The Effects of Historical Settlement Patterns on Oklahoma Student Achievement Test Scores

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Abstract

This research demonstrates how cultural differences affect the efficiency of increased public school district expenditures on students' achievement test scores. Results indicate that equality of outcome as measured by achievement test scores may be impossible to achieve using school district expenditures.

Introduction

Historical differences in settlement patterns and political development may have lasting effects on the economic strength of a region. Oklahoma was settled in two distinctly different ways. Eastern Oklahoma has historically been behind western Oklahoma in literacy rates and educational attainment. Income disparity also has existed, with the east having significantly lower per capita income than the west. The east-west economic disparity that exists today can be linked to the original settlement patterns of the state (Warner, 1995b: p.10). This is because the level of human capital defined in terms of the educational level of the region, is less in eastern Oklahoma (Warner, 1995a: p. 10).

Eastern Oklahoma was settled beginning in the 1820's by Indians from the eastern United States. The forty eastern Oklahoma counties were originally Indian Territory. Further settlement of Indian Territory was by migrants from the southeastern United States. Western Oklahoma was settled primarily by white Europeans from the northern and midwestern United States The western 37 counties of Oklahoma were originally Oklahoma Territory. This area was settled in large part by the land runs of 1889 and 1893. The cultural differences in these two populations are quite evident, with issues such as land tenure and private ownership being well-understood by those settling in the west, and culturally foreign to the original inhabitants of the east (Warner, 1995a). This has been described not as an east-west dichotomy, but as a north south one, with people from the northern United States settling in western Oklahoma (Hale, 1982).

One reason for the economic disparity between Indian Territory and Oklahoma Territory at the time of statehood (1907) was the lack of governmental institutions, especially schools in Indian Territory. Whites migrated into Indian Territory in spite of the

fact that they had no political rights, no right to own land, and no access to formal schooling. Warner (1995a) suggests that these migrants probably placed little value on education. Settlers of Oklahoma Territory set up communities, local governments and schools immediately after the "land runs." Public services provided to the settlers of Oklahoma Territory by political agencies were not only important to them, but something that many of them expected.

Research has shown that most of the factors affecting school achievement test scores are from outside the school. Family background is one of the major factors determining performance on achievement tests (Chubb and Moe, pp. 105-111).

We want to determine the effects of various factors such as expenditures per student on achievement test scores for Indian Territory counties and Oklahoma Territory counties. We also will look at the potential to remove the regional disparities by reallocating educational spending.

The production function approach to educational output has been used with various measures of output and functional forms employed (Butler and Monk, 1985; Hanushek, 1986; Hanushek, 1996; Ferguson and Ladd, 1996). Ferguson and Ladd (1996), using a high quality dataset from Alabama schools, developed a school production function with achievement test scores as a proxy for school output. This analysis uses a linear production function, with achievement test scores as the output and various socioeconomic, school, and expenditures as inputs. Correction for hetersocedasticity was required.

Data

Data for this research were obtained from the Oklahoma Department of Education. Test results from the Criterion Referenced Test (CRT) and Norm Referenced Test (NRT) were available for each school district. The CRT is given to grades 5, 8, and 11, and is a test to ascertain whether or not students are at grade level. The NRT is given to grades 3 and 7, and is a test of knowledge level, not a test of grade level. Both the CRT and NRT have three tests, reading, science, and math.

There are admittedly problems with using test scores as a measure of school performance. These problems include 1) they are a one-shot measure of learning, are imperfect measures of knowledge, and fail to measure all areas of knowledge, 2) schools and teachers may adapt their procedures to "teach to the test", and 3) test scores are due in part to schools, but also include student aptitude, social class, and other causes (Chubb and Moe, p.198). Schools also teach social skills and a variety of other skills such as music, athletics, and drama, to name a few which are not reflected in achievement test scores. Since special education students usually do not take the tests, test scores do not measure how well schools are teaching these students. Also, CRTs do a poor job of measuring how well schools are teaching their most gifted students.

