The Efficiency-Equity Trade-off in a Federal System: Local Financing of Schools and Student Achievement

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Federalism theorists debate the desirability of funding local services from local revenues or inter-governmental grants. Tiebout expects efficiency gains from local funding, but Oates says it perpetuates inequalities. Research using data from national probability samples has yet to show whether efficiency-equity trade-offs are associated with funding sources. We describe the trade-off in education by estimating the effect of revenue share from local sources on math and reading achievement. Data come from national probability samples of student performances on tests administered between 1990 and 2017. Relationships are estimated with OLS descriptive models, event study models of school finance reforms, and geographic discontinuity models that exploit differences in state funding policies. For every ten-percentage point increase in local revenue share, mean achievement rises by 0.05 standard deviations (sd) and socio-economic achievement gaps widen by 0.03sd. Voice and exit channels moderate the size of the efficiency-equity trade-off. Implications for inter-governmental grant policy are discussed.

Public policy generally requires trade-offs between efficiency (the overall quality of public services controlling for spending) and equity [differential service impacts on the more and less advantaged (Okun 1975)]. For example, efficiency may generate economic growth but at the price of growing inequality (Hochman and Rodgers 1969). In the United States, local governments are said to be more efficient if their revenues come from local sources, but that efficiency comes with the risk of greater inequality in service delivery (Oates 1972; Peterson 1981; Tiebout 1956). Prior research has explored one side or another of the equality-efficiency trade-off in U.S. federalism. But scholars have yet to estimate its size empirically with data from a national sample. The goal of this article is to investigate the existence and extent of this tradeoff for a locally provided public service: education.

Localities expend a larger share of fiscal resources on elementary and secondary education than on any other public service. In 2007, K-12 education expenditures accounted for 35 percent of all local government spending, or over $455 billion

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(U.S. Bureau of the Census 2019).[1] The efficiency-equity trade-off provokes intense discussion in the education arena. Schools are supposed to enhance human capital and contribute to national growth (Hanushek and Woessmann 2012; Murnane et al. 1995), but they are no less expected to provide all students with equal educational opportunities (Coleman et al. 1966).

Student performance on standardized tests provide a window on the efficiency-equity trade-off in education. After adjusting for student background, test scores are predictive of important life outcomes, such as college enrollment, degree attainment, earnings, or rates of criminal activity (Chetty, Friedman and Rockoff 2014a, 2014b). At state and national levels, performance on standardized tests has been shown to be correlated with economic growth rates (Hanushek and Woessmann 2012). When tests are used to assess the educational efficiency and equity of U.S. schools, they seem to fall short on both sides of the trade-off. U.S. mean student performance on international tests in math, reading and science ranks below that of many other countries (Hanushek, Ruhose, and Woessmann 2016; Pál, Marec, and Schwabe Henderson 2019). Meanwhile, the divide between those at the top and bottom deciles of the income distribution is said to have increased over the past half century (Reardon 2011, but see Shakeel and Peterson 2022).

The U.S. Supreme Court has found no constitutional basis for addressing inequality in school financing. However, the Sixth Circuit Court of Appeals in *Gary B. v. Whitmer* (2020), has revisited this question and further litigation is possible (Ogletree and Robinson 2015). At the state level, California's highest court, in *Serrano v. Priest* (1976), ruled that per pupil expenditure disparities violate its state constitution and ordered larger grants to poorer districts. Other state courts have issued similar rulings (Hanushek 2006; West and Peterson 2007). Still, serious fiscal inequalities between districts persist (Brunner, Hyman and Ju 2020; Guin et al. 2007; Lafortune, Rothstein and Schanzenbach 2018).

We build on prior research on efficiency and equity by estimating the effects on student achievement of variation in the share of funding from local revenue sources rather than by inter-governmental grants. Between 1990 and 2017 the National Assessment of Educational Progress (NAEP) administered tests to more than 100,000 nationally and state representative 8th grade students in each of twelve waves in math and fourteen waves in reading. We identify the efficiency of service delivery by estimating the effects of funding arrangements on mean performances in the two subjects. To observe potential inequities, we estimate heterogeneous effects by socioeconomic status (SES).

We first estimate relationships with ordinary least squares (OLS) models of tests administered in 2007 after controlling for a wide range of student background characteristics included in the NAEP data set, as well as for per pupil expenditure and other school district characteristics. See Online Appendix table A.1 for

summary statistics. We use similar models to estimate heterogeneous effects by SES. We next estimate effects with two models less subject to potential endogeneity. Event study models are used to estimate impacts of court-induced school finance reforms in eleven states (that implemented reforms between 1990 and 2014) on the relationship between local revenue shares and student performance. Included are all states for which three test score observations in each subject are available both before and after the reform. Estimates of effects are unbiased unless changes in revenue share induced by the reforms are correlated with other relevant events. Geographical discontinuity regressions are used to estimate effects on achievement levels in 2007 in districts at borders of states with disparate fiscal regimes (Tolbert and Sizer 1996). Differences in funding shares of bordering districts are plausibly exogenous if observed characteristics of those on either side of state borders do not differ significantly and if observables capture differences in "tastes for education."

The OLS, event study, and geographic discontinuity models find a positive relationship between local revenue share and mean student performance, and most show heterogeneous effects that widen SES-achievement gaps. Our preferred OLS estimation finds that mean 8th grade math and reading performances increases by approximately 0.05 standard deviations (sd) with every 10 percent increase in the share of revenues received from local sources. Similar results are obtained from the event study and geographical discontinuity analysis. Efficiency gains come at the price of equity. Our preferred model shows a widening of the SES-achievement gap by 0.03sd for every 10 percent increase in local share; our event study model shows substantially higher equity impacts of school finance reforms, primarily by adversely affecting the performance of high SES students.

Following Hirschman (1970), we explore "voice" and "exit" channels as moderators that may connect local revenue share to outcomes. Two popular policies—lower pupil–teacher ratios and larger shares of expenditure allocated to instruction—are positively correlated with achievement. Both occur when the share of funding from local sources is greater, and both are positively correlated with student achievement after controlling for expenditures per pupil and other district characteristics. These results suggest that the voice channel may be a moderator of the connection between local revenue share and achievement.

