Understanding the Incentives in California's Education Finance System

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Introduction

California's unique education finance system combines general state support for school districts that is based on complex constitutional provisions, numerous state categorical aid programs, and a variety of small local revenue sources, including a parcel tax and contributions from educational foundations. In this report, we explore the incentives this system creates for voters and school officials and estimate the extent to which these incentives influence educational spending and student performance.

We begin with an overview of the California education finance system. This overview describes the broad outlines of this system and compares it to the education finance systems in other states. The next part of this report explains how scholars study the incentives created by an education finance system through an examination of the factors that determine both school district expenditures and the demand for student performance. This part also shows how the lessons from previous research can be applied to the unique features of the education finance system in California, such as the parcel tax. We then turn to our empirical results. We describe our data and methodology and present the results from our estimated expenditure equation and our estimated demand equation. The final section presents our conclusions, offered in the form of nine lessons about California's education finance system.

Overview of the California Education Finance System

The education finance system in California is constrained in two fundamental ways. On one side, Proposition 13 limits the local property tax rate to 1 percent of assessed value and restricts the growth in assessed values for property that does not change hands. Most of the resulting property tax revenue goes to schools. On the other side, the court rulings in the

Serrano case have limited differences across districts in general-purpose revenue per pupil, defined as unrestricted state aid plus property taxes.

The initial *Serrano* decision found that California's education finance system was unconstitutional because the funds available for a child's education depended on the wealth in his or her school district. The state responded to this ruling by designing a new education finance system that specified a revenue limit, that is, a particular amount of general-purpose revenue, that each district would receive. A subsequent court decision ruled that a reformed education finance system would be constitutional if it produced differences in general-purpose revenue across districts of less than $100 per pupil (in 1974 dollars), and another decision concluded that the post-*Serrano* education finance system was close enough to satisfy this standard. See Timar (2006).

The Proposition 13 limit is very binding because school districts have no other major sources of revenue. As a result, the revenue available to a school district is largely determined by state policy makers. The *Serrano* restriction is less binding for two reasons. First, it does not apply to state categorical aid, which can, and does, vary widely across districts. Second, now that the state has met the revenue-limit guidelines set down by the court, it is free to implement additional education finance reforms.[1]

These features lead to an education finance system in which, compared to other states, the state government plays a relatively large role but general-purpose aid plays a relatively small role.

State and Local Shares

Table 1 shows the state, local, and federal shares of school revenue for California and several comparison states in the 2003-2004 school year. The state share in California, 54.5 percent, is higher than the share in the average state, much higher than the share in other large states (Illinois, Florida, New York, Pennsylvania, and Texas), 39.2 percent, and about the same as the share in the two other states on the West Coast (Oregon and Washington), 57.2 percent. Overall, California had the 18th highest state share among the 50 states.

Table 2 compares types of state education aid in California and other states in 2003-2004. This table shows that a relatively small share of state education aid in California takes the general purpose form, 52.7 percent, compared to the average state, 68.0 percent, or to the other states on the West Coast, 84.1 percent. Among all states, California ranked 44th in the share of its aid provided in general-purpose form. General-purpose aid makes up almost as much of the aid in California as in other big states, however.

General-Purpose Aid

The formula used to distribute general-purpose aid in California is equivalent to a foundation aid formula, which is used in most other states. According to Huang (2004, Table B.3), 30 states use a foundation formula for all their general-purpose aid and 11 other states use a foundation formula in combination with some other type of formula.

With a foundation aid formula, the amount of aid a district receives per pupil equals a spending target minus the expected local contribution (Yinger, 2004). In principle, the spending target, also called the foundation amount, is the spending needed to provide the minimum education level expected by the state. This principle is closely followed by 12 states, in which aid is "based on a state-determined number of teachers per student or on the expenditures in a real or hypothetical school district" (Huang, 2004, p. 348). Moreover, this approach, often called costing-out, is now an active topic of research for education policy scholars (Duncombe, 2006; Downes, 2004; Guthrie and Rothstein, 1999).

The foundation amount is not so closely linked to principle in other states. According to Huang's classification, 22 states set the foundation level each year based on "historical data, the state's fiscal situation for that year, and the state's priority for supporting elementary and secondary education compared with other items in the state budget" (p. 348). The remaining states with foundation plans rely on a foundation amount set in the past and adjusted with a legislated percentage increase each year, usually tied to inflation and to changes in enrollment.

In California, the revenue limit is the analog to the foundation amount. The details of the revenue-limit calculations in California are complicated and we do not attempt to describe them here (see Goldfinger, 2006).[2] Roughly speaking, however, each district's limit equals its 1972-73 spending level increased for subsequent changes in state-wide income per capita. These increases are higher in some districts than in others to minimize divergence from the average revenue limit, as the *Serrano* decisions require. Nevertheless, this approach is a version of the third approach mentioned above, which is used by six other states.

The foundation amount in an aid formula is often adjusted for the fact that it costs more to provide education in some districts than in others, either because some districts must pay higher wages to attract teachers of any given quality level or because some districts face extra expenses due to a concentration of disadvantaged students. Huang (2004, Table B.3) reports that 24 of the states using a foundation formula follow this approach.

The foundation amount in California is not adjusted in any way for the higher cost of education in some districts. This situation is consistent with the *Serrano* guidelines for a minimal revenue-limit deviation across districts, which is expressed in terms of actual spending per pupil, not in terms of real spending per pupil (that is, spending per pupil adjusted for educational costs).

The California approach is not consistent, however, with the central normative argument for a foundation formula, which is an education finance system should lead to an adequate student performance in every district. This view requires not only a decision about the resources needed to reach this performance level in a typical district, that is, a decision about the basic foundation amount, but also a decision about the best way to account for variation across districts in the cost of education. As indicated above, most states with a foundation formula make some kind of a cost adjustment, but California does not, perhaps because the *Serrano* decisions were crafted before the issue of educational costs—and their link to student performance—was widely recognized by courts, policy makers, and scholars.

The expected local contribution in a foundation aid formula is usually expressed as a percentage of the local property tax base. This approach conforms with the basic philosophy of a foundation formula, which is that the state will make up the difference between the amount of revenue a district could raise at a given property tax rate and the amount the district must spend to achieve the expected education level. In most states the local contribution in the formula is a required minimum (Huang, 2004, Table B.4). In other states the local contribution serves only as a place holder in the aid formula. Districts are free to set a tax rate below the rate in the formula, but if they do so, they fail to have enough revenue to reach the foundation spending level.

In California, Proposition 13 sets the parameters of the expected local contribution. It not only sets limits on assessing (a practice used in only a few other states) but also sets the property tax rate. This rate equals the share of the 1 percent maximum local property rate that the state allocates to schools, which varies across school districts and, in some cases, within school districts that contain multiple jurisdictions of other types. This rate (or value-weighted average rate) serves as both the rate in the aid formula and as the actual tax rate.

State restrictions on school district revenues are not limited to California. In fact, 24 other states with foundation formulas limit supplementation by school districts to some degree, and two other states allow supplementation but only with a financial penalty. In all these states, therefore, many districts cannot spend as much as they want on education. Most of these restrictions are less severe than those in California, which limits revenue beyond a district's state-specified revenue limit to a parcel tax and a few other miscellaneous revenue sources. A few states (Alabama, Nevada, and, once its reforms are fully implemented, Michigan) have total restrictions on supplementation, however, and one state (Hawaii) has no independent school districts at all. See Huang (2004, Table B.4).

In a fundamental sense, these restrictions on local supplementation transform "local" revenue into "state" revenue, that is, they take decisions about the property tax and other local revenue sources out of local control. The property tax checks still are paid to the school district, but the district has little or no say about the property tax rate (or even, as in California and a few other states, about assessed values). According to this approach, California has one of the most centralized, that is, state-controlled, education finance systems in the nation. Many other states are also highly centralized in the same sense, however. These states include Oregon on the West Coast as well as Florida and Texas among the big states.

Because it has such a highly centralized system and because the *Serrano* decisions reduced revenue-limit differences across districts, one might think that total revenue has much less variation in California than in other states. As shown by Table 3, this turns out not to be the case. This table compares the across-district variation in revenue in California and in New York, which has one of the most decentralized education finance systems in the nation. This table shows that the amount of revenue is much higher in New York, but that, in some cases, the variation in revenue is higher in California. Measuring variation by the ratio of the 95th percentile to the 5th percentile, we find that variation in total revenue is higher in California than in New York (3.7 to 2.6).[3] This higher variation does not show up in local revenue, property tax revenue, or even basic state aid plus property taxes (which equals the revenue limit in California). All of these categories exhibit similar variation in the two states. Instead, it shows up in state categorical aid and in federal revenue. For more insight into this variation, therefore, we now turn to state revenue other than basic aid, that is, to categorical aid.

Categorical Aid

Table 2 reveals that California devotes more of its education aid budget to categorical aid, which appears in rows 2 though 6, than do many other states. The second row indicates that California devotes somewhat more of its aid budget than do other states to what the Census calls "compensatory" aid programs, which include programs "for 'at risk' or other economically disadvantaged students including migratory children." These programs place California in a category with 17 other states that combine compensatory categorical aid programs with a foundation aid program that is unadjusted for costs (Huang, 2004).[4]

The main difference between California and other states shows up in the "other" category, which is in row 6. According to the Census, this category includes aid for "bilingual education, gifted and talented programs, food services, debt services, instructional materials, textbooks, computer equipment, library resources, guidance and psychological services, driver education, energy conservation, enrollment increases and losses, health, alcohol and drug abuse, AIDS, child abuse, summer school, pre-kindergarten and early childhood, adult education (excluding vocational), desegregation, private schools, safety and law enforcement, and community services." California has dozens of categorical aid programs for one or more of these purposes (Goldfinger, 2006). These programs are designed to ensure that school districts spend at least a minimum amount on certain programs, such as bilingual education, transportation, and early childhood education, or are earmarked for certain resources, such as computers and textbooks.[5]

The emphasis on categorical aid in California reveals another dimension of centralization in the state's education finance system. Each categorical aid program puts additional programmatic constraints and administrative responsibilities on school districts. Thus, heavy reliance on categorical aid, as in California, gives state lawmakers more control over the allocation of school district budgets, but it also limits local flexibility and innovation and raises the share of resources that are devoted to bookkeeping instead of education. This trade-off is recognized in California. The six AB 825 block grants, which were passed in 2004, each combine several categorical aid programs and give school districts more flexibility in deciding how to spend the aid funds (Goldfinger, 2006). We believe these block grants were a step in the right direction.[6]

As discussed earlier, state-level restrictions on the property tax effectively transform the property tax into a state-level revenue source for local education. A district's total unrestricted revenue from state-level sources therefore equals unrestricted state aid plus property tax revenue, which is a district's so-called revenue limit. This line of reasoning suggests that the most appropriate way to evaluate the relative role of categorical aid is to examine its share of total state-level revenue, including the property tax. In 2002-03, categorical aid made up 25.8 percent of this total. As shown in Table 4, this share is larger than the share in 1994-5 (20.3 percent), but smaller than the share in the 1998-2002 period, when it reached a maximum of 29.6 percent (in 2000-01). Because a district's revenue limit tends to grow fairly steadily over time, the instability in this share largely reflects variation in the set of categorical aid programs, as new programs are added or existing programs are consolidated. Categorical aid programs may therefore add to district inefficiency not only by adding constraints, but also by being unpredictable.

Although California's "other" categorical aid is not explicitly "compensatory," it includes bilingual education, which has a large impact on cost differences across districts, and it may flow disproportionately to districts with more 'at-risk' students as defined by income. Along with compensatory categorical aid, therefore, this other categorical aid may, to some degree, offset the fact that California has no cost adjustments in its revenue-limit calculations.

Some evidence that this is true is provided by the Education Trust, which compares the funding provided to the 25 percent of districts with the most poverty with that provided to the 25 percent of districts with the least poverty, after adjusting for the higher costs of educating students from poor families.[7] As shown in Table 5, this "poverty gap" is considerably lower in California than in the average state or the average big state. Nevertheless, this gap is still quite large, $534 per pupil, and it is larger than the gap in other West Coast states, $309 per pupil.[8] To some degree, the relatively small absolute poverty gaps in California reflect the state's relatively low spending per pupil. In fact, Baker and Duncombe (2004) find that per pupil education aid in the poorest quarter of districts was only 12 percent above the aid in the average district in California in 2001, compared to a differential of 24 percent in the average state.

The Education Trust report also calculates the cost-adjusted funding gap between the 25 percent of districts with the highest minority concentration and the 25 percent of districts with the lowest minority concentration. The pattern for these spending gaps is similar to those linked to poverty. To be specific, California has a lower cost-adjusted gap than the average state or the average big state, but it also has a much larger cost-adjusted gap than do Oregon and Washington.

Overall, therefore, the underfunding of districts with a high concentration of minority students or students from poor families may not be as severe in California as in some other states, but this outcome is more by accident than by design. California's unrestricted aid programs do not adjust at all for the high costs of educating disadvantaged students, and its categorical aid programs are not designed to address these costs in a comprehensive manner. This ad hoc approach was retained in the state budget for 2006-07, which adds $350 million in categorical grants directed toward disadvantaged students and English language learners (ELL), along with $50 million in one-time grants to help attract and retain teachers in districts with poorly performing schools (California School Boards Association, 2006).

Sources of State Funding

State education aid in California is funded by the State's own general revenue.[9] As shown in Table 6, the income tax provides a larger share (and selective sales taxes a smaller share) of own-source general revenue in California than in comparison states. Individual income taxes make up 34.7 percent of own general revenues in California compared to 24.6 percent in the average state, for example. These differences largely reflect the fact that seven states, including two big states (Florida and Texas), as well as Washington on the West Coast, do not collect individual income taxes. In fact, Table 6 reveals that the California system is typical of a state with an income tax.

Table 6 also reveals that California relies more heavily on corporate income taxes than other states. These taxes provide 6.6 percent of state general revenue in California compared to 3.8 percent in the average state and 4.2 percent in the average big state with an individual income tax.[10] In addition, a relatively small share of California's general revenue comes from current charges (10.9 percent compared to 14.4 percent in the average state) or from miscellaneous revenue (7.5 percent compared to 11.8 percent), which includes the lottery.

A full evaluation of California's revenue system is beyond the scope of this report. Nevertheless, it is worth pointing out that this system appears to be roughly consistent with the general principles applied to revenue systems by most economists.[11] These principles call for a revenue system that meets several broad principles. First, the system should minimize distortion, which is defined as a shift in economic behavior brought on by a tax or other revenue source. Second, it should result in a fair distribution of the tax burden. Different people have different views of fairness, of course, but most analysts argue that a fair tax system minimizes taxes on the poorest households and imposes a burden that is proportional to income, if not mildly progressive, for others. Third, it should take advantage of opportunities to export the burden of taxation to nonresidents. Fourth, it should yield a reasonably steady flow of revenue. Fifth, it should not have a high administrative burden.

The California system has a good mix of revenues, which minimizes the distortion that occurs from over-reliance on a single tax source. It focuses on broad-based income and sales taxes, which tend to be fairer, less distortionary, and less expensive to administer than taxes with narrow bases. It has a reasonable balance between an income tax and a sales tax. On the one hand, an income tax tends to be fairer, because it can exempt low-income households from taxes, and some of its burden is exported to nonresidents through its deductibility on the federal income tax.[12] On the other hand, a sales tax tends to be less volatile.[13] Overall, there is still plenty of room for debate about the features of each component in the California state revenue system, but the mix of revenue sources does not appear to be in need of a major overhaul.

