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SCHOOL DISTRICT RESPONSES TO MATCHING AID PROGRAMS FOR CAPITAL FACILITIES: A CASE STUDY OF NEW YORK'S BUILDING AID PROGRAM

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States are financing a larger share of capital investment by school districts but little is known about how districts respond to facility aid programs. Our paper addresses this gap in the literature by examining how a short-term increase in the matching rate for the Building Aid program in New York affected district capital investment decisions. We estimate a capital investment model and find that most districts are responsive to price incentives but that price responsiveness is related to the fiscal health and urban location of the district. Drawing on these results, we provide recommendations for the design of capital investment aid programs to increase their effectiveness in supporting high-need urban districts.

Keywords: capital investment, education finance, matching grant

JEL Codes: H71, H72, H75, H77

I. INTRODUCTION

Public school enrollment in grades pre-K through 12 increased by 25 percent from 1985–2008 (National Center for Education Statistics (NCES), 2010). This enrollment growth combined with class-size reduction programs has led to large and growing school facility needs (U.S. Government Accountability Office (GAO), 1995; Crampton and Thompson, 2001). Indeed, NCES (2000) estimated that $127 billion is needed for school construction and renovation. Despite this need, state governments provide considerably less financial support to school districts for capital investment than for school operating expenses (Sielke, 2001; Wang and Duncombe, 2009), and in many states the

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quality of school facilities varies widely across districts (GAO, 1995). School spending grew rapidly over the 1995–2004 decade (Filardo et al., 2006), but the scale and scope of facility needs are so large that more funding for school construction and renovation is still needed. Moreover, the disparity in school facility spending documented by GAO in 1995 has not yet been alleviated. This paper adds to the debate on revising state funding for school facilities by developing a model of school districts' capital investment decisions and using it to estimate districts' responses to an open-ended matching grant for school facilities in New York state.

New York is a particularly appropriate location for this type of analysis for several reasons. First, the Building Aid program is an open-ended matching grant, which provides an opportunity to examine districts' investment responses to tax price changes. Moreover, New York increased the matching rate by 10 percentage points in July 1, 1998, and then removed this increase after July 1, 2000. These policy changes provide an additional source of variation to help identify districts' responses to tax price changes. Third, the design of this aid program has remained relatively stable for three decades which makes it easier to isolate school district price responses from program changes. Finally, the availability of a long time-series of capital investment information in New York (1977–2008) makes it possible to account for the lumpiness of capital spending by small governments.

We find that capital investment decisions by school districts are indeed influenced by the state matching rate, but that this impact is much lower in urban districts with poor fiscal health. In fact, some urban districts responded very little even to generous price incentives. We also examine factors other than tax price that may influence districts' capital investment decisions.

The next section reviews the literature on building aid programs and state and local capital investment decisions. We then describe, in Section III, the Building Aid program in New York. Section IV presents a model designed to capture the long time frame and lumpiness that characterize capital investment decisions. In Section V we discuss empirical methods, data sources, and the measures used to estimate our model. Section VI presents the results from our regression analysis of school-district capital investment and examines the robustness of our estimates. We conclude with a discussion of the implications of our research for the design of state aid programs to support school facility investment as well as some suggestions for future research.

II. LITERATURE ON BUILDING AID AND CAPITAL INVESTMENT

Historically, funding for school infrastructure has been a local responsibility (GAO, 1995). Most school districts issue long-term general obligation bonds to finance capital investment, and local property tax revenues are used to cover debt service payments (Plummer, 2006). Many states provide considerably less financial support for capital investment by districts than for operating expenses (Sielke, 2001), which has resulted in significant disparities across districts in their ability to fund school infrastructure.

As a consequence, school finance systems have increasingly been challenged as inconsistent with the state's constitution (Plummer, 2006; Sciarra, Bell, and Kenyon, 2006), and successful court cases are associated with significant increases in capital funding (Filardo et al., 2006). In response to law suits, 20 states have reformed their school facilities funding schemes, and courts in Alaska, New Jersey, Ohio, and elsewhere have specifically determined that adequate facilities are an important component of the state's constitutional responsibility.[1] Equitable funding of school facilities is likely to be a continuing aspect of school finance litigation (Crampton, Thompson, and Vesely, 2004) and states will be under increasing pressure to cover a larger share of the cost of school construction and renovation.

Most research on state school facilities aid has concentrated on describing the design and funding of these assistance programs (Honeyman, 1990; Sielke, 2001; Wang and Duncombe, 2009). In addition, the government financial management literature contains studies both on capital (facility) planning processes and documents (Earthman, 2000; Association of School Business Officials, 1999), and on capital financing mechanisms, particularly long-term debt.[2]

Several scholars have examined the macroeconomic impacts of public infrastructure investments.[3] Existing studies of state and local capital spending decisions include Holtz-Eakin and Rosen (1989, 1993) and Bruce et al. (2007).[4] Holtz-Eakin and Rosen develop and test a model of capital spending based on forward-looking, rational decision makers for a sample of communities in New Jersey. They find support for this model in some areas, but not others.

Research on financing school facilities includes several studies of California (Brunner and Rueben, 2001; Balsdon, Brunner, and Rueben, 2003; and Brunner, 2006). Balsdon, Brunner, and Rueben (2003) develop a theoretical model of voter demand for capital investment that accounts for the long life of capital assets and possible agenda setting by school boards. They estimate a capital spending equation that accounts for the tax price for local voters, the value of the existing capital stock, other revenue sources including general and categorical state aid, and several other price and demand variables. They find that capital investment responds inversely to the local tax price. Because all

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1 See "Facilities: Overview." National Access Network, http://www.schoolfunding.info/policy/facilities/facilities.php3 for a more detailed description of litigation on school facilities funding.

2 The empirical research on capital finance has concentrated on debt finance, including determinants of bond yields, credit ratings (Ammar et al., 2001; Johnson and Kriz, 2005), and long-term debt burdens (Brecher, Richwerger, and Wagner, 2003; Hildreth and Miller, 2002).

3 The literature on public capital investment has generally focused on the impact of tax policy on private investment (Jorgenson, 1974; Hall and Jorgenson, 1967; Gravelle, 1982; Hubbard, 1998) and the relationship between government investment in infrastructure and economic growth and productivity (Gramlich, 1994; Holtz-Eakin, 1994; Hulten and Schwab, 1991, 1993; Munnell, 1992).

4 Bruce et al. (2007) examine state highway spending using a simultaneous-equations model in which each state's spending is influenced by the spending of its neighbors. They find evidence of positive spillovers across state boundaries.

school districts receive a 50 percent state match on local capital spending (Brunner, 2006), it is not possible in California to examine how districts respond to variation in the matching rate.

Cromwell (1991) examines the impact of federal matching grants on maintenance and new investment in urban mass transit systems. As expected, he finds that local maintenance spending is inversely related to the state and federal government matching rate. Moreover, he finds that private operators are much more likely than their public-sector counterparts to spend money on maintenance partly because generous federal grants for new capital induce local governments to substitute away from maintenance toward new investment.

III. NEW YORK'S BUILDING AID PROGRAM

State government financing of school facilities is a relatively recent development in most states. As late as 1993–1994, 14 states had no formal program to assist districts in financing school facilities, and many existing state programs were small (Sielke, 2001). New York's Building Aid program is unique in its longevity, stability, and size. The program has been in effect since the 1960s, and its major components have remained roughly the same for three decades, including over 50 percent state funding, on average.

School facilities aid programs are typically formula grants, which require project approval by a state education department or building authority. Most are designed as open-ended matching grants (20 states) that limit the size of the project (Wang, 2004). A much smaller share are either closed-ended matching grants (three states), lump-sum grants (six states), or some combination of matching and lump-sum grants (nine states). Most of these formulas are wealth-equalized (or use some fiscal capacity adjustments), but only a few states adjust for cost factors, such as enrollment growth, district need, or geographic cost differences.

New York's Building Aid program has many of the features of the typical program. It is an open-ended wealth-equalized matching grant, at a rate that averages roughly 50 percent, but can vary widely depending on the conditions discussed below. It requires state project approval and places limits on the maximum funding for a given project. Building Aid is available for instructional buildings costing more than $10,000 and for school bus garages. No administrative buildings are eligible. The Facilities Planning Unit of the New York State Education Department (SED) must approve the project after the school district school board of education has voted for it (Zedalis, 2003). New York's Building Aid program funds major renovations but does not fund routine maintenance. In fact, 93 percent of major building projects from 1984–2002 were for renovation of existing buildings. The generous funding associated with the Building Aid program and lack of funding for maintenance may provide an incentive for districts to underinvest in maintenance.

Once the project is approved by SED, the amount of Building Aid is calculated using a Building Aid formula (Education Priorities Panel, 2002), which can be represented as

$$(1)\quad Aid_i = \sum_{j=1} [\min(C_{ij}, MCA_{ij}) \times AR_i]$$

$$MCA_{ij} = BAU_{ij} \times CCI_{ij} \times RCI_i$$

$$AR_i = 1 - \left[\frac{FV_i / N_i}{\overline{FV / N}} \times .51 \right],$$

where i represents a district, j represents a project, Aid = the amount of building aid, C = actual project cost, MCA = Maximum Cost Allowance determined by the SED, AR = the state aid ratio, BAU = Building Aid Units, CCI = Construction Cost Index, RCI = Regional Cost Index, FV = full property value, N = average daily attendance in the district,[5] and $\overline{FV/N}$ = average full value per pupil in the State. For district i and project j, aid is determined as the product of the state aid ratio and the minimum of the actual project cost and the MCA.