To ascertain exit effects, we, following (Hoxby 2000), hypothesize that achievement increases when exit potential is greater, that is, when school districts are more densely concentrated within a geographic area, provided that a larger share of funding comes from local sources. Results are consistent with the hypothesis. Local revenue share has a larger impact on mean achievement in commuter zones with greater school district density, which provides residents with more exit options. These effects are concentrated on students from higher SES backgrounds.

Federalism Research on Equity and Efficiency

Federalism research has explored each side of the efficiency-equity trade-off. However, scholars have yet to estimate the size of the trade-off empirically with data from national probability samples.

Efficiency Studies

Tiebout (1956) theorizes that a system of local governments necessarily provides efficient services because citizens maximize utilities by migrating to communities that provide preferred services at lowest cost (see also Ostrom, Tiebout and Warren 1961). Buchanan and Wagner (1977) theorize that a fiscal illusion results whenever there is no "fiscal equivalence" between those who pay and those who benefit from public goods. Individuals who would not pay for services will consume them when paid for largely by others (Cutler and Zeckhauser 2000). The greater the share of local services covered by revenues from nonlocal resources, the greater the moral hazard (Hines and Thaler 1995). In the words of Rodden (2016, 3): "Voters face strong incentives to monitor service provision when they understand their role in paying the bill, and [they] may be willing to tolerate much higher levels of inefficiency… [if money arrives via] intergovernmental transfers."

These considerations might not apply to educational services, because many residents do not use schools and many parents rent rather than own their homes.[2] Also, it may make no difference to homeowners whether a funding source is local or from a higher tier of government, because it is school quality, not funding source, that becomes capitalized into property values. When services are funded by a higher tier of government, administrators may try to shift blame for inefficient service delivery to regulations imposed by the higher tier. But blaming is not the issue. If schools are defective, the consequences for property values are adverse regardless of funding source. In sum, it is not clear that school quality has a larger impact on local property values when residents pay for schools out of local taxes than when resources come from a wider resource base.

Tiebout and followers such as Rodden (2016) might reply that the quality of locally funded schools is strongly anchored and revenues from intergovernmental grants may appear as "manna from heaven" that could disappear at any moment. If both the funding and management of schools are local, the quality of the education is more likely to be fully capitalized into property values than quality dependent on external funding subject to regulation by higher tiers.

This theoretical debate raises questions that can be investigated empirically. In this study, we investigate whether the share of funding raised locally is associated with student achievement, other things being equal. More research is needed to explore effects of achievement on property values, resident expectations, and the inter-play between expectations and policy choices.

The efficiency of local governments has been empirically estimated in various ways. Numerous studies have shown that residents are willing to pay for higher quality services by showing impacts of services on property values (Black 1999; Bogart and Cromwell 2000; Bradbury, Mayer and Case 2001; Hayes and Taylor 1996; Weimer and Wolkoff 2001). Berry (2009) shows that services are more efficiently provided when the same governmental jurisdiction (the municipality) is responsible for raising the revenue needed to provide the service. When multiple local governments have access to a common fiscal pool, costs rise but services do not improve. Emanuelson (2003) reports a similar result for services provided by park districts. Elinor Ostrom and her colleagues (Ostrom, Parks and Whitaker 1973, 1974; Ostrom 1983) find police services are more efficiently provided if paid for by small jurisdictions. In education, Hoxby (2000) reports higher quality service delivery, as measured by student test performance, in metropolitan areas with more dense concentrations of school districts.[3]

Equity Studies

Oates (1972, 2006) theorizes that local governments will underprovide redistributive services if costs and benefits spill across jurisdictional boundaries. Similarly, Peterson (1981, 1995) theorizes that local governments maximize local property values. To attract residents with more resources and skills, they deliver to them higher quality services than those provided to the disadvantaged.

Numerous scholars have examined local government's capacity to provide services in an equitable manner. In a classic case study, Dahl (1961, 92) interprets a pluralist local polity as broadly representative and responsive to a wide range of social groups. But conclusions reached by most research points in a quite different direction. A robust literature has documented the conservative bias of local government (Ejdemyr 2017; Oates, 1972; Peterson 1981; Rae 2008; Trounstine 2018). Research also finds the broader public to be no less conservative in local politics. For example, homeowners and interest groups object to affordable housing developments expected to have a negative impact on property values (Fischel 2001; Gerber, Kessler, and Meredith 2011; Hankinson 2018). However, states reduce inequalities if left-oriented parties are in power (Kelly and Witko 2012). In education, court-ordered reforms and other state policies reduce expenditure inequalities and narrow achievement gaps across socio-economic divides (Jackson, Johnson, and Persico 2015; Lafortune, Rothstein, and Schanzenbach 2018), particularly if teacher unions are influential (Brunner, Hyman and Ju 2020). But these studies have not estimated equity-efficiency trade-offs within districts. We contribute to these literatures by estimating mean effects and heterogeneous effects by SES of variations in the share of funding covered by local resources.

More broadly, we speak to recently revived debates on U.S. local politics, some of which have focused on the importance of partisanship in local politics (de Benedictis-Kessner and Warshaw 2016; Bucchianeri 2020; Einstein and Glick 2018; Einstein and Kogan 2016; Hopkins, 2018; Tausanovitch and Warshaw 2014). Our contribution places that literature in context by showing the importance of enduring institutional features of localities and by connecting local political processes to policy outcomes.

In sum, we synthesize perspectives offered by literatures initiated by Tiebout (1956) and Oates (1972, 2006) by exploring the trade-off between efficiency and equity. We propose that both theoretical perspectives offer valuable insights. Local funding improves the average quality of service delivery by enabling greater accountability in the form of voice or exit mechanisms. However, since these mechanisms are not exercised to the same extent by all residents, benefits to high SES residents may exceed those to low SES ones.

