



### Introduction

The small-town education budget process is an annual conflict over spending. At the heart of this conflict is disagreement over what factors matter most to keeping their school effective. Local administrators, taxpayers, school administrators and teachers, and school families take different perspectives on the most important factors. In their 2023 literature review of school effectiveness research, Javornik & Klemenčič Mirazchyski write:

*Educational (school) effectiveness can be defined as the degree to which an educational system and its components and stakeholders achieve specific desired goals and effects [...] but there is still much debate and discussion surrounding the factors that contribute to school effectiveness.*

Given that so much school funding decision-making is local, it would be helpful to give local governments better guidance on how to make their schools more effective based on factors that are subject to local influence.

### Research Question

In Massachusetts small town elementary schools, which factors have the strongest association with school effectiveness, and which are subject to local influence?

- **Response variable:** Student achievement is an element of school effectiveness. This study uses student achievement as measured by the Massachusetts Comprehensive Assessment System (MCAS), administered to students in grades 3 through 8 and in grade 10. Note that compliance with MCAS is not 100% of elementary schools, but test scores are available for most schools.
- **Predictor variables:** Finance, demographics, and school performance as measured by 16 variables grouped as *endogenous* (subject to local influence) or *exogenous* (not subject to local influence).

### Hypotheses

If in the set of predictors in the *endogenous* group, there is at least one variable with a significant influence on  $y$ , then we reject H1<sub>0</sub>. If we find the same for the *exogenous* group, then we reject H2<sub>0</sub>.

$$y_{MCAS} = \beta_0 + \beta_1 X_{endogenous[1...k]} + \beta_2 X_{exogenous[1...k]} + \epsilon$$

**Hypothesis 1:** The endogenous case

$$H1_0: \beta_{endogenous} = 0$$

$$H1_a: \beta_{endogenous} \neq 0$$

**Hypothesis 2:** The exogenous case

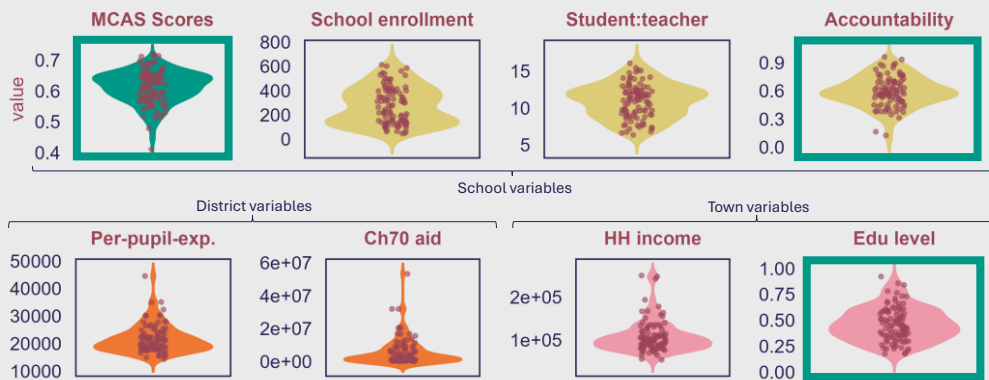
$$H2_0: \beta_{exogenous} = 0$$

$$H2_a: \beta_{exogenous} \neq 0$$

This study will test the model with a 0.1 significance level.

### Exploratory Data Analysis

Sample data observes 100 unique Massachusetts towns with elementary schools and populations of approximately 10,000 or less, in 88 unique school districts, in 13 unique counties.



### Analysis

Beginning with a full model of all 16 predictor variables, backward elimination using Akaike information criterion (AIC) selected the following as the most fit model to predict MCAS achievement outcomes:

$$MCAS\ scores \sim School\ accountability + Town\ education\ level + Ch70$$

This is the summary of the fittest linear model:

	Estimate	Signif.	Conf (low)	Conf (high)
(Intercept)	0.520	P<0.001	0.483	0.556
School accountability score	0.066	p<0.01	0.019	0.113
Town level of education	0.018	P<0.001	0.121	0.228
Ratio edu to Ch 70 min budget	-0.001	p>0.1	-0.029	0.004
District Ch 70 aid	0	p<0.1	0	0
Observations	100 (9 omitted due to NA)			
Residual standard error	0.03399 (df = 86)			
Multiple R <sup>2</sup>	0.474			
Adjusted R <sup>2</sup>	0.449			
F-statistic	19.35 (df = 4; 86)			
p-value	2.21E-11			

Although not significant, eliminating the *Ratio Ch70 min budget* from the model reveals that it is moderating *Ch70 Aid* and increasing Adjusted R<sup>2</sup>. *Ch70* has a mediating effect on *School accountability* and *Town education level*.