MCA is determined using several methods[6] but typically is the product of a measure of capacity for different types of schools (BAU),[7] an estimate of the base cost per BAU adjusted for inflation (CCI),[8] and a cost adjustment reflecting regional variation in construction costs (RCI).[9] According to a SED survey of new schools built in the state (excluding New York City), an average of 22 percent of construction costs were not eligible for reimbursement by the state because they exceeded the MCA (Campaign for Fiscal Equity, 2004).

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5 Specifically, resident-weighted average daily attendance, which includes only students that are residents of the school district, is used as the measure of attendance (SED, 2001).

6 Methods for calculating *MCA* differ depending on how special education students are included in the calculation, on the level of education and whether special education programs are attached or detached from the school. Districts are eligible for full funding for major contracts (general construction, heating and ventilating, plumbing, and electrical), but only for 20 percent of incidental expenses (site purchase, site development, original equipment, furnishings, machinery or apparatus, and professional fees). For a complete description of the aid formula, and facilities planning and approval process, see "Facilities Planning," State Education Department, Albany, NY, http://www.emsc.nysed.gov/facplan.

7 *BAU* was originally designed to reflect building capacity, but now reflects building type (Education Priorities Panel, 2002).

8 The base cost per Building Aid Unit is determined by the SED and gets adjusted by the Construction Cost Index issued for the month that the construction contract for the specific project was executed (Zedilas, 2003). The *CCI* is a "New York State Labor Department index, which represents the cost of labor and materials," (Thurnau, 2004, p. 9).

9 The *RCI* is calculated by dividing the county composite labor rate for three construction-related industries by the median statewide labor rate ("2007–2008 State Aid Handbook." State Education Department, Albany, New York, https://stateaid.nysed.gov/publications/handbooks/hndbk07.htm).

The final multiplier in the Building Aid formula is the wealth-equalized Building Aid Ratio (*AR*), which is based on a district's full property value per pupil relative to the state average in a given year (Zedalis, 2003). The state share of expenditure equals 49 percent for districts of average wealth, and can range from zero to 95 percent. For projects approved before 1998, a district automatically received the highest aid ratio it was entitled to in any year since 1982. For projects approved between July 1, 1998 and June 30, 2000, an additional 10 percentage points were added to the aid ratio, with a maximum of 95 percent.[10] After July 1, 2000, districts were given the choice between the current aid ratio plus 10 percentage points or its highest aid ratio since 1982 without the 10-percentage-point boost.[11] According the New York State Comptroller, "The additional 10 percent building aid incentive appears to have been a victim of its own success. It spurred such growth in local building projects that the State's reaction was to largely eliminate the incentive for all projects approved after July 1, 2000 …" (McCall, 2001, p. 7).

Once SED has approved a capital project, it (and the associated debt) must be approved by voters of the district either during a regular budget referendum or in a special referendum.[12] Voter approval is not required in the "big five" school districts (New York City, Buffalo, Rochester, Syracuse, and Yonkers), which are fiscally dependent on the city government.

School districts are potentially constrained not only by voter approval but also by limits on general obligation debt as a share of property value. The debt limit is generally more constraining for city districts (particularly large cities) than for suburban and rural districts. Suburban and rural districts can deduct state building aid in calculating total debt, while city districts cannot. The big five city governments have nearly the same overall debt limit to fund all municipal services, as suburban and rural school districts only have to fund education facilities (SED, 2002). Small city districts can also temporarily exceed the debt limit if authorized by 60 percent of the district's voters, whereas large cities do not have this option.[13]

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[10] Governor Pataki proposed this increase in Building Aid in his Executive Budget as part of a package of school aid increases and a school property tax relief plan (New York State Division of the Budget, 1998). New York experienced a rapid increase in state revenues during the late 1990s, driven primarily by soaring stock prices on Wall Street.

[11] This change has resulted in four times more districts than before, 292 of 680 districts, using their current year aid ratio for capital construction approved since 2000 (SED, 2002).

[12] Between 2000–2008, over 90 percent of districts passed their budget referenda, on average, with the lowest passing rate being 85 percent. SED does not maintain information on budget referenda votes before 2000 or maintain information on separate bond referenda.

[13] The debt limits of small city districts and the big five districts are contained in Article 8 of the New York State Constitution. The debt limit of small city school districts, which have territory that is partially or wholly within the limits of a city having a population of less than 125,000, is 5 percent of the average full property value of the last five years' tax rolls. New York City has a limit of 10 percent of the five-year average for full value, and the Big Four cities are limited to 9 percent. The debt limit for other suburban and rural school districts is defined in Section 104.00 of New York's Local Finance Law. Their limit is 10 percent of the full value of the most recent tax roll (SED, 2002).

IV. A MODEL OF SCHOOL DISTRICT CAPITAL INVESTMENT

This section derives a theoretical capital investment model that can be estimated using linear regression methods. Our model builds on the models of Holtz-Eakin and Rosen (1989, 1993) and Balsdon, Brunner, and Reuben (2003) by accounting for the lumpy nature of capital investment and recognizing the derived nature of demand for school facilities. We begin with a standard identity linking new investment (I^n) and replacement investment (I^r) (Jorgenson, 1974; Gravelle, 1982),

$$(2) \quad I_t = (1-\lambda)(K_t^* - K_{t-1}) + vK_{t-1},$$

where $I^n = (1 - \lambda)(K^* - K_{t-1})$ and $I^r = v K_{t-1.}$ New capital investment (I^n) is assumed to be equal to a fixed share, $(1 - \lambda)$, of the gap between the optimal capital stock, K^*, and the actual capital stock last year, K_{t-1}. The replacement of the capital stock (I^r) is assumed to be equal to a fixed share, v, of last year's capital stock. These investment and stock variables are all measured in units of physical capital per pupil. If information is available on K_{t-1}, then (2) can be re-arranged to express total capital investment as a function of the optimal capital stock and the parameters λ and v, or

$$(3) \quad I_t + (1-\lambda-v)K_{t-1} = (1-\lambda)K_t^*.$$

The optimal capital stock is a school district's desired capital input, given its decisions about target levels of school performance and the production function its faces. Thus, we begin by deriving an expression for K_t^* under the assumption that a school district minimizes the cost of producing any given level of school performance. However, school districts, like other public organizations, may face constraints on salaries, working conditions (such as limits to production hours per day), and factor substitution (such as class size requirements) that result in deviations from cost-minimizing choices. As a result, we also introduce measures of political and institutional constraints.

We begin with a standard cost-minimization problem assuming that intermediate school outputs, G, such as geometry lessons, are produced with a Cobb-Douglas technology in which b_1 is the exponent on the labor input (L), b_2 is the exponent on the capital input (K), and $\beta = b_1 + b_2$. Note that β can be interpreted as a measure of technical returns to scale in educational production (Duncombe and Yinger, 1993). The derived demand for capital can be represented as

$$(4) \quad K^* = aP_K^{(-b_1/\beta)} P_L^{(b_1/\beta)} G^{(1/\beta)},$$

where P_K is the price of capital, P_L is the price of labor, and a is a constant.

Since parents and voters are interested in the outcomes from education (S), such as student performance on tests and graduation rates, we follow the education production function literature by modeling S as a function of school outputs (G) and non-school factors, such as enrollment size (N) and the share of disadvantaged students (Z). For simplicity, we assume that the production function for S has the constant elasticity form,

$$(5) \quad S = a'G^{\rho}N^{(-\alpha)}Z^{(-\varphi)},$$

where a' is a constant, α and φ are elasticities measuring the impact of N and Z on student performance (given G), and ρ is the elasticity capturing differences between technical economies of scale and economies of quality scale (Duncombe and Yinger, 1993).

In addition, we recognize that from the perspective of a school district in New York, the price of capital has two components. First, borrowing from the investment literature, we express the annual rental price of capital for a school district as[14]

$$(6) \quad P_k = q(d + r),$$

where q is the purchase price of a capital asset, d is the depreciation rate, and r is the real interest rate. The purchase price of capital is potentially a function of the price of land and construction costs in an area. The depreciation rate depends on the useful life of the asset and the level of maintenance. The real interest rate facing a district typically varies with the credit rating a district receives, which is often directly related to the district's economy and finances (Ammar et al., 2001). Second, an open-ended matching grant reduces the tax price of capital to a school district because the local share (LS) of capital spending equals $(1 - AR)$, where AR is the "aid ratio" or state share. In most states with matching grants, including New York, LS is a function of the district's relative property wealth.

Now combining (4) and (5) and introducing the LS as part of the price of capital we obtain

$$(7) \quad K^* = a'' P_K^{(-b_1/\beta)} LS^{\gamma(-b_1/\beta)} P_L^{(b_1/\beta)} S^{[1/(\rho\beta)]} N^{[\alpha/(\rho\beta)]} Z^{[\varphi/(\rho\beta)]},$$

where a'' is a constant (which includes both a and a'), γ measures the extent to which districts respond differently to LS than to the rental price of capital, and $\rho\beta$ captures economies of quality scale.[15] Note that the price elasticity of demand for capital is negative and the cross-price elasticity of demand for capital in response to a change in the price of labor (P_L) is positive, which indicates that capital and labor are substitutes when there are only two inputs. Finally, we can translate the demand for

[14] The investment literature looks at the effect of the corporate income tax on the price of capital and the level of investment (Gravelle, 1982). Since this is not an issue for local governments, such as school districts, the price without taxes is used.