Data

Our main sample consists of over 100,000 math and reading test performances on each wave of the National Assessment of Educational Progress (NAEP) administered to nationally representative and state representative samples of students (Rogers and Stoeckel 2008) between 1990 and 2017.[4] Fourteen waves were administered in reading and 12 waves were administered in math, which are used in the event study analyses. The 2007 math and reading waves, administered prior to the recession of 2008, are used for the OLS and geographical discontinuity analyses. Observations are weighted to be district representative (Little 1993). In the preferred analyses, we combine results from math and reading test administrations. All outcomes are reported in sd.

Contemporaneous per pupil expenditures and the local share of revenue in the test-taker's school district (for the school year 2006–2007 in the preferred specification) are taken from the NCES Common Core of Data (NCES 2019). We divide the total local revenue by the total revenue from all local, state, and federal sources.[7] Our event study analysis uses NAEP data for the period 1990–2017. See Online Appendix for a description of the data and a variety of robustness checks, including one that uses house price changes as an instrument.

The NAEP dataset contains two variables that are used to estimate heterogeneity by socioeconomic status (SES). Parental education, our preferred SES indicator, is obtained directly from test-takers and is dichotomized between those who have or do not have at least one parent with a college education. Household income is measured by student eligibility for free and reduced lunch, a noisy measure of household income (Michelmore and Dynarski 2017; Chingos 2016; Koedel and Parsons 2020). NAEP also provides information on gender, special education

status, English language learner status, and minority (neither white nor Asian) status, which we include as controls. We also obtain and include from the 2000 census (US Bureau of the Census 2019) three district-level covariates: household median income, percent urban, and percentage of those 26 and older with a 4-year college degree. The fourth district-level covariate, median house prices, is obtained from the Zillow Home Value Index (Zillow 2018). For its use, see Guerrieri, Hartley, and Hurst (2013), This variable is available for 72 percent of the weighted observations in our sample.

Analytical Strategies

We estimate relationships between local funding and student performance with three types of models: cross-sectional OLS, an event study of school finance reforms, and geographic discontinuities across state borders. The three types of models have complementary strengths and limitations. The OLS models estimate, arguably, longer-term relationships that may be generalized to patterns across the United States. However, the estimations provide observational information, as patterns could be endogenous. The event study of school finance and geographic discontinuity models have been used by others to estimate causal effects, but here they are used in specific state and local contexts, which may not be generalizable. The OLS and geographical discontinuity estimates are based on observations from 2007. The event study model uses observations from all waves of the surveys administered between 1990 and 2017. Given the novelty of the terrain we explore, we interpret our results as descriptive but worthy of further investigation.

OLS Models

In our OLS analyses, we estimate the relation between a district's local revenue share and student performance with the following regression specification:

$$Y_{ids} = \beta L_d + \boldsymbol{\delta} \mathbf{X}_i + \boldsymbol{\xi} \mathbf{D}_d + \gamma E_d + B_s + R_i + \varepsilon_{ids}, \quad (1)$$

where Y is the NAEP test score for individual i in district d, in state s, measured in standard deviations; L is the local share of revenues in the district; **X** is a vector of the individual-level covariates described above, **D** is a vector of school district characteristics described above; E is the district's current per pupil expenditure; B are state fixed effects; R is an indicator for whether the test is a reading or math test; and ε is the error term, which we cluster by district d to account for interactions among student observations within a school district.

When analyzing heterogeneous effects, we consider cleavages driven by differences in either the income indicator or level of parental education, by

adding the interaction term L ×SES in addition to using these SES variables as covariates:

$$Y_{ids} = \zeta L_d \times SES_i + \beta L_d + \eta SES_i + \boldsymbol{\delta} \mathbf{X}_i + \boldsymbol{\xi} \mathbf{D}_d + \gamma E_d + B_s + R_i + \varepsilon_{ids} \quad (2)$$

Estimation of those models via OLS may be biased by an endogenous relationship between revenue share and student performance. For example, observables may not distinguish those who seek high-quality schools by migrating to districts that receive more of their funding from local school revenues. We address potential endogeneities with event study models that estimate exogenous impacts of court-ordered school finance reforms on local revenue shares and geographic regression discontinuity models that exploit funding formula discontinuities at state borders.

Event Study of School Finance Reforms

Ever since the *Serrano* decision in 1976, state courts have ordered state legislatures to enhance equal educational opportunity by reducing the variation in per pupil expenditure across school districts. The court orders have been interpreted by the school finance literature as exogenous shocks, which allows for causal estimations of school expenditure on student performance (Jackson, Johnson, and Persico 2015; Brunner, Hyman, and Ju 2020; Lafortune, Rothstein, and Schanzenbach 2018, hereinafter LRS).

LRS (Online Appendix, 23–26) provides information on the dates when states' major school finance reforms took place during the period 1990 through 2017. We identify the states in which major school finance reform allows for the identification of at least three NAEP test administrations both before and after the reform was introduced. The eleven states and the year of their school finance reform, as reported by LRS are as follows: Arkansas (2002), Colorado (2000), Indiana (2011), Kansas (2005), Maryland (2002), Montana (2005), New Hampshire (2008), New York (2006), North Dakota (2007), Washington (2010), and Wyoming (2001).[5]

Following LRS, we assume these shifts in state funding levels are random shocks uncorrelated with other state policies that affect student achievement. By including year-by-year fixed effects, we control for trends in student achievement nationwide and estimate only disproportionate changes in student achievement that occur simultaneously with the court-induced school finance reforms. By controlling for district expenditures per pupil we net out any reform impacts on spending levels. We also control for other district and individual characteristics included in our OLS models. Our model can thus be seen as akin to difference-in-differences models if one assumes that districts not subject to the finance reforms are, on average, moving consistently with national trends in achievement.

The model first estimates the impact of court-ordered reforms on funding levels with the following equation:

$$L_{yds} = \beta\ \text{PostReform}_{ys} + \ B_s + \ T_y + \varepsilon_{yds} \tag{3}$$

Here, PostReform is an indicator for whether the observation occurs after the school finance reform in the state, T is the year relative to the reform event date, and the remaining symbols remain as in (1) and (2).

