Economics of Education Review 28 (2009) 90–98

Contents lists available at ScienceDirect

Economics of Education Review

journal homepage: www.elsevier.com/locate/econedurev

# Education inputs, student performance and school finance reform in Michigan

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ARTICLE INFO

*Article history:*
Received 19 October 2006
Accepted 13 November 2007

*JEL classification:*
I21
I22

*Keywords:*
Analysis of education finance
School finance reform
Educational economics

ABSTRACT

This paper estimates the impact of the Michigan school finance reform, *Proposal A*, on education inputs and test scores. Using a difference-in-difference estimation strategy, I find that school districts in Michigan used the increase in educational spending generated through *Proposal A* to increase teacher salaries and reduce class size to a smaller extent. Then, using the foundation allowance created by *Proposal A* as an instrument, I estimate the causal effect of increased spending on 4th and 7th grade math scores for two test measures – a scaled score and a percent satisfactory measure – and find positive effects of increased spending on 4th grade test scores. A 60% increase in spending increases the percent satisfactory score by one standard deviation. The positive impact of expenditures on test performance seems largely due to higher teacher salaries.



## 1. Introduction

In July 1993, the state of Michigan enacted a dramatic change to its school finance system by implementing legislation known as *Proposal A*, which replaced the former local property tax system with a centralized state system of school finance. One of the main goals of *Proposal A* was to increase spending in initially low spending districts by placing a floor of $5000 on per-pupil revenues across all districts. Following the reform, expenditures increased in both initially low spending districts and districts with per-pupil spending over $5000 in 1993.

Michigan's *Proposal A* follows an era of state-level school finance reforms that first began in the early 1970s with the historic case of *Serrano* vs. *Priest* in California. Traditionally, revenues for school districts came from local property taxes. However, plaintiffs in the *Serrano* case argued that the property tax system was unfair to poorer districts because they faced higher tax rates and generated lower revenues as compared to wealthier districts that set lower rates and generated higher revenues because of a larger tax base. *Serrano* led to a wave of similar cases in other states with plaintiffs questioning the constitutionality of school finance systems. This led many states to enact school finance reforms in the late 1970s and 1980s to ensure a more equitable distribution of resources across districts. *Proposal A* shares a similar spirit of equity to these earlier reforms because it reduces the variance across districts in revenues and expenditures by leveling up revenues in initially low spending districts.

Most school finance reforms, which improve equity assume that redistributing revenues to increase expenditures in low spending districts will translate into better student outcomes. However, there is no consensus in the education literature on the causal link between increased expenditures and improved student performance due to confounding factors such as family income that might be correlated with both district expenditures and student performance (Hanushek, 1986, 1996). To disentangle the causal effect of spending on student outcomes, one needs an instrumental variable that is correlated with spending

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doi:10.1016/j.econedurev.2007.11.004

but uncorrelated with other unobservables that affect test scores.

*Proposal A* provides such an instrument through the School Aid Fund (SAF) foundation allowance, which is the annual grant given to districts based on per-pupil revenues in 1993/1994 according to a non-linear formula and current foundation levels set by the state.[1] Annual increases in the foundation level are indexed relative to state revenues in the current year and revenues in 1994/1995, the first year following the reform. The state-set foundation allowance determines operating expenditures in a district and after controlling for 1993/1994 base revenues, it is unlikely to be correlated with other time-varying unobservables that might affect test scores. *Proposal A* thus offers a unique setting to explore the causal effect of increased spending on student outcomes.

This paper analyzes the effects of Michigan school finance reform on educational inputs and outputs. The goal is two-fold—first to explore the impact of *Proposal A* on education inputs, and second to use the foundation allowance as an instrument to measure the causal effect of increased spending on 4th and 7th grade math scores. Using a difference-in-difference (DID) estimation strategy with Michigan school districts as the treatment group and neighboring Illinois school districts as the control group, I find that following *Proposal A* Michigan school districts increased operating expenditures by 5.8%. The increase in spending was used to increase teacher salaries and reduce class size. The instrumental variable (IV) results focus on Michigan school districts and find positive effects of increased spending on 4th grade math scores but no statistically significant effects on 7th grade scores. Since expenditures are not disaggregated by grade, it is unclear whether schools intentionally targeted spending toward lower grades or whether higher spending is more effective at increasing outcomes in lower grades. Although the DID results highlight that teacher salaries increased and class sizes decreased following *Proposal A*, IV estimates of the educational inputs suggest that the positive effects on 4th grade scores are largely driven by higher teacher salaries.

The rest of the paper is organized as follows: Section 2 summarizes the relevant literature; Section 3 briefly reviews the school finance system in Michigan before and after *Proposal A*; Section 4 discusses the DID and IV methodology; Section 5 describes the data; Section 6 presents the results and Section 7 concludes.