[15] Duncombe and Yinger (1993) state that economies of quality scale exist when a one unit increase in final outcomes (e.g., student test score performance) is associated with a decline in average costs, defined as costs per unit of outcome (e.g., cost per test score point).

physical capital, K^*, into the demand for annual capital spending, KE^*, by multiplying both sides of (7) by P_k. The result is

$$(8)\quad KE^* = a'' P_K^{(b_2/\beta)} LS^{\gamma(-b_1/\beta)} P_L^{(b_1/\beta)} S^{[1/(\rho\beta)]} N^{[\alpha/(\rho\beta)]} Z^{[\varphi/(\rho\beta)]}.$$

Equation (8) expresses capital demand as a function of S. Measures of S are often available for cross-sectional analysis or short times series, but consistent measures of S are usually not available over longer periods of time because of changes in performance assessment instruments. This data limitation is particularly binding for a model of capital demand decisions, which are made over a long time horizon. As a result, we follow an alternative approach, namely, to develop a model of the demand for S and then to substitute that model into (8).

Assuming a simple median voter model and a constant elasticity demand function (Balsdon, Brunner, and Rueben, 2003), the median voter's demand for S is

$$(9)\quad S = cTY^{\phi}TP^{\mu}\ T^{\theta},$$

where c is a constant, TY is voter income augmented by state aid, TP is the tax price for public education, and T represents voter preference variables. Measures of T that appear in the literature include the age distribution, the religious affiliation, and the educational attainment of the population.

Expressions for TY and TP can be obtained from the standard median voter framework (Rubenfeld, 1987; Ladd and Yinger, 1991). Let Y be the median voter's income, V be the median voter's house value, $\bar{V}$ be the district's property value per pupil, and A be lump-sum state aid. Then,

$$(10)\quad TY = Y + \kappa(V/\bar{V})A.$$

In this expression, state aid reduces the need for local taxes, so its impact on the demand for S is weighted by $V/\bar{V}$, which is the share of local taxes paid by the median voter. In addition, many scholars have found that the impact of aid on the demand for S is larger than the impact of an equivalent change in income; this so-called flypaper effect is indicated by κ.

The variable TP is defined as the amount the median voter must pay for another unit of S. It depends on the marginal resource cost of S, MC, and on tax share, or

$$(11)\quad TP = MC(V/\bar{V}).$$

Note that MC is the derivative of the education cost function (as derived from a Cobb-Douglas production function) with respect to S, or

$$(12)\quad MC = a^* P_K^{(b_2/\beta)} P_L^{(b_1/\beta)} S^{[1/(\rho\beta)-1]} N^{[\alpha/(\rho\beta)]} Z^{[\varphi/(\rho\beta)]},$$

where a^* is a constant. Substituting (9)–(12) into (8) results in

$$(13)\quad KE^* = a^{**} P_K^{(1+\mu/\varepsilon)(b_2/\beta)} LS^{\gamma(-b_1/\beta)} P_L^{(1+\mu/\varepsilon)(b_1/\beta)} N^{(1+\mu/\varepsilon)[\alpha/(\rho\beta)]} Z^{(1+\mu/\varepsilon)[\varphi/(\rho\beta)]} (V/\bar{V})^{(\mu/\varepsilon)} \times [Y + \kappa(V/\bar{V})A]^{(\phi/\varepsilon)} T^{(\theta/\varepsilon)},$$

where $\varepsilon = [\rho\beta - (1 - \rho\beta)\mu]$ and a^{**} is a constant.[16]

In (3), $(1 - \lambda)$ is the share of the gap between the existing and the optimal capital stock funded this year and captures the adjustment process, which may vary across districts based on political and institutional constraints. Districts facing tighter legal limits on the maximum level of outstanding debt (D), for example, may require more time to adjust. Because most capital investments are long-term and expensive, school districts with more stable management (M) might be more apt to make capital investments. One of the major challenges confronting large central city school districts is the frequent turnover of superintendents. Districts experiencing a rapid increase in enrollment (R) may have difficulty increasing school facilities at the same rate as their growth in need. Assuming a multiplicative function for the factors potentially affecting the adjustment process, multiplying both sides of (3) by the price of capital, and substituting into (13) results in our final equation,

$$(14)\quad IE_t + (1 - \lambda - v)KE_{t-1} = \{a^{**} P_K^{(1+\mu/\varepsilon)(b_2/\beta)} LS^{\gamma(-b_1/\beta)} P_L^{(1+\mu/\varepsilon)(b_1/\beta)} \times N^{(1+\mu/\varepsilon)[\alpha/(\rho\beta)]} Z^{(1+\mu/\varepsilon)[\varphi/(\rho\beta)]} (V/\bar{V})^{(\mu/\varepsilon)} [Y + \kappa(V/\bar{V})A]^{(\phi/\varepsilon)} T^{(\theta/\varepsilon)}\} [D^{\pi_1} M^{\pi_2} R^{\pi_3}],$$

where IE_t and KE_t are new and replacement investment spending, respectively, and π indicates a parameter for one of the adjustment variables. Our empirical model is expressed in linear form by taking the natural log of (14).

V. DATA SOURCES AND MEASURES

This paper analyzes the determinants of school district capital investments by estimating (14) using an extensive data set on New York school districts. In this section, we discuss our data sources and measures. Table 1 presents descriptive statistics for the variables used in the empirical model. All financial variables are deflated using the consumer price index for all urban consumers (CPI-U).

The long-term nature of capital investments implies that an empirical examination of capital investment should involve an extended time series. For this paper, we assembled a 19-year panel data set for approximately 634 school districts in New York state.[17]

[16] Identifying the structural parameters in (13) requires some assumption about returns to quality scale ($\rho\beta$) in education and technical returns to scale (β) (Duncombe and Yinger, 1993).

[17] Approximately, 35 districts were dropped from the sample because they had missing data, had fewer than eight teachers, or served only special student populations. In addition, we dropped New York City because capital spending information was not available from the New York State Office of the State Comptroller (OSC). In addition, the implementation of the Building Aid program in New York City has been different than in other districts in the state (Education Priorities Panel, 2002).

As discussed below, the capital stock estimate was constructed for the time period 1990–2008, which allows for eight years of capital investment information before the 10 percentage point increase in state aid ratio in 1998 and eight years after this incentive was removed in 2000.

The process of planning for capital construction, applying for Building Aid, getting voter approval, and issuing municipal bonds is time consuming and is likely to take several years to complete. Thus, changes in the aid ratio in the Building Aid program (or changes in any other independent variable) are likely to take several years before they are reflected in capital spending.[18] We try various lags for the independent variables ranging from two to four years and, as reported below, do not find that these variations cause large differences in the results. For the final model we use a three-year lag for our independent variables (1987–2005). The sample includes 25 districts that are the product of reorganization (consolidation or annexation) during the sample period. To maintain a balanced panel we combined the information for the consolidating districts before consolidation to create one observation throughout the sample period.

A. Estimate of the Capital Stock

To construct the dependent variable $[IE_t + (1 - \lambda - v)\, KE_{t-1}]$, we added capital spending in the current year (IE_t) and an estimate of the value of the capital stock in the previous year (KE_{t-1}) multiplied by an assumed value for $(1 - \lambda - v)$. We do not have a direct measure of the value of the capital stock, but we do have data on capital spending starting in 1977, so we assume a baseline depreciation rate (d) of 2 percent based the depreciation rate calculated by the U.S. Bureau of Economic Analysis for government educational buildings[19] and construct KE_{t-1} as the sum of depreciated capital investment over the previous 10 years. We examine the sensitivity of the model to values for d ranging from 1 to 3 percent and values for $(1 - \lambda - v)$ ranging from 0.6 to 1.4; as reported below, the results are not sensitive to these values. Ten years may not be adequate time to accurately capture relative capital stock differences across districts. We also estimate a capital stock measure using 15 years of capital spending data. Capital spending is reported in annual financial reports submitted by school districts to the New York Office of the State Comptroller (OSC, 2007). Capital expenditures include spending on facilities, land, and equipment.[20]

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[18] This conclusion is based on our discussions with the staff of the Facilities Planning Unit of the New York State Education Department.

[19] See U.S. Bureau of Economic Analysis, "BEA Depreciation Estimates," Bureau of Economic Analysis, Washington, DC, http://www.bea.gov/National/FA2004/Tablecandtext.pdf).

[20] Capital spending includes all types of capital investments including those not funded by Building Aid (e.g., administrative buildings and some athletic facilities). Investment in facilities is generally recorded in the capital projects fund. We use a composite measure of capital expenditures developed by the New York Office of the State Comptroller as part of their *Special Report on Municipal Affairs* (OSC, 2007).

Table 1

Descriptive Statistics for Variables Used in Capital Investment Model (New York School Districts in 2005)

Variable	Mean	Standard Deviation	Minimum	Maximum
Estimated value of per pupil capital stock (2008)	14,428	8,051	1,702	75,116
Per pupil capital spending (2008)	1,035	1,515	22	12,058
Cost variables				
Local capital share (all districts)	33.21	24.97	5.00	90.00
Annual county construction wages	36,430	6,691	20,468	48,708
Teacher salary (one to five years of experience)	36,125	5,574	20,567	54,128
Enrollment	2,639	3,326	43	41,412
Share of students receiving subsidized lunch (%)	30.21	19.92	0.00	86.39
Demand variables				
Local tax share (median house values divided by per pupil property values)	3.50	1.27	0.13	7.94
Estimated market property values per pupil	63,678	190,693	5,574	3,628,453
Income per pupil (adjusted gross income)	146,600	145,154	28,602	1,961,096
Operating aid ratio (operating aid divided by income and multiplied by local tax share)	0.1070	0.1010	0.0001	0.1590
Need/capacity index (index of student poverty divided by index of property values)	3.01	3.07	0.00	24.71
Share of African American students (%)	5.49	11.35	0.00	81.33
Share of all African American students who live in a district that has a majority African American population (%)	0.55	6.33	0.00	81.33

Adjustment variables				
Debt limit variable (dummy variable equals 1 if the ratio of statutory debt limit relative to property values is below 0.07)	0.099	0.298	0.000	1.000
Enrollment change in last five years (%)	–0.0229	0.0979	–0.4273	0.5685
Change of superintendent (= 1 if in last three years)	0.19	0.39	0.00	1.00
Consolidated school district (= 1 if year after consolidation)	0.04	0.19	0.00	1.00

Notes: The sample size (*n*) is 649. The sample does not include New York City, districts with fewer than eight teachers, and districts serving special needs populations. All financial variables are inflation-adjusted and expressed in 2000$ using the consumer price index for urban consumers (CPI-U).