The question is, if achievement test scores are not to be used to measure school performance, is there another quantifiable measure? The answer is apparently not. It is important to recognize the limitations of using test scores as a proxy for school performance, such as their inability to measure student aptitude (Borland and Howser, 1996).

Student data includes number of students for each gender and each race by grade for each school district. Race data includes Asian, Black, Hispanic, Native American, and

White. Parental data were derived from the 1990 census. Parental variables chosen were educational attainment. Educational attainment of the parents was divided into four categories; proportion with at least a bachelor's degree, with some college, with a high school diploma, and no high school diploma. A criticism of this research could be that using 1990 parent's data and 1995 test scores is inappropriate. The 1990 census data by school district was made available by the United States Department of Education in 1995.

Some schools are more restrictive than others about who they allow to take the tests. Schools can increase average tests scores by not letting their weaker students take the tests. We use the percentage of students enrolled in each grade who actually took the test to correct for differences in who schools let take the tests. School information used was proportion of special education students by district and proportion of students obtaining a free or reduced-price lunch by district.

To calculate per student expenditures, both average daily attendance (ADA) and average daily membership (ADM) by district were also available. ADM was chosen for our analysis. The range of ADM for the Oklahoma school districts used in this research is from less than 50 students to about 7,000 students.

The definition of the counties that were in Oklahoma Territory and Indian Territory is the same as Warner (1995a, 1995b). In order to isolate cultural effects on the regions, the metropolitan counties of Tulsa and Oklahoma were eliminated from the analysis. In addition, the cities of Lawton, Norman and Moore were also eliminated. Norman and Moore are suburbs of Oklahoma City even though they are not in Oklahoma County. Lawton is the third largest city in Oklahoma, and many of its citizens are military personnel.

Variable averages for each region are shown in Table 1. Indian Territory's achievement test scores are 2.2 points lower than Oklahoma Territory. It also has less educated parents with lower median incomes, more students receiving subsidized lunches, and more minority students. Average per student expenditures are also lower in Indian Territory.

Methods

Regression analysis is used with achievement test scores as the dependent variable and various socio-economic and school factors as dependent variables. An intercept dummy variable was included to reflect differences between the forty Indian Territory counties and the rest of the state not reflected in the other variables. The data are cross-sectional, and there are many small school districts and few large school districts. Because of varying numbers of students in each school district, heteroscedastic disturbances are expected. Therefore, maximum likelihood estimation (MLE) assuming exponential heteroscedasticity is used instead of ordinary least squares (Greene, pp.384-410). The MLE is needed to gain asymptotically efficient parameter estimates and so that the hypothesis tests will be valid.

The following equation was estimated using maximum likelihood estimation:

$$\mathbf{Y} = \mathbf{S}\$ + \mathbf{X}\mathrm{N} + \mathbf{G}* + , \qquad (1)$$

where **Y** is a vector of test scores for school districts, * is the parameter describing a set of dummy variables **G** for type of test (NRT or CRT), kind of test (math, reading, or science), and grade level of the test (third and seventh for the NRT, and fifth, eighth, and eleventh for the CRT). The variable for CRT, grade 11, math test was left in as part of the intercept.

The matrix **S** contains student effects which vary by school district and grade. Student effects are proportions for each grade by race and gender, and the percent of students taking the tests. Since the proportions by race and gender sum to one, this procedure required leaving one variable in the intercept, which was white males.

The socioeconomic effects matrix, **X**, varies only by school district. It includes the percent of students in special education, the percent of students receiving free or reduced-price lunches, expenditures per student, and four levels of education attainment of the parents. The proportion of parents without a high school education was left in the intercept.

Initially a dummy variable describing the differences in test scores between Oklahoma Territory and Indian Territory was included in the above equation. Since parameter describing the dummy variable was significant, the dummy variable was dropped, the data was sorted by territory, and analysis was performed on each region separately using equation 1.