## 2. Related literature

Studies on school finance reforms have either examined the direct impact of reforms on the distribution of resources (Hoxby, 2001; Murray, Evans, & Schwab, 1998), or the effect of the reform on student performance (Coate & VanderHoff, 1999; Downes, 1992) with mixed results. The former set of studies generally indicate that school finance reforms reduce the variance in spending patterns across districts and states, but the latter set of studies find limited effects of improved performance following equalizations in expenditures. Downes, Dye, and McGuire (1998) find that math test scores decline modestly in Chicago school districts subject to tax caps relative to districts not subject to caps. In the case of California, Downes (1992) finds no significant equalizations in mean student test scores across districts despite equalizations in per-pupil spending.

These findings mirror the lack of consensus among researchers on the nature of the causal relationship between expenditures and student performance. Hanushek (1986, 1996) evaluates 112 studies on the effects of different educational inputs on student outcomes, and finds that half the studies report a positive association, while the other half find no association or a negative association. Given these results, he concludes that expenditures are perhaps not an important determinant of student performance as compared to family background characteristics. However, Card and Krueger (1992, 1996) suggest that increased spending is productive and does translate into better outcomes such as higher wages.

Michigan's *Proposal A* has also received some attention in recent years. Several studies have outlined the school finance system before and after *Proposal A*, and have generally documented a reduction in the variance of spending across districts.[2] Courant and Loeb (1997) suggest that smaller rural districts were the key beneficiaries because their spending increased sharply after accounting for cost differences across districts. On the general equilibrium front, Roy (2004) finds positive effects of *Proposal A* on housing values and other socio-economic indicators in former low spending districts. Papke (2005) uses *Proposal A* to examine the nature of the relationship between spending and test scores, and finds positive effects of increased spending on 4th and 7th grade scores.[3]

Broadly, this paper contributes to the school finance reform literature by studying the impact of the spending floor created through *Proposal A* on different inputs into the education process and student outcomes. None of the previous studies have examined the impact of *Proposal A* on specific educational inputs. The DID strategy controls for secular trends in inputs and indicates that the positive impact on test scores is largely driven by higher teacher salaries. Moreover, the IV analysis finds positive effects of increased spending on 4th grade math scores, but not on 7th grade scores after accounting for other confounding factors.

## 3. Overview of Michigan school finance system

Prior to *Proposal A*, Michigan school districts were funded through a District Power Equalization system that combined local property taxes with state aid payments.

[1] The basic foundation level is determined by the state and "increases automatically each year by the ratio of current earmarked State Aid Fund revenues to 1995 revenues" (Cullen & Loeb, 2004, p. 6). See Cullen and Loeb (2004) for more details.

[2] See Courant, Gramlich, and Loeb (1995), Courant and Loeb (1997), and Cullen and Loeb (2004) among others.

[3] While her paper is innovative in exploring the specific functional form of the relationship between spending and test scores, this paper extends her work by studying the impact of *Proposal A* on both inputs and outputs.

School districts collected local property taxes at voter approved rates and the state guaranteed a minimum return per-pupil for each mill of property tax levied. If district tax revenues were less than the state guaranteed level, the district was compensated the difference in state aid and if tax revenues exceeded the state guaranteed level, the district lost its state aid through taxation. Prior to *Proposal A*, roughly one-third of Michigan school districts were in the latter category and consequently received no state aid.

Due to tremendous voter dissatisfaction with local property taxes, they were eliminated as the main source of district revenues in August 1993 and a new system of school finance, *Proposal A*, was adopted in March 1994. Following *Proposal A*, state revenues for education increased from 37% to 80% and the reform represented a shift toward a state centralized system of school finance from the former local property tax system. State revenues for education were financed primarily from an increased sales tax, an increased tobacco tax, a statewide property tax and a real estate transfer tax. Revenues from the new earmarked sources were deposited in the School Aid Fund (SAF).

*Proposal A* introduced a new foundation grant system of distributing revenues based on base revenues per-pupil in 1993/1994 and guaranteed foundation levels set by the state. A basic foundation (BF) level of 5000 was set for 1994/1995 and the BF increased annually according to an index of current SAF revenues relative to 1994/1995 revenues.[4] Since the state was unable to increase revenues in all districts to $5000, *Proposal A* also created a minimum foundation (MF) level to gradually increase revenues in low spending districts to the BF. The following table shows BF and MF levels from 1994/1995 to 1999/2000 when the MF caught up with the BF and henceforth the two levels were the same.