Sources of Local Revenue

The property tax is, of course, the main source of local revenue for elementary and secondary education. This is documented in Table 7. At first glance, it appears as if California relies more heavily on the property tax than does the average state but less heavily than other big states. In many states, however, some of the school districts are dependent, in the sense that they are organized as a department of a "parent" government, usually a city. Although a few of these parent governments, such as New York City, have an income tax and/or a sales tax, the vast majority of the revenue they collected comes through the property tax. Thus a more accurate picture can be seen by adding the entries in the "property tax" and "parent government" rows. This step reveals that California is not so different after all, with a "school tax plus parent government" share of 76.5 percent compared to 82.6 percent in the average state, 86.8 percent in the average big state, and 77.7 percent in the other West Coast states.

Table 7 also indicates that taxes other than the property tax make up a very small share of local school revenue in California, as they do in other states. A notable difference between California and other states appears in the last row of this table: 16.8 percent of local revenue in

California falls into the "other category," compared to only 6.6 percent in the average state. As discussed below, the main source of this difference appears to be that in California, unlike other states, private educational foundations make large contributions to public schools in several school districts.

A breakdown of local revenue sources other than the property tax is provided in Table 8.[14] The first column of this table refers to the parcel tax, which is unique to California and which is not considered to be a property tax by the Census. A parcel tax cannot be implemented without a two-thirds favorable vote from the voters in a school district, and, in the vast majority of cases, it is levied at a fixed rate per parcel.[15] This column shows that the parcel tax provided 8.0 percent of local non-property-tax revenue in 2002-03, compared with 5.6 percent in 1995-96. This growth in the reliance on this tax is likely to continue, because the parcel tax is one of the few revenue sources with clear expansion possibilities, but the 2/3 voting requirement obviously has minimized reliance on this tax up to now. More specifically, only 208 parcel taxes had been passed by November 2005 (Timar, 2006). In addition, only 58 districts had a parcel tax in 2004, and parcel tax revenue was less than $500 per pupil in all but 26 of these districts (Brunner and Sonstelie, 2005).

According to the criteria developed by public finance economists, a parcel tax is a poor substitute for a property tax. First, a parcel tax does not meet basic standards of fairness. Property value is recognized as a reasonable measure of taxpayers' ability to pay, and the property tax payments in a jurisdiction equal a proportion (determined by the tax rate) of property value. This satisfies the principle of vertical equity, which says that taxpayers with a higher ability to pay should have higher tax payments. A parcel tax does not satisfy this principle. The owner of a mansion pays the same amount as the owner of small house, and the owners of a huge factory pay the same amount as a mom-and-pop store. Unlike a property tax, in other words, a parcel tax is very regressive.[16]

Second, a parcel tax does not have the same effects on economic behavior as a property tax, but both taxes are distortionary. A distortion arises whenever taxes influence people's choices in the market place. By altering the the price of housing, a property tax affects housing consumption and is therefore distortionary. By raising the price of living in a particular community, a parcel tax alters location decisions and is therefore distortionary, as well, although the magnitude of the distortion has not yet been studied.[17] Location decisions by owners of large factories may not be affected by a parcel tax, but smaller firms and households may decide to avoid communities where a parcel tax is in place.

Table 8 also shows that the most important sources of local revenue other than the property tax are fees, which have remained a fairly constant share over time; interest, which is a declining share; and miscellaneous sources, which now constitute almost half of this revenue. These miscellaneous sources include many different sources, but they appear to consist mainly of donations from educational foundations.

We compared school-district level data on net giving by education foundations, which is based on tax return data (Brunner and Sonstelie, 2003), with "other" local revenue. The correlation between these two variables is very high, namely, 0.86. We find that a $1 increase in net foundation giving per pupil in a district is associated with a $0.73 increase in that district's other local revenue per pupil in 2004 and a $0.89 increase in 2005. These results indicate that, on average, 73 to 89 percent of foundation gifts go directly to the school district. Moreover, a $1 increase in local revenue per pupil is associated with a $0.93 increase in foundation giving per pupil in 2004 and with a $0.91 increase in 2005. It appears, therefore, that about 92 percent of other local revenue per pupil comes from foundations.

Revenue from private foundations is distributed in a relatively inequitable manner, because districts with richer residents can attract more contributions. Unlike state aid given to wealthy districts, however, these contributions do not come out of the same budget that must provide funds to the neediest districts. Moreover, private contributions may be difficult to regulate; even if contributions directly to schools were prohibited, parents could make equivalent contributions through tutoring, art, music, sports, or other programs run outside the school system.

Modeling Incentives in the California Education Finance System

Although the California education finance system places severe constraints on school districts and voters, it also creates some incentives for these local actors to behave in certain ways. This report draws on a large literature on education finance to identify the key incentives,[18] shows how these incentives can be incorporated into models of voter and school district behavior, and estimates the extent to which these incentives influence educational outcomes in California.

The literature on education finance examines the determinants of educational spending and student performance at the school district level using two principal tools, an education cost equation and an education demand equation. These tools are derived using basic economic principles and then estimated using data from the school districts in a state. Many of the incentives in an education finance system can be studied by including appropriate variables in an estimation of one or the other of these equations. This section explains cost and demand equations and explains how they can be used to examine the incentives in the California education finance system.

Education Cost and Expenditure Equations

An education cost equation indicates the amount of money a district must spend per pupil to obtain a given level of student performance. This type of cost equation is analogous to a cost equation in private production, which is a central tool in economics. A cost equation explains cost as a function of output level and input prices. The output in our case is student performance, as measured by the Academic Performance Index, API, which is a weighted average of a district's student test scores on a variety of subjects from grades 2 through 11. This index was defined by the 1999 Public Schools Accountability Act and continues to be a focus on California's school accountability system. The key input price is a measure of teacher salaries.

As shown by previous studies, application of this tool to education requires three principal extensions.[19] First, educational costs depend not only on input prices, as in cost equations for private production, but also on student characteristics, which are often called fixed inputs. Second, estimation of an educational cost equation must recognize that both measures of student performance and teachers' salaries are influenced by school district decisions and are therefore, to use the statistical term, endogenous. Third, any estimation of a cost equation must recognize the difference between costs and spending.

Our approach to each of these extensions is discussed in detail below. Before turning to the details, however, it may prove useful to highlight the importance of the third extension for the interpretation of our result. A cost equation indicates how much a school district would have to spend to achieve a given performance level if it used the best available technology, that is, the best available teaching methods and management policies. We cannot observe costs in this sense, however, but instead observe actual spending, which may not reflect the best available technology. To put it another way, the dependent variable in our analysis, spending per pupil, is equivalent to educational costs divided by an index of school district efficiency. As a result, we need to control for efficiency to preserve the cost interpretation of student characteristics and other cost variables.

District efficiency is difficult to study because it cannot be directly observed. Instead, scholars must come up with methods to account for efficiency indirectly. The method we use here, which has appeared in several previous studies, is to identify variables that are conceptually linked to school district efficiency and to include them in our estimated educational expenditure equation (Eom, Duncombe, and Yinger, 2005; Duncombe and Yinger, 2001, 2005a, and 2005b; Duncombe, Lukemeyer, and Yinger, 2003; Imazeki and Reschovsky, 2004b). Results from this approach can provide evidence that certain incentives lead to more or less efficiency in some districts, but they do not provide direct evidence of the determinants of school district efficiency.

It is also important to emphasize that efficiency can only be defined in relation to a particular performance standard. A school district that is efficient in delivering student performance in mathematics might not be efficient in delivering student performance in English or art. Indeed, spending on art is likely to a source of inefficiency in the production of mathematics performance. Our main analysis measures school district performance using API.[20] As a result, this analysis explores school-district efficiency in delivering API, not in delivering any other measure of student performance. We also discuss some results using an alternative measure of performance, namely, the share of students who are judged to be proficient on state math and English tests.

Student Characteristics and Other Fixed Inputs

Many studies have documented that the per-pupil cost of education (that is, of achieving a given level of student performance) is higher in a school district with a higher concentration of disadvantaged students. Our analysis looks at the cost impacts of student poverty (as measured by the share of students eligible for a free lunch) and the share of students with limited English proficiency.

Educational costs are also affected by the share of students with various types of disabilities. Because there are so many types of disabilities, however, these costs impacts are difficult to sort out, and we estimate our models excluding spending for special education.[21] Instead, we include the share of students with severe disabilities in our analysis to determine whether the concentration of students with severe disabilities alters the cost of education for other students.

We also account for cost differences associated with the set of grades served by the school district by including dummy variables for high-school-only and elementary-school-only districts, with unified districts as the omitted category.

In addition, we estimate the extent of economies or diseconomies of scale by determining the relationship between spending per pupil and school district enrollment. As in previous studies, our equation allows for a U-shaped relationship between enrollment and per-pupil costs.

Finally, we investigate the impact of short-run enrollment change on spending per pupil, defined as enrollment change over a three-year period. Enrollment change is largely outside a district’s control, so enrollment change variables determine what happens to spending in response to an external change in the educational environment, which is, by definition, a cost factor.[22]

We estimate the impact of enrollment increases and enrollment decreases separately. Because we also control for total enrollment, the estimated impacts of these variables indicate whether two districts with the same current enrollment and the same student performance will have different costs if one of these districts has experienced a recent enrollment change and the other has not. We expect that short-run per-pupil costs will decline when enrollment rises and increase when enrollment declines. In the short run, adding new students to existing classrooms has little impact on the budget and therefore lowers spending per pupil. Similarly, taking students out of existing classrooms causes spending per pupil to rise. This may not be the end of the story; several studies find that smaller classes lead to higher student performance, all else equal (Boozer and Rouse, 2001; Krueger, 1999; Krueger and Whitmore, 2001; Finn, Gerber, and Zacharias, 2005). If these short-run class-size changes do affect student performance, then it is theoretically possible that short-run enrollment decline will lower the per-pupil cost of obtaining a given level of student performance, which is what we are estimating. In practice, however, the impact of class size on performance does not appear to be large enough for this to occur, and we expect that these enrollment change variables will both have a negative impact on expenditures.

Addressing Endogeneity

Some unobserved district characteristics may affect both the dependent variable in our cost equation, spending, and a key explanatory variables, API. Districts with a particularly skilled superintendent, for example, might have both higher API and lower spending; the standard regression approach, called ordinary least squares, ignores this possibility and therefore may understate the spending required to boost the API. This so-called endogeneity problem can be addressed through the use of an alternative regression approach, called two-stage least squares. This approach makes use of one or more “instrumental variables,” which are correlated with the endogenous explanatory variable but are outside a district’s control. By incorporating these instrumental variables into the regression procedure, a researcher can obtain an unbiased estimate of the impact of the explanatory variable on spending, that is, an estimate that does not reflect the role of unobservable factors. The technical details of our instrumental variables procedure, including the selection of instrumental variables, are presented in Appendix A.

Actual teachers’ salaries also might be endogenous for the same reason; that is, unobserved district traits might influence both teachers’ salaries and district spending. We avoid this type of endogeneity problem by using predicted minimum salary instead of actual salary in our cost regression. As discussed in Appendix A, minimum salary is predicted based on county population, comparable private salaries, and the share of the population in urban, as opposed to rural, areas.

Accounting for Efficiency

The variables in our expenditure equation that are linked to efficiency fall into two categories: variables associated with the incentives that lead voters to monitor school officials and variables associated with the incentives of school officials themselves. For example, voters may have a stronger incentive to monitor school officials, that is, to force them to be more efficient, if they must pay a high price for any additional school spending. As it turns out, the price of education varies a great deal across districts in most states. With a standard property tax, voters in some districts can shift the burden of additional property taxes onto commercial and industrial property whereas voters in other districts, where commercial and industrial property is limited, cannot. Several studies have found evidence that this incentive is at work: a higher tax price is associated with lower spending (that is, a more efficient school district), holding constant other factors such as student performance and student characteristics (Eom, Duncombe, and Yinger, 2005; Duncombe and Yinger, 2001, 2005a, and 2005b; Duncombe, Lukemeyer, and Yinger, 2003). This result supports the view that voters' facing a higher tax price engage in more monitoring, thereby inducing their school districts to be more efficient.

We now turn to variables linked to voters' incentives and variables linked to the incentives of school officials. Our hypotheses for these two sets of variables are summarized in Table 9.

Variables Linked to Voters' Incentives in California. Voters influence the efficiency with which a school district operates by monitoring school officials. We cannot observe monitoring activities directly, but we can observe several factors that might influence monitoring, and hence efficiency. Then we can determine whether these variables are associated with lower spending for a given performance level, which is an indication that they are associated with school district efficiency.

The most basic variable influencing voter monitoring is the wage rate, which is a measure of the opportunity cost of a person's time. People who earn a high wage have a higher opportunity cost and therefore will decide to do less monitoring of the API level, all else equal. Because wages and incomes are highly correlated, higher wages are also associated with higher incomes, and voters with higher incomes demand a broader range of educational services. As indicated earlier, spending on educational services not associated with the API, regardless of how valuable they are to voters, counts as inefficiency in an API-based expenditure equation. Thus, our estimated expenditure equation includes the median earnings in a school district; we expect this variable to have a positive impact on spending, either because it measures opportunity cost or because it is associated with a broader range of demand for educational services—or both.

California does not, of course, have a standard property tax. Instead, voters can decide to levy a parcel tax. As shown by Brunner (2001), a parcel tax implies a tax price for education equal to one divided by the number of parcels in a district per pupil. Voters in a district with many parcels per pupil can spread the cost of an additional dollar of revenue per pupil over many parcels and therefore pay only a small fraction of this cost themselves. Voters in a district with few parcels per pupil cannot spread out the burden in this manner. Thus, the price of additional education in California depends on the number of parcels in a district. This price is lower in a district with many parcels per pupil than in a district with only a few. Voters in districts with a low number of parcels per pupil must pay a high price for additional spending and hence are more likely to engage in monitoring and thus to raise district efficiency.

A parcel tax must be passed with a 2/3 vote and must be renewed after a few years. Nevertheless, the parcel tax remains a key measure of the cost to voters of additional school revenue. School districts may have other local revenue sources, such as leases, that are easier to implement under some circumstances, but eventually they will have to turn to a parcel tax if they want additional revenue. Moreover, the other sources of revenue are not so transparent, and voters may be more aware of the parcel-tax-based price of education than of the price associated with other revenue sources. It seems reasonable, therefore, to interpret the number of parcels as a measure of the price of education as seen by voters and to include it in the expenditure equation. Our analysis indicates that more parcels per pupil corresponds to a lower tax price and hence will be associated with less monitoring and less efficiency.

We also hypothesize that voters who are more connected to their community are more likely to engage in monitoring activities. As a result, monitoring, and hence efficiency, should decline as the share of migrants into a school district increases. We measure migration by the share of the population that moved into the school district from outside the county from 1995 to 2000. We cannot formally rule out the possibility that migration into a school district affects educational costs. Recall, however, that we already control for the shares of students from poor families, who are English learners, and who have severe disabilities, and we control for total enrollment and enrollment change. We do not know of any cost factor associated with migration that is separate from the cost factors on this list.