There can still be bias due to missing explanatory variables. The parental, student, and school variables may not adequately capture all the cultural differences between communities.

Results

The dummy variable for regional differences in equation 1 had a parameter value of !0.178 and was significant at the 0.017 level. This indicates that achievement test scores are significantly lower in Indian Territory than in Oklahoma Territory.

Regression results are shown in Table 2. The variable for parents with at least a bachelor's degree had over twice the effect in Oklahoma Territory as in Indian Territory.

All parent's education variables for Oklahoma Territory were positive, statistically significant, and economically significant with relatively larger parameter values than in Indian Territory. The parents with some college education variable for Indian Territory was statistically insignificant and the parameter value was close to zero. The parents with a high school diploma variable for Indian Territory was significant with a p-value of 0.021, and a parameter value of -1.50. As seen in Table 1, Oklahoma Territory school districts average about four percent more parents with at least a bachelor's degree than does Indian Territory, which has about four percent more parents without a high school education. There are more highly educated parents and educational effects of parents are larger in Oklahoma Territory than in Indian Territory.

Table 1 shows that Indian Territory school districts have about two percent less students taking tests than Oklahoma Territory. As shown in Tables 2, the parameter values for proportion allowed to take tests were negative for both regions, with Indian Territory having nearly twice the magnitude of Oklahoma Territory. This indicates that even though less students are allowed to take tests in Indian Territory schools than in Oklahoma Territory schools, the effect of allowing another percent take the test has a much larger negative effect.

The effect of free and reduced price lunches were negative for both regions, with parameter values of -3.80 for Indian Territory and -2.01 for Oklahoma Territory. Free and reduced price lunches can be used as a proxy for parental income. The magnitude of the parameter for Indian Territory indicates that low income parents have a greater negative effect in Indian Territory than in Oklahoma Territory.

Effects of special education students was insignificant in Oklahoma Territory. Indian Territory schools had a different effect from special education students, with a parameter value of -3.46 and p-value of 0.0046. This indicates that the number of special education students in school districts in Indian Territory have a more profound negative effect on achievement test scores than in Oklahoma Territory.

Race and gender variables for both regions showed that white females do not score significantly better on achievement tests than do white males. All minority parameters for Oklahoma Territory were negative and large, but only three were statistically significant at the five percent level. As shown in Table 1 Indian Territory school districts have more Indian and black students than does Oklahoma Territory, but less Spanish and Asian students. The large difference is in Indian students, which Indian Territory has about ten percent more than does Oklahoma Territory. The racial differences in the regions do not appear to explain much of the differences in test scores.

Indian Territory school districts spend about $200 per student less than Oklahoma Territory school districts. A disappointing parameter for Indian Territory is the school expenditure parameter. Additional moneys spent in Indian Territory have about half the effect of additional expenditures in Oklahoma Territory (Table 2). This may reflect the attitude eluded to by Warner, that perhaps historically less emphasis has been placed on educational attainment in Indian Territory. Therefore, productivity of additional expenditures is lower in Indian Territory.

Equality of opportunity is in terms of equal expenditures could be obtained with small changes in expenditures. However, increasing school expenditures in Indian Territory to the levels in Oklahoma Territory would have a negligible effect on test scores.

Our parameter estimates indicate that the effect of equalizing expenditures per student would increase average test scores in Indian Territory by about 0.04, well short of the 2.2 point difference[1].

Some have indicated that equality of outcome should be the relevant goal (Ferguson and Ladd, 1996). If Oklahoma Territory's expenditures were held constant, and our parameter estimate for expenditures did not decrease as expenditures increased in Indian Territory (this heroically assumes away diminishing marginal returns to investment) it would take about an additional $12,000 per student in Indian Territory to equalize outcomes. With current expenditures of about $5000 per student, this would more than triple current expenditures. This is not a viable option: the state already has budget problems. Thus, equality of outcome cannot be practically achieved by reallocating money.