Foundation levels

| | Year | | | | | |
|---|---|---|---|---|---|---|
| | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 |
| Minimum foundation level | 4200 | 4506 | 4816 | 5124 | 5170 | 5700 |
| Basic foundation level | 5000 | 5153 | 5308 | 5462 | 5462 | 5700 |

The 1994/1995 MF was set at $4200 per-pupil and districts spending less than $3950 in 1993/1994 were allocated allowances of $4200. For districts with base revenues between $4200 and $6500 per-pupil, the following formula was used to determine the foundation allowance in 1994/1995: 0.961 × base revenues per-pupil in 1993/1994 + 414.35.[5] This translated into increases ranging from $250 to $160 per-pupil. Districts spending more than $6500 per-pupil in 1993/1994 were allowed increases of $160 over their 1993/1994 base revenues. The foundation allowance was financed by state revenues and a mandatory local property tax of 18 mills on non-homestead property, however the state placed a ceiling of $6500 on the available allowance. High spending districts with allowances greater than $6500 received the state set maximum of $6500 and were allowed to set additional local property taxes on homestead property to raise revenues.[6]

After 1994/1995 districts with foundation allowances below the BF received larger annual increases as illustrated by the annual MF and BF levels over time. In comparison, districts with foundation allowances above the BF received the same annual increase to their 1994/1995 foundation grant. The annual increase was the nominal change in the School Aid Fund Index (SAFI), which was the ratio of current state SAF revenues per-pupil relative to revenues in 1994/1995. Following *Proposal A*, both high and low spending districts experienced revenue increases, however the reform reduced the across-district variance in spending by allocating larger annual increases to low spending districts until they reached the BF.

Michigan's annual foundation allowance provides a good instrument because it is strongly correlated with district expenditures. Moreover, it is unlikely to be correlated with district-level unobservables that might affect test scores as long as one controls for base revenues in 1993/1994 because the allowance is a function of base revenues in 1993/1994 and state SAF revenues. *Proposal A* thus offers a valid instrument and the increase in spending following the reform also provides an opportunity to study the effect of the reform on educational inputs.

## 4. Empirical methodology

### 4.1. Difference-in-difference

Michigan school finance reform increased expenditures in all districts, but also reduced the variance in spending by disproportionately increasing annual revenues in initially low spending districts. If the increased expenditures were used for instruction then one would expect to see increases in instructional expenditures, decreases in class size and increases in teacher salary. It is unclear ex ante whether all three inputs would increase, but one would expect at least class sizes to go down or teacher salaries to go up if instructional expenditures increase.

A DID estimation strategy is well-suited to explore the impact of a policy change on expenditures and inputs if one can find an adequate control group for Michigan school districts after *Proposal A*, which is the treatment group. School districts in the neighboring state of Illinois offer a natural control group—Illinois is a neighboring state with similar demographics to Michigan. Table 1 presents district-level summary statistics on educational inputs and demographic controls across Michigan and Illinois districts from 1991/1992 to 1997/1998. The demographics are very similar across the two states and they also share a similar history of school finance. Both states have historically

[4] The annual increase was based on the ratio of current SAF revenues to 1994/1995 revenues.

[5] If 1993/1994 revenues were less than 1992/1993, then an average of the 2 years was used.

[6] These 41 districts were known as "hold harmless districts" and were allowed 18 additional mills on homestead property to raise the difference between $6500 and their foundation allowance.