Decisions about monitoring activities may be linked to expectations. Voters who have come to expect high performance may enforce these expectations through their monitoring activities. In California, the education finance system has gradually eliminated some funding disparities by raising the revenue limits for under-funded, typically low-performing, districts at a higher rate than for well-funded districts, most of which had high levels of student performance. As shown by Sonstelie, Brunner, and Ardon (2000), between 1974-75 and 1989-90, the revenue limit actually declined in real terms in many districts but increased dramatically in others. Voters in districts with real declines in their revenue limits, which tend to be high-performing districts, expect their high performance in previous years to continue, so their monitoring activities may boost efficiency. Voters in districts with relatively large increases in their revenue limits, which tend to be low-performing districts, observe funding and performance increases compared to their expectations, so their monitoring activities may have a smaller impact on efficiency.

To look for this type of behavior, we include in our expenditure equation a variable to measure the change in a district's revenue limit between 1974-75 and 2004-05. A positive sign for this variable would support the view that this type of monitoring exists. As in other cases, we cannot formally rule out the possibility that this variable picks up the impact of cost variables that are correlated with revenue limit changes and that we cannot observe. Because we observe the key cost factors found to be important in previous studies, however, we believe that an efficiency interpretation for this variable is far more compelling than a cost interpretation.

Variables Linked to School Officials' Incentives in California. Revenue limit changes may also be linked to the incentives facing school district officials. School officials in high revenue/high performance districts may work especially hard to maintain the performance level in their district despite the decline in their revenue. Similarly, school officials in low revenue/low performance districts may be able to use the relatively large increases in their revenue limits to increase their relative performance even without being relatively efficient.

The options available to school officials also are influenced by the restrictions linked to the state aid they receive. The property taxes and unrestricted aid that make up a district's revenue limit are largely under the control of school officials. In contrast, categorical aid comes with various restrictions on its use, generally linked to the programs on which it must be spent. The law makers who pass categorical aid programs apparently believe that the restrictions in these programs will foster the achievement of the state's educational objectives. Because the API is the measure of student performance emphasized by the state, one might even say that law makers expect these restrictions to result in a higher API than the same amount of funds provided without restrictions. Goldfinger (2006, p. 177) reports, for example, that lawmakers fear that additional funds will simply go to higher teacher salaries and that these salary increases will be ineffective in boosting student performance.

An alternative view is that school district officials are in the best position to determine the allocation of their funds that maximizes student performance. According to this view, the restrictions in categorical aid programs get in the way and are likely to make a district less efficient. They require a school to devote more resources to red tape; to spend time and energy on programs that may not boost API; and, if the categorical aid program is underfunded, to shift money out of general-purpose funds where it may have more impact on API. This view suggests, in other words, that categorical aid will have a smaller impact on student performance, as measured by the API, than would an equal amount of unrestricted aid.

We can determine which of these two arguments is correct by including in our expenditure equation a variable measuring the share of aid that comes in the form of categorical grants. If the first view is correct, the sign of this variable will be negative, which indicates that categorical grants lower spending (i.e. raise efficiency) compared to unrestricted aid. A positive sign for this variable would indicate that the restrictions in categorical aid undermine efficiency and therefore result in more spending to achieve the same student performance.

Education Demand Equations

An education demand equation is analogous to a demand equation for a private commodity. The demand for education, like the demand for a private good, is influenced by a household's income and preferences and by the price of education it faces (Eom, Duncombe, and Yinger, 2005; Duncombe and Yinger, 1998, 2001). To put it another way, income, preferences, and education price determine a household's preferred level of education. Our estimated demand equation explains the level of student performance in a school district, which is our indicator of education demand, as a function of voters' incomes, the price of education, and variables associated with voters' preferences. The dependant variable is the same measure of student performance that appears in the cost equation, namely a district's API.

One might wonder at the value of an education demand equation for California's relatively centralized education finance system. After all, if all the decisions are made in Sacramento, then local voters have no say in the final outcome. Even in California, however, local voters can influence the level of student performance in their district by taking advantage of the revenue sources over which they do have control, including the parcel tax, leases, fees, education foundation contributions, and so on. These revenue sources do not provide a great deal of money, but they can result in different amounts of revenue and different student performance levels in different districts.

Our approach is to estimate a demand equation that contains not only the standard demand variables, but also variables to measure the constraints imposed on voters in various districts by the unique features of the California education finance system. In effect, therefore, we are testing the view that local voters have some say despite the degree of centralization in California and the view that constraints in the California system alter the student performance that each district can obtain. Our hypotheses about the demand variables are summarized in Table 10.

Income Variables

Our measure of voter income is the 67^{th} percentile of the household income distribution in a school district. This percentile is selected to reflect the fact that 67 percent of the voters must agree before the main avenue for a revenue increase, the parcel tax, can be activated. This variable differs from the earning variable that appears in the expenditure equation because it reflects all sources of income, not just wages. Following previous studies, we expect that higher-income voters will demand higher levels of student performance.

Voters' demand for education is also influenced by the support their district receives from the state and the federal governments. We measure intergovernmental support as the sum of a district's revenue limit and categorical aid (both state and federal). Our precise specification is presented in Appendix C.

The incentives associated with local revenue sources other than the parcel tax are difficult to specify. Except in the case of contributions from foundations, which are discussed below, we suspect that voters know very little about these revenue sources and are not in a position to influence them. Moreover, we know of no way to identify the incentives that lead school districts to select one of these local revenue sources over another.

Private educational foundations play an unusually important role in California, but revenue from these foundations is endogenous in the sense that it might be influenced by unobserved school district traits that also influence school spending. Our approach, therefore, is to include a district's contributions from education foundations as an endogenous variable in our demand equation. As discussed in detail in Appendix A, we select the required instrumental variables for this procedure based on the analysis of private educational foundations in Brunner and Sonstelie (2003).

Price Variables

As discussed earlier, the appropriate tax price variable for California is based on the parcel tax, not the property tax. Following Brunner (2001), the tax price variable in our equations is the inverse of the number of parcels per pupil. A higher number of parcels results in a lower price, that is, in a greater ability to spread out the cost of education over many parcels, so this tax price variable should be negatively associated with student performance. Also as discussed earlier, most districts do not actually decide to levy a parcel tax, but the parcel tax still provides a clear measure of what it would cost voters to raise revenue beyond the limits imposed by Proposition 13—that is, of the tax price.

The parcel tax applies to parcel owners. In the case of rental housing, however, it might to some degree be shifted to the tenants. If so, a district's response to the parcel tax incentives might depend on whether or not it had a large share of renters. Because the parcel tax requires a 2/3 vote, renters could be influential if they constitute at least 1/3 of the population. As a result, our equations also determine whether the responsiveness of district to tax price is different when renters' incentives can influence the voting outcome.[23]

We also consider two other dimensions of the price of education, education costs and district efficiency. First, as is well known, the overall price of education depends not only on the tax system but also on the resources required to obtain a given increase in student performance. This level of resources varies across districts because some districts must pay more than others to attract teachers of a given quality and because some districts have higher concentrations of students who require additional resources to obtain the same performance, such as students with limited English proficiency. We calculate a cost index based on the results of our cost equation and include this cost index in our demand model.[24] A higher value for this cost index implies a higher price for education, so we expect the coefficient of this variable to be negative.

Our main cost index focuses on long-run cost factors. Short-run cost factors also might matter. As discussed earlier, enrollment changes affect short-run costs, and voters might respond to short-run costs in the same way they respond to long-run costs. Our earlier discussion also pointed out, however, that the class-size changes associated with short-run enrollment change may lead to changes in student performance. If so, an enrollment decline would increase short-run costs (and therefore might decrease demand) but would also increase student performance. Thus, the net impact of short-run enrollment change on student performance could be either positive or negative. We include a short-run cost index based on the enrollment change results from the cost model to determine which of these effects dominates.

The resources required to obtain an increase in student performance, which is the general definition of a price, also depend on the efficiency with which a school district operates. If voters know that their district is relatively inefficient, for example, they know that they will not receive a large return on the dollars they invest in education and they will substitute away from education toward other things. We calculate an efficiency index based on the results of our cost equation and include this index in our demand model.[25] Because higher efficiency corresponds to a lower price, and hence a higher demand, we expect the coefficient of this variable to be positive.

Other Demand Variables

Our demand equation also includes additional control variables, which are variables identifying the concentration of groups that may have an unusually high or unusually low demand for student performance on the API or that might be associated with unobserved cost factors. These variables are the percent of the district that is rural, and the percent of the students in the district who are African American, the share of the population that is school age (5 to 17 years old), and the share of the population made up of senior citizens.

Finally, we account for the fact that some of the intergovernmental support a district receives comes with strings attached and may therefore constrain voter' choices. To be specific, our demand equation includes the share of intergovernmental support that takes the form of categorical grants (a variable that also appeared in the cost equation). If the restrictions in categorical grants make it difficult for voters to reach the level of student performance they prefer, as measured by the API, then the estimated coefficient of this variable will have a negative sign.

A Comment on the Link Between Capital and Operating Spending

Although California requires a two-thirds vote to pass a parcel tax, it requires only a 55 percent vote to pass a property tax levy that supports capital spending (as of November 2000). This arrangement creates an incentive for voters who want to spend more on education (but who do not have enough support for a two-thirds vote) to pass a property tax levy for capital spending and use some of the proceeds to cover what would otherwise be treated as operating spending—or to reduce the need for transfers from operating funds to capital funds. We do not know the extent to which this type of arrangement is possible. The rules for using the funds from a levy of this type appear to be fairly strict, but some items that normally appear in an operating budget, such as laboratory equipment, might also qualify as capital spending when a new building is built.

To explore this possibility, we devised a model in which some of the funds raised for capital spending could be used for operating purposes and incorporated this model into our estimating equations. This model and estimating procedure is described in Appendix C. As it turns out, however, we found no empirical support for this type of operating-capital link so we do not present our results for this procedure in this report.

Estimates of the Impact of Incentives in the California Education Finance System

This section presents the results of our empirical analysis. We briefly describe our data and methodology, then discuss the results for our expenditure equation and our demand equation. Additional information is provided in Appendix A (Data Sources and Measures), Appendix B (Additional Tables), and Appendix C (Formal Model Description).

Data and Method

Our expenditure equations are estimated with data for most school districts in California in 2003-04 and 2004-05.[26] Data from the two years are pooled, a dummy variable for 2003-04 is included in the regression, and the standard errors are adjusted to account for the fact that there are two observations for each school district.

Details of our data collection procedures and summary statistics for our variables are presented in Appendix A. The dependent variables for our expenditure and demand equations are, respectively, per pupil operating spending minus transportation and a district's score on the API. We have also estimated our equations using the share of students judged proficient on the state math and English tests. The results, which are similar to the results using API, are in Appendix B.

Our expenditure equation is estimated with two-stage least squares (treating API as endogenous) and our demand model is also estimated with two-stage least squares (treating contributions from education foundations as endogenous). Our procedures for selecting instruments for inclusion in the two-stage least squares regressions are discussed in Appendix A.

Expenditure Results

The estimation results for our expenditure equation are presented in Table 11. The first panel of this table contains the result for the student performance variable, the API. This variable is highly significant and its positive sign indicates that higher student performance requires higher spending. Some scholars have argued that "money does not matter" in education. This result provides strong evidence that, despite all the restrictions associated with *Serrano* and Proposition 13, money does matter in California. Indeed, the estimated API coefficient implies that a 10 percent increase in API requires a 7.1 percent increase in spending per pupil, all else equal. This result is similar to results obtained in New York using a different index of student performance (Eom, Duncombe, and Yinger, 2005).

The second panel of this table presents results for the cost variables, namely teacher salaries (predicted teacher salaries) and student characteristics (log of enrollment, square of the log of enrollment, percent free lunch, percent English learners, percent with a severe handicap). The estimated coefficients for these variables all have the expected signs. The student disability variable is significant at the 8 percent level; all the other variables are significant at the 1 percent level.

The coefficient of the wage variable indicates that a 10 percent increase in the salary required to attract teachers of a given quality leads to an 7.1 percent increase in the spending required to maintain the same API. In other words, districts have limited ability to maintain performance while substituting other inputs for teachers.

The estimates for the variables describing the composition of the student body indicate the extra cost to achieve the same student performance associated with different student characteristics. We find that that the per pupil cost of education is 23 percent higher for a student from a poor family than for a student from a non-poor family (as measured by the free lunch variable); 32 percent higher for a student with limited English proficiency than for a student proficient in English; and 87 percent higher for a student with a severe handicap than for a student with no handicaps. The estimated impacts of poverty and limited English proficiency are significantly lower than in some other states. In New York, for example, the extra cost associated with a student from a poor family is 140 percent New York (Duncombe and Yinger, 2005a).[27] These results are not strictly comparable, however, because they are based on a different index of student performance.

The coefficients for the enrollment variables indicate a U-shaped relationship between cost per pupil and student enrollment. This type of relationship has been found in many previous studies. The minimum cost enrollment implied by these estimates is for a school district with about 36,500 pupils, which is larger than the comparable estimate for other states. The estimated scale effects are not very large, however; in fact, predicted per-pupil spending at the minimum-cost enrollment size is less than 5 percent lower than per-pupil spending at an enrollment of 5,000 students.[28]

We also find that educational costs decrease with a short-run (three-year) enrollment increase and increase with a short-run enrollment decline. These results support the view that school districts do not instantly adjust their student-teacher ratios in response to short-run enrollment changes, but instead accept the savings in per-pupil costs that arise when their student-teacher ratio temporarily goes up and pay the increase in these costs when this ratio temporarily declines.

School districts in California are either high-school districts, elementary-school districts, or unified districts. The final two rows in the first panel show that elementary districts have a lower cost per pupil and high school districts a higher cost per pupil than do unified districts, which are the omitted category in this regression. These findings probably reflect the added costs, such as science laboratories, that come with the increased specialization in high schools. Recall, however, that the API weights test scores from elementary, middle, and high-school grades. These estimated cost effects are valid for the API as it is defined, but they might be different for a different weighting scheme.

The third and fourth panels of Table 11 presents the results for the efficiency variables. As explained earlier, four of these variables are linked to efficiency through the incentives facing voters. As predicted by the analysis presented earlier, school district efficiency decreases with median earnings (a result that is significant at the 10 percent confidence level), the number of parcels, the share of recent migrants, and the change in the district's revenue limit. These results are consistent with a strong role for voter monitoring. Voters are less likely to monitor if they have a high opportunity cost on their time or demand a broad range of educational services beyond API, if they have a low tax price (as measured by the number of parcels), if they are recent migrants into a county, and if they are not used to living in a well funded district.

Another four of these variables are linked to efficiency through the incentives facing school officials. We find that school district efficiency decreases with an increase in the district's revenue limit, which is consistent with the view that school officials feel pressure to maintain student performance in the face of declining revenues. We cannot determine, however, whether this pressure comes from the school officials themselves or through monitoring by voters.

We also find that school district efficiency decreases with the share of state aid that comes in the form of categorical grants. This result indicates that the restrictions in categorical aid programs are a barrier to efficiency, not a way to promote it. In interpreting this result, it is important to re-state that efficiency in this regression is defined in relation to the API. The lesson of this result is that lawmakers obtain a larger boost in the API for their aid dollars, if they provide those dollars in the form of unrestricted aid instead of categorical aid.

An alternative interpretation of this result is that it captures the impact of a cost factor or factors that are correlated with categorical aid but omitted from the explanatory variables in our regression. One might think, for example, that this result could reflect the presence of students with special needs, who do receive some categorical grants. In fact, however, we exclude spending on special education from our dependant variable and control for the share of students with severe disabilities.[29]

In short, the impact of the categorical aid share on educational spending does not reflect a link between categorical aid and the relatively high costs of students with special needs. In principle, this categorical aid might be capturing the effect of some other cost factor we do not observe, but we find nothing in the categorical aid formulas in California or in the estimated cost functions from other states to suggest that this is true. We conclude that the result for the categorical aid variable in Table 11 is very likely to reflect the impact of categorical aid on school district efficiency.