Picking maximizing the state's average test scores as the goal would suggest shifting spending from Indian Territory to Oklahoma Territory, where expenditures have a larger effect. This strategy fails to consider the social costs associated with such a policy

Conclusion

Significant differences were found in average achievement test scores between eastern Oklahoma and western Oklahoma. Econometric modeling for each region separately shows that expenditures in the east have less than half the effect of expenditures in the west. Because the difference in test scores between the regions is so large, it is economically infeasible to achieve outcome equity by increasing spending in Eastern Oklahoma. Evidence from Warner (1995:a, 1995:b) and from this research indicates that

cultural forces are powerful and that cultural attitudes towards education may cause increased expenditures in education to have little or no effect.

Educational equity and adequacy are important issues because they have a direct impact on the well being of those in a community or area. Equality of opportunity as measured by expenditures could easily be achieved. Cooper et al. (1996) and Hirth (1996) argue for equity in public school expenditures across school districts. This research indicates that policy makers should not expect equity in school financing to bring outcome equity, as measured by achievement test scores.

[1] Equation 1 was estimated for both regions using each grade and test as output. Results confirm our findings from pooling the tests and using dummy variables. The expenditure parameter was larger in every estimation for Oklahoma Territory. Indian Territory's expenditure parameter was insignificant either economically or statistically in each estimation. Pooling the test scores gave more powerful statistical tests and allowed the expenditure parameter for Indian Territory to be significant.

Table 1. School District Per Student Averages for Oklahoma Regions

Variable	Oklahoma Territory	Indian Territory
Average test score[a]	50.90	48.70
Parents wo/high school education	0.16	0.22
Parents w/high school education	0.39	0.39
Parents with some college	0.28	0.27
Parents with Bachelor's degree	0.16	0.12
Parent's median income	27,851.00	24,709.00
Proportion Black males	0.01	0.02
Proportion Black females	0.01	0.02
Proportion Indian males	0.05	0.15
Proportion Indian females	0.05	0.15
Proportion Spanish males	0.02	0.01
Proportion Spanish females	0.03	0.01
Proportion Asian males	0.002	0.001
Proportion Asian females	0.002	0.001
Proportion White males	0.43	0.34
Proportion White females	0.39	0.31
Proportion free or reduced lunch	0.48	0.59
Proportion special education	0.12	0.13
Proportion taking tests	0.90	0.88
Average daily membership[b]	744.00	716.00
Expenditures per student[c]	4,957.00	4,718.00

Note: The means are unweighted averages of each district's proportion and therefore they will not match state averages.

[a] These are average per student test scores, across all achievement tests.

[b] Average daily school district student membership.

[c] Total expenditures per district divided by average daily membership.

Table 2 Estimates of the Effects of Various Factors on Oklahoma Public School Achievement Test Scores by Region

Variable	Oklahoma Territory Parameter est.	(std.error)	Indian Territory Parameter est.	(std. error)
Intercept	75.07	1.15	79.09	0.83
Grade 3 math[a]	-51.11	0.32	-49.26	0.30
Grade 3 reading[a]	-59.20	0.30	-57.26	0.29
Grade 3 science[a]	-58.46	0.30	-56.72	0.28
Grade 5 math[a]	-2.71	0.42	-2.86	0.37
Grade 5 reading[a]	5.51	0.38	5.95	0.34
Grade 7 math[a]	-50.90	0.35	-49.53	0.32
Grade 7 reading[a]	-53.75	0.31	-52.55	0.29
Grade 7 science[a]	-51.04	0.31	-49.65	0.29
Grade 8 math[a]	-0.69	0.45	-0.84	0.40
Grade 8 reading[a]	0.73	0.39	1.15	0.37
Grade 8 science[a]	-2.72	0.36	-1.85	0.35
Grade 11 reading[a]	-6.34	0.52	-8.62	0.48
Parents w/Bachelor's degree	8.09	0.92	3.95	0.69
Parents w/some college	3.71	1.06	0.64	0.61
Parents w/high school edu.	3.47	1.02	-1.50	0.65
Proportion White female	0.29	0.62	0.52	0.58
Proportion Black female	-5.07	2.95	-4.63	2.02
Proportion Indian female	-1.96	1.05	-0.26	0.59
Proportion Spanish female	-2.55	1.61	-2.54	2.17
Proportion Asian female	-2.73	7.58	7.78	6.36
Proportion Black male	-5.25	2.74	-5.84	1.75
Proportion Indian male	-3.29	1.06	-0.48	0.58
Proportion Spanish male	-2.69	1.71	-1.84	2.15
Proportion Asian male	-13.14	5.20	10.92	6.07
Percent subsidized lunch	-2.38	0.47	-2.46	0.34
Percent special education	-1.18	1.77	-3.46	1.22
Percent taking test	-2.01	0.72	-3.80	0.50
Expenditures[b]	0.36	0.06	0.18	0.07