B. Price Variables

The key price variable considered in our analysis is the share of capital spending financed through local property taxes (*LS*). *LS* equals one minus the state aid ratio, which is 49 percent in a district with average property values. State aid ratios are reported annually in the detailed *State Aid Files* maintained by SED.[21] School districts that consolidated are entitled to additional Building Aid (Reorganization Building Aid) of 25 percent (if the consolidation was before FY 1983) or 30 percent (if it was after FY1983) as long as the state aid ratio does not exceed 95 percent. The aid is available for projects for which the "general construction contract" is signed within ten years from the date the consolidation goes into effect (SED, 2007).[22]

The input factor prices considered in this analysis are the price of capital and teacher salaries. We use a measure of the price of capital (P_K) similar to that used by Balsdon, Brunner, and Reuben (2003), namely, the annual wage rate for construction workers (at the county level) based on the data from the New York State Department of Labor. The annual wage for construction workers captures most of the variation across school districts in the price of capital because most capital spending is for renovations of existing buildings and we expect there is little variation in depreciation rates and interest rates on municipal bonds across school districts (see (6)).[23]

The major labor prices (P_L) affecting school district costs are teacher salaries. To ensure comparability across districts, we use data on individual teachers with one to five years of experience to predict what teachers' salaries would be in each district if

[21] SED's *State Aid Files* are the working files used by SED to calculate formula aid. Besides the aid districts receive by program, they include all the factors used in aid calculations, such as the state aid ratios used in the calculation of Building Aid, adjusted gross income, and the share of students receiving free or subsidized school lunch. The *State Aid Files* are not published but are available from SED upon request.

[22] We have information on school consolidations dating back to 1980. It is possible that some districts consolidated between 1977–1980 and their increased Building Aid is not reflected in the local capital shares we used. Given that there were only two district consolidations from 1980–1984, we do not expect that very many districts fall into this category.

[23] We do not anticipate substantial differences in depreciation rates across districts in New York, because the Building Aid program provides strong incentives to under-invest in routine maintenance (SED, 2002). The principal factor affecting differences across districts in interest rates for municipal bonds is the credit rating on the bond issue. There are not large variations across districts in their credit rating, because New York has strong state restrictions on the type of debt districts can issue and provides strong security for bond holders through aid intercept provisions (Zedalis, 2003). In principle, capital prices also depend on the cost of land, which varies widely across districts. In fact, however, most capital spending is for renovations of existing buildings and even new construction generally takes place on land already owned by a school district, so that real estate prices have little impact on capital spending (even if they do affect opportunity costs!). Based on the capital project database maintained by SED, 98 percent of the school buildings in 2002 were built before 1984 and over 93 percent of major building construction projects from 1984–2002 were for renovation of existing buildings.

teachers had average experience and education.[24] Since teacher salaries are potentially set simultaneously with district spending as part of the annual budgeting process, this variable may be endogenous. We estimate the regression model with 2SLS and test several different instruments, all of which are related to comparable private sector wages.[25] County population was found to be the strongest instrument based on weak instrument tests (Stock and Yogo, 2005).

The tax share variable is the ratio of the district's median house value to full property value per pupil ($V/\bar{V}$). District property values are an estimate of full market value ("equalized value") developed by the New York Office of Real Property Services (ORPS) and reported by OSC (2007). Median house values are constructed from detailed house-level information collected by ORPS as part of its Real Property System (RPS) database.[26] RPS data is only available from 1999–2008. In order to construct the tax share variable, median house values for other years were predicted using a regression on district per pupil income, county per capita income, and the share of county personal income in transfer payments. This model explained a high share of the variation ($R^2 = 0.85$) in median house values.[27]

C. Augmented Income

Measures of income and state aid are available from SED in the *State Aid Files*. Income (Y) is measured as adjusted gross income per pupil in a district and is calculated from personal income tax returns for SED by the New York Department of Taxation and Finance. For the state aid variable, we use Operating Aid, which is a general purpose foundation aid program accounting for approximately 50 percent of total formula aid. The design of the Operating Aid Program remained fairly stable during the sample period. The aid ratio is calculated by dividing operating aid by income and multiplying by the tax share $(A/Y)(V/\bar{V})$.[28]

[24] In the 2006–2007 academic year, 25 percent of teachers had total experience between one and five years. See "New York State Education Department, "Information, Reporting and Technology Services Experience Distributions For Classroom Teachers 2006–2007," http://www.p12.nysed.gov/irs/pmf/2006-07/2007_Stat-17.pdf.

[25] Ideally, we would use a measure of comparable private wages as an instrument. While Taylor and Fowler (2006) have developed a comparable wage index (CWI) for the NCES, it is only available from 1999–2005. To select possible instruments we looked at variables that were strongly correlated with the CWI including county population (0.75) and average county private sector wages (0.86).

[26] Property classes used in the calculation include one-family, two-family, and three family residential housing, rural residence with acreage, mobile homes, and multiple residences (condominiums).

[27] The RPS database is discussed on the ORPS website; see "Offices of Real Property Tax Services." New York State Department of Taxation and Finance, www.orps.state.ny.us. The regression coefficients (and robust standard errors in parentheses) are: log median house value = –3.455 + 0.594 (0.028) log of per pupil income + 0.827 (0.045) log of county per capita income – 0.023 (0.0019) share of county personal income in transfer payments ($n = 7136$), (adjusted R-squared = 0.85).

[28] To keep the estimating equation log-linear, we approximate the log of TY by splitting it into the log of Y and (unlogged) per pupil operating aid divided by per pupil income and multiplied by the tax share.

D. Student Variables

Several student measures are included to capture differences in education costs and in preferences for education services. The enrollment variable (*N*) is the fall enrollment count from the OSC database (OSC, 2007). Poverty (*Z*) is measured by the percentage of students in a district receiving a subsidized lunch. Differences in the racial composition of districts, measured by the percentage of African American students, are included to capture possible differences in white residents' support for public schools (*T*). To allow for the possibility that this effect may be different in districts where the majority of residents are African American, we include an interaction term between percent African American students and whether a majority of the district's population was African American. Population data come from the 1990 and 2000 *Census of Population*.[29] Student demographics are available from SED in either the *State Aid File* or in the *Institutional Master File* collected from each district on an annual basis.[30]

E. Factors Affecting the Adjustment Process

To capture the relative constraint from the debt limit (*D*), we divided a district's total debt limit by the total market value of its property.[31] This ratio is 10 percent for most districts but lower for city districts. To capture those districts facing a particularly tight debt limit, we use a dummy variable defined to equal one if the ratio of debt limit to property value is 7 percent or less (which is approximately the 10th percentile for all districts). We approximate the stability of district management (*M*) using a dummy variable indicating whether there was a change in the district superintendent in the last three years. Enrollment change (*R*) is the percent change in enrollment over the last five years. New York state provides both operating and capital incentives for districts to consolidate. We modified the local share to reflect the additional Building Aid available to consolidated districts (see above). We also included a dummy variable that equals one in a consolidating district after it consolidates to capture the possible effects of increased Operating Aid on capital investment decisions.

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29 See U.S Census Bureau, http://www. census.gov. Four districts had a majority African American population in 1990 and five districts had a majority African American population in 2000. For the one district that changed between these years, we assumed the there was a linear transition in the share African American population between 1990–2000, which implies that this district became majority African American in 1994.

30 The *Institutional Master File* (IMF) is data collected by SED from surveys of school principals and central office administrators. It provides information on student and teacher demographics. The IMF data are not published but are available from SED upon request.

31 The total amount of constitutional and statutory debt limits is available from the New York Office of the State Comptroller for all districts except for the four large central city districts that are fiscally dependent, where the debt limit is 9 percent for all municipal debt. Assuming that half of the debt limit in the dependent cities is used for school facilities, we multiplied 4.5 percent by the five-year average of full property value to obtain the approximate total debt limits in these cities.

VI. EMPIRICAL ANALYSIS

A. Descriptive Results

Figure 1 and Table 2 compare variable means using categories developed by SED to indicate the ratio of student needs to resource capacity.[32] The lowest capital spending in the past 20 years has been in the large central cities and other high-need urban/suburban districts (where "high-need" is short for "high need/resource capacity index" (Table 2)). During the first half of the 1990s, large cities had higher capital spending than other high-need urban/suburban districts, but after 1995 this pattern reversed with large cities generally having the lowest capital spending (Figure 1). High-need rural districts have spent by far the most on capital — around 32 percent higher than average-need districts and 60 percent more than high-need urban/suburban districts (Table 2). While high rural capital spending is expected considering the low required local contribution rate (a local share of less than 20 percent), the lower capital spending in high-need urban/suburban districts occurs despite an almost equally low local contribution rate (a local capital share averaging 25 percent). While the local capital share is over twice as high in the low-need districts as in the high-need urban/suburban districts, they spend 15 to 20 percent more per pupil on capital.