The model then estimates the impact on achievement that can be attributed to the court-ordered changes in funding levels with the following equation:

$$Y_{idsy} = \beta\widehat{L}_{dy} + \boldsymbol{\delta}\mathbf{X}_{iy} + \boldsymbol{\xi}\mathbf{D}_{dy} + \gamma E_{dy} + B_s + R_i + T_y + \varepsilon_{iyds} \tag{4}$$

Geographic Discontinuities across State Borders

Since intergovernmental grants are largely determined at the state level, students attending schools close to state borders may find themselves in districts receiving widely disparate funding shares via intergovernmental grants. The discontinuity may be used to estimate effects on student performance if other unobserved state policies do not affect performance and if observed differences in the background characteristics of both students and districts near borders capture unobserved difference.[6]

To estimate a local average treatment effect of differences in local revenue share near state borders, we employ a fuzzy geographic regression discontinuity design with linear distance of the student's school to the border as the running variable. The effect of local revenue share is estimated as the magnitude of the difference in linear intercepts at the border between higher and local revenue share states. Following Cattaneo, Idrobo, and Titiunik (2019, ch. 4.2), we select the bandwidth that minimizes the mean squared error (MSE) of the point estimator. This bandwidth is 11.9 km (7.39 miles) on either side of the border for the estimation of the mean effect. The bandwidth contains 17,140 student observations located within 236 school districts in 25 unique states, near 45 state borders. We use the same bandwidth to estimate heterogeneities by SES. In a robustness check, we also estimate effects that use the optimal bandwidth for each subgroup specification. We follow Keele and Titiunik (2015) by also estimating effects using three alternative bandwidths of 10 km, 20 km, and 30 km in order to mitigate concerns about linear indicators in contexts where distance is bi-dimensional (see Online Appendix, table A.8).

In the implementation of this strategy, we restrict our sample of students to those living near the borders of states with fiscal regimes that differ by an average of ten percentage points or more. Consistent with Keele and Titiunik (2015), we

further restrict the sample to borders where student ethnicity (white and Asian versus others) does not differ by more than 10 percentage points.

When we restrict the sample to borders and bandwidths that meet these specifications, we observe students who (with one exception) have characteristics that do not significantly differ on either side of the border, in analyses reported in Online Appendix table A.6. See Online Appendix for further methodological details. We observe a difference in the share of English Language Learners but the sign on this variable is negative, which indicates that the percentage is greater on the side of the border with districts more dependent on local revenue, a value that potentially biases our estimates toward zero. We control for three state policies thought to affect teacher quality, because the effectiveness of the teacher is the school factor most closely correlated with educational outcomes (Chetty, Friedman, and Rockoff 2014b).[7]

Results

We report results from OLS models, event study, and geographic discontinuity models. See Online Appendix for alternative analyses and robustness checks (including one exploiting house price changes as an instrument). In most estimations, an efficiency-equity trade-off is detected.

OLS Models

Table 1 displays the results of four OLS models that estimate the impact of local revenue share on educational outcomes in math and reading: (1) a simple relationship between local revenue share and educational outcomes; (2) relationships after controlling for student background characteristics, 2000 district characteristics, per pupil expenditure and state fixed effects; (3) Model 2 plus the inclusion of a term that interacts the low income indicator with local revenue share; and (4) Model 2 plus a term that interacts the low education indicator with local revenue share. We prefer Model 2 as the best estimate of the efficiency effects of local revenue share, because (i) it is based upon data from the entire national probability sample; (ii) it is reasonably assumed to estimate long-term rather than temporary relationships; and (iii) the similarity of its results to those obtained from the event study and geographic discontinuity estimates suggests its estimates are unbiased. We prefer Model 4 as the best estimate of the equity of effects of local revenue share, because the parental education indicator has greater face validity than the free-and-reduced lunch indicator.

Model 1 indicates that average student math performance increases by 0.09sd for every ten percentage-point increase in the share of revenue coming from local sources. The effect is reduced to 0.05sd in Model 2, our preferred model, when per

Table 1 OLS estimated relationship between local share of revenue and student achievement (math and reading combined)

	(1)	(2)	(3)	(4)
Local revenue share	**0.0943*****	**0.0530*****	**0.0599*****	**0.0744*****
	(0.00757)	(0.00497)	(0.00525)	(0.00659)
Low income × Local revenue share			**–0.0158*****	
			(0.00459)	
Low education × Local revenue share				**–0.0287*****
				(0.00488)
Low income		–0.282***	–0.204***	–0.283***
		(0.00678)	(0.0187)	(0.00673)
Low education		–0.205***	–0.204***	–0.105***
		(0.00635)	(0.00623)	(0.0160)
Per pupil expenditure		–0.0121**	–0.0122**	–0.0127***
		(0.00386)	(0.00380)	(0.00378)
Number of students	226210	194950	194950	194950
Number of districts	3,033	2,959	2,959	2,959
R^2	0.054	0.259	0.259	0.260

Bolded values are key estimates discussed in the text. Test scores in standard deviations, from the average of first five plausible values. Local revenue share in 10 percentage point units. Per pupil expenditure in thousands of dollars of current expenditure. Weighted observations are district-representative. Income indicated by free or reduced lunch; parental education is indicated by college degree for at least one parent. Observations rounded to nearest tenth to comply with privacy requirements. Models 2, 3, and 4 include state fixed effects, a reading test indicator and individual controls for disability (Individualized Education Program), English learner, race (White or Asian) and Gender. They also include district controls for 2000: share White or Asian, household median income, share urban, and share of those age 26 and older with a 4-year college degree, as well as median house prices. Robust standard errors, clustered by district, in parentheses. Sources: NAEP 2007; NCES 2007; U.S. Census Bureau's Education Demographic and Geographic Estimates project (EDGE). + 0.10, *0.05, **0.01, ***0.001.

pupil expenditure, individual characteristics, district demographic characteristics, and state fixed effects are introduced as controls.