**Table 1**
Annual means of select variables for Michigan and Illinois school districts

| | | Mean | Pre-*proposal A* | | | Post-*proposal A* | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | 1991–1992 | 1992–1993 | 1993–1994 | 1994–1995 | 1995–1996 | 1996–1997 | 1997–1998 |
| Total expenditures per-pupil | IL | 6,488 | 5,687 | 5,813 | 6,028 | 6,326 | 6,753 | 7,227 | 7,654 |
| | MI | 5,348 | 4,389 | 4,592 | 4,988 | 5,480 | 5,678 | 6,047 | 6,153 |
| Average operating expenditures per-pupil | IL | 5,276 | 4,722 | 4,824 | 5,027 | 5,201 | 5,430 | 5,730 | 6,046 |
| | MI | 5,162 | 4,224 | 4,445 | 4,836 | 5,289 | 5,467 | 5,828 | 5,936 |
| Total instructional expenditures per-pupil | IL | 3,080 | 2,722 | 2,821 | 2,938 | 3,038 | 3,177 | 3,346 | 3,547 |
| | MI | 3,315 | 2,665 | 2,822 | 3,094 | 3,427 | 3,534 | 3,764 | 3,822 |
| Average teacher salary | IL | 34,689 | | 32,357 | 33,364 | 33,729 | 34,939 | 36,258 | 37,617 |
| | MI | 41,756 | 37,586 | 39,582 | 41,247 | 42,198 | 42,858 | 44,008 | 44,454 |
| Constructed K-12 pupil–teacher ratio | IL | 14.29 | 14.31 | 14.58 | 14.64 | 14.55 | 14.44 | 13.81 | 13.45 |
| | MI | 17.89 | 15.45 | 18.91 | 18.74 | 18.33 | 18.04 | 17.86 | 17.26 |
| Percent White | IL | 88.59 | 90.13 | 89.61 | 89.19 | 88.56 | 87.98 | 87.56 | 87.00 |
| | MI | 90.43 | 90.95 | 90.80 | 90.58 | 90.59 | 90.29 | 90.04 | 89.83 |
| Percent Black | IL | 6.06 | 5.34 | 5.57 | 5.79 | 6.07 | 6.36 | 6.55 | 6.83 |
| | MI | 4.64 | 4.44 | 4.50 | 4.61 | 4.50 | 4.62 | 4.81 | 4.99 |
| Percent Asian | IL | 1.81 | 1.70 | 1.76 | 1.78 | 1.84 | 1.87 | 1.85 | 1.89 |
| | MI | 0.85 | 0.81 | 0.81 | 0.86 | 0.84 | 0.86 | 0.88 | 0.91 |
| Percent Hispanic | IL | 3.44 | 2.77 | 2.98 | 3.15 | 3.43 | 3.70 | 3.94 | 4.17 |
| | MI | 2.33 | 2.09 | 2.19 | 2.24 | 2.30 | 2.45 | 2.53 | 2.47 |
| Percent students on free lunch program | IL | 16.33 | 16.06 | 16.08 | 16.05 | 16.04 | 16.07 | 16.60 | 17.43 |
| | MI | 21.21 | 21.64 | 23.82 | 20.41 | 20.93 | 20.55 | 20.33 | 20.89 |
| Number of schools Per district | IL | 4.31 | 4.33 | 4.34 | 4.38 | 3.77 | 4.40 | 4.43 | 4.50 |
| | MI | 6.37 | 6.24 | 6.30 | 6.34 | 6.15 | 6.46 | 6.54 | 6.54 |
| Observations | IL | 6406 | 942 | 929 | 922 | 908 | 905 | 903 | 897 |
| | MI | 3786 | 524 | 524 | 524 | 553 | 554 | 554 | 553 |

*Note*: See text for specific details on data sources. All expenditure variables are expressed in nominal terms.

relied on local property taxes for school revenues and the supreme courts of Illinois and Michigan have upheld cases questioning the constitutionality of their finance systems.[7] Despite the similarities, Table 1 indicates that there are pre-existing differences in inputs across the two states. Hence, it is important to control for both state fixed effects as well as state specific time trends in the DID estimation.

I estimate the following reduced form DID equation:

$$Y_{jst} = \alpha_0 + \alpha_t T + \alpha_s M + \delta M \times T + \gamma X_{jst} + M \times \text{time-trend} + \text{Ill} \times \text{time-trend} + \mu_{jst} \quad (1)$$

$Y$ is the natural log of different inputs into the education process—average operating expenditures per-pupil, instructional expenditures, average teacher salary and pupil–teacher ratio for district $j$, in state $s$ and year $t$. $M$ is a dummy for Michigan and $T$ is a dummy for years after 1994/1995 (post-policy year). The coefficient $\alpha_s$ captures pre-existing differences between Michigan and Illinois school districts, and the post-policy dummy captures any aggregate temporal factors that affect $Y$ in the same manner across the two states (for example, this would capture any federal education mandates affecting both Michigan and Illinois). Since there could be aggregate factors that differentially affect $Y$ over time across the two states, I also include state specific time trends in the estimation. The estimation also controls for standard district specific covariates ($X$) such as racial composition, percentage of students eligible for free lunch, number of schools in the district, natural log of enrollment, the square of the natural log of enrollment and a rural dummy.

The DID estimator is the coefficient $\delta$, which captures the interaction between the Michigan dummy and post-policy dummy. For $\delta$ to be unbiased, *Proposal A* has to be systematically uncorrelated with other unobservables conditional on the observables included in $X$, the state specific dummies and time trends. Given the set of controls, it seems reasonable that the unobservables that might affect inputs are unlikely to be correlated with *Proposal A*.

### 4.2. Instrumental variables

To disentangle the causal effect of increased spending on student performance, I use the foundation allowance created through *Proposal A* as an instrument for expenditures. If expenditures per-pupil are correlated with unobservables such as family background characteristics, an OLS estimate of spending on test scores will be biased and inconsistent. To get a consistent estimate, an instrumental variable is required that is correlated with expenditures but uncorrelated with the error term conditional on the observables. The foundation allowance provides such an instrument.[8]

[7] There were no significant changes to the Illinois school finance system over this period. Property tax limits were imposed in some counties of Illinois in 1991. Since *Proposal A* was enacted in 1995, a sufficient length of time has passed between the two policy changes. Moreover, Downes et al. (1998) do not find any adverse effects of tax limits on student performance.

[8] Papke (2005) uses a similar instrument.