Figure 1 and Table 3 highlight differences by type of district in the response to the 10 percentage point changes in the state aid ratio in 1999 and 2000. Capital spending after 2000 went up by a modest 20 percent in the four large cities (Buffalo, Rochester, Syracuse, and Yonkers) and by 55 percent in other high-need urban/suburban districts compared to the period before 1999. By contrast, it more than doubled in the other districts, on average. The slower growth in capital spending in the high-need urban districts occurred despite a much larger percentage decrease in the local capital share in these districts, especially in the large cities. These results are consistent with early findings of SED regarding diverging patterns in capital investment across district types:

> During the incentives, rates of capital construction in the high need urban or suburban districts, the Big Four, and New York City lagged behind those of other need/resource categories. On the whole districts in these categories did increase the rate of capital construction while the incentives were in effect, but not by as much as the other districts (SED, 2002, p. 20).

[32] SED's "Need-to-Resource-Capacity Index" is calculated as the ratio of a standardized measure of student poverty and resource capacity (average of income and property wealth indexes). The numerator is measured using a weighted average of the two-year average of the subsidized lunch rate for 2001 and 2002 and the 2000 Census child poverty rate. The denominator is a fiscal capacity measure used by New York called the combined wealth ratio (CWR), which is an average of an income index and property wealth index (centered around the state average) and was measured for 2001 (SED, 2010).

Figure 1

Comparison of Capital Spending and Local Share Between Large Cities, Other High Need Urban Districts and Other Districts in New York

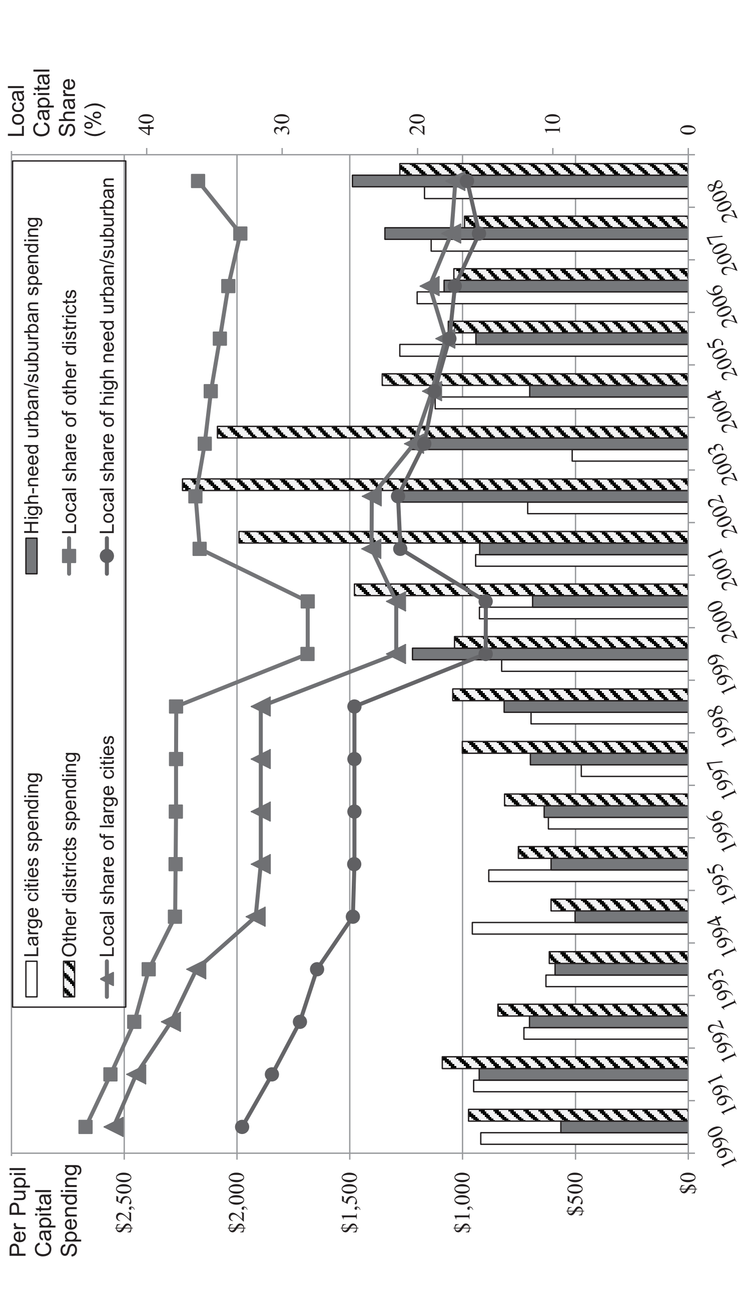

Table 2

Comparison of Means (1987–2005) by Need/Resource-Capacity Category

Variable	Large Cities	High-Need Urban/ Suburban	High-Need Rural	Average-Need	Low-Need
Estimated value of per pupil capital stock (2008)	7,124	7,488	11,921	9,009	8,685
Per pupil capital spending (2008)	784	795	1,334	1,030	1,056
Cost variables					
Local capital share (all districts)	31.74	25.07	21.95	33.15	68.74
Annual county construction wages	39,364	36,021	29,640	34,017	42,101
Teacher salary (one to five years of experience)	36,131	34,749	31,905	34,137	39,944
Enrollment	30,768	4,954	1,145	2,591	2,658
Share of students receiving subsidized lunch (%)	74.18	57.18	43.87	24.07	6.00
Demand Variables					
Local tax share	5.09	4.51	2.99	3.51	3.53
Estimated market property values per pupil	21,252	20,653	20,429	30,700	122,012
Income per pupil (adjusted gross income)	88,993	86,403	59,162	100,977	270,072
Operating aid ratio	0.1909	0.1834	0.2125	0.1147	0.0205
Need/capacity index	7.77	5.60	4.99	1.93	0.17
Share of African American students (%)	44.40	23.20	1.83	4.15	3.83
Share of all African American students who live in a majority African American district (%)	0.0000	7.2453	0.0000	0.3747	0.0000
Adjustment variables					
Debt limit variable	1.0000	0.6667	0.0749	0.0687	0.0158
Enrollment change (last five years)	0.0239	–0.0002	–0.0230	0.0102	0.0656
Change of superintendent (= 1 if in last three years)	0.2632	0.2066	0.1912	0.1786	0.1613
Consolidated school district (=1 if year after consolidation)	0.0000	0.0000	0.0500	0.0249	0.0000

Notes: Sample size (*n*) is 12,042 (634 districts). The sample does not include New York City, districts with fewer than eight teachers, and districts serving special needs populations. All financial variables are inflation-adjusted and expressed in 2000$ using the consumer price index for urban consumers (CPI-U).Need/resource-capacity categories were developed by the New York State Education Department and were based on a ratio of student poverty and an index of income and property values (combined wealth ratio). Large cities include Buffalo, Rochester, Syracuse, and Yonkers.

Table 3

Comparison of Means Before and After the 10 Percentage Point Reduction in the Local Capital Share

Variable	1990–1998	2001–2005	Percent Change	
Capital variables				
Estimate of value of capital stock	6,596	12,232	85.45	*
Large cities	5,979	7,747	29.58	*
Other high-need urban/suburban	6,041	8,396	38.99	*
High-need rural	8,143	15,874	94.94	*
Other districts	6,112	11,330	85.36	*
Per pupil capital spending	844	1,690	100.16	*
Large cities	762	914	19.83	
Other high-need urban/suburban	675	1,047	55.07	*
High-need rural	1,031	2,163	109.81	*
Other districts	794	1,585	99.67	*
Cost variables				
Local capital share	38.05	34.26	–9.96	*
Large cities	35.11	20.78	–40.81	*
Other high-need urban/suburban	26.86	19.64	–26.88	*
High-need rural	22.47	18.42	–18.02	*
Other districts	44.27	40.77	–7.91	*
Annual county construction wages	33,719	36,426	8.03	*
Teacher salary	35,261	35,926	1.88	*
Enrollment (thousands)	2,522	2,653	5.20	
Share of students receiving subsidized lunch	27.65	29.01	4.91	*
Demand Variables				
Local tax share	3.16	3.56	12.66	*
Property values per pupil	46,072	54,362	17.99	*
Income per pupil	118,396	138,949	17.36	*
Operating aid ratio	0.1150	0.1170	1.74	
Need/capacity index	2.6451	2.6915	1.76	
Share of African American students (%)	4.6597	5.3269	14.32	*
Share of all African American students who live in a majority African American district (%)	57.65	57.93	0.49	
Adjustment variables				
Debt limit variable	0.10	0.10	2.12	
Enrollment change (last five years)	0.042	–0.006	–113.99	*
Change of superintendent (= 1 if in last three years)	0.1691	0.2051	21.27	*
Consolidated school district (= 1 if year after consolidation)	0.02	0.04	66.98	*

Notes: Sample size (*n*) averages 638 per year. The sample does not include New York City, districts with fewer than 8 teachers, and districts serving special needs populations. All financial variables are inflation-adjusted and expressed in 2000$ using the consumer price index for urban consumers (CPI-U). Need/resource-capacity categories were developed by the New York State Education Department and were based on a on a ratio of student poverty and an index of income and property values (combined wealth ratio). Large cities include Buffalo, Rochester, Syracuse, and Yonkers. Asterisks denote statistically significant difference in means at 5% level.

The SED report suggests that the lower investment in cities and other high-need urban districts may be due to stricter debt limits, fiscal dependent status (for the five largest cities),[33] and reluctance by districts in fiscal stress to commit to large projects when state aid levels are uncertain. In the next section, we formally examine some of these explanations.