Demand Results

Table 12 presents the results for our first demand equation. By way of introduction, these results indicate that the demand for student performance in California responds to many of the same incentives as student performance in other states and to some incentives that are unique to California. Despite all the restrictions imposed by *Serrano* and Proposition 13, in other words, voters find a way to move student performance toward their preferred level, given their funding options.

Income Variables

The first panel of this table presents results for income variables. Like previous studies, we find that household income has a significant impact on demand. The income variable is the 67th percentile of the household income distribution, but we obtain similar results using median income. We find a highly significant income elasticity of 0.13, that is, a 1.0 percent increase in income results in a 0.13 percent increase in desired student performance, as measured by the API. The small value for this income elasticity is consistent with previous studies for other states. A recent study based on a test-score index for New York, for example, finds an income elasticity of 0.05 (Eom, Duncombe, and Yinger, 2005).

We also find that voters consider intergovernmental support to be another form of income, with a strong impact on desired student performance. This is consistent with previous studies. Moreover, we find, also like previous studies, that an increase in state aid has a larger impact on desired student performance than a comparable increase in income. This is called the flypaper effect. Our estimate of the flypaper effect is 2.71, that is, an increase in aid has a 1.71 percent larger impact on desired student performance than a comparable increase in income. This estimate is on the low end of estimates in the literature, but it is also not fully comparable to previous estimates because it applies to all intergovernmental support, including state-determined property tax payments, not just to state aid.

To account for the role of education foundations, we include a district's contributions from education foundations (from IRS records) as an endogenous component of income, broadly defined.[30] It is endogenous in the sense that characteristics of the district we cannot observe may increase both the role of foundations and the demand for student performance. Indeed, foundation giving may be an expression of underlying demand. Because we treat foundation giving as endogenous, our estimates indicate whether a school district in which education foundations succeed in raising a relatively large amount of money per pupil have a higher demand for education than other districts that are comparable on both observable and unobservable characteristics.

We find, not surprisingly, that contributions from education foundations do indeed raise the desired level of student performance in a district. In fact, the flypaper effect in this case is huge. A $1 contribution from an education foundation has the same impact on desired student performance as $539 of private income (and as $199 of state support). The high estimated impact of foundation revenue on demand appears to reflect the fact that, from a voter's point of view, foundation donations are already designated for education, whereas private income must support all types of consumer spending (and state support opens the door to lower local revenue). In any case, this result shows that when the conditions are right for an education foundation to succeed, voters will take advantage of the added funding to demand a higher level of student performance.

Price Variables

The second panel of Table 12 presents results for price variables. The tax price associated with the parcel tax, as measured by the inverse of the number of parcels per pupil, is highly significant. The estimated price elasticities is quite small, namely, -0.04; that is, a 1 percent increase in tax price leads to a 0.04 percent decline in demand for API. This result is consistent with previous studies, most of which find small price elasticities. For example, a recent estimate for New York, which is based on the tax price associated with the property tax, is -0.08 (Eom, Duncombe, and Yinger, 2005). Our estimate for California indicates that voters do, indeed, respond to the incentives created by the parcel tax, but this responses is small in magnitude.

The second row in this panel tests the hypothesis that the response to this tax price is different for renters and owners. The coefficient of the renter variable is close to zero and not close to statistical significance. Thus, we cannot reject the view that the presence of renters does not alter a community's response to the parcel tax.

The other two components of tax price, broadly defined, are educational costs and school district efficiency. The coefficients for our cost and efficiency indexes are presented in the next three rows. The standard long-run cost index, which summarizes the impact of opportunity wages and student characteristics on education costs, has the expected sign and is statistically significant. To be specific, the price elasticity associated with the cost index is -0.33, which is similar to the elasticity in previous studies. This result indicates that voters are well aware of the high costs of attracting teachers to some districts and of the high costs of educating disadvantaged students and respond to these high costs by cutting back significantly on the level of student performance they prefer.

As discussed earlier, short-run enrollment changes could, in principle, affect costs or student performance. We find, however, that short-run enrollment change does not have a significant impact on the demand for API. Indeed, the estimated coefficient of the short-run enrollment change variable is close to zero. Thus we find no sign that short-run enrollment changes affect student performance. This result also indicates either that voters do not perceive the cost impact of short-run enrollment changes or that they do not respond to these impacts because they do not expect them to persist.

The final row in this panel presents results for our school-district efficiency index. We find, as expected, that voters respond to a relatively high efficiency level by demanding a higher level of student performance. The price elasticity associated with the efficiency index is 0.11. This result indicates that, to some degree, voters can determine whether their district is inefficient, understand that inefficiency raises the price of education, and cut back their demand for education in the presence of inefficiency. This is smaller than equivalent elasticities estimated for New York (Duncombe and Yinger, 2001; Eom, Duncombe and Yinger, 2005).

Other Variables

The last panels of Table 12 contains results for the other variables in our demand model. The first row in this panel refers to our measure of the role of categorical aid, namely categorical aid as a share of intergovernmental support. We find that student performance is lower in districts that receive a relatively higher share of their intergovernmental support in the form of categorical grants. This result controls for demand determinants, including school district efficiency. Because the categorical share variable also affects school district efficiency, this variable has a direct impact on API and an indirect effect through efficiency. These two effects work in the same direction.

The result for the categorical share variable in the demand equation has two possible interpretations. The first is that voters have different responses to different components of school-district efficiency. More specifically, voters may have better information about or respond more strongly to efficiency differences associated with differences in the categorical grant share than to those associated with, say, differences in tax price. Under this interpretation, therefore, the result for the categorical share variable simply corrects for the stronger response associated with this variable.

The second possible interpretation is that the restrictions in categorical grant programs prevent voters from reaching their desired level of API, even after accounting for the efficiency consequences of these restrictions. Consider, for example, two districts that have exactly the same resources, costs, efficiency, but different categorical aid shares. Because categorical aid influences efficiency, this situation can only arise if the districts also differ on some other efficiency determinant, such as their migration rates or the percent change in their revenue limits. In any case, these two districts have the same demand for API, despite the difference in their categorical aid shares. The result for the categorical aid share variable in Table 12 indicates that the API outcomes in these two districts are not the same despite their equal demands. In other words, the restrictions in categorical grants programs prevent the district from reaching the API level that voters prefer.

Regardless of which interpretation is correct, this result indicates that the State of California could increase API levels at no cost to the state either by re-designing categorical aid programs so that they are not so restrictive or by transforming categorical aid programs into general-purpose aid.

The last seven rows of Table 12 presents results for other control variables. First, we find that the demand for API is lower in districts with a higher concentration of African Americans and higher in a rural than in an urban district. These results could reflect either cost or preference factors. Because of the legacy of discrimination in this country, school districts with a high concentration of African Americans might have higher educational costs based on factors we do not observe, such as a high concentration of single-parent families.[31] If so, these higher costs could lead to lower demand. Alternatively, these districts might have a stronger preference than other districts for educational outcomes other than the API. Similarly, rural districts might have lower costs (and hence higher demand) than urban districts based on cost factors we cannot observe or they might have a systematically higher demand for API compared to other measures of student performance.

The variables indicating the age distribution of the population in the school district are included to capture differences in preferences across districts. A high concentration of school age children suggests that a district has many parents, who are likely to demand relatively high levels of student performance. Similarly, several previous studies have found that elderly voters have a relatively low demand for student performance, because they no longer have children in public schools. The results in Tables 12 indicate, however, that demand is lower in districts with a high concentration of school-aged children and higher in a district with a high concentration of elderly residents. These effects are not large, but they are statistically significant, although the effect of elderly residents is only significant at the 9 percent level. These effects are the opposite of what one would expect on the basis of preferences. An alternative interpretation is that they are capturing cost effects. The cost of education per voter is higher when many children are present, and voters will respond to this relatively high cost by demanding a relatively low level of education, all else equal. Similarly, a high concentration of elderly residents lowers the cost of education per voter. Our results suggest that these cost effects are stronger than the preference effects we expected to find.

We also find that student performance is lower in high-school districts than in unified or elementary school districts. Voters' response to the relatively high cost of high schools is already captured by our cost index, so this variable indicates that the demand for high-school student performance is lower than the demand for student performance in lower grades even after cost effects are considered. Recall that the API is a weighted average of student test scores in high school and other grades. This result indicates, therefore, that the weight voters place on high school performance is lower than the high-school weights that go into the API.

Conclusions and Policy Implications

This section highlights the key conclusions from our analysis and discusses their policy implications. We believe that our approach makes the best use of available information in analyzing California's education finance system, but as emphasized throughout this report, the estimation of expenditure and demand equations cannot fully resolve some issues, such as the extent to which student performance is influenced by voter monitoring. In addition, school district efficiency can only be defined relative to some measure of student performance. We focus on the API as a measure of student performance, but our results also hold when student performance is measured by proficiency rates in math and reading.

The discussion in this section follows the organization of the report. We first discuss the findings from our expenditure equation and then turn to the demand equation. This discussion is organized around the key lessons from our results.

Lesson 1: Money Matters

Our expenditure function finds a strong, statistically significant link between school district spending and student performance. All else equal, a 7.1 percent increase in spending is required to obtain a 10 percent increase in student performance as measured by the API. This lesson is central to any debate about education finance reform in California. Although many other factors matter as well, school districts cannot be expected to meet performance standards unless they have sufficient funds.

The implications of this result are pursued in Table 13, which shows the funding needed to close the existing performance gaps between high- and low-poverty school districts.[32] In this table, the poorest 10 percent of districts are called high-poverty and the least-poor 10 percent are called low-poverty. As shown by the first panel of this table, the current API gaps between high- and low-poverty schools are quite large, namely 27 to 34 percent, depending on enrollment size. These gaps exist despite the fact that high-poverty schools spend more per pupil than low-poverty schools. As discussed earlier, the modest tilting of categorical aid toward high-poverty schools is not sufficient to offset their lower performance.

The second panel of Table 13 indicates the increase in spending required in the average high-poverty school to reach the performance level of low-poverty schools in the same enrollment class. These estimates, which are based on the results from our estimated cost equation, assume that districts are able to maintain their current level of efficiency. We find that spending in high-poverty districts would have to increase between 18 and 23 percent, again depending on enrollment class, to bring them up to the performance levels in low-poverty districts. In dollar terms, spending per pupil would have to increase by $1,398 per pupil in the highest enrollment class and by $1,802 per pupil in the lowest enrollment class. (The implications of these changes for the state aid budget are explored in Appendix D.) As shown in the last row of this panel, spending increases of this magnitude would dramatically increase the overall spending gaps between high- and low-poverty districts.

The third panel presents an alternative set of calculations based on the assumption that the extra spending for high-poverty districts is provided exclusively through categorical grants. As discussed earlier, existing categorical grants reduce school-district efficiency, so any expansion in these grants will reduce school efficiency even more. We assume that any new categorical grants would have the same impact on efficiency as current categorical grants. As a result, using categorical grants to bring high-poverty districts up to the spending level needed for them to reach the same performance as low-poverty districts would significantly lower the efficiency of high-poverty district, and thus would increase the spending needed to meet any student performance target. In fact, we find that this type of efficiency response would almost double the funds needed to eliminate poverty-based student performance gaps.

Lesson 2: Student Characteristics and Labor Market Conditions Affect Educational Costs

Our expenditure equation results reveal that in California, as in other states, the cost of education is higher in districts with a higher concentration of students from poor families or students who are English learners. We estimate that the cost of obtaining a given level of student performance is 23 percent higher for a poor than for a non-poor child, as measured by whether the child is eligible for a free lunch, and 32 percent higher for an English learner than for a student who is fluent in English. These cost differences are even higher when a Census poverty measure is used.

In addition, we find that school districts located in relatively high-wage labor markets must pay more to obtain the same level of student performance, presumably because they must pay more than other districts to attract teachers of any given quality. Indeed, a 10 percent increase in the opportunity wage leads to an 7.1 percent increase in school costs.

We also find different costs for different types of districts. Educational cost per pupil is 7 percent higher in high school districts and 17 percent lower in elementary school districts than in unified districts, all else equal.

The role of educational costs was not well understood at the time of the *Serrano* decisions, so the *Serrano* limits on variation in revenue limits across districts do not address this issue. As discussed earlier, California's categorical aid programs partially offset the high costs associated with a concentration of student disadvantages, but do not come close to a full accounting for these costs. These programs also do not adequately account for across-district variation in the wages needed to attract high-quality teachers. As a result, districts with high concentrations of poor students or of English learners and districts in high-wage labor markets do not currently receive enough funds to reach the same API targets as other districts.

This situation is fundamentally unfair. We recommend that California consider putting cost adjustments for both student disadvantages and the wage environment into its revenue-limit calculations.[33] An alternative approach would be a drastic reform in California's categorical aid programs so that they are more compensatory and recognize the wage costs in a school district's labor market. If history is any guide, however, individual categorical aid programs tend to be small and to have limited objectives; as a result, the categorical aid route is unlikely to provide the across-the-board cost adjustments that are required to give every district the resources it needs to meet the state's API target.

Lesson 3. The Parcel Tax Affects School-District Efficiency, Presumably by Affecting Voters' Incentives to Monitor School Officials, and It Affects Voters' Demand for Student Performance

The parcel tax is the most visible and most predictable local revenue source other than the property tax. Our results are consistent with the view that voters understand how the parcel tax works and respond to the incentives it creates.

First, the parcel tax affects voters' incentives to monitor school officials. Voters in districts with relatively few parcels per pupil, which implies a high tax price, have an incentive to monitor school officials to keep them efficient and lower the need for parcel tax revenue. Similarly, voters in districts with many parcels per pupil might not mind a parcel tax so much, because their share of the tax will be small, and they have less incentive to monitor for efficiency. The results of our expenditure equation support this view.

Second, the parcel tax alters the tax price of education, as measured by the API, and voters in districts with a high tax price (i.e., with few parcels per pupil) demand lower levels of the API than voters in districts with a low tax price (i.e., with many parcels per pupil). This price elasticity in our demand equation is fairly small, about -0.04, but it is highly significant statistically.

These results demonstrate that across-district variation in student performance in a state depends on the financing tools that are given to school districts. If California still had a property tax controlled by school districts, the tax price would equal the ratio of the median residential assessed value to total assessed value per pupil. Districts with high values of this ratio would be more efficient and demand lower levels of student performance than districts with low values, all else equal. The parcel tax shifts these incentives so that they simply depend on the number of parcels per pupil. Districts with few parcels are more efficient and demand lower levels of student performance.

A complete comparison of a property tax and a parcel tax is beyond the scope of this report, but these results show that a parcel tax has many of the same features as a property tax. Like a property tax, a parcel tax induces some districts to be more efficient than others and leads to a higher demand for student performance in places with a relatively large number of parcels per pupil. As pointed out by Brunner (2001), however, the tax prices with a parcel tax are considerably higher, on average, than the tax prices with a property tax. Compared to a property tax, therefore, a parcel tax will tend to result in higher efficiency and lower student performance. Moreover, the distribution of these impacts across districts is quite different with the two taxes, because one is based on assessed value and the other on the number of parcels and the correlation between these two variables is low, namely, 0.14.