The annual allowance was allocated to each district based on changes in the current School Aid Fund (SAF) revenues per-pupil relative to 1994/1995 SAF revenues, along with district-specific 1993/1994 base revenues as outlined in Section 3. SAF revenues are state-level revenues and are unlikely to affect any district-level unobservables that might be correlated with test scores. Moreover, year dummies can capture any uniform temporal changes that might affect school districts. To control for differences in 1993/1994 base revenues across districts and other time-invariant district characteristics, I include district fixed effects in the IV regression. The identifying assumption is that the foundation allowance is uncorrelated with any time varying unobservables that might affect test scores after controlling for district fixed effects and year effects. This appears to be a reasonable assumption given how the foundation allowance was calculated.

Using data on Michigan school districts after the implementation of *Proposal A*, I estimate the following equation for years 1995 through 2000:

$$Y_{jt} = \alpha_0 + \alpha_1 \times 1995/1996 + \alpha_2 \times 1996/1997 + \cdots + \alpha_5 \times 1999/2000 + \beta S_{jt} + \gamma X_{jt} + d_j + \varepsilon_{jt} \quad (2)$$

where $Y$ is the mean test score in district $j$ at time $t$, $\alpha_1$ through $\alpha_5$ are year dummies to control for aggregate temporal patterns in test scores, $S$ is current operating expenditure per-pupil, $X$ is a vector of district controls, and $d_j$ is the district-specific fixed effect. I instrument operating expenditures with the foundation allowance and interactions of the foundation allowance with year dummies (1995/1996, 1996/1997, 1997/1998, 1998/1999, 1999/2000). A positive estimate of $\beta$ implies that increased school expenditures do lead to higher test scores.

## 5. Data

For the empirical analysis, I created a panel dataset of Michigan and Illinois school districts. The data on Michigan school districts range from 1991/1992 to 1999/2000 and are from the Michigan School Report and Bulletin 1014: MI K-12 Financial Data and Ranking provided by the Michigan Department of Education (MDE). These data have detailed information on different revenue sources, expenditures and educational inputs.

The Illinois data range from 1991/1992 to1997/1998 and are from the Illinois Report Card Database and Fiscal School Data compiled by the Illinois Department of Education. Demographic data for both states are constructed from the National Center for Education Statistics, Common Core of Data, which is compiled annually. As discussed in Section 4, Table 1 presents summary statistics of Michigan and Illinois school districts over time. The biggest increase in Michigan current operating expenditures occurred in 1994/1995 following *Proposal A*. Michigan instructional expenditures also experienced their largest percentage increase of 10% in 1994/1995.

Michigan test score data are from the Michigan Education Assessment Program (MEAP) and consist of two

**Table 2**
Difference-in-difference results

| | Log operating expenditures per-pupil (1) | Log instructional expenditures per-pupil (2) | Log pupil–teacher ratio (3) | Log average teacher salary (4) |
|---|---|---|---|---|
| D-n-D (Interaction of MI dummy w/post 1995 dummy) | 0.0580 | 0.0832 | −0.0464 | 0.0665 |
| | [0.0160]*** | [0.0147]*** | [0.0126]*** | [0.0107]*** |
| Post 1995 dummy | −0.0147 | −0.0212 | 0.0222 | −0.0324 |
| | [0.0118] | [0.0112]* | [0.0081]*** | [0.0073]*** |
| Michigan dummy | −0.0301 | 0.0587 | 0.0905 | 0.2374 |
| | [0.0110]*** | [0.0097]*** | [0.0092]*** | [0.0091]*** |
| Illinois time trend | 0.0452 | 0.0479 | −0.0154 | 0.036 |
| | [0.0028]*** | [0.0028]*** | [0.0020]*** | [0.0020]*** |
| Michigan time trend | 0.0487 | 0.0490 | 0.0151 | 0.0189 |
| | [0.0027]*** | [0.0023]*** | [0.0026]*** | [0.0022]*** |
| Percent Black | 0.0038 | 0.0029 | −0.0004 | 0.0016 |
| | [0.0002]*** | [0.0002]*** | [0.0001]*** | [0.0001]*** |
| Percent Asian | 0.0233 | 0.0235 | −0.0078 | 0.0152 |
| | [0.0013]*** | [0.0009]*** | [0.0004]*** | [0.0006]*** |
| Percent Hispanic | 0.0031 | 0.0035 | 0.0000 | 0.0017 |
| | [0.0005]*** | [0.0005]*** | [0.0003] | [0.0003]*** |
| Percent Native American | 0.0062 | 0.0061 | −0.0034 | 0.0001 |
| | [0.0007]*** | [0.0007]*** | [0.0006]*** | [0.0005] |
| Percent free lunch program | −0.0028 | −0.0022 | −0.0016 | −0.0037 |
| | [0.0003]*** | [0.0002]*** | [0.0002]*** | [0.0002]*** |
| Log district enrollment | −0.1800 | −0.1389 | 0.3394 | 0.1585 |
| | [0.0271]*** | [0.0246]*** | [0.0239]*** | [0.0130]*** |
| Square of log district enrollment | 0.0142 | 0.8529 | −0.0194 | −0.0058 |
| | [0.0019]*** | [0.0018]*** | [0.0017]*** | [0.0010]*** |
| Number of schools | −0.0011 | −0.0008 | 0.0006 | −0.0005 |
| | [0.0002]*** | [0.0002]*** | [0.0001]*** | [0.0002]** |
| Rural dummy | −0.0052 | −0.0159 | −0.0303 | −0.0731 |
| | [0.0053] | [0.0049]*** | [0.0042]*** | [0.0034]*** |
| Constant | 8.8819 | 8.2120 | 1.3709 | 9.543 |
| | [0.0956]*** | [0.0855]*** | [0.0836]*** | [0.0441]*** |
| Observations | 10192 | 10192 | 10192 | 8718 |
| *R*-squared | 0.34 | 0.40 | 0.50 | 0.68 |