[a] These are intercept-shifting dummy variables.

[b] These are average per student expenditures.

Note: Parameter estimates were corrected for exponential heteroscedasticity using ordinary least squares and an iterative process to produce asymmetrically efficient estimates.

References

Chubb, John E. and Moe, Terry M. (1990) *Politics, Markets, and America's Schools*. Washington, DC: The Brookings Institution.

Borland, M. V. and Howsen, R. M. (1996) Competition, Expenditures and Student Performance in Mathematics: A Comment on Couch et al. *Public Choice* (87), 395-400.

Brewer, Dominic J. (1996) Does More School District Administration Lower Educational Productivity? Some Evidence on the "Administrative Blob" in New York Public Schools. *Economics of Education Review* 15(2) 111-124.

Butler, R. J., and D. H. Monk. (1985) The Cost of Public Schooling in New York State: The Role of Scale and Efficiency. *The Journal of Human Resources*. 20(Summer) 361-381.

Cooper, B.S., D.C. Bloomfield, and S.T. Speakman. (1996) School-Site Finance and Urban Education Equity, New Legal Arguments, New Reform Opportunities. *Education and Urban Society.* 29(2): 162-181.

Ferguson, Ronald F., and Helen F. Ladd. (1996). How and Why Money Matters: An Analysis of Alabama Schools. *Holding Schools Accountable*. Washington, DC: The Brookings Institution. 265-298.

Greene, William H. (1993) *Econometric Analysis* Second Edition, Chapter 14, Heteroscedasticity. Englewood Cliffs, NJ: Prentice-Hall.

Hale, D. (1982) The People of Oklahoma, Economics and Social Change. in Anne Hodges and H. Wayne Morgan. *Oklahoma, New Views of the Forty-Sixth State*. The University of Oklahoma Press. Norman, Oklahoma.

Hanushek, Eric A. (1996) School Resources and Student Performance. *Does Money Matter?* (edited by Burtless, Gary) Washington, DC: The Brookings Institution. 43-70.

Hanushek, Eric A. (1986) The Economics of Schooling: Production and Efficiency in Public Schools. *Journal of Economic Literature* 24(September) 1141-1177.

Hirth, M.A. (1996) Systemic Reform, Equity, and School Finance Reform: Essential Policy Linkages. *Educational Policy*. 10(4): 468-479.

Oklahoma Department of Education. (1996). Unpub. electronic data. (Oklahoma Department of Education, Oklahoma City, OK)

United States Department of Education. (1995). 1990 Census Data by School District. Washington DC. National Center for Education Statistics, United States Department of Education (CD Rom).

Warner, Larkin A. (1995) An Overview of Oklahoma's Economic History, Part I." *Oklahoma Business Bulletin* 63(September) 5-21.

Warner, Larkin A. (1995) An Overview of Oklahoma's Economic History, Part II." *Oklahoma Business Bulletin* 63(December) 5-13.