B. Empirical Methodology

Our log-linear specification of (14) addresses a wide range of factors likely to affect school facility investment decisions, but our results could be biased if these decisions are also influenced by unobserved time-invariant district characteristics. To account for this possibility, we include school-district fixed effects in the model. As discussed in the previous section, teacher salaries could be endogenous, so we estimate the regression model with 2SLS using county population as an instrument.[34]

To account for potential biases in the standard errors we have taken two steps. First, we include year fixed effects to remove statewide factors that do not vary across districts (such as general economic growth) but may be correlated over time.[35] Second, we use the method developed by Newey and West (1987) for estimating heteroskedasticity- and autocorrelation-consistent (HAC) standard errors (Baum, Schaffer, and Stillman, 2007).[36]

[33] Fiscally dependent school districts in New York can determine the allocation of the budget and select capital projects, but the city council and mayor control the overall size of the budget and the level of debt that is issued. School districts have to compete with other municipal functions in capital funding and debt issuance decisions of the municipal government.

[34] The model was estimated with xtivreg2 in STATA (Schaffer, 2005). The weak instrument test involves comparing Kleibergen-Paap rk statistic to critical values established by Stock and Yogo (2005). While this comparison is not technically correct given non-i.i.d. errors, Baum, Schaffer, and Stillman (2007) argue that this is a reasonable approximation. The Kleibergen-Paap rk statistic is over 35 in all of the models and well above any critical values established by Stock and Yogo (2005).

[35] An alternative approach to controlling for changes in state economic conditions is to include measures of the state economy directly in the model instead of year fixed effects. We estimated Models 1–3 (Table 4) by dropping the year fixed effects and including instead state averages of per capita gross state product, per capita personal income, the unemployment rate, and level of total employment. The coefficients on the local share variables are similar to those reported in Table 4 and are statistically significant. These estimates are available from the authors upon request.

[36] The Newey-West estimation involves specifying the maximum lag to be considered in the autocorrelation structure. Newey and West (1987) recommend calculating the maximum lag using $4(n/100)^{(2/9)} = 4(19/100)^{(2/9)} = 2.76$; others have suggested using $n^{(1/4)} = 19^{(1/4)} \approx 2$ (Wooldridge, 2003). We experimented with one-year to three-year lags and found that the estimates were not very sensitive to this variation; we used a two-year lag in the models presented in Tables 4 to 6. Because one of the variables, the tax share, has as its numerator a predicted value from a regression (median house value), it is possible that the standard errors are biased. We checked this by calculating bootstrapped robust standard errors (100 repetitions). The procedure, xtivreg2 (or xtivreg), does not include an option to calculate bootstrapped HAC standard errors. We are reporting HAC standard errors because they are higher for all variables.

C. Results of Capital Investment Models

The descriptive results suggest that all school districts except some high-need urban/suburban districts respond to the incentives in New York's Building Aid program. Other factors that influence school district investment decisions also change over time (Table 3), however, so we estimate our multivariate model, a log-linear version of (14) to isolate the impacts of this program. Our baseline estimates construct the capital stock variable using a 2 percent depreciation rate and an adjustment factor of 1.

Tables 4 presents the results for versions of (14), each with a different specification for the local capital share term, *LS*. Model 1 assumes that the local capital share elasticity is the same for all districts. Model 2 allows for possible differences in the investment response to changes in the local capital share between high-need urban/suburban districts and other districts. We measure this by interacting *LS* with a dummy variable for whether a district is a high-need urban/suburban district. Model 3 also examines whether the price response is different for the four large central city districts by including a *LS* interaction variable for these districts as well as an interaction variable for other high-need urban/suburban districts.[37]

The main results of interest are the elasticities of a district's capital stock with respect to the local capital share (*LS*) in the Building Aid formula. In Model 1, the local capital share elasticity is –0.39, which indicates that a one percent increase in the local share is associated with a decrease of 0.39 percent in the value of the capital stock. Using Model 2, this elasticity is –0.42 for most districts, but drops to approximately zero (–0.023) for high-need urban/suburban districts. In other words, high-need urban/suburban districts respond very little, on average, to the price incentives provided in the Building Aid program. The results for Model 3 indicate that large cities are also unresponsive to these price incentives.[38]

The finding of a significantly lower price response to changes in the local share in high-need urban/suburban districts than in other districts is compelling because we control for other factors that might lead to lower capital spending in these districts. They might, for example, have lower debt limits and thus face more binding constraints in issuing debt for capital projects. The results in Table 4 are consistent with this possibility; to be specific, districts with low relative debt limits, which include 100 percent of the large cities and 67 percent of the other high-need urban/suburban districts (Table 2), have lower capital investment than other districts. The magnitude of this effect is between 8 and 11 percent, but it is statistically significant only in Model 1.

[37] In model 3, the *LS* interaction variable for other high-need urban/suburban districts excludes the four large cities (Buffalo, Rochester, Syracuse, and Yonkers).

[38] The sum of the coefficients for the local capital share and the interaction with high-need urban/suburban districts in Models 2 and 3 are not statistically significant from zero based on a Wald test. The same is true for the sum of the local capital share and the interaction with large city districts in Model 3. There is not a statistically significant difference between the coefficients on the interaction variable for the large central cities and the interaction variable for other high-need urban/suburban districts in Model 3.

Table 4

Regression Results for Capital Investment Models (New York School Districts)

Explanatory variable	Models 1	Models 2	Models 3
Cost variables			
Local capital share (all districts)	–0.394***	–0.426***	–0.426***
	(–11.94)	(–12.35)	(–12.34)
Local capital share (high-need urban/suburban districts)		0.403***	0.408***
		(6.43)	(6.20)
Local capital share (four large central cities)			0.371**
			(2.28)
Annual construction wages	0.120	0.068	0.068
	(0.87)	(0.55)	(0.55)
Teacher salary	1.798	2.394*	2.397*
	(1.32)	(1.73)	(1.73)
Enrollment	0.892*	0.824**	0.829*
	(1.91)	(1.74)	(1.74)
Enrollment squared	–0.075**	–0.076*	–0.077**
	(–2.36)	(–2.35)	(–2.36)
Share of students receiving subsidized lunch (%)	–0.001	0.000	0.000
	(–0.60)	(–0.51)	(–0.50)
Demand Variables			
Local tax share	–0.186***	–0.171***	–0.171***
	(–3.64)	(–3.27)	(–3.27)
Income per pupil	0.216***	0.155**	0.155**
	(3.47)	(2.39)	(2.39)
Operating aid ratio	0.193	0.301	0.298
	(1.03)	(1.56)	(1.54)
Share of African American students (%)	–0.010***	–0.007**	–0.007**
	(–3.50)	(–2.39)	(–2.40)
Share of all African American students who live in a majority African American district (%)	0.006**	0.004*	0.004*
	(2.49)	(1.80)	(1.80)
Adjustment variables			
Debt limit variable	–0.110**	–0.087	–0.086
	(–1.97)	(–1.53)	(–1.52)
Enrollment change (last five years)	0.270***	0.259**	0.260**
	(2.67)	(2.50)	(2.50)
Change of superintendent (= 1 if in last three years)	–0.025*	–0.028**	–0.028**
	(–1.95)	(–2.16)	(–2.16)
Consolidated school district (= 1 if year after consolidation)	0.279***	0.227**	0.227**
	(3.11)	(2.43)	(2.43)
Prob > F	0.00	0.01	0.00
RMSE	0.44	0.44	0.44

Notes: Sample size is 12,042 (634 districts). The sample does not include New York City, districts with fewer than eight teachers, and districts serving special needs populations. The dependent variable is the estimated value of the capital stock from 1990–2008. The independent variables are lagged three years (1987–2005). All financial variables are inflation-adjusted and expressed in 2000$ using the consumer price index for urban consumers (CPI-U). All variables except for the operating aid ratio, enrollment change, subsidized lunch, share of African American students, and dichotomous variables are expressed in natural logs. The model is estimated with linear 2SLS (with teacher salaries treated as an endogenous variable) with district and year fixed effects. z-statistics (in parentheses) are based on robust HAC standard errors. Asterisks denote statistical significance at the 1% (***), 5% (**), and 10% (*) levels.

These high-need urban/suburban districts also might have lower capital investment due to higher construction prices or higher costs in general for providing education. On average, the county construction wages are the highest in the low-need districts and large cities and lowest in the high-need rural districts (Table 2). Table 4 reveals, however, that the capital price elasticity is not statistically significant.[39] As expected, we find that the coefficient on the teacher salary variable is positive and statistically significant at the 10 percent level in Models 2 and 3.

To allow for a possible non-linear relationship between enrollment and the value of the capital stock, we include a quadratic term in the model.[40] We find that growth in enrollment is positively related to value of the capital stock up to an enrollment of between 220 and 380 students, and negatively related thereafter. Given that over 95 percent of districts have enrollment of over 300 students, this elasticity is negative for most districts. The enrollment elasticity is approximately equal to –0.30 in a district of average size but reaches –0.80 in the largest districts.

We expect lower capital investment in districts that have lower demand for education due to lower income, state aid, tax prices, and preference factors. We find a positive and statistically significant income elasticity ($\phi = 0.20$) and negative and statistically significant tax share elasticity ($\mu = -0.22$).[41] Given that high-need urban/suburban districts tend to have lower income and higher tax shares than average-need or low-need districts, these results help explain the patterns in Table 2. We also find that the operating aid ratio has a positive impact on capital investment but this effect is not statistically significant.

In addition, we find that the share of African American students has a statistically significant and negative relationship with capital investment in most districts. Because African Americans constitute a small share of the population in most districts, this result suggests that whites' willingness to support capital spending declines as the minority share increases. When African Americans represent the majority of popula-

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[39] This result probably reflects the high correlation between the capital price variable, which is based on county construction wages, and both teacher salaries and the instrument used for teacher salaries, county population. When the labor price is dropped, the coefficient on the construction wage becomes statistically significant.