*Note*: Robust standard errors in brackets. (*) Significant at 10%; (**) significant at 5%; (***) significant at 1%. Data range from 1991/1992 to 1997/1998 for specifications (1), (2) and (3), and from 1992/1993 to 1997/1998 for specification (4). Pupil–teacher ratio is constructed as ratio of K-12 enrollment to total teachers.

measures of math test scores – a mean scaled score and a percent satisfactory score – that are reported for 4th and 7th grade students. The mean scaled score is constructed from individual student scaled scores that are averaged across students in each district. In comparison, the percent satisfactory score is the percentage of students that met the state set satisfactory standard in the district.[9] Students are assigned a satisfactory, moderate or low grade based on their scaled scores and districts report the percentage of students to receive each grade (satisfactory, moderate or low). Scaled scores of less than 500 are grade low, scores between 500 and 519 are grade moderate and scores above 519 are grade satisfactory. It is unclear which measure is more accurate at capturing student performance—while the percent satisfactory measure represents the percentage of students meeting a state set criterion, the scaled score captures test performance.

## 6. Results

### 6.1. DID results

Table 2 presents results for the DID estimation for expenditures and educational inputs. Specification 1 on log

[9] The test score data are available online at the Michigan Department of Education website.

**Table 3**
IV–FE regression—math scores

| | 4th Grade | | 7th Grade | |
|---|---|---|---|---|
| | Scaled score (1) | Percent satisfactory (2) | Scaled score (3) | Percent satisfactory (4) |
| Log operating expenditures per-pupil | 12.0009 [6.8072]* | 27.4391 [10.0787]*** | −9.5860 [7.4083] | 3.1995 [12.7978] |
| Percent Black | −0.3624 [0.2095]* | −0.7108 [0.3103]** | −0.5038 [0.1720]*** | −0.7713 [0.2987]*** |
| Percent Hispanic | −0.3455 [0.1356]** | −0.7242 [0.2024]*** | −0.2684 [0.1579]* | −0.2775 [0.2742] |
| Percent Native American | 0.1291 [0.2291] | 0.6126 [0.3422]* | 0.5044 [0.1876]*** | 0.5874 [0.3257]* |
| Percent free lunch program | 0.0497 [0.0500] | 0.1180 [0.0746] | −0.1116 [0.0396]*** | −0.0436 [0.0688] |
| Log district enrollment | 2.6028 [10.5868] | 10.1958 [16.3700] | −28.4124 [10.1172]*** | −136.7694 [17.5213]*** |
| Square of log district enrollment | −0.3306 [0.7749] | −1.2129 [1.1714] | 1.5223 [0.6808]** | 8.4487 [1.1805]*** |
| Number of schools | −0.0784 [0.1914] | −0.0221 [0.2854] | 0.0220 [0.1528] | 0.1379 [0.2653] |
| Rural dummy | 2.9425 [2.1818] | 9.0308 [3.2546]*** | −2.7423 [1.7391] | −4.8415 [3.0194] |
| Dummy for 1995/1996 | 1.1213 [0.4255]*** | 0.7533 [0.6332] | 2.7353 [0.3521]*** | 5.8460 [0.6109]*** |
| Dummy for 1996/1997 | −2.0687 [0.5768]*** | −3.1100 0.8529 | 0.5586 [0.5334] | 1.9065 [0.9247]** |
| Dummy for 1997/1998 | 8.6586 [0.5996]*** | 11.5662 [0.8812]*** | 7.5779 [0.5528]*** | 13.0055 [0.9545]*** |
| Dummy for 1998/1999 | 8.6242 [0.7175]*** | 10.4693 [1.0536]*** | 9.2505 [0.6837]*** | 14.9909 [1.1829]*** |
| Dummy for 1999/2000 | 11.1194 [0.8693]*** | 12.7901 [1.2754]*** | 10.2065 [0.8614]*** | 14.4248 [1.4941]*** |
| Constant | 421.3685 [92.1303]*** | −186.3600 [141.4788] | 732.9216 [99.4336]*** | 565.1013 [171.7333]*** |
| Observations | 3285 | 3286 | 3240 | 3249 |