The two remaining models indicate an efficiency-equity trade-off: Students from higher SES backgrounds disproportionately benefit from greater local funding.[8] For every 10 percent increase in local share, the performance of low-income students increases by just 0.04sd as compared to 0.06sd for high-income students (Model 3). In Model 4, the increase for students of parents with less than a college degree is just 0.04sd, while for students with higher levels of parental education it is 0.07sd. In other words, the SES-achievement gap in our preferred model widens by 0.03sd for every 10 percent increase in local revenue share. The OLS relationships

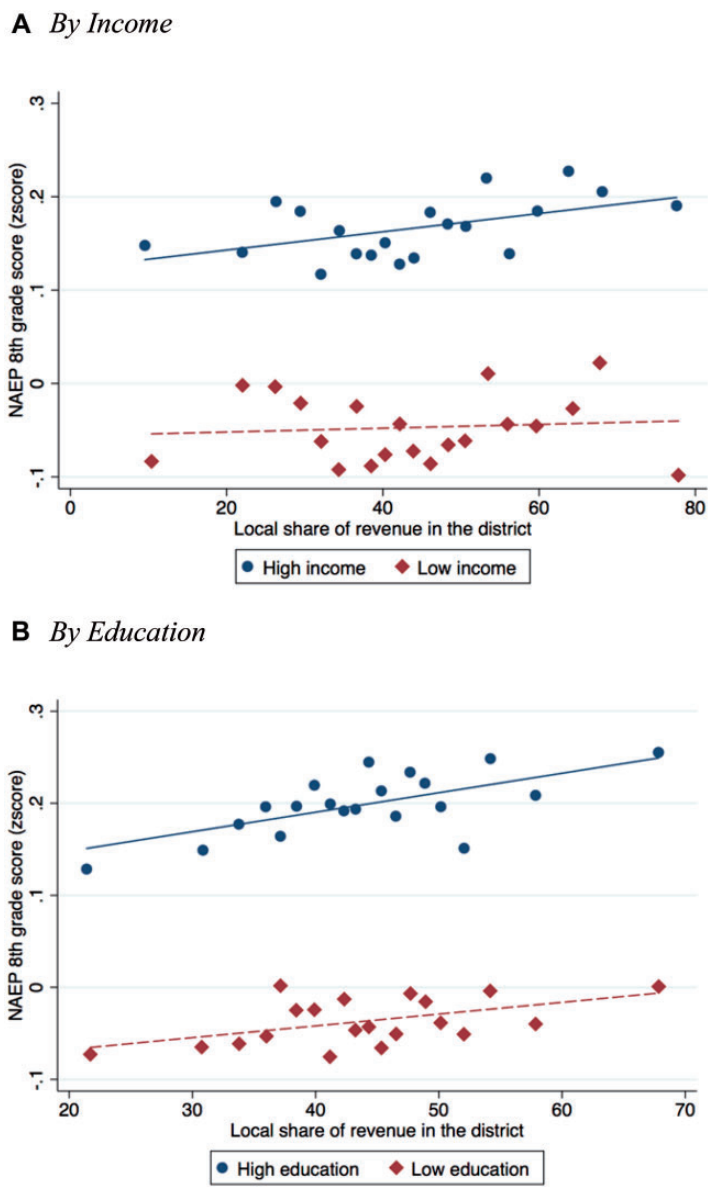

Figure 1 Relationship between local share of revenue and student achievement. (A): by income; (B): by education. Specifications as in Models 3 and 4 of table 2. Individual observations are grouped into twenty equally sized bins.

we have just described are displayed graphically in figure 1. Notice that both lines have an upward slope but diverge as the percentage of revenue from local resources increases.[9]

Event Study of School Finance Reforms

School finance reforms affect the share of district revenue coming from local sources. Prior to the reforms, the local share in the eleven states was 44 percent, roughly the same as that throughout the United States in 2007. The finance reforms reduce local revenue share by 2.73 percentage points or about 6 percent. As can be seen in figure 2A, the pre-event trendline is flat, though the estimation is noisy. Post-event (from the year of reform onwards), there is, as expected, an immediate downward shift in the share of revenue coming from local sources that persists for several years.

We then estimate the effect of the finance reform on student performance, controlling for the same individual and district characteristics included in the OLS analysis. To isolate the impact of changes in local revenue share induced by the reforms, we control for the same covariates and school expenditure per pupil, thereby excluding impacts of changes in expenditure. The pre-event trend line is noisy but upward sloping (figure 2B).

The impact on mean math and reading performance of a 2.7 percentage point decline in local revenue share induced by the reforms is 0.01sd (table 2). That implies a decline of 0.04sd in student performance for every 10 percentage point decrease in local revenue share, nearly the same mean estimate obtained from our preferred OLS model. Note that the negative impact of the reform is felt immediately and remains low throughout the observed period. The switch in financing sources appears to have had a decidedly negative effect.

The equity effects of school finance reforms are more substantial than those estimated by our preferred model. Total impact of the finance reforms is trivial for those whose parents lack college education (<.002sd), but they reduce by 0.02sd the performance of students who have a college educated parent (table 2). The same pattern is observed for those of lower and higher income. This implies equity effects of 0.1sd for every ten percentage-point change in local revenue share. These effects are almost entirely concentrated on students from higher SES backgrounds. The large effects might have been induced by other equity reforms introduced at the same time, if they had negative impacts on high SES students. In other words, school finance reforms, by shifting financing from localities to the state, have adverse effects on the education of advantaged students but no effect on the performance of disadvantaged ones.[10]

Geographic Discontinuity across State Borders

We find comparable efficiency effects of local funding when employing the geographic discontinuity model. For the first stage of the discontinuity regression, we estimate a 15.6 percentage point average difference in local revenue share at state borders (see Online Appendix figure A.1). At the second