[40] We examined possible non-linear relationship for all of the continuous variables in the model. Enrollment is the only variable that is statistically significant at the 10 percent level in all models. The quadratic terms for local tax share and construction wage were significant in some models. We examine the results of the model with both of these variables in quadratic form as part of the sensitivity analysis (Table 6).

[41] The tax share elasticity is similar to that found in other education demand studies (Fisher and Papke, 2000). Assuming constant technical returns to scale ($\beta = 1$) and using an estimate of economies of quality scale ($\rho\beta = 1.4$) from another study (Duncombe, Lukemeyer, and Yinger, 2008), it is possible to calculate the structural parameters for the other cost variables in the model. Using the estimates in Model 2, ε is calculated to be 1.31. For the demand parameters, the structural parameter is equal to the reported coefficient multiplied by ε. For example, the income elasticity (ϕ) is equal to the reported coefficient on income (0.155) multiplied by 1.311.

tion, however, demand for capital spending appears unrelated to the share of African American students.[42]

High-need urban districts may also face other challenges that reduce their rate of adjustment between desired and actual capital stocks. We find that a recent change in superintendents is associated with 2.8 percent lower capital investment; high-need urban/suburban districts are much more likely to experience superintendent changes. We also find that enrollment increases in the last five years are positively related to capital investment. The low-need districts and large cities have had the highest five-year enrollment growth on average from 1997–2005, while high-need rural districts have experienced enrollment declines on average (Table 2). Finally, we find that there is a substantial increase (23 percent) in the value of a district's capital stock after consolidation, even after accounting for the higher price subsidy that consolidating districts receive.

D. Local Response and District Fiscal Health

The key conclusion from Table 4 is that high-need urban districts have not responded to the price incentives in the Building Aid program, controlling for a number of other factors that may affect their price response. These results are even more striking given that the state has paid between 70 percent and 80 percent of their reimbursable facility cost during this time period. For the large upstate central cities, the state aid ratio has typically been above 90 percent. We now explore further the relationship between district fiscal health and price response to Building Aid.

The classification of fiscal health developed by SED, which they call "need/resource-capacity categories," was developed using data for 2000–2002. Their fiscal health measure is the ratio of student poverty to district fiscal capacity. Districts above the 70th percentile on this ratio are identified as high need; those between the 20th and 70th percentile are identified as average need, and those under the 20th percentile are identified as low need. SED separates districts into urban and rural using information on both enrollment and pupil density. To incorporate fiscal health into our analysis, we calculate the ratio of student poverty to property value per pupil for all the years in our sample.[43] This measure, which is centered on the state average, is similar to the SED measure. A higher value for this need/capacity index indicates worse fiscal health. This index ranges from 7.8 in the large central cities to 0.17 in the low need districts (Table 2). In Table 5, we present results for capital investment models that include the local capital share variable and the interaction between this variable and the need/capacity index (Model 4). (The models in this table also include the uninteracted need/capacity index in place of the student lunch variable.) Model 5 also includes a variable for the local share-need/

[42] The sum of the coefficients on percent African American students and the interaction term with the dichotomous variable for majority African American population is not statistically significant from zero, based on a Wald test.

[43] More comprehensive measures of fiscal health (Ladd and Yinger, 1991) are not feasible with our approach.

Table 5

Regression Results for Capital Investment Models with Interaction Terms with Local Capital Share Variable and Need/Resource Capacity Index (New York School Districts)

Explanatory variable	Models 4	Models 5
Cost variables		
Local capital share (all districts)	–0.508***	–0.490***
Local capital share interacted with need/capacity index and district type		
All districts	0.025***	0.020**
Urban districts		0.014**
Annual construction wages	0.076	0.077
Teacher salary	2.073	2.169*
Enrollment	0.898*	0.962**
Enrollment squared	–0.080**	–0.084***
Demand Variables		
Local tax share	–0.176***	–0.178***
Income per pupil	0.215***	0.216***
Operating aid ratio	0.207	0.180
Need/resource capacity index	–0.075***	–0.07***
Share of African American students (%)	–0.009***	–0.010***
Share of all African American students who live in a majority African American district (%)	0.005**	0.005**
Adjustment variables		
Debt limit variable	–0.104*	–0.112*
Enrollment change (last five years)	0.281***	0.284***
Change of superintendent (= 1 if in last three years)	–0.026**	–0.027**
Consolidated school district (= 1 if year after consolidation)	0.250***	0.260***
Average elasticity for change in local share	–0.398	–0.405
Three large upstate central cities	–0.148	–0.002
Other high-need urban/suburban	–0.329	–0.251
High-need rural	–0.366	–0.376
Average-need	–0.451	–0.436
Low-need	–0.504	–0.484
Prob > F	0.00	0.00
MSE	0.44	0.44

Notes: Sample size is 12,042 (634 districts). The sample does not include New York City, districts with fewer than eight teachers, and districts serving special needs populations. The dependent variable is the estimated value of the capital stock from 1990–2008. The independent variables are lagged three years (1987–2005). All financial variables are inflation-adjusted and expressed in 2000$ using the consumer price index for urban consumers (CPI-U). All variables except for the operating aid ratio, enrollment change, subsidized lunch, share of African American students, and dichotomous variables are expressed in natural logs. The models are estimated with linear 2SLS (with teacher salaries treated as an endogenous variable) with district and year fixed effects. Asterisks denote statistical significance at the 1% (***), 5% (**), and 10% (*) levels.

capacity interaction in urban districts (using the SED definition of "urban"). In both Models 4 and 5, the coefficients of the local share-need/capacity interaction variables are positive and statistically significant. These results indicate that the local response to the price incentives in the Building Aid program is lower in districts in poor fiscal health than in other districts. Model 5 indicates that for any given value of the need/capacity index, the fiscal response is lower in urban districts than in non-urban districts. Coefficients for the other variables in Models 4 and 5 are similar to those in Models 1–3.

At the bottom of Table 5, we present the estimated local capital share elasticities by type of district. We group the three large upstate cities (Buffalo, Rochester, and Syracuse) as one group because their need/capacity index is much higher (approximately 15) than for Yonkers (2.2). On average the elasticity is similar to those estimated in Models 1–3, approximately –0.40. The average elasticity for most types of districts is similar between Models 4 and 5. The exception is for urban districts. The difference is particularly striking for the large upstate cities, where the estimated elasticity is –0.148 in Model 4 and approximately zero in Model 5. For other high-need urban districts, 25 percent are estimated to have elasticities below –0.2 and 10 percent have an estimated elasticity below –0.1. Over 90 percent of rural districts have below-average fiscal health, but rural districts have a much higher response to matching aid incentives than do urban districts with the same need/capacity index. Figure 2 illustrates the estimated local share elasticities based on coefficients in Models 4 and Model 5. The average value for the need/capacity index is 3 and the median is 2.2. For the district in average fiscal health, we find that there is very little difference in the local share elasticity (less than 0.04) between urban and non-urban districts. However, for districts with a need/capacity index above 10 (90^{th} percentile for high-need urban districts and 95^{th} percentile for high-need rural districts), the price response in urban districts is estimated to be half of that in rural districts.

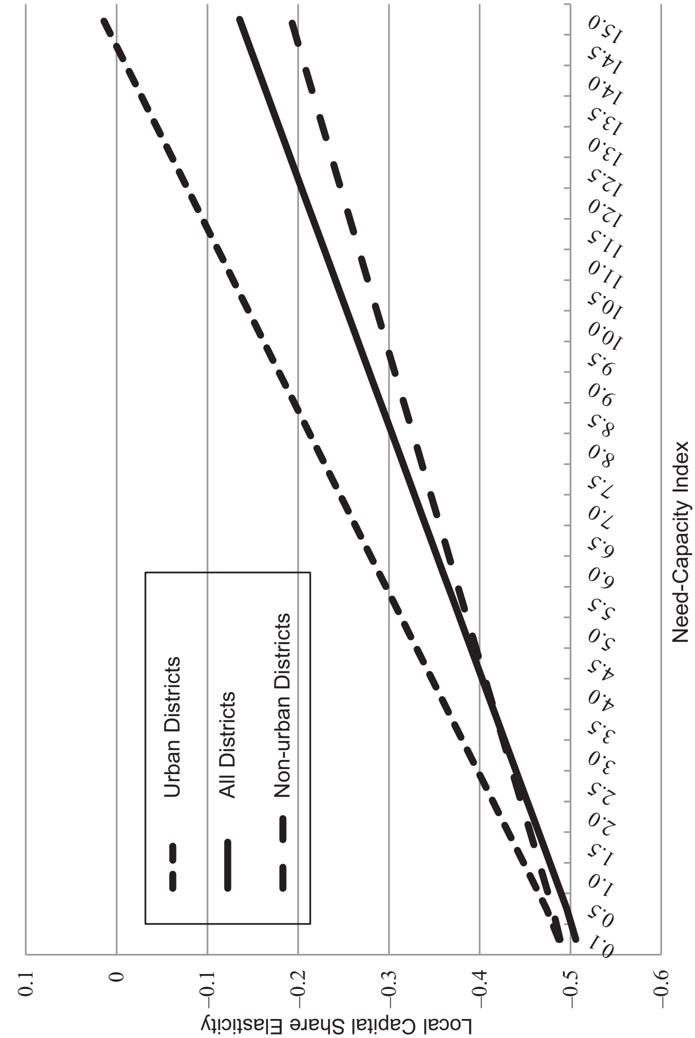
E. Robustness Checks

We also explored several alternative models based on different choices about measures and model specification. As indicated previously, the estimate of the capital stock requires assumptions about the depreciation rate and adjustment factor. Table 6 presents results for two alternative depreciation rates and levels for the adjustment factor (top two panels). Even with substantial differences in assumptions about these factors, the estimated elasticities are similar to those in baseline model. We also estimated elasticities when the capital stock measure is based on 15 years of past capital spending rather than 10 (last line of Table 6). While the elasticities in this case show a similar pattern across districts, they are much lower. This result may be partly due to the loss of five years of data (1987–1992), which included both an expansion and a recession.