Robust standard errors in brackets. (*) Significant at 10%; (**) significant at 5%; (***) significant at 1%. Data range from 1994/1995 to 1999/2000. All regressions include district fixed effects and year effects (omitted group is 1994/1995). Instruments for Exp. are State School Aid foundation allowance (FA) and interactions of FA with year dummies.

operating expenditures per-pupil indicates that *Proposal A* increased operating expenditures by 5.8% on average. Districts with larger proportions of minorities had higher spending, while districts with larger proportions of free lunch students (i.e. poorer districts) had lower spending on average. The overall findings on instructional expenditures mirror those on operating expenditures and show that instructional spending increased by 8.3% on average following *Proposal A* (specification 2).

Specifications 3 and 4 present results on the two educational inputs namely pupil–teacher ratio and average teacher salary. Since the Illinois data do not report class size, average pupil–teacher ratio is constructed as the ratio of total K-12 enrollment to total teachers for both Michigan and Illinois school districts. Hence, these results should be interpreted with some caution because there might be concern that this particular construction does not accurately reflect average pupil–teacher ratios. In fact, reported average pupil–teacher ratios in Michigan are higher than the constructed ratios.

Following *Proposal A* class size decreased by 4.6% on average and there is a similar pattern of improvement in teacher salaries that increased by 6.6%. In general, higher enrollments lead to bigger classes and lower salaries for both inputs, although decreasing returns set in after a certain point as indicated by the negative sign on the coefficient of enrollment square. Taken together, the findings show that the increase in expenditures following *Proposal A* led to higher teacher salaries and smaller class sizes in Michigan.

### 6.2. IV–FE results

While the DID results established that school inputs changed following Michigan school finance reform, it is unclear how test scores responded to the increase in expen-

**Table 4**
Educational inputs

| | Log pupil–teacher ratio | | Log average teacher salary |
|---|---|---|---|
| | Constructed (1) | Reported (2) | (3) |
| Log operating expenditures per-pupil | −0.1197 [0.0784] | 0.0353 [0.0702] | 0.1132 [0.0606]* |
| Percent Black | 0.0008 [0.0027] | −0.0021 [0.0022] | −0.0076 [0.0019]*** |
| Percent Hispanic | −0.0031 [0.0018]* | 0.0026 [0.0014]* | 0.0011 [0.0012] |
| Percent Native American | 0.0033 [0.0030] | 0.0101 [0.0024]*** | 0.0010 [0.0021] |
| Percent free lunch program | 0.0009 [0.0006] | −0.0019 [0.0005]*** | −0.0023 [0.0004]*** |
| Log district enrollment | 1.5760 [0.1268]*** | 1.5706 [0.1141]*** | 0.4354 [0.0985]*** |
| Square of log district enrollment | −0.0792 [0.0094]*** | −0.0923 [0.0082]*** | −0.0306 [0.0070]*** |
| Number of schools | −0.0053 [0.0022]** | −0.0067 [0.0020]*** | −0.0051 [0.0017]*** |
| Rural dummy | −0.0232 [0.0242] | 0.0196 [0.0227] | −0.0062 [0.0196] |
| Dummy for 1995/1996 | −0.0125 [0.0054]** | −0.0172 [0.0050]*** | 0.0130 [0.0044]*** |
| Dummy for 1996/1997 | −0.0148 [0.0098] | −0.0617 [0.0088]*** | 0.0336 [0.0076]*** |
| Dummy for 1997/1998 | −0.0459 [0.0112]*** | −0.0446 [0.0100]*** | 0.0464 [0.0086]*** |
| Dummy for 1998/1999 | 0.0000 [0.0000] | −0.0663 [0.0129]*** | 0.0586 [0.0111]*** |
| Dummy for 1999/2000 | 0.0000 [0.0000] | −0.0857 [0.0169]*** | 0.0722 [0.0145]*** |
| Constant | −3.2136 [1.0805]*** | −3.5816 [0.9804]*** | 8.2859 [0.8464]*** |
| Observations | 2194 | 3282 | 3281 |

Robust standard errors in brackets. (*)Significant at 10%; (**) significant at 5%; (***) significant at 1%. Data range from 1994/1995 to 1997/1998 for (1) and from 1994/1995 to 1999/2000 for (2) and (3). Regressions include district fixed effects and year effects (omitted group is 1994/1995). Instruments for inputs are State School Aid foundation allowance (FA) and interactions of FA with year dummies.