Lesson 4. Existing Categorical Aid Programs in California Undermine School District Efficiency and Pull Voters from their Preferred Level of Student Performance

Our expenditure equation provides clear evidence that an increase in categorical aid as a share of state support lowers the efficiency with which a district provides student performance as measured by the API. A district that received all its aid through categorical grants would spend about 50 percent more to achieve the same API than a district with the same amount of aid in the form of unrestricted grants. We cannot totally rule out the possibility that this result reflects some cost factor that is omitted from our expenditure equation. We show, however, that this result does not reflect the costs associated with special education, and we have no evidence from California or other states to suggest that our expenditure equation omits any other important cost factors.

In addition, our demand equation indicates that the student performance level is lower in districts that receive a relatively higher share of their state support in categorical grants, controlling for school district efficiency and other factors. As discussed earlier, this result might indicate that voters are more responsive to inefficiency caused by categorical grants than to inefficiency from other sources or it might indicate that the restrictions imposed by categorical grant programs prevent voters from reaching the level of API they prefer. In either case, voters in districts with a high concentration of categorical grants end up with a lower level of API than voters in other districts, all else equal.

Overall, these results imply that the categorical aid programs in California are not, as a whole, an effective way to boost student performance as measured by API. Because API is the focus of California's accountability system, these results indicate that California's categorical grants and accountability system are working at cross purposes. To the extent that lawmakers want to promote high student performance on the API, they should either shift away from categorical toward unrestricted grants or else revise the state's categorical grant programs so they do not undermine this objective.

Lesson 5. The Legacy of the Pre-Serrano Education Finance System Still Lingers in School District Efficiency

One somewhat surprising result is that the *Serrano* legacy still reverberates in the distribution of student performance across districts in California. Because of the *Serrano* decisions, the revenue limits were adjusted over time to reduce variation across districts. We find that districts with declines in their revenue limits over time, which are relatively wealthy and high-performing districts, tend to have lower costs per pupil, controlling for student performance, than districts with increases in their revenue limit over time.

One possible interpretation of this result is that principals, other school supervisors, and parents in these districts have come to expect high performance and engage in relatively intensive monitoring. Another possible interpretation is that districts with declines in their revenue limits over time tend to have favorable cost characteristics that we cannot observe. In either case, some portion of the disparities in student performance that existed before *Serrano* would be preserved even when differences in revenue limits were fully eliminated.

Lesson 6. All Else Equal, Higher Household Mobility Is Associated with Lower Student Performance.

Our expenditure equation implies that, all else equal, student performance is lower in counties that have a high share of new residents. This result could be related to efficiency or to educational costs or to some combination of the two. The efficiency effect would arise if new residents are less likely than long-time residents to engage in the type of monitoring that encourages school officials to be efficient. New residents are less likely, for example, to be well connected in the community and to participate in community organizations, such as the PTA. The cost effect would arise if the children of new residents require extra services that school districts need to pay for. These extra services cannot be related to language or poverty, because we control for the share of students who are English learners and the share of students eligible for a free lunch. They also cannot be due to changes in student enrollment, because our regressions control for them, too. We do not know of other costs that could explain the magnitude of this effect so we suspect, but cannot prove, that it mainly reflects the role of monitoring.

Lesson 7. Enrollment Change Has Short-Run Cost Consequences

In the short run, defined as a three-year period in our analysis, an increase in enrollment is associated with a small decline in spending per pupil and a decrease in enrollment is associated with a large increase in spending per pupil, holding constant student performance. These results control for student enrollment, so they indicate that two districts with the same current enrollment and the same student performance will have different costs if one of these districts has experienced a recent enrollment change and the other has not.

These effects appear to reflect what happens to costs when the number of pupils changes but the number of classrooms and teachers does not. In the short run, adding new students to existing classrooms has little impact on the budget and therefore lowers spending per pupil. Similarly, taking students out of existing classrooms causes spending per pupil to rise.

We also find that voters do not lower their demand for student performance in response to these short-run education cost increases, either because they are not perceived or because they are not expected to persist.

Lesson 8. School Districts with Conditions that Favor Education Foundations have Higher Levels of Student Performance

Education foundations raise funding for public schools in many districts and provide a significant amount of funding in a few. The impact of education foundations on the demand for student performance is difficult to determine, however, because the presence of a foundation may simply reflect the presence of factors that boost demand but that researchers cannot observe. We explore the role of education foundations by including foundation contributions to a school district as an explanatory variable in our demand equation and by treating this variable as endogenous. In principle, this approach removes the impact of unobserved factors that might influence both demand and contributions, so that our results can be interpreted as the impact on the demand for student performance of exogenous conditions that lead to foundation giving.

This analysis reveals that when factors supporting successful education foundations are present, the contributions of these foundations have a strong impact on the demand for student performance. Districts in which conditions are right for foundations to succeed therefore end up with higher levels of student performance than other districts, all else equal.

Lesson 9. Despite the Centralization in the California Education Finance System, Student Performance Outcomes Still Respond to Voter Demand

In a totally centralized system, variation in student performance across districts would be determined solely by the decisions of state-level decision makers and there would be no room for the preferences of local voters. Our demand equation shows that California is not nearly this centralized. As in other states, the level of student performance is higher in districts with higher incomes and, as indicated earlier, in districts with lower tax prices (as defined by the parcel tax). The income and price elasticities are at the low end of previous estimates, which may indicate that voter demand is somewhat constrained in California, but student performance outcomes in California clearly reflect the key determinants of voter demand.

These results come from a demand equation that controls for school district efficiency, state support, and federal grants, so they appear to reflect the ability of school districts to raise additional revenue through the parcel tax and other sources if their voters demand higher levels of API. In other words, districts with higher incomes and lower tax prices are more likely than other districts to make use of the parcel tax and other local revenue sources over which they have control and to use the added funds to reach the higher levels of the API that they demand.

These results shed light on one of the education finance issues discussed in the introduction, namely, whether to limit supplementation of state funds by school districts. The current system in California limits, but does not prohibit local supplementation. Our demand results show that there is enough local control in the California system so that API outcomes are responsive to the determinants of voter demand, such as income and tax price. On the one hand, further limitations on supplementation would undoubtedly be controversial because they would pull voters farther from their preferred levels of student performance. On the other hand, the supplementation currently available to voters results in higher student performance in higher-income districts, even after controlling for state support. As a result, this supplementation violates the spirit if not the letter of the *Serrano* decisions.

Thus, California, like every other state, faces a trade-off between local control and the fairness of the distribution of student performance across districts. In our judgment, it would be a mistake for California to move toward more equality of outcomes by further restricting local control. This step would not only be controversial but would also do little to address the main fairness problem in California, which is that districts with a relatively high concentration of disadvantaged students or in a relatively high wage environment do not currently receive enough state support to reach even a minimal student performance target. This fairness problem can be addressed by incorporating educational costs into each district's revenue limit. This change would make sure every district has the resources it needs to reach a given student performance target.

ENDNOTES

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[1] A complex set of constitutional provisions sets the minimum amount of state funding to support revenue limits, but these provisions do not determine the way this funding is allocated. See Goldfinger (2006).

[2] District revenue limits are calculated in two steps. First, a complicated set of amendments to the California state constitution determines how much money is available for elementary and secondary education. Under most circumstances, the amount of money per pupil equals the amount from the previous year increased by an inflation factor (although the precise inflation factor depends on various circumstances). If state tax revenue is growing sufficiently fast, however, the amount of money available equals 39.032 percent of state general fund taxes. Second, another complicated formula determines the revenue limit for each district based on previous spending, an inflation factor, and various other variables. The set of district revenue limits is adjusted upward or downward to add up to the total amount of money available from the first step. See Goldfinger (2006).

[3] The results are similar with the other comparison in the table, namely the 75th percentile divided by the 25th percentile. A comparison of pupil-weighted spending indicates that these two states have about the same total revenue variation across districts, but California has much more variation in state categorical aid and New York has much more variation in local property taxes and in federal aid.

[4] In addition, five states without a foundation formula also have compensatory categorical aid (Huang, 2004, Table B.4).

[5] A well-known theorem in public finance is that categorical aid is no different from unrestricted aid if it provides a small amount of money relative to the amount that the district would spend in that category absent the aid. Categorical aid is different from unrestricted aid, however, when it provides more money for a category than the district would otherwise spend and thereby increases spending in that category. This theorem is not widely known among lawmakers, however, and many small categorical aid programs add red tape without altering school districts' spending patterns.

[6] We have recommended an alternative approach, namely, for the state to provide both more unrestricted aid and more assistance in identifying the promising education and management programs and then to hold school districts accountable for student performance. See Duncombe and Yinger (2004). An application of this approach to California would require the state to give up some of its direct control over school district budgets and then take more responsibility for understanding and conducting education research. A more centralized version of this approach, in which the state requires certain programs (instead of simply recommending them) is proposed by Grubb, Goe, and Huerta (2004).

[7] The Education Trust calculations account for wage differences across districts and the extra costs of students with special needs. In addition these calculations assume that a student from a poor family (as indicated by eligibility for a free or reduced-price lunch) costs 40 percent more to educate than a student from a non-poor family. See Education Trust (2005).

[8] An alternative calculation is provided by Rose et al. (2003), who estimate the impact of poverty on total revenue per pupil in 2001-2002, including federal aid but excluding special education. They find that the revenue for a poor student exceeds the revenue for a non-poor student by 18.0 percent in unified districts and by 7.4 percent in elementary districts, but falls short of the

revenue for a non-poor student by 4.2 percent in high-school districts. Even in unified districts, this extra revenue for poor students falls far short of the added costs of educating poor students as estimated by the Education Trust (2005), namely, 40 percent, or as estimated by scholars for other states. In the case of New York, for example, Duncombe and Yinger (2005a) estimate that the cost of a poor student exceeds the cost of a non-poor student by over 100 percent.

[9] State general revenue in California includes all revenue received by the state except intergovernmental revenue (which largely comes from the federal government), utility revenue, and insurance trust revenue. See U.S. Census (2006b).

[10] Individual and corporate income taxes go together except in Alaska and Florida, which have corporate income taxes without individual income taxes.

[11] For a clear application of these principles to state revenue systems, see Fischer (2006).

[12] Under current federal law, a taxpayer who itemizes deductions can deduct either state income tax payments or state sales tax payments but not both. For the vast majority of taxpayers in California, deducting the income tax is the better choice. As a result only a tiny share of any increase in the sales tax would be exported through this route.

[13] The point here is that reliance on a mix of broad-based taxes, including the sales tax, is widely seen as critical to minimize revenue volatility. This volatility is also influenced, of course, by the specific provisions of an income or sales tax, but an evaluation of the provisions in the income and sales taxes in California is beyond the scope of this report,

[14] For a discussion of possible local revenue sources for California school districts, see Loeb (2001).

[15] Using a data base for all parcel tax votes since the parcel tax was first authorized, we find that the parcel tax is levied at a fixed rate per parcel in 93.8 percent of the cases. Other designs that

appear in a few districts are separate rates for residential and commercial parcels, separate rates for single-unit and multi-unit parcels, and rates based on a parcel's square footage. The latter approach, which appears in 4 percent of the parcel taxes, blends the design of a standard parcel tax and a property tax. We are grateful to Eric Brunner of Quinnipiac University for proving us with this data base.

[16] Full evaluations of the incidence of the property tax and the parcel tax, which are beyond the scope of this report, would have to account for the possibility that firms may be able to shift some of the burden of the property tax to consumers or workers and the owners of rental property may be able to shift some of the burden to tenants. See, for example, Fischer (2006). A full evaluation would also have to account for capitalization, that is, for the impact of property taxes on house values. See Ross and Yinger (1999). With full capitalization, the burden of increases in property tax rates or parcel taxes fall entirely on property owners at the time the increase is announced. Accounting for these possibilities would not alter the conclusion that a parcel tax is far more regressive than a property tax.

[17] Hamilton (1975) argues that the property tax is not distortionary because it serves as the price of access to a certain package of public services. This argument is based on strong assumptions and its implications are rejected by the evidence. See Ross and Yinger (1999). Some people also have argued that a head tax, which is similar to a parcel tax, is nondistortionary because it, too, serves as a price of entry into a community. This argument also has been refuted. See Wildasin (1986).

[18] Much of this literature is reviewed in Yinger (2004). Other citations are provided below.

[19] Education cost functions have been estimated for New York (Duncombe and Yinger, 2000, 2005a; Duncombe, Lukemeyer, and Yinger, 2003), Arizona (Downes and Pogue, 1994), Illinois

(Imazeki, 2001), Texas (Imazeki & Reschovsky, 2004a, 2004b; Gronberg, Jansen, Taylor & Booker, 2004), and Wisconsin (Reschovsky & Imazeki, 1998, 2001).

[20] Both the API and our alternative measure of student performance, the percent reaching proficiency, are described in more detail in Appendix A.

[21] Our procedure removes all spending labeled "special education," but may not remove some spending items given a different label, such as special education spending run through county offices of education. Because school districts may have some influence over the number of students placed in some categories, a full analysis of the costs of students with disabilities would require an investigation into the procedures used to classify students with disabilities. We avoid this problem by using the share of students with severe disabilities, which is a classification over which school district officials are likely to have little or no control.

[22] In principle, the behavior of school district officials might attract students or drive them away. We have not explored this possibility here but suspect that it accounts for a small fraction of observed enrollment change. In fact, the largest enrollment declines we observe (all in percentage form) are in rural districts where economic circumstances probably account for student movement. In addition, some districts may do a better job responding to enrollment change than others, which would be a sign of efficiency, but we cannot observe differences of this type.

[23] The precise specification of this variable is given in Appendix A.

[24] Our method for calculating this index is described in Appendix A.

[25] Our efficiency index assumes that all unexplained variation in spending across districts reflects variation in efficiency, not in costs. We cannot test this assumption, but we regard this as conservative in the sense that it only associates variation with costs, which are supposed to be

outside a district's control, when an explicit link to a cost factor can be identified. In any case, the distinction between costs and efficiency is not central to our demand model, as both higher costs and higher inefficiency lead to lower demand. The details of our calculations are presented in Appendix A.

[26] Because of missing data, the cost and demand models were estimated with between 928 and 936 school districts, which represent more than 95 percent of the total number of school districts in California in 2004 and 2005.

[27] We also estimate models using the 2000 child poverty rate provided by the Census instead of the free lunch variable. The Census variable is probably more accurate, but it is out of date and does not vary across time. The estimated extra costs for a student from a poor family is about 55 percent in this case. Using the Census poverty measure also raises the estimated extra cost of an English learner to about 45 percent.

[28] We also estimated models that included the cubic of the log of enrollment or a number of enrollment classes. These approaches led to similar results for economies of size and for the other variables in the cost model.

[29] We obtain a similar result for the categorical aid variable when special education spending is included in the dependent variable. This probably reflects two features of the California system. First, as of 1998-99, when AB62 was passed, California's categorical aid programs for special education are based on a formula in which reimbursement is "not linked to pupils served or services provided," but is instead based on an average share of students in various categories as reported by the U.S. Census (Goldfinger, 2006, p. 103). This change was implemented to ensure that "there are not benefits driving placements" (p. 127). Second, we find only a small, insignificant correlation between our categorical aid variable and the share of students in various

special education categories, as reported by the State of California. The correlation between our categorical aid variable and various categories of students with special needs, from both the California and Census data, ranges between -0.20 and 0.20, with most correlations close to zero. Moreover, the correlation between our percent categorical variable and the per pupil special education aid variable from the Census is only 0.24.