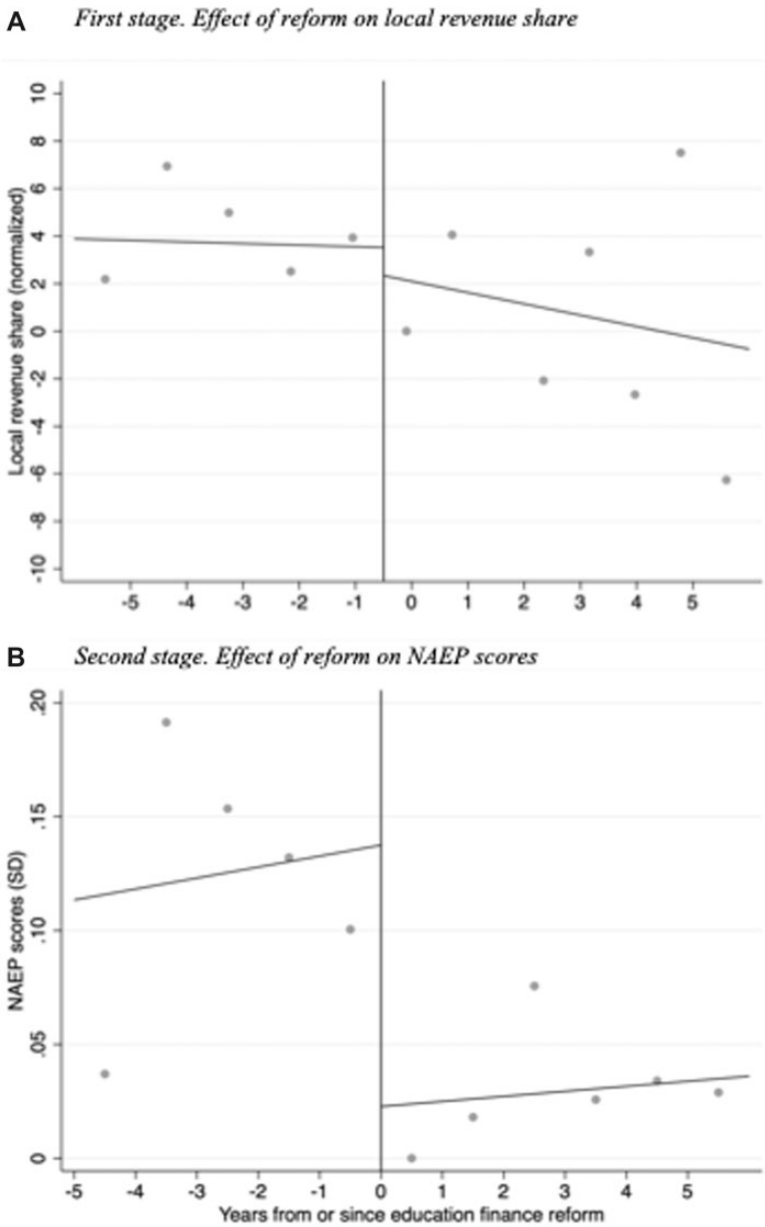

Figure 2 Event study of school finance reforms in eleven states, 1990–2017. (A): First stage. Effect of reform on local revenue share. (B): Second stage. Effect of reform on NAEP scores. See Notes to table 2.

Table 2 Event study estimates of the effects of school finance reforms on NAEP scores in reading and math

	(1)	(2)	(3)
Post reform	−0.0110**	−0.0163***	−0.0212***
	(0.00311)	(0.00351)	(0.00358)
Low education × Post reform			0.0206***
			(0.00263)
Low income × Post reform		0.0200***	
		(0.00315)	
Low income	−0.00485***	−0.00200***	−0.0503***
	(0.000681)	(0.000240)	(0.00683)
Low education	0.000277	0.000423	−0.0161***
	(0.000944)	(0.000918)	(0.00236)
Observations	749,590	749,590	749,590
R^2	0.9836	0.9836	0.9836

Models include NAEP individual level test scores in reading and math 1990–2017. Test scores in standard deviations, from the average of first five plausible values. Post Reform refer to school finance reform. Following LRS (2018), we estimate effects of 11 state finance reform events. All models include state and year fixed effects as well as gender, race, disability indicators, and a continuous measure of spending per student. Robust standard errors, clustered by state, are in parentheses. *Source*: NAEP 1990–2017.

stage, we estimate that this difference has an effect on achievement of 0.09sd (table 3). This is therefore equivalent to a 0.06sd increase for every 10 percentage point increase in local revenue share.

A trade-off between efficiency and equity is detected when the geographic discontinuity model estimates heterogeneous impacts, though equity estimations are noisy, given the smaller sample size. We show in table 3 substantial, statistically significant effects at the border of 0.13sd on the achievement of students from high-income households but no significant effects for students from low-income ones. However, we do not detect significant SES differentials when using parental education as our SES indicator.

Mechanisms

Following Hirschman (1970), we examine the potential of voice and exit channels as moderators connecting local revenue share and policy outcomes.

Table 3 Geographic regression discontinuity estimates of the effects on achievement of attending a school in a state with higher rather than lower mean local revenue share

Sample	Effect of high local revenue share	Obs.
All students	0.08615*	17140
	(0.03721)	
High income	0.12848*	10250
	(0.05956)	
Low income	0.01257	11102
	(0.0558)	
High education	0.0583	7980
	(0.0552)	
Low education	0.0568	7420
	(0.0533)	

Estimate is the effect of location in a high local revenue share state. Estimations restricted to borders of states with differences in average local share of revenue of ten percentage points or more and difference in non-white or Asian share is less than 10 percent. First specification pools all observations, while others restrict samples to each subgroup. Bandwidth defined as the optimal in the specification that pools all observations (11.9 km, including 236 unique districts). Linear specification on either side of the border as in table 1, Model 2. Robust standard errors, clustered by district, in parentheses.

Voice: Fiscal Allocation

Surveys of public opinion find that sizeable majorities favor smaller class sizes and higher salaries for teachers, both costly instructional expenses (Peterson, Henderson and West 2014; Henderson, Peterson and West 2019). Prior research also shows a positive correlation between student achievement and both the proportion of expenditures allocated to instruction (Brewer 1996; Jacques and Brorsen 2002; Wenglinsky 1997) and the pupil-teacher ratio (Krueger 1999).