ditures. There was a general trend of higher math scores over this period, but it is unclear whether that reflects a causal effect of increased spending. To explore the causal effect of higher expenditures on outcomes, Table 3 presents IV estimates for 4th and 7th grade math scores with district fixed effects and other time varying district controls using the foundation allowance and its year interactions as instruments for operating expenditures.[10]

While the results on 4th grade scores indicate that increased expenditures translate into higher student outcomes, the 7th grade results are not as reassuring. The coefficients on operating expenditures per-pupil suggest that a 10% increase in spending ($580 on average) would increase 4th grade scaled scores by 1.2 points, which is one-tenth of a standard deviation of 4th grade scaled scores. Although statistically significant, this is not a substantially large economic effect of increased spending because one would need to increase spending by 100% to increase scaled scores by one standard deviation. In comparison, the magnitude of the effect is somewhat larger for percent satisfactory scores, where a 60% increase in expenditures would increase 4th grade satisfactory scores by one standard deviation.

The definitional differences across the two measures can potentially account for the difference in coefficient magnitudes. Students with scaled scores over 519 received a satisfactory grade, while students with scaled scores below 519 and 500 received moderate and low grades respectively. If mean scaled scores in a district increase from 518 to 519, then a significant number of students

[10] First stage results are available upon request. The IV results are robust to using the foundation allowance as a single instrument.

jump to the satisfactory grade, which translates into a large increase in the percentage of students receiving the satisfactory grade (the percent satisfactory measure). This particular system of evaluating test performance could potentially create incentives for schools to focus on marginal students that are on the border of moderate and satisfactory grades as opposed to extremely low performing students.[11]

The findings thus far point to a causal effect of increased spending on 4th grade scores, but no effect of increased expenditures on 7th grade scores. There is a strong trend of higher 7th grade scores over this period, but higher spending appears to be statistically uncorrelated with 7th grade outcomes. There are two possible explanations for this finding. First, it might be the case that operating expenditures per-pupil vary by grade and schools may have targeted higher expenditures to lower grades. An alternate explanation may be that the relationship between spending and student achievement is heterogeneous across grades with performance in younger grades being more responsive to improvements in inputs. Unfortunately, disaggregated spending data are unavailable by grade to distinguish between these two alternate explanations.

Although higher spending has a positive effect on 4th grade test outcomes, it is unclear what specific educational inputs are driving the results on operating expenditures. The DID results on educational inputs suggest that smaller class sizes and higher teacher salaries might be responsible for the positive effects on 4th grade scores. Given the pre-existing trends in educational inputs in Illinois and the perhaps inaccurate measurement of class size in the DID specifications, Table 4 presents additional results on the two educational inputs instrumenting for operating expenditures with the foundation allowance. Specification 1 focuses on constructed pupil–teacher ratios, while specification 2 represents reported pupil–teacher ratios. The year dummies pick up most of the variation in class size and there do not appear to be any significant effects of spending on either measure of pupil–teacher ratios. However, there does seem to be a positive effect of spending on average teacher salaries. Thus, improvements in 4th grade math tests are largely driven by higher teaching salaries, which perhaps crudely capture teacher quality.

## 7. Conclusion

Over the past 30 years, school finance reforms have been implemented in numerous states with mixed results. Most of the reforms have increased spending in poorer districts on the presumption that these increases will translate into better student outcomes. The findings of this paper suggest that there is a causal relationship between spending and test performance. But, we have to interpret the results with caution for two reasons. First, increased expenditures appear to be beneficial only for 4th grade test scores, which suggest that either the causal relationship varies by grade or that schools allocated varying expenditures per-pupil to different grade levels. These findings accord with Guryan (2001) that finds positive effects of higher spending on 4th grade scores but statistically insignificant effects on 8th grade scores in Massachusetts. Second and finally, although the results on the beneficial effects of class size are inconclusive, higher teacher salary does appear to positively impact test performance. Overall, the findings suggest that school finance reforms, which increase expenditures might be more effective if spending increases are targeted toward increasing teacher salaries that are perhaps a crude proxy for teacher quality.

[11] Quantile regressions provide some evidence in favor of this view because the effects of increased spending are smaller in magnitude and statistically insignificant for the lowest 1 percentile of the score distribution and larger in magnitude and statistically significant for the 99th percentile of the score distribution.

## Acknowledgements

I am grateful to Sandra Black and Janet Currie for advice and comments and to Therese McGuire for her help in getting access to the financial data for Illinois. I would like to thank the Hoover Institution for financial support through the National Fellows Program as well as Paul Devereux, V. Joe Hotz, Enrico Moretti, Ken Sokoloff and an anonymous referee for valuable feedback.

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