[30] More formally, we estimate this model with two-stage least squares. We examined a variety of variables as potential instruments, which are discussed in Appendix A. The final list of instruments that passed all the relevant instrument tests is presented in Appendix Tables A-1 and A-2 and the first-stage estimates are presented in Appendix Tables B-6 and B-7.

[31] Some previous cost studies have found that educational costs increase with the share of families that have a single parent, even after controlling for the poverty rate. See Duncombe and Yinger (2001).

[32] The results in Table 13 are simple averages across districts. We obtain similar results for a version of these calculations based on pupil-weighted averages.

[33] As discussed earlier, we also find apparent cost differences based on the grades covered by a school district. We do not know if current aid formulas adequately compensate districts for cost-differences of this type. If not, a strong case could be made for including these cost differences in aid formulas, as well.

Table 1: Education Funding by Level of Government, 2003-4

	California	United States	Big States	West Coast
State %	54.48%	47.14%	39.21%	57.24%
Local %	34.14%	43.94%	51.85%	33.92%
Federal %	11.38%	8.93%	8.94%	8.84%

Source: U.S. Census (2006a). Big states are Illinois, Florida, New York, Pennsylvania, and Texas; West Coast is Washington and Oregon. Local percentage includes all tax revenue collected locally, even if the rate is set by the state.

Table 2: Decomposition of State Aid to Education, 2003-4

	California	United States	Big States	West Coast
Formula %	52.65%	67.98%	57.95%	84.12%
Comp. %	4.26%	2.20%	0.15%	0.73%
Sp. Ed. %	8.58%	6.54%	10.37%	4.11%
Voc %	0.02%	0.39%	0.71%	0.00%
Transp. %	1.84%	1.76%	3.95%	2.28%
Other %	31.17%	17.71%	21.98%	8.76%
Payment %	1.48%	3.41%	4.88%	0.00%
Total	100.00%	100.00%	100.00%	100.00%

Source: U.S. Census (2006a). Big states are Illinois, Florida, New York, Pennsylvania, and Texas; West Coast is Washington and Oregon.
Formula = Unrestricted, formula-driven aid; Comp. = Compensatory categorical aid for "at-risk" students; Sp. Ed.= Categorical aid for special education; Voc.= Categorical aid for vocational education; Transp. = Categorical aid for transportation; Other = Other categorical aid; Payment = Other payments, mainly payments for teacher pensions.

Table 3. Distribution of Per Pupil School District Revenue by Level of Government in California and New York (2003)

	Total Revenue	State Revenue	State Formula Aid	State Categorical Aid	Federal Revenue	Local Revenue	Property Taxes	State Formula Aid + Property Taxes
California:								
Ratio of 95th to 5th	3.7	6.9	23.1	7.5	28.8	9.5	14.7	2.1
Ratio of 75th to 25th	1.4	1.6	1.8	1.7	2.7	2.3	2.4	1.2
95th percentile	$24,889	$13,174	$5,429	$5,157	$5,160	$12,283	$6,333	$8,871
75th percentile	$10,683	$6,122	$3,591	$1,543	$1,080	$4,739	$3,089	$5,521
Median	$8,762	$4,871	$3,008	$1,160	$690	$3,070	$1,924	$4,835
25th percentile	$7,721	$3,794	$2,023	$904	$404	$2,079	$1,287	$4,528
5th percentile	$6,770	$1,921	$235	$686	$179	$1,290	$430	$4,270
New York:								
Ratio of 95th to 5th	2.6	4.7	14.3	2.6	6.9	9.6	11.6	2.8
Ratio of 75th to 25th	1.3	1.8	2.6	1.4	2.5	2.6	2.8	1.4
95th percentile	$28,275	$10,596	$7,438	$3,575	$1,452	$22,533	$17,611	$18,662
75th percentile	$15,850	$8,479	$5,646	$2,750	$838	$9,324	$8,189	$11,366
Median	$13,530	$6,770	$4,073	$2,384	$568	$5,368	$4,354	$9,175
25th percentile	$12,078	$4,629	$2,208	$1,995	$341	$3,614	$2,918	$8,122
5th percentile	$10,776	$2,242	$520	$1,363	$211	$2,345	$1,521	$6,774
California median as percent of New York	64.8%	72.0%	73.8%	48.7%	121.4%	57.2%	44.2%	52.7%

Source: U.S. Department of Education, School District Finance Survey, 2002-03. This information can be accessed on the web at nces.ed.gov/ccd/f33agency.asp.

Table 4. Composition of "State-Level" Revenue for Schools In California, 1994-95 to 2002-2003

	Categorical Aid	Unrestricted Funds	
		Operating Aid	Property Taxes
1994-95	20.30%	41.93%	37.77%
1995-96	21.40%	43.32%	35.29%
1996-97	24.60%	44.01%	31.39%
1997-98	24.90%	44.50%	30.60%
1998-99	27.05%	42.82%	30.13%
1999-2000	28.55%	41.44%	30.00%
2000-01	29.57%	41.75%	28.68%
2001-02	28.13%	41.87%	30.00%
2002-03	25.79%	41.75%	32.46%

Source: U.S. Department of Education, School District Finance Survey, 2002-03. This information can be accessed on the web at nces.ed.gov/ccd/f33agency.asp.

Table 5: Gaps in State Aid to Education, 2002-3

	California	United States	Big States	West Coast
Poverty	-$534	-$1,436	-$1,688	-$309
Minority	-$684	-$964	-$1,209	-$57

Source: Education Trust (2005).

Table 6. Own-Source State General Revenue, 2004

		All States			States with an Income Tax		
	CA	**US**	**Big**	**West**	**US**	**Big**	**West**
Taxes	81.69%	73.85%	74.37%	69.84%	74.97%	76.14%	63.54%
General sales	25.26%	24.76%	27.86%	23.08%	23.68%	20.92%	0.00%
Selective sales	7.13%	11.93%	15.78%	10.59%	11.49%	14.41%	7.80%
License taxes	5.47%	4.96%	6.14%	5.27%	4.77%	5.79%	6.78%
Indiv. income tax	34.69%	24.55%	17.48%	22.23%	28.55%	29.14%	44.46%
Corp. income tax	6.60%	3.78%	3.24%	1.67%	4.13%	4.20%	3.33%
Other taxes	2.54%	3.87%	4.32%	7.01%	2.42%	2.46%	1.17%
Current charges	10.85%	14.37%	12.58%	19.07%	14.89%	12.79%	22.32%
Misc. general revenue	7.45%	11.78%	13.06%	11.09%	10.14%	11.07%	14.14%

Source: U.S. Census (2006b). Big states are Illinois, Florida, New York, Pennsylvania, and Texas; West Coast is Washington and Oregon.
Note: Miscellaneous general revenue includes net lottery revenue

Table 7. Local Revenue for K-12 Education, 2003-04

	California	**United States**	**Big States**	**West Coast**
Property Taxes	73.04%	65.34%	80.18%	77.65%
Other Taxes	1.17%	2.60%	2.64%	0.01%
Parent Government.	3.49%	17.27%	6.60%	0.00%
Other Government.	1.35%	2.29%	0.42%	3.95%
School Lunch	2.78%	3.11%	2.50%	3.61%
Tuition & Transportation	0.28%	0.49%	0.30%	1.23%
Other Charges	1.06%	2.25%	1.78%	4.42%
Other Revenue	16.83%	6.64%	5.59%	9.12%

Source: U.S. Census (2006a). Big states are Illinois, Florida, New York, Pennsylvania, and Texas; West Coast is Washington and Oregon.
Note: Other revenue includes rental income, interest on investments, private contributions, reimbursements for previous years.

Table 8. Composition of Local School Revenue Other than the Property Tax in California, 1995-96 to 2002-03

	Parcel Tax	Local Other Sales	Leases and Rents	Interest	Fees	Other
1995-96	5.6%	0.7%	8.7%	35.4%	18.6%	31.0%
1996-97	5.5%	0.5%	8.4%	37.1%	18.3%	30.2%
1997-98	5.3%	0.4%	7.8%	36.5%	16.9%	33.1%
1998-99	5.2%	0.3%	7.0%	36.7%	16.8%	34.1%
1999-2000	5.1%	0.5%	6.4%	35.7%	17.2%	35.1%
2000-01	4.5%	0.3%	6.4%	37.0%	16.7%	35.1%
2001-02	6.1%	0.4%	7.7%	25.1%	18.6%	42.1%
2002-03	8.0%	0.3%	7.8%	15.4%	19.7%	48.8%

Source: California Department of Education unaudited financial information from J-200 and SACS. This information can be accessed on the web at www.cde.ca.gov/ds/fd/fd/. Each row sums to 100 percent.

Table 9. Variables to Measure Incentives in the Expenditure Equation

Variable	Impact on School District Efficiency	Expected Sign in Expenditure Equation
Variables Associated with Voters' Incentives		
Median earnings (log)	Higher opportunity cost leads to less voter monitoring and hence less school-district efficiency; higher income leads to demand for broader set of services and hence less efficiency in delivering API.	+
Number of parcels per pupil	More parcels per pupil lowers the tax price of education and leads to less voter monitoring and hence less school district efficiency.	+
Share of migrants	Migrants engage in less monitoring, so school district efficiency declines with the share of migrants.	
Change in revenue limit	Voters in districts with declines in their revenue limit monitor to ensure that previous high performance levels can persist.	+
Variables Associated with School Officials' Incentives		
Change in revenue limit	School officials in districts with declines in their revenue limit are judged based on their ability to maintain previous high performance levels and are therefore more efficient.	+
Share of intergovernmental support in the form of categorical grants	Restrictions in categorical aid undermine district flexibility and shift focus away from API or these restrictions prevent school officials from using grant money unwisely.	?

Table 10. Variables to Measure Incentives in the Demand Equation

Variable	**Impact on the Demand for Student Performance**	**Expected Sign in Demand Equation**
Variables Associated with Augmented Income		
Household income (67th percentile)	Higher household income leads to higher demand for student performance.	+
State and federal support per pupil	A higher revenue limit and higher categorical aid boost the demand for student performance	+
Contributions from Educational Foundations per Pupil (Endogenous)	Voters will demand a higher level of student performance when they live in a district with education foundations that are successful in raising funds.	+
Variables Associated with Tax Price		
Increase of number of parcels per pupil	An increase in the number of parcels lowers the price of raising money for education through the parcel tax, and hence boosts demand.	-
Long-run educational cost index from the expenditure equation	A higher cost of education corresponds to a higher price and results in lower demand.	-
Short-run educational cost index from the expenditure equation	A higher short-run cost of education results in lower demand or class size changes associated with short-run enrollment change alter student performance.	?
Efficiency index from the expenditure equation	Higher efficiency corresponds to a lower price and results in higher demand.	+
Other Variables		
Share of intergovernmental support in the form of categorical grants	Restrictions in categorical grants may limit voters' ability to reach the level of student performance they prefer.	-

Table 11
Expenditure Equation Estimates
California School Districts (2003-04 and 2004-05)

Variables	**Coefficients**	**t-statistics**	**p-value**
Intercept	-3.0072	-1.52	0.13
Academic Performance Index[a]	0.7090	2.98	0.00
Cost variables:			
Predicted minimum teacher salaries[b]	0.7060	4.07	0.00
Share of free lunch students	0.0023	3.74	0.00
Share of limited English language students	0.0032	7.86	0.00
Share of disabled students out of classroom 80% of the time	0.0087	1.77	0.08
Enrollment[a]	-0.2411	-13.13	0.00
Enrollment squared[c]	0.0115	9.56	0.00
Percent 3-year enrollment change if positive	-0.0892	-17.83	0.00
Percent 3-year enrollment change if negative	-0.3982	-6.42	0.00
Elementary district (1=yes)	-0.1711	-11.46	0.00
High school district (1=yes)	0.0698	2.95	0.00
Efficiency Variables Associated with Voter's Incentives:			
Median earnings (2000)[a]	0.0426	1.53	0.13
Parcels per pupil[a]	0.0792	10.10	0.00
Population migration rate (2000)	0.0026	5.11	0.00
Percent change in revenue limit since 1975	0.1462	11.10	0.00
Efficiency Variables Associated with School Officials' Incentives:			
Categorical aid as percent of total operating revenue	0.4495	7.13	0.00
Other Variables:			
Year=2004 (1=yes)	0.0143	1.39	0.16

Note: Estimated with 2SLS, with the log of current general fund expenditures (less capital spending, debt service, transfers, transportation, and special education) as the dependent variable, and the log of API treated as endogenous. See Table B-3 in Appendix B for a first stage results for the instruments. Sample size is 1836. Robust standard errors are reported (controlling for clustering at district level). For more details on data and methodology, see Appendixes A and C.

[a]Expressed as natural logarithm.

[b]Predicted based on a regression of the log of minimum teacher salaries regressed on the log of county population, comparable private sector wages, and percent of district population in urban areas.

[c]Square of the log of enrollment.

Table 12
Demand Equation Estimates with Foundation Measure
California School Districts (2003-04 and 2004-05)

Variables	**Coefficient**	**t-statistic**	**p-value**
Intercept	6.1391	26.85	0.00
Augmented income variables:			
Income at 67th percentile[a]	0.1329	8.72	0.00
Total lumpsum aid	0.3606	3.12	0.00
Foundation revenue	71.6378	3.34	0.00
Taxprice variables:			
Tax price for parcel tax[a]	-0.0427	-5.06	0.00
Tax price adjustment for renters	0.0003	0.09	0.93
Cost index[a]	-0.3254	-9.55	0.00
Short-run enrollment change index[a]	0.0044	0.22	0.82
Efficiency index[a]	0.1161	5.08	0.00
Other variables:			
Categorical aid as percent of total operating revenue	-0.1272	-2.81	0.01
Percent of population that is African American	-0.2455	-5.25	0.00
Percent of population that lives in rural areas	0.0293	3.25	0.00
Percent of population 5 to 17 years old	-0.0016	-1.94	0.05
Percent of population over 65 years old	0.0010	1.70	0.09
Elementary district (1=yes)	0.0052	0.83	0.41
High school district (1=yes)	-0.0548	-6.32	0.00
Year=2004 (1=yes)	-0.0413	-12.29	0.00

Note: Estimated with 2SLS, with the log of API as the dependent variable and foundation revenue treated as endogenous. See Table B-4 in Appendix B for first stage results for the instruments. Sample size is 1857. Robust standard errors are reported (controlling for clustering at district level). For more details on data and methodology, see Appendixes A and C.
[a]Expressed as natural logarithm.

Table 13
Spending Required to Equalize Performance in High- and Low-Poverty Districts, by Enrollment Classes

	Enrollment Class		
Variables	**<500**	**500-15000**	**>15,000**
Current Gap Between High- and Low-Poverty Districts			
API (Low - High) (%)	27.5%	33.5%	31.3%
Spending per pupil (High - Low) (%)	10.4%	4.7%	7.2%
Spending per pupil (High - Low) ($)	$903	$321	$439
Added Spending Needed to Close the High-Low Poverty API Gap (beyond current gap)			
Increase (%)	18.8%	22.7%	21.3%
Increase ($)	$1,802	$1,632	$1,398
Increase as % of Current Spending Gap	99.5%	408.4%	218.2%
Added Spending Needed to Close the High-Low Poverty API Gap, If Funded by Categorical Aid			
Increase (%)	36.3%	44.8%	42.2%
Increase ($)	$3,487	$3,213	$2,771
Increase as % of Current Spending Gap	286.0%	901.0%	530.9%

Note: Low poverty indicates a poverty rate below 6% (10th percentile) and high poverty indicates a poverty rate above 70% (90th percentile). These results are based on estimates in Table 11.