We hypothesize that public demand for allocating a larger share of resources toward instruction and smaller classes could be a channel connecting local resource share and educational outcomes. To test the hypothesis we draw upon data from NCES (2019), which reports district-level pupil-teacher ratios and allocations of district expenditures to instruction and other school operations. Using an OLS model that controls for per pupil expenditure and the same individual and district-level characteristics as in table 1, we find that, for every 10 percent increase in the share of revenue funded locally, districts allocate one percent more of their resources toward instruction and that the pupil-teacher ratio is reduced by 0.25 pupils. These are shown in table 4. We also show in models 3 and 4 that an

Table 4 Relationships among local revenue share, spending on instruction, pupil–teacher ratio, and achievement

	(1) Instruction share	(2) Pupil–teacher ratio	(3) Student achievement	(4) Student achievement
Local revenue share	–0.0956*	–0.250**		
	(0.0450)	(0.00943)		
Instruction share			0.0677**	
			(0.0293)	
Pupil-teacher ratio				–0.000629^{+}
				(0.000368)
Observations	12010	12010	66880	136410
R2	0.226	0.255	0.257	0.255

District-level OLS Model 1 regresses percentage share of spending on instruction on local revenue share (both in units of 10 percentage points) as defined by NCES (2019), controlling for expenditures per pupil and other controls as in table 1, Model 2. Model 2 regresses pupil–teacher ratio on local revenue share using the same model. Robust standard errors in Models 1 and 2 are clustered by state. Models 3 and 4 regress individual NAEP test performance (*z*-scores) in reading and math combined on indicated variables, with controls as in table 1, Model 2. Robust standard errors in Models 3 and 4 are clustered by district.

increase in the percentage allocated to instruction is in fact positively correlated with mean student achievement, and that the pupil–teacher ratio is negatively correlated with achievement at a marginally significant level.

These results suggest that the voice channel may be a moderator of the connection between local revenue share and achievement. However, these policies could be adopted to forestall migration to other districts, the exit option to which we now turn.

Exit: Tiebout Choice Effects

Hirschman (1970) hypothesizes that residents of a community can influence policy because they may move from a community to another one that has services and policies they prefer (also, see Epple and Zelenitz 1981 and Nechyba 1997). To estimate the exit channel, we build on Hoxby (2000) by hypothesizing that the effects of local revenue share on the efficiency-equity trade-off are larger in districts located in commuting zones where exit potential is greater. To test this proposition, we, following Hoxby, construct a district choice index (1-Herfindahl index, where the Herfindahl index is the same as the one used by the U.S. Department of Justice to estimate the degree to which an industry is competitive or oligopolistic). The district choice index may vary between one and zero, with 1.0 being maximum choice within a commuting zone and 0.0 if no other school

Table 5 OLS estimated relationship between student achievement and the interaction of local revenue share and a commuting zone choice index

	(1)	(2)	(3)	(4)
Local revenue share	0.0574***	0.0147*	0.00374	0.00410
	(0.00128)	(0.00619)	(0.00713)	(0.00769)
Local rev. × Choice index		**0.0495*** **	**0.0747*** **	**0.0815*** **
		(0.00699)	(0.00813)	(0.000875)
Low inc. × Local rev. × Choice Index			**−0.0792*** **	
			(0.0115)	
Low ed. × Local rev. × Choice Index				**–0.0722*** **
				(0.0131)
Choice Index	**0.0329***	**−0.175****	**−0.280*** **	**−0.298*** **
	(0.0166)	(0.0342)	(0.0410)	(0.0437)
Low inc. × Choice Index			0.305***	
			(0.0568)	
Low inc. × Local rev.			0.0369***	
			(0.00981)	
Low income	–0.362***	–0.0362***	−0.500***	–0.0362***
	(0.00416)	(0.00416)	(0.04181)	(0.00416)
Low ed. × Local rev.				0.0335***
				(0.00930)
Low ed. × Choice Index				0.0287***
				(0.00544)
Low education	–0.239***	–0.248***	–0.246***	–0.199***
	(0.00536)	(0.00537)	(0.00538)	(0.0194)
Observations	194,950	194,950	194,950	194,950

Bolded values are key quantities discussed in the text. Specifications as in table 1, Model 2. Choice index defined as in Hoxby (2000, 1215, index c). It is based on a Herfindahl index of concentration of students in the districts within a commuting zone and is defined, for a commuting zone m with K districts, as $1 - \sum_{k=1}^{K} s_{km}^2$, where $s_{km} = \frac{dist.enrollment_{km}}{cz.enrollment_m}$. Robust standard errors, clustered by commuting zone, in parentheses.

district is in the commuting zone. In our sample, the mean of the choice index is 0.849, its standard deviation is 0.162, and its inter-quartile range of 0.133 varies between 0.811 and 0.944.

To estimate the moderating effects of greater exit opportunities, we use OLS models with the same covariates as those used for our preferred Model 2 in table 1. When the district choice variable is added to the estimation (table 5, Model 1), local revenue share remains much the same as in our preferred model (0.057sd). In this model, the district choice variable is also significant but its effect size (0.033sd)

is modest, given that the choice variable shifts from its minimum to its maximum in this estimation. In Model 2 of table 5, an interaction term is added (local revenue share X district choice) to the equation; it measures the effects of changes in local revenue share as the value of the choice variable shifts upward. When this term is included, the district choice variable turns significantly and sharply negative (−0.175sd), as can be seen in table 5, Model 2. Meanwhile, the interaction term itself is significantly positive (0.05sd). This tells us that at the mean of the district choice variable, the effect of a 10 percent change in local revenue share has a 0.05sd effect on student achievement. But as exit opportunities increase, so does the impact of local revenue share on achievement. In other words, efficiency effects of local revenue share are dependent on the level of district choice available within a commuting zone.

In Models 3 and 4 of table 5, effects on disadvantaged students are estimated by introducing triple interaction terms. In Model 3, the low-income term is interacted with both district choice and local revenue share. Its significantly negative value (−0.079sd) indicates that the benefits of local revenue share become more concentrated on students from high-income families as district choice increases within a commuting zone. The size of the estimate (−0.077sd) is almost exactly the same when the parent education variable is substituted for the income variable in the triple interaction estimation (table 5, Model 4). Note that the main local revenue term becomes insignificant after the triple interaction term is introduced in Models 3 and 4. In short, the equity effects of local revenue share are increasingly negative when district choice is ever more prevalent within a commuting zone.

