation suggests that when average number of students per teacher is 0, students who meet the TAKS standard is 67.32%. Obviously, this interpretation does not make sense because if there were 0 students in the classroom, the outcome variable would be absent; however, this interpretation may suggest that when the number of students per teacher is very low that the TAKS pass rate will be around 67.32%. This equation also suggests that for each additional student per teacher, student

proficiency increases by 0.61%, which seems to run against our intuition. Typically, we expect that the greater the number of students in the class, the less attention each student receives and the more distractions from learning he/she is presented with. Consequently, we may expect test scores to be lower. However, it may be the case that students with disabilities or ESL students may be placed in smaller classes where they can receive more personalized attention but still may perform relatively poorly compared to students in larger classrooms who are not disadvantaged in these ways.

Figure 6



Charter vs. non-Charter Schools

I was also interested in exploring whether significant differences existed between charter and non-charter schools. I conducted a significance test to compare mean proficiency rates of

the TAKS overall and on each of the four subject tests. The null hypothesis is that no difference exists between mean percent proficient of charters and non-charters; the alternative states that such a difference exists and is significant at the 0.05 level. *Table 3*, below, shows the means for charters and non-charters as well as the difference between the two. This analysis found that, on all counts, non-charters performed significantly better than charters.

The analysis includes data from 254 charters and 5682 non-charters. Comparing performance of charters to non-charters may not be very fair. This is because the population of students who attend charters may differ in some significant way from the population of students who attend non-charters. For this reason, we may expect them to perform significantly differently. That is, it may not be the nature of the charter school that leads to a difference in performance but instead a difference in the population of students who attends charters.

Table 3

Subject/Overall	Charter mean	Non-charter mean	Difference between means	Significantly Different* (y/n)
Overall	59.83	76.71	-16.89	Y
Math	68.21	85.14	-16.93	Y
Science	61.16	76.81	-15.24	Y
Social Studies	78.20	89.67	-11.48	Y
Reading	84.54	90.76	-6.22	Y

* A difference in means was considered significant at the 0.05 level. All p-values were essentially 0.

Discussion and Conclusion

Overall, students appear to do well in reading and social studies and relatively worse in math and science. This statement remains true and is even more exaggerated for minority students. Compared to white students, both black and Hispanic students prove to have lower

proficiency rates in all subjects--performing worse in math and science and better in reading in social studies, just as in the overall trend. Compared to their white peers, black and Hispanic students performed substantially worse in science relative to their performance in other subjects; however, the difference between Hispanic students' science performance and white students' science performance, was much smaller that the difference between that of black and white students.

Upon examining the characteristics of public school students in Texas elementary and middle schools, it is clear that there is a high rate of economically disadvantaged students. Strong negative correlations exist between the proportion of economically disadvantaged students within a school and test scores in all subject areas and overall—i.e., the higher the rate of economic disadvantage, the lower the pass rate. Another student population characteristic with a strong negative correlation against test performance is students' mobility. Essentially, the less time students have spent in a particular school, the lower the rate of percent proficient. It must be noted that while it may be easy to assume causality in both of the aforementioned cases, my analysis can only go so far as to suggest correlation.

Other factors correlating with student test performance that are worth mentioning include teachers' average years of experience and percent of minority staff within a school. Surprisingly, the relationship between average years of experience and test performance is, yes, positive but, at best, weak. More notably, the relationship between percent of minority staff within a school and test performance is bit stronger and is negative—the correlation is especially strong for reading performance.

A brief comparison of charter and non-charter schools suggests that charters perform worse; however, a more in-depth analysis would need to examine the comparability of student populations between the two types of schools before conclusions are drawn about any differences.

This analysis endeavored to superficially examine a broad range of data from Texas elementary and middle schools including their test performance on the TAKS. While more in-depth statistical and policy analyses would need to be conducted before any serious action is taken, this analysis may be able to serve as a starting point for policymakers. Three potential areas for concern that arose from this analysis are as follows: (1) Students appear to struggle most greatly in math and science and so, it may be advisable for the state to put more effort into assessing the different options for improving these outcomes. (2) The achievement gap between white and minority students deserves serious attention. (3) The state education system may benefit from analyzing ways to combat the *apparent* effects of economic disadvantage on educational outcomes.