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Understanding the Incentives in California's Education Finance System

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Appendix A: Data Sources and Measures

The statistical analysis in this report draws on a number of databases. Most of the data are produced by the California Department of Education (CDE) and were downloaded from the CDE website. The analysis was based on two years of data (2003-04 and 2004-2005) unless otherwise specified. We used data for all regular school districts in California. This appendix is organized by major type of variables used in the cost model and demand model. Summary statistics for the cost model are reported in Table A-1 and for the demand model in Table A-2.

Expenditure Model

District Expenditures

The dependent variable used in the cost function is district operating expenditures per pupil. To construct a broad measure of operating expenditures we used spending in the general fund and in several special revenue funds as defined in the Standard Accounting Code System (SACS).[1] Included in operating expenditures were all personnel compensation (objects 1100-3902), books and supplies (4100-4700), services and other operating expenses (5200-5900) except transfers of direct costs to other funds

[1] Specifically we used spending in the Charter School Special Revenue Fund, Child Development Special Revenue Fund, Cafeteria Special Revenue Fund, Deferred Maintenance Special Revenue Fund, Special Reserve Fund for Other than Capital Outlay Projects Fund, Foundation Special Revenue Fund, and Special Reserve Fund for Postemployment Benefits.

(5750), and tuition (7110-7143). We excluded the functions for pupil transportation, facilities acquisition and construction, facilities rents and leases, and debt service. The detailed SACS database is available on the CDE website and is the source of this data.

Student Performance

The student performance measures used in previous studies estimating cost models and demand models reflect broad measures of student performance that typically match the principal academic standards in the school accountability system (Duncombe and Yinger, 2006; Duncombe, Lukemeyer and Yinger, 2003). In California, the Academic Performance Index (API) is "the cornerstone of the state's academic accountability requirements. The API, established by the [Public School Accountability Act] PSAA, is a numeric index (or scale) ranging from a low score of 200 to a high score of 1000." (CDE, 2006, p. 1). The API is a weighted average of test results in several subjects from grades 2 to 11. The test results are divided into 5 levels of proficiency (far below basic, below basic, basic, proficient, and advanced) and assigned API scores. The API is the principal performance measure used in this report; however, we also estimate models using the average percent proficient on math and English language arts (ELA) exams as a performance measure. The cost and demand model estimates using the student proficiency rate are presented in Appendix B.

Student Enrollment Measures

A key variable in a cost model is the number of students served by the district. Student counts are used both directly as a variable in the cost model, and to transform other variables into per pupil measures. Three different student count measures are generally available: enrollment (typically counted on one day each year), average daily membership (ADM), which captures the average enrollment in a district over the course of the year, and average daily attendance (ADA), which is based on actual attendance rates. For most districts, these measures are highly related. For this analysis, we use enrollment as the student count measure. Enrollment measures are reported in the California Basic Education Data System (CBEDS) and are available on the CDE website.

Student Poverty Measure

One of the key factors affecting the cost of reaching performance standards is the number of students requiring additional assistance to be successful in school. Many studies have found that students from poor families require additional assistance on average. The most commonly used measure of poverty in education research is the share of students receiving free or reduced price lunch in a school.[2] Another measure of child poverty is the child poverty rate produced by the Census Bureau every ten years as part of the *Census of Population and Housing* and updated every two years. For this study, we are using the percent of students receiving free lunch as the child poverty measure, because it is available every year and is strongly correlated (0.77) with the Census child poverty rate for California school districts.

English Learners (EL)

Another student characteristic that can affect the cost of bringing students up to a performance level is their fluency in English. Particularly in a state, such as California, with a large share of recent immigrants, it is important to consider the additional costs of

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[2] The National School Lunch Program is administered by the U.S. Department of Agriculture, and individual school districts are reimbursed by the meal depending on the level of subsidy for which a child is eligible. Children with incomes at or below 130 percent of the federal poverty line are eligible for free lunch, and students between 130 and 185 percent of the poverty line are eligible for reduced price lunch. In addition, households receiving Food Stamps, Temporary Assistance to Needy Families (TANF), or the Food Distribution Program on Indian Reservations (FDPIR) are also eligible for free lunch. A description of the program and eligibility requirements is available on the Food and Nutrition Service website: http://www.fns.usda.gov/cnd/lunch/.

helping these students reach academic standards. We have used the share of students classified as English learners (EL) based on data from the Language Census. According to California's classification system,

> English learner students are those students for whom there is a report of a primary language other than English on the state-approved Home Language Survey **and** who, on the basis of the state approved oral language (grades kindergarten through grade twelve) assessment procedures and literacy (grades three through twelve only), have been determined to lack the clearly defined English language skills of listening comprehension, speaking, reading, and writing necessary to succeed in the school's regular instructional programs. (R30-LC) (CDE website: http://www.cde.ca.gov/ds/sd/cb/glossary.asp#el)

Special Education

Students with disabilities face special challenges meeting academic standards depending on the nature of their disability. We used counts of students by types of disability provided by the CDE staff. Specifically, we used the number of students who are outside of a regular classroom at least 80 percent of the time as a share of total enrollment. To impute missing observations for this variable, we used the predicted value when this variable is regressed on share of enrollment with more severe disabilities.[3] The latter is defined as the share of disabled students, who are not classified as having a "speech or language impairment" or "specific learning disability." These data were graciously provided to us by Jay Chambers of American Institutes for Research.

Teacher Salaries

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[3] The correlation between the two special education variables is 0.52, and the regression line is equal to Y = 0.32 + 0.74 X, where X is the severe disability variable.

A key part of a cost model is measures of prices for education resources. Since teachers are the primary resource used to produce education, teacher salaries is the most important resource price to include in the model. In addition, teacher salaries are typically highly correlated with salaries of other certified staff, so that teacher salaries serve as a proxy for salaries of all certified staff. To measure teacher salaries we used data on minimum teacher salaries in each district from district salary schedules. Salary schedule data is available from the report, "Salary and Benefits Schedule for the Certificated Bargaining Unit" (Form J-90), published by CDE. Because teacher salaries are set as part of the district budgeting process they can be endogenous in a cost model. To avoid this endogeneity problem, which can bias regression coefficients, we predict minimum teacher salaries from a regression using a measure of private salaries for college-educated employees, county population, and percent of the district population in urban areas.[4] The private salaries were developed by Heather Rose as a part of the "Getting Down to Facts" project, and are discussed in more detail in her report (Rose, 2006). County population and the share of the district population in urban areas are available from the *2000 Census of Population and Housing* (Table P5).

Efficiency-Related Measures

Costs are defined as the minimum spending of school resources required to provide students an opportunity to reach a given level of student performance, but the dependent variable in our "cost" model is per pupil spending. Some school districts may have higher spending relative to their level of student achievement not because of higher

[4] Separate regressions were run for 2004 and 2005 using the logarithm of minimum salaries (Y), the log of private sector salaries (X1), log of county population (X2), and percent of urban population in the district (X3). The regression results for 2005 are (t-statistic in parentheses): Y =8.229 (20.6) + 0.1895 (5.02) X1+ 0.0095 (3.46) X2 + 0.0612 (6.51) X3. (r-square=0.205)

costs, but because of inefficient use of resources. In addition, some districts may choose to focus on other subject areas (e.g., art, music, and athletics) that may not be directly related to improving test score performance in math and reading or improving the graduation rate. Factors affecting the monitoring of district efficiency are discussed in more depth in our report and the detailed models are presented in Appendix C.

The wage of the decisive voter is approximated by median earnings from the *2000 Census of Population* (Table P85). To measure the mobility of the population we use the share of population 5 years or older that lived in a different county in 1995 than in 2000 from *2000 Census of Population and Housing* (Table PCT21). Enrollment change is measured as the percent change in total enrollment over the last 3 years. Separate variables are included in the model for when the enrollment change was positive (0 if negative) or negative (0 if positive) to allow for different effects. Change in the revenue limit since 1975 is based on two different estimates of the revenue limit. For 2004 and 2005, we used total revenue from revenue limit sources (objects 8011-8099) from SACS. For 1975, the revenue limit per ADA (average daily attendance) was collected from financial records in that year and graciously provided to us by Eric Brunner of Quinnipiac University. Categorical aid includes other state revenue in both the general fund and several special revenue funds (objects 8311-8590) and all federal aid (objects 8110-8290). The denominator for the percent categorical aid variable also includes revenue from all revenue limit sources (objects 8011-8099).

Information on the number of parcels (and their assessed value) in each school district is not readily available from a centralized source in the California. To gather this data we contacted the offices of auditor-controller or assessor in each county and received data back from 28 counties, and 507 school districts. For assessed value we were able to match up the data we received with data collected by Eric Brunner, which increased the number of districts to 926. To impute missing parcel data we regressed the parcels per pupil on the number of housing units per pupil, county establishments per pupil, and total employment in the district per pupil and used the predicted value for missing observations.[5] The number of housing units and the total employment is from the *2000 Census of Population and Housing* (Tables H3 and P49). The number of private establishments in 2005 is from the Quarterly Census of Employment and Wages (ES202), which is produced by the California Labor Market Information Division.

Demand Model

Augmented Income Measures

The demand for education services among the decisive voter is likely to be affected by the resources available to the voter including personal income and intergovernmental aid received by the district from the state or federal governments. Because of the requirement that new revenue sources must be passed by a two-thirds majority, we use an estimate of income at the 67th percentile. The income measure is calculated using information on the distribution of households by income class from the *2000 Census of Population and Housing* (Tables P52). Total aid is measured as the sum of federal and state aid divided by the number of parcels and the income at the 67th percentile. The derivation of this form is given in Appendix C.

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[5] The number of parcels per pupil (Y), regressed on the log of private sector salaries (X1), per pupil housing units (X1), per pupil business establishments in the county (X2), and per pupil private employment in the district (X3). The regression results are (t-statistic in parentheses): Y =1.1104 (1.69) + 2.3416 (23.42) X1 + 0.0382 (8.78) X2 – 0.9502 (-5.12) X3. (r-square=0.51)

We also include contributions from education foundations as a component of augmented income and include it as a separate endogenous variable in the demand model. To be consistent with the measure of aid, per pupil foundation revenue is divided by the number of parcels and income at 67th percentile (see Appendix C). The data on contributions by school district, which is based on IRS records, was provided to us by Eric Brunner.

Tax Price Measures

The price for educational services can affect the demand for education and is a composite of several variables. The parcel tax share is defined as the inverse of the number of parcels. We include in the model a separate renter parcel tax share, which is equal to the parcel tax share multiplied by an indicator that equals one for districts in which more than one-third of their households are renters. Data on renters is available from the *2000 Census of Population and Housing* (Table HCT1). This variable allows us to determine whether the presence of renters alters voters' responsiveness to the tax-price signal.

A cost index and an efficiency index are derived from the results of the cost model. To calculate a cost index, we first multiply the coefficients for all cost factors by the actual values for each district. The coefficients for the other variables in the cost model are multiplied by the state average, and the (antilog of the) sum of all these products is the predicted spending required for a district of average efficiency to raise its students to the average performance level. Predicted cost for each district is divided by predicted cost in a district with average characteristics (and multiplied by 100) to get a cost index. The two variables on enrollment change may be picking up short-run adjustment costs associated with large changes in enrollment. We used the results for these two variables to create a short-run enrollment change index that is included in the cost model. The efficiency index is derived in a similar fashion to the cost index, except that the coefficients on the efficiency variables are multiplied by actual district values and all other coefficients are multiplied by the state average. The sum of these products plus the residual from the cost regression is used to predict spending in districts with actual efficiency but average performance and costs. The predicted spending in the most efficient district (minimum spending) is divided by the predicted spending in other districts to estimate an efficiency index.

Preference Variables

Education demand can also be affected by differences in the socio-economic background of the population that may affect their preferences for education relative to other local services. The age distribution of the population in a district may affect demand for education. We include measures of the share of the population that is African American, the share of a district located in rural areas, the share of the population between 5 and 17 years old, and the share of the population 65 years old or older based on data from the *2000 Census of Population and Housing* (Tables P5, P6, and P8).

Instruments

Because expenditure and performance targets are set as part of the district planning and budgeting processes, the performance measure needs to be treated as an endogenous variable in the cost model. We use an instrumental variable regression method (two-stage least squares) to control for the endogeneity of performance, which requires the selection of instruments. Ideally, instruments should be strongly related to the endogenous variable but not independently related to the error term of regression.

The selection of instruments for the API is challenging because a number of factors associated with student performance are already in the cost model. For example, we do not use income and tax price as instruments (as some other studies have done) because these variables influence efficiency, which means they influence the dependent variable in the main regression, spending per pupil, and violate a critical requirement for a valid instrument. In addition, we need to find a set of instruments for the foundation funding variable in the demand model.

The approach we take is to assume that student performance in a district is influenced by the performance in comparable districts or in nearby districts. This influence could operate through administrator actions, as school officials try to make sure they do not fall behind their competitors, or it could operate through voter monitoring, as voters ask why they cannot do as well as neighboring districts. Thus we look for valid instruments among average values averages for other districts in the same Census district type or in the same county for several performance, financial, and socio-economic variables. The Census district types are large cities, medium cities, urban fringe of large cities, urban fringe of medium cities, large towns, small towns, rural metro, and rural non-metro. The actions of administrators or voters also might be influenced by how far a district falls from comparable districts. Thus, we also look for instruments among differences between the district values and the Census region or county average. Variables examined include API, predicted minimum salaries, percent free lunch, percent EL students, percent African American, Hispanic, or non-white students, median income, median property values, percent renter, total enrollment, county population, per pupil assessed value, and percent college.

The final set of instruments was selected first using a weak instrument test to identify instruments that are strongly correlated with API or the foundation measure (Bound, Jaeger, and Baker, 1995) and then the appropriateness of the instruments was tested using an overidentification test (Woolridge, 2003). The selected instruments are listed with the first-stage regression results in Appendix B.

Table A-1
Descriptive Statistics for Variables in Cost Model
California School Districts (for 2004-05 unless noted otherwise)

Variables	Sample size	Mean	Standard Deviation	Minimum	Maximum
Academic Performance Index (API)	970	740	80	512	958
Per pupil operating expenditures	946	$7,255	$2,454	$383	$28,448
Cost variables:					
Predicted minimum teacher salaries[a]	967	$35,380	$1,678	$31,339	$38,440
Share of free lunch students	972	37.0	24.9	0.0	136.8
Share of limited English proficient students	996	17.8	18.3	0.0	96.4
Share of disabled students out of class room 80% of the time	973	1.4	1.1	0.0	11.1
Enrollment	986	6366	25649	8	741367
Percent enrollment change (since 2000) if positive	977	0.1042	0.5720	0.0000	14.8750
Percent enrollment change (since 2000) if negative	996	-0.0393	0.0841	-0.9242	0.0000
Elementary district (1=yes)	996	0.5633	0.4962	0.0000	1.0000
High school district (1=yes)	996	0.0863	0.2810	0.0000	1.0000
Variables Associated with Voter's Incentives:					
Median earnings (2000)	977	$24,224	$9,204	$4,545	$73,060
Parcels per pupil	972	7.5	13.3	0.5	227.5
Population migration rate (2000)	977	19.9	8.8	0.0	79.9
Percent change in revenue limit since 1975	996	0.5384	0.4335	-0.9502	3.8861
Variables Associated with School Officials' Incentives:					
Categorical aid as percent of total operating revenue	970	0.2975	0.0923	0.0704	0.8011
Instruments-- Average for other districts in Census Region:					
Median house value (2000)	977	$213,796	$50,384	$127,871	$280,768
Total enrollment	986	6366	8279	423	39904
Percent renter (2000)	977	0.3488	0.0377	0.2808	0.4394
Academic performance index	963	739.7	15.1	700.4	761.4
Share free lunch students	972	37.0	5.2	28.4	46.2
Share of limited English proficient students	996	17.8	6.8	4.3	31.9
Share African American students	986	3.8	2.4	1.3	13.9

[a]Predicted based on a regression of the log of minimum teacher salaries regressed on the log of county population, comparable private sector wages, and percent of district population in urban areas.