It is reasonable to identify *School accountability* in the endogenous group and *Town education level* in the exogenous group as the primary predictors, with a close eye on Chapter 70 as secondary predictors that should not be omitted without closer examination.

### Regression Diagnostics

- Residuals vs fitted supports assumption of linear relationship between predictor and response.
- Normal Q-Q supports assumption of normal distribution of residuals.
- Scale-Location supports assumption of homoscedasticity.
- Cook's Distance supports assumption that model is not disproportionately influenced by outliers.

### Hypothesis test results

In the model under study, the endogenous predictor *School accountability* and the exogenous predictor *Town education level* together have a significant association with student achievement as measured by MCAS scores.

Analysis and diagnostics support **rejection of both H1<sub>0</sub> and H2<sub>0</sub>** for this model:

$$y_{MCAS} = \beta_0 + \beta_1 X_{endogenous[1...k]} + \beta_2 X_{exogenous[1...k]} + \epsilon$$

Each unit increase in *School accountability score* is associated with an MCAS score increase of 0.066 (on a scale of 0 to 1). Each unit increase in *Town level of education* is associated with an MCAS score increase of 0.18.

### Conclusion

In Massachusetts small town elementary schools, the following have the strongest association with student achievement as measured by MCAS:

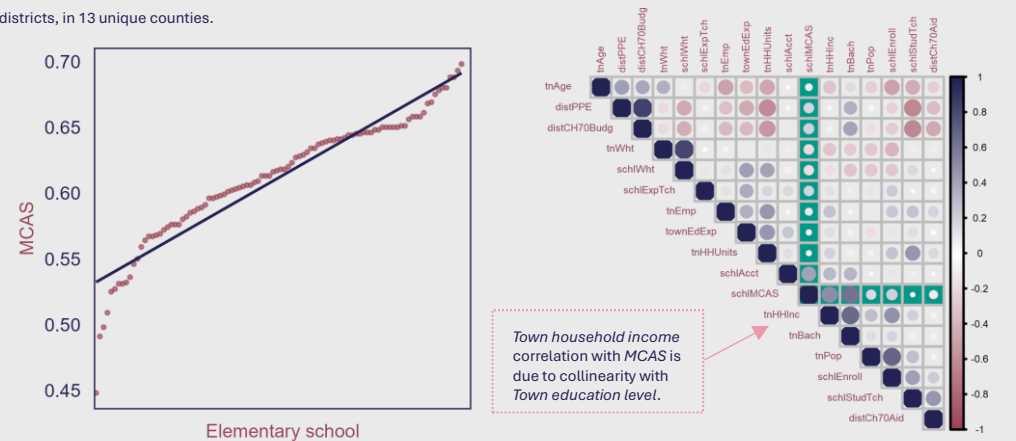
1. **Accountability** as measured by a state program that develops individual school goals and measures school progress toward those goals. **This factor is subject to local influence** because administrators can decide to prioritize the school's progress toward its goals.
2. **Town education level** as measured by the population proportion with a bachelor's degree or higher. **This factor is not subject to local influence.**
3. The state **Chapter 70 school aid program** in terms of aid awarded to each district and the quotient of district municipal budgets over district minimum budgets required by the Chapter 70 program. These predictors only moderate and mediate the other variables in the model.

### Literature review

Detailed literature review for this study can be found in Javornik, Š., & Klemenčič Mirazchyski, E. (2023). *Factors Contributing to School Effectiveness: A Systematic Literature Review*. European journal of investigation in health, psychology and education, 13(10), 2095–2111. <https://doi.org/10.3390/ejihpe13100148>

### Data sources

2020 Federal Census, Massachusetts Census Data, MA Department of Education School and District Profiles, DESE School report cards, DESE Chapter 70 Program, MA Department of Revenue budgets, and MCAS Program school achievement data.



School MCAS averages range from 0.45 to 0.7 on a scale of 0 to 1. How does a school effectively increase its achievement score?

Matrix shows that *Accountability* (schlAcct) and *Education level* (tnBach) correlate strongest with MCAS scores (highlighted green).