Appendix

Table 1

TAKS/TAAS all tests group a

Percentiles		Smallest		
1%	31	5		
5%	51	6		
10%	58	8	Obs	6,119
25%	68	8	Sum of Wgt.	6,119
50%	78		Mean	76.00049
		Largest	Std. Dev.	14.06527
75%	86	99		
90%	92	99	Variance	197.8318
95%	95	99	Skewness	-1.004887
99%	98	99	Kurtosis	4.721756

TAKS/TAAS math group a

Percentiles		Smallest		
1%	41	4		
5%	64	6		
10%	71	9	Obs	6,063
25%	79	10	Sum of Wgt.	6,063
50%	87		Mean	84.45027
		Largest	Std. Dev.	11.6409
75%	93	99		
90%	96	99	Variance	135.5105
95%	98	99	Skewness	-1.956295
99%	99	99	Kurtosis	9.839678

TAKS/TAAS science group a (2002-03 fwd)

Percentiles		Smallest		
1%	33	5		
5%	48	6		
10%	55	8	Obs	5,277
25%	67	11	Sum of Wgt.	5,277
50%	79		Mean	76.17699
		Largest	Std. Dev.	15.2613
75%	88	99		
90%	94	99	Variance	232.9073
95%	96	99	Skewness	-.8788944
99%	98	99	Kurtosis	3.787303

TAKS/TAAS soc stud group a (2002-03 fwd)

Percentiles		Smallest		
1%	48	26		
5%	72	29		
10%	78	33	Obs	1,701

25%	86	36	Sum of Wgt.	1,701
50%	91		Mean	88.84891
		Largest	Std. Dev.	9.494586
75%	95	99		
90%	97	99	Variance	90.14716
95%	98	99	Skewness	-2.336652
99%	99	99	Kurtosis	11.17743

TAKS/TAAS reading group a

Percentiles		Smallest		
1%	68	11		
5%	77	17		
10%	81	39	Obs	5,927
25%	87	40	Sum of Wgt.	5,927
50%	92		Mean	90.50127
		Largest	Std. Dev.	7.153891
75%	96	99		
90%	98	99	Variance	51.17815
95%	99	99	Skewness	-1.869208
99%	99	99	Kurtosis	11.13863

Table 2

Subject or Overall	Mean % of White Passing	White Conf. Interval	Mean % of Black Passing	Black Conf. Interval
Overall	83.7	76.69-78.15	66.6	56.09-58.23
Math	89.1	84.90-86.21	76.1	68.99-71.12
Science	84.5	77.10-78.53	64.1	51.62-54.13
Social Studies	92.3	91.88-92.75	83.5	83.01-84.82
Reading	94.0	94.45-94.98	85.7	87.69-88.80

Table 3

Subject or Overall	Mean % of White Passing	White Conf. Interval	Mean % of Hispanic Passing	Hispanic Conf. Interval
Overall	83.7	76.69-78.15	72.2	61.95-63.44
Math	89.1	84.90-86.21	82.1	74.86-76.32
Science	84.5	77.10-78.53	70.5	58.07-59.64
Social Studies	92.3	91.88-92.75	85.6	85.15-86.18
Reading	94.0	94.45-94.98	88.1	88.33-89.07

Table 4

Characteristic	Average percent of students within a school with characteristic	Median percent of students within a school with characteristic	Standard Deviation
Mobility	20.2%	17.8%	12.9%
Bilingual Education	16.9%	8.6%	19.5%
Black	14.0%	6.9%	18.6%
Economically Disadvantaged	60.2%	62.6%	26.7%
Gifted/Talented	6.2%	5%	6.3%
Hispanic	46.2%	39.5%	31.3%
Special Education	10.3%	9.4%	6.6%
White	36.8%	33.7%	30.3%

Table 5

economically disadvantaged students (percent)

Percentiles		Smallest		
1%	2.2	0		
5%	10.8	0		
10%	21	0	Obs	6,354
25%	40.5	0	Sum of Wgt.	6,354
50%	62.6		Mean	60.19298
		Largest	Std. Dev.	26.72116
75%	84	100		
90%	93.6	100	Variance	714.0205
95%	96.6	100	Skewness	-.3890003
99%	99.7	100	Kurtosis	2.151217

Table 6

	Presence of characteristic with a school, on average	**Median presence of characteristic within a school**	**Standard Deviation**
Minority Staff (%)	35.3	25.0	30.6
Beginning Teachers (%)	8.1	6.1	9.5
Average Years of Experience	11.1	11.2	3.3
Students per Teacher	14.3	14.5	2.9

Table 7

Variable	Obs	Mean	Std. Dev.	Min	Max
bwa	3,516	-17.10466	12.89557	-77	38
bwm	3,152	-12.94004	10.9966	-69	34
bwc	1,877	-21.6537	15.2706	-80	38
bws	580	-9.167241	10.9805	-71	34
bwr	2,570	-7.736187	8.516399	-57	31

Table 8

Variable	Obs	Mean	Std. Dev.	Min	Max
hwa	4,627	-11.21634	10.52905	-62	43
hwm	4,236	-7.06067	8.791181	-65	48
hwc	2,894	-15.74568	12.69609	-72	31
hws	877	-7.621437	8.436055	-51	42
hwr	3,595	-5.205563	6.70333	-52	52