Table A-2
Descriptive Statistics for Variables in the Demand Model
California School Districts (for 2004-05 unless noted otherwise)

Variables	Sample size	Mean	Standard Deviation	Minimum	Maximum
Academic Performance Index (API)	970	740	80	512	958
Percent of students reaching proficiency	962	47.0	15.8	9.4	90.2
Augmented income variables:					
Income at 67th percentile	977	$54,521	$20,387	$22,500	$175,000
Total lumpsum aid[a]	964	0.0373	0.0346	0.0012	0.4731
Foundation revenue[b]	969	0.00031	0.00071	0.00000	0.00893
Taxprice variables:					
Parcel tax share[c]	972	0.2558	0.1904	0.0044	1.8754
Parcel tax share for renters[d]	972	0.1120	0.1628	0.0000	1.6282
Cost index[e]	941	100.5	14.1	72.8	174.8
Short-run enrollment change index[f]	977	100.2	5.9	25.7	152.6
Efficiency index[g]	928	7.4	3.5	3.0	100.0
Other variables:					
Percent of population that is African American	967	0.0279	0.0484	0.0000	0.5020
Percent of population that lives in rural areas	970	0.4165	0.4218	0.0000	1.0000
Percent of population 5 to 17 years old	977	21.1535	4.9784	0.0000	72.0000
Percent of population over 65 years old	977	12.0927	5.3457	0.0000	52.7845
Instruments:					
Average percent 5 to 17 year olds in other districts in county	970	21.18	2.61	12.79	26.13
Average percent nonwhite students in other districts in Census region	986	50.23	12.65	26.39	74.82
Difference between district population and average population other districts in county	961	-0.94	1.61	-6.76	4.05

[a]Per pupil operating aid divided by estimated parcels and median household income. Operating aid includes all state aid and federal aid except aid for capital and transportation.

[b]Per pupil foundation revenue divided by estimated parcels and household income at 67th percentile.

[c]The inverse of the number of parcels in a school district.

[d]Parcel tax share multiplied by an indicator variable for whether at least a third of the housing units are for renters.

[e]Calculated by multiplying the coefficients in the cost model on the cost variables by the actual values for each district, and multiplying the other coefficients in the cost model by the state average for each variable. The anti-log of the sum of these products is the predicted spending required to produce the average API at average efficiency. The cost index is the predicted spending in each district divided by the spending in the average district (and multiplied by 100).

[f]Calculated by multiplying the coefficients in the cost model on the enrollment change variables by the actual values for each district, and multiplying the other coefficients in the cost model by the state average for each variable. The (antilog of) of the sum of these products is predicted costs with 3-year enrollment change and is divided by predicted cost of the average district to get the enrollment change index.

[g]Calculated by multiplying the coefficients in the cost model on the efficiency variables by the actual values for each district, and multiplying the other coefficients in the cost model by the state average for each variable. The sum of these products is added to the residual to the cost model (and the antilog taken of this sum). The efficiency index is the minimum of this calculated number divided by the actual value for each district.

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Appendix B: Additional Tables

Part 1. Tables with Proficiency Rates as a Measure of Student Performance

Table B-1
Cost Function Estimates with Proficiency Rate
California School Districts (2003-04 and 2004-05)

Variables	Coefficients	t-statistics	p-value
Intercept	0.5272	0.31	0.76
Student Proficiency Rate[a]	0.2160	3.04	0.00
Cost variables:			
Predicted minimum teacher salaries[a,b]	0.7311	4.23	0.00
Share of free lunch students	0.0026	3.74	0.00
Share of limited English language students	0.0034	7.77	0.00
Share of disabled students out of classroom 80% of the time	0.0065	1.39	0.16
Enrollment[a]	-0.2505	-13.34	0.00
Enrollment squared[c]	0.0119	9.75	0.00
Percent 3-year enrollment change if positive	-0.0881	-17.25	0.00
Percent 3-year enrollment change if negative	-0.3802	-6.15	0.00
Elementary district (1=yes)	-0.1498	-12.92	0.00
High school district (1=yes)	0.0054	0.29	0.77
Variables Associated with Voter's Incentives:			
Median earnings (2000)[a]	0.0515	2.00	0.05
Parcels per pupil[a]	0.0803	10.17	0.00
Population migration rate (2000)	0.0027	5.35	0.00
Percent change in revenue limit since 1975	0.1444	10.72	0.00
Variables Associated with School Officials' Incentives:			
Categorical aid as percent of total operating revenue	0.4405	6.99	0.00
Other Variables:			
Year=2004 (1=yes)	0.0243	1.98	0.05

Note: Estimated with 2SLS, with the log of current general fund expenditures as the dependent variable, and the student performance measure (percent of students reaching proficiency on math and English language arts exams) treated as endogenous. Instruments are the same as those reported in Table B-3. Sample size is 1835. Robust standard errors are reported (controlling for clustering at district level). For more details on data and methodology, see Appendixes A and C.

[a]Expressed as natural logarithm.

[b]Predicted based on a regression of the log of minimum teacher salaries regressed on the log of county population, comparable private sector wages, and percent of district population in urban areas.

[c]Square of the log of enrollment.

Table B-2
Demand Model Estimates with Proficiency Rate and Foundation Measure
California School Districts (2003-04 and 2004-05)

Variables	**Coefficient**	**t-statistic**	**p-value**
Intercept	2.9925	3.15	0.00
Augmented income variables:			
Income at 67th percentile[a]	0.3856	6.80	0.00
Total lumpsum aid[b]	1.3758	3.11	0.00
Foundation revenue[c]	287.4551	3.45	0.00
Taxprice variables:			
Tax price for parcel tax[a]	-0.1558	-4.91	0.00
Tax price adjustment for renters	0.0008	0.07	0.94
Cost index[a]	-1.2722	-9.96	0.00
Short-run enrollment change index[a]	0.0890	1.08	0.28
Efficiency index[a]	0.4868	5.61	0.00
Other variables:			
Categorical aid as percent of total operating revenue	-0.3857	-2.34	0.02
Percent of population that is African American	-0.9554	-5.25	0.00
Percent of population that lives in rural areas	0.0935	2.75	0.01
Percent of population 5 to 17 years old	-0.0091	-2.71	0.01
Percent of population over 65 years old	0.0018	0.79	0.43
Elementary district (1=yes)	-0.0840	-3.84	0.00
High school district (1=yes)	0.0555	1.91	0.06
Year=2004 (1=yes)	-0.1933	-14.59	0.00

Note: Estimated with 2SLS, with the log of the proficiency rate as the dependent variable, and the foundation measure treated as endogenous. Instruments are the same as those reported in Table B-4. Sample size is 1857. Robust standard errors are reported (controlling for clustering at district level). For more details on data and methodology, see Appendixes A and C.

[a]Expressed as natural logarithm.

Table B-3
First Stage Equation for Expenditure Model (Academic Performance Index)
California School Districts (2003-04 and 2004-05)

Variables	Coefficients	t-statistics	p-value
Intercept	19.6978	12.88	0.00
Cost variables:			
Predicted minimum teacher salaries[b]	0.1798	2.11	0.04
Share of free lunch students	-0.0023	-13.60	0.00
Share of limited English language students	-0.0007	-4.05	0.00
Share of disabled students out of classroom 80% of the time	-0.0069	-3.04	0.00
Enrollment[a]	0.0118	1.34	0.18
Enrollment squared[c]	-0.0013	-2.24	0.03
Percent 3-year enrollment change if positive	-0.0042	-1.26	0.21
Percent 3-year enrollment change if negative	0.0236	0.76	0.45
Elementary district (1=yes)	0.0353	7.49	0.00
High school district (1=yes)	-0.0629	-8.42	0.00
Variables Associated with Voter's Incentives:			
Median earning (2000)[a]	0.0726	6.49	0.00
Parcels per pupil[a]	-0.0003	-0.07	0.95
Population migration rate (2000)	0.0004	1.92	0.06
Percent change in revenue limit since 1975	0.0218	3.88	0.00
Variables Associated with School Officials' Incentives:			
Categorical aid as percent of total operating revenue	-0.0464	-1.59	0.11
Other Variables:			
Year=2004 (1=yes)	-0.2848	-11.53	0.00
Instruments-- Average for other districts in Census region:			
Median house value (2000)[a]	-0.2061	-5.53	0.00
Total enrollment[a]	-0.2708	-11.88	0.00
Percent renter (2000)	0.7260	5.50	0.00
Academic performance index[a]	-0.0134	-10.76	0.00
Share free lunch students	-0.0520	-12.25	0.00
Share of limited English proficient students	0.0121	7.02	0.00
Share African American students	0.1148	11.86	0.00

Note: Estimated with OLS, with the log of API as the dependent variable. Sample size is 1873. Robust standard errors are reported (controlling for clustering at district level). For more details on data and methodology, see Appendices A and C.

[a]Expressed as natural logarithm.

[b]Predicted based on a regression of the log of minimum teacher salaries regressed on the log of county population, comparable private sector wages, and percent of district population in urban areas.

[c]Square of the log of enrollment.

Table B-4
First Stage Equation for Demand Equation With Foundation Measure (Academic Performance Index)
California School Districts (2003-04 and 2004-05)

Variables	Coefficient	t-statistic	p-value
Intercept	-0.0004	-0.18	0.85
Augmented income variables:			
Income at 67th percentile[a]	0.0003	2.18	0.03
Total lumpsum aid[b]	-0.0005	-0.38	0.70
Taxprice variables:			
Parcel tax share[c]	0.0003	3.82	0.00
Parcel tax share for renters[d]	0.0000	0.74	0.46
Cost index[e]	0.0002	0.70	0.49
Short-run enrollment change index[f]	0.0005	2.69	0.01
Efficiency index[g]	-0.0007	-3.20	0.00
Other variables:			
Categorical aid as percent of total operating revenue	0.0006	1.23	0.22
Percent of population that is African American	0.0001	0.36	0.72
Percent of population that lives in rural areas	0.0000	0.27	0.79
Percent of population 5 to 17 years old	0.0000	-1.80	0.07
Percent of population over 65 years old	0.0000	1.37	0.17
Elementary district (1=yes)	0.0000	0.78	0.44
High school district (1=yes)	0.0002	1.72	0.09
Year=2004 (1=yes)	0.0001	2.07	0.04
Instruments:			
Average percent 5 to 17 year olds in other districts in county	0.0000	-3.97	0.00
Average percent nonwhite students in other districts in Census region	0.0000	-2.17	0.03
Difference between district population and average population other districts in county	-0.0001	-2.82	0.01

Note: Estimated with OLS, with the foundation revenue measure as the dependent variable. Sample size is 1857. Robust standard errors are reported (controlling for clustering at district level). For more details on data and methodology, see Appendices A and C.

[a]Expressed as natural logarithm.

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Appendix C: Formal Model Description

This appendix presents formal versions of the analytical models we use to derive our estimating equations. These models identify financial incentives facing voters and school officials in California and show how they can be incorporated into empirical analyses of education spending and student performance.

The California education finance system is very centralized and greatly restricts the behavior of local voters and school officials. Nevertheless, this system does allow some local discretion. Voters can decide to implement a parcel tax, for example, and they can decide on the extent to which they want to monitor school officials. In addition, voters may be able to use property tax levies for capital spending to help cover operating expenses. In addition, the management decisions of school officials may be influenced by certain features of the education finance system.

In this appendix, we present a formal model of voter behavior along with a less formal discussion of the behavior of school officials and show how to incorporate these analyses into estimated educational cost and demand functions.

Deriving Cost and Demand Models

A Model of Voter Incentives

Voters can decide to levy a parcel tax, which is a fixed amount on every real estate parcel in a school district. The parcel tax must be passed by a 2/3 vote. In addition, voters must devote time to monitoring public officials. Their monitoring decisions can be modeled as decisions about the allocation of time.

To see how these incentives appear, start with a voter utility function that depends on a composite good (*Z*), leisure time (*L*), and school quality (*S*). The composite good includes housing, which plays no special role in this model, and is defined so that it has a price of unity.

$$U = U\{Z, L, S\} \tag{1}$$

The household budget constraint requires that income, which is the wage rate (*w*) multiplied by work hours (*W*), equals expenses, which consist of spending on the composite good, property taxes (*tV*), and the parcel tax (*P*). The parcel tax is a choice variable.

$$wW = Z + tV + P \tag{2}$$

The household also has a time constraint. Total hours (*T*) must equal the sum of work hours, leisure hours (*L*), and monitoring hours (*M*):

$$T = W + L + M \tag{3}$$

The community budget constraint requires spending per pupil to equal revenue per pupil. As in Duncombe and Yinger (2001) and Duncombe, Eom, and Yinger (2005), spending per pupil equals a cost function $C\{S\}$, divided by school district efficiency, *e*. As in that paper, *e* is an index with a minimum of zero (pure waste!) and a maximum of 1 (best use of available technology). Revenue per pupil comes from property taxes (the state set tax rate, *t*, multiplied by assessed value per pupil, $\bar{V}$), state aid (*A*), and parcel tax revenue. The latter equals the parcel tax (*P*) multiplied by the number of parcels per pupil (*N*).

$$\frac{C\{S\}}{e} = t\bar{V} + A + PN = A^* + PN \tag{4}$$

Note that A^* equals total state-determined revenue per pupil, which also equals the so-called "revenue limit" in the California system plus categorical aid. Federal aid could be included here, too. Miscellaneous sources of local revenue (interest, rents and leases, fees) are ignored (at least for now).

Equation (4) can be solved for the budget-balancing value of *P*, namely,

$$P = \left(\frac{1}{N}\right)\left(\frac{C\{S\}}{e} - A^*\right) \tag{5}$$

Finally, efficiency (*e*) is determined by the level of monitoring per pupil, $\bar{M}$. Two assumptions are needed to bring this relationship into the model. First, we must make an assumption about a voter's perception concerning this average level of monitoring. Our approach is to assume that a voter perceives monitoring in the community relative to her own efforts; that is,

$$\bar{M} = vM \tag{6}$$

This new parameter, *v*, could be greater than one, which indicates that the median voter is a shirker, or less than one, which indicates that the voter does more monitoring than average. This parameter could be a function of community characteristics, such as the average level of education among adults or the distribution of income, but for now we will just treat it as a constant. We also assume that the voter's perceptions are accurate.

Second, we must make an assumption about the link between monitoring and efficiency. Consider first the simplest possible approach, namely that efficiency is a linear function of average monitoring:

$$e = \alpha + \sigma \bar{M} \tag{7}$$

In other words, some causes of district efficiency (those in the α term) are beyond the influence of voters (and must be considered in a model of the behavior of school officials), but voter monitoring can increase efficiency. Putting equations (