Based on our conversations with SED staff, our baseline model assumes that capital investment decisions are made three years after a change in key independent variables, such as the local capital share. When we relax this assumption and look at lags of two years or four years (third panel in Table 6), the estimated elasticities are similar to the baseline. The fiscal health measure we developed uses contemporaneous data. We also

Figure 2

Estimated Capital Share Elasticity by Need-Capacity Index and District Type



Note: The estimates for urban and non-urban districts are based on Model 5 and for all districts based on Model 4.

looked at models in which the school lunch index and property value index are based on two-year or three-year moving averages (fourth panel in Table 6) and also found similar elasticities.

We also looked at several alternative specifications of the model.[44] We included quadratic terms for the continuous variables and interactions between the other continuous variables with the local share.[45] The only variables for which the quadratic terms were significant at the 10 percent level in some models were the construction wage and teacher salaries. Including these quadratic terms had little impact on the elasticity estimates. The numerator of the tax share variable is the predicted median house value from a regression based on 10 years of data (1998–2008). This coefficient could be biased if the coefficients in the regression model do not apply to the previous decade (1987–1997). Given that the tax share is not the main policy variable of interest in this paper, we estimated a model using district property value per pupil instead of tax share and found little impact on the capital share elasticities.

Finally, we looked at an alternative specification of the model in which the capital stock in the previous year is included as a right-side variable and per pupil capital spending is the dependent variable. This is the approach used by Balsdon, Brunner, and Rueben (2003). Based on (14), moving the previous year's capital stock to the right side requires a non-linear estimator. Instead, we assumed for simplicity that the log of the capital stock can be included as an additive term to the existing log-linear model.[46] As might be expected, the local share elasticity with respect to capital spending is somewhat larger than the elasticity for the capital stock. Our main result still holds, however, as the urban high-need districts still have lower price responses than other districts. Indeed, the estimated elasticity is actually positive (but insignificant) for the three large upstate cities.

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[44] One alternative we examined was whether the local response was related to enrollment changes in the district, by interacting the local capital share variable with a dichotomous variable for whether the district had declining enrollment over the previous five years. We found that the interaction term was statistically significant and positive but very small. We also interacted the local share with the five-year enrollment change variable and the interaction was statistically insignificant. These results imply that district response to the local share is not greatly influenced by whether the district had experienced recent enrollment declines.

[45] We estimated a translog cost model with quadratics for continuous variables and interaction terms between independent variables, and found that the vast majority of coefficients were statistically insignificant. It is likely that collinearity is one of the major reasons for the imprecise estimates. To avoid collinearity problems, we have taken a more systematic approach to making the model more general by testing quadratics for all of the continuous variables and looking at interaction terms, which have a meaningful interpretation.

[46] This model includes the interaction between the local share and fiscal health measures for urban districts only because the coefficient for all districts was not statistically significant. All independent variables are lagged two years.

Table 6

Sensitivity Analysis of Local Capital Share Elasticity with Different Assumptions about the Capital Stock, Lags of Independent Variables, and Model Specifications

	All Districts	Three Large Upstate Cities	Other High-Need Urban/ Suburban	High-Need Rural	Average-Need	Low-Need
Baseline (depreciation = 2%, adjustment factor = 1)	–0.405	–0.002	–0.251	–0.376	–0.436	–0.484
Depreciation (adjustment factor = 1)						
1%	–0.418	0.000	–0.250	–0.371	–0.435	–0.486
3%	–0.420	–0.004	–0.251	–0.381	–0.436	–0.483
Adjustment factor (depreciation = 2%)						
0.6	–0.404	–0.006	–0.240	–0.376	–0.418	–0.458
1.4	–0.427	0.000	–0.256	–0.377	–0.445	–0.498
Different lags of independent variables						
2-year lag	–0.398	0.067	–0.220	–0.318	–0.422	–0.493
4-year lag	–0.389	–0.037	–0.240	–0.375	–0.399	–0.429
Multi-year average used to calculate need/resource capacity index						
2-year average	–0.397	0.050	–0.220	–0.367	–0.412	–0.455
3-year average	–0.380	0.052	–0.194	–0.365	–0.392	–0.427
Other Model Specifications						
Quadratic price variables	–0.407	–0.001	–0.241	–0.372	–0.422	–0.466
Property values used instead of tax share	–0.434	–0.002	–0.263	–0.387	–0.452	–0.503
Value of capital stock as RHS variable[1]	–0.468	0.265	–0.137	–0.510	–0.477	–0.503
Capital stock based on 15 years rather than 10	–0.246	0.065	–0.122	–0.209	–0.259	–0.298

Notes: Based on Model 5 in Table 5. The sample does not include New York City, districts with fewer than eight teachers, and districts serving special needs populations. The dependent variable is the estimated value of the capital stock (from 1990–2008) unless otherwise specified. The independent variables are lagged three years (1987–2005) unless indicated otherwise. The capital stock is estimated with a depreciation rate of 2 percent and an adjustment factor of 1 unless indicated otherwise. All financial variables are inflation-adjusted and expressed in 2000$ using the consumer price index for urban consumers (CPI-U). All variables except for operating aid ratio, enrollment change, subsidized lunch, share of African American students, and dichotomous variables are expressed in natural logs. The models are estimated with linear 2SLS (with teacher salaries treated as an endogenous variable) with district and year fixed effects.

(1) The dependent variable is capital spending per pupil. Estimates include the interaction between local share and fiscal health for urban districts only because the coefficient for all districts was not statistically significant. All independent variables are lagged two years.

VII. SUMMARY AND CONCLUSIONS

Despite the significant growth in state financial support for school infrastructure in the last decade, relatively little research has examined the determinants of capital investment decisions by school districts. The objective of this paper is to help fill this gap by providing an empirical analysis of school district capital investment in New York.

New York's Building Aid program is a categorical grant, which requires project approval by the SED. The grant distribution is by an open-ended matching formula, although the state imposes ceilings on the maximum size of the project to limit the burden on the state budget. The grant is wealth equalized and adjusted for construction costs in different regions of the state. The 10-percentage-point increase in the state matching aid ratio in 1998–2000 provides a natural experiment for examining how districts respond to different tax price reductions. While many districts (particularly the high-need rural districts) significantly increased capital spending after this price change, the high-need urban/suburban districts expanded capital spending at a much lower rate than other districts despite very large price reductions.

To empirically examine these differential price responses, we first develop a theoretical model of capital investment that incorporates variables from a capital demand equation and a general education demand equation. The dependent variable for this model is an estimate of the value of the capital stock. The capital investment model was estimated using a 19-year panel for the majority of school districts in New York state. The results of the model generally fit theoretical expectations and we find an inelastic but statistically significant response of capital investment decisions to the local capital share. For high-need urban/suburban districts, however, this price elasticity is much smaller than in other districts, after controlling for other determinants of capital investment. We estimate that this lower price response is the principal reason that the value of the capital stock in the high-need urban/suburban districts is approximately two-thirds of the state average and half of that in high-need rural districts in 2005. These results suggest that the budgetary problems of high-need urban/suburban districts are so severe that they are unwilling to undertake new capital projects even when virtually all the cost will be picked up by the state government. The lack of capital investment by high-need urban/suburban districts in New York is of concern because of recent evidence indicating that a larger capital stock is associated with higher student performance and property values (Jones and Zimmer, 2001; Cellini, Ferreira, and Rothstein, 2010).[47]

These results pose a major dilemma for state policy makers in New York. The capital stock in large, high-need urban districts still lags behind that in other districts, but the ability of policy makers to eliminate this inequity through price incentives appears to be quite limited. Moreover, our finding of a weak relationship between capital investment and Operating Aid suggest that increasing general-purpose foundation aid is unlikely to

[47] However, Gronberg, Jansen, and Taylor (2011) find that educational costs increase with the value of a district's capital stock. This result suggests that a larger capital stock may result in lower student performance.

result in significant capital investment. Given that New York's Building Aid program is unusually generous, our results suggest that the price response facilities aid programs in most other states are unlikely to be effective in stimulating capital investment in high-need urban/suburban districts.

Other approaches, such as full state funding or loosening of debt limits need to be explored. Earlier studies (Wang and Duncombe, 2009) provide suggestive evidence that the type of building-aid formula used by a state may affect the level of inequality in capital investment. State policymakers should explore other methods of funding school facilities, such as the adoption of lump-sum capital aid programs, rather than relying predominantly on matching aid. In addition, long-term capital planning requirements for school districts and the development of capital project priorities by state education departments (as in Florida and West Virginia) might help to reduce inequality in capital facilities and ensure that the most-needed projects have first claim on state funds. The fact that rural districts in New York significantly increased capital investments over the last decade relative to other districts even though many were experiencing significant enrollment declines suggests that the targeting of Building Aid in New York could be improved.

An important area for future research is the examination in other states of the impact of political and management factors on decisions about capital investment in high-need urban districts compared to other districts. Are the lower elasticities we found for these districts in New York driven by specific fiscal and institutional constraints unique to New York state, or does the same pattern emerge in other states as well?

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