Figure 1

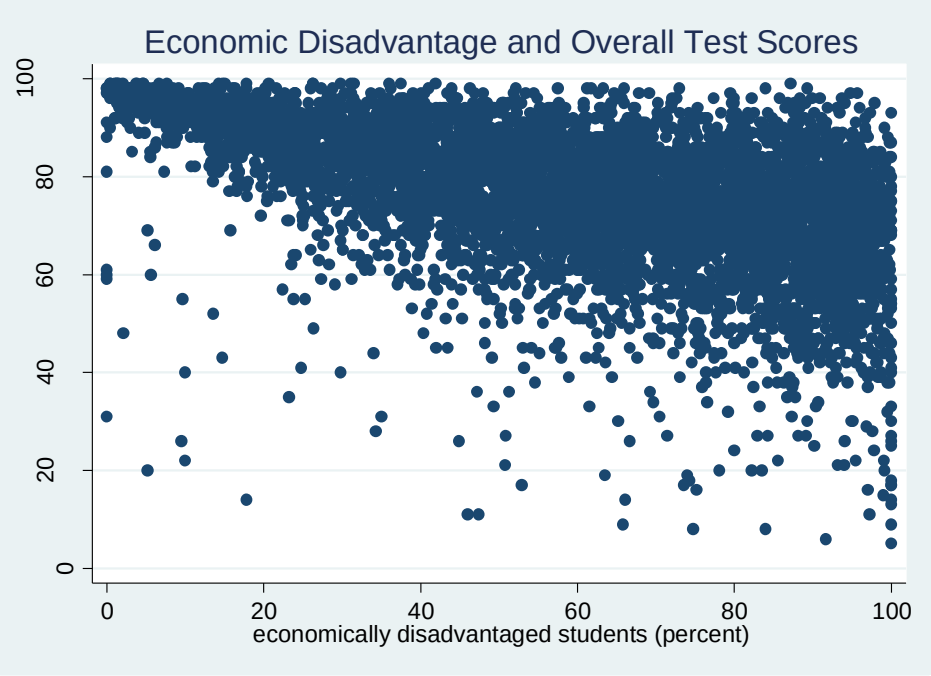
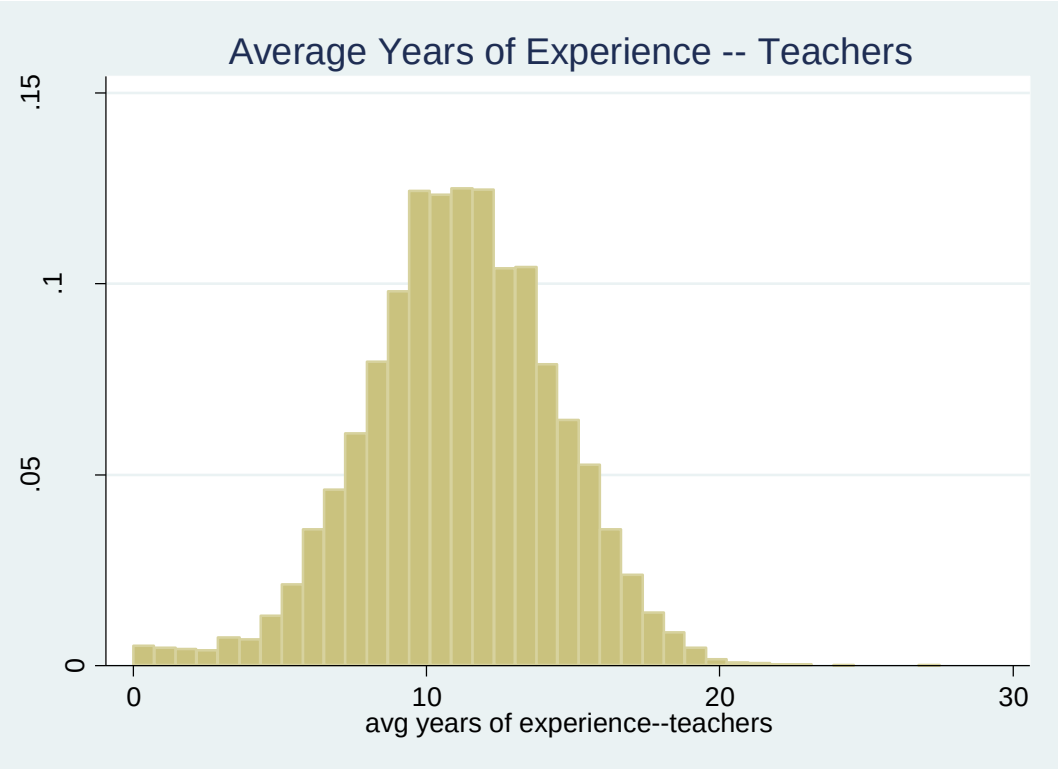


Figure 2


Average Years of Experience -- Teachers
.15
.1
.05
0
0
10
20
30
avg years of experience--teachers