In other words, the exit channel appears to be the primary moderator that accounts for the observed efficiency-equity trade-off. All estimates are subject to an error term, so we cannot rule out the voice channel as a potential moderator as well, but the evidence is strongly supportive of Tiebout's and Oates' theories, which together hypothesize that competition among local governments generates an efficiency-equity trade-off in the delivery of locally funded government services.

Discussion

The fiscal federalism literature has debated whether local services are best funded locally or by means of intergovernmental grants. Our research provides support for both perspectives and highlights the efficiency-equity trade-off that is at stake when funding regimes are established. Consistent with Tiebout theory, we find an increase in efficiency when funding comes more from local resources. In education, our preferred model indicates that achievement in math and reading rises by 0.05sd for every 10 percent increase in local revenue share. Our analysis also supports Oates who theorizes that funding from local sources impedes the

allocation of public services equally to the "haves" and the "have-nots." In our preferred model, we find the SES-achievement gap increases by 0.03sd for every 10 percent increase in local revenue share. These findings are supported by the geographic discontinuity and finance reform models. The finance reform model estimates a somewhat larger equity impact than our preferred model, perhaps because the school finance reforms were accompanied by other equity-inducing enactments.

The voice mechanism appears to moderate more efficient allocations in a federal system. In education, citizens prefer that class size be reduced and fiscal resources be concentrated on instructional rather than other services. Both policies have favorable impacts on achievement and both are more likely if a district funds itself disproportionately from local sources. The exit mechanism facilitates more efficient delivery of educational services for the benefit of the children of the more advantaged residents.

Efficiency and equity trade-offs occur in other local policy domains. Transportation expenditures may be used to enhance business activity or be allocated equitably across residential neighborhoods. Police, fire, and sanitation services may be concentrated on the protection and care of high-value properties or provided to all parts of the community equally. Housing and land-use policy may be designed to enhance local property values or to encourage construction of low-income housing. To what extent do policy decisions in these domains depend on the amount of revenue coming from local resources? What are the effects on efficient delivery of such services when inter-governmental grants are used to fund them?

These issues are relevant to contemporary policy discussions. During the Covid pandemic, intergovernmental grants from the federal government, as a percentage of total local revenue, is estimated to have increased from 18 percent in 2018 to over a third by 2022. (Peterson and Lastra-Anadón 2022). That shift may be temporary. Were it to continue, one expects less efficient delivery of local services but more equitable resource distribution.

In education, school finance reforms are shifting revenue sources from the local tier to the state. Our results suggest that a shift in funding of 30 percentage points (about the inter-quartile range across school districts) to higher tiers of government would have a negative impact on student performance of around 0.15sd but would shrink the SES-achievement gap by 0.09sd. Hanushek et al. (2016) estimate that that 0.25sd is roughly equivalent to one year's worth of learning. If that is correct, an increase in inter-governmental aid of this magnitude would have by 8th grade a negative impact on student learning equivalent to a half years' worth of learning and would close the SES-achievement gap by about a third of a year.

Our work explores new research terrain and therefore necessarily has certain limitations. The OLS models suffer from potential endogeneity, though their results are confirmed by models designed to be causal. Data for the finance reform analysis is available from only eleven states, though a robustness check shows similar results from twenty-four states. The timing of these reforms could be simultaneous with other, unobserved changes, which might have had positive effects on equity. In our geographic discontinuity models, we cannot rule out differential state policies or between-state differences in tastes for education uncorrelated with observables. Generalizability is another concern. For that reason, our preferred estimates rely upon models for which we have information from a national probability sample. Even so, we cannot generalize from the United States to other countries.

Given these limitations, we interpret our findings as descriptive. They nonetheless support claims that funding of local services by higher tiers of government may introduce more equity but are also likely to reduce the efficiency with which services are delivered.

Supplementary Data

Supplementary data are available at *Publius: The Journal of Federalism* online.

Notes

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1. A large share of these expenditures is obtained from property taxes and other local revenues. In 2007, 45 percent of school revenues came from local sources, 45 percent from state grants, and the remaining 11 percent from the federal government (NCES 2019). The mean masks wide variation across the country. In 2007, the share of total revenues coming from local sources ranges between one percent and 92 percent, with an inter-quartile range of 31 percentage points. The local revenue share has declined over time. In 1920, 83 percent of all revenues came from local governments, but with the consolidation of school districts and the growth of the inter-governmental grant system, the percentage declined to 45 percent by 2007 (Berry and West 2008). Still, the local share in the United States is twice as large as the mean of 22 percent for all member countries of the Organization for Economic Cooperation and Development (OECD 2014).

2. We thank a reviewer for making this suggestion.
3. These "Tiebout choice" effects are disputed by Rothstein (2007), with a reply by Hoxby (2007).
4. Researchers with restricted-use data licenses may obtain NAEP individual-level micro-data from the NCES, which has approved for disclosure all results reported in this paper. We thank M. Danish Shakeel and Jesse Rothstein for their assistance with data identification for the event study analysis.
5. LRS estimate effects for 24 states by relaxing the requirement that in each state pre-reform and post-reform trends must both be estimated by at least three NAEP observations. As a robustness check, we did the same. Results do not differ significantly from those reported in the text. See Online Appendix table A.11.
6. Similar estimations inferred from policies or institutions with geographical variation have been used to study the effects of urban policies in US cities (Gerber, Kessler and Meredith 2011), media penetration on political attitudes (Kern and Hainmueller 2009), ballot initiatives on voter turnout (Keele and Titiunik 2015), and teacher union effects (Brunner, Hyman and Ju 2020).
7. The three state policies (and data sources) are as follows: alternative certification (National Council for Teacher Quality), performance pay (Education Commission of the States), and right-to-work (National Education Association).
8. Heterogeneous effects by ethnicity are similar to (though smaller than) SES heterogeneities. See Online Appendix, table A.4.
9. We find similar results when using an alternative dataset (the Stanford Educational Data Archive (Reardon et al. 2017)) that leverages state exams in the period 2009-18 aggregated by district. These results are shown and discussed in the Online Appendix, table A.5.
10. We perform similar equity analyses by differentiating on the basis of the average income in the district (rather than the individual-level socioeconomic status). Results follow a very similar pattern and are shown and discussed in the Online Appendix, table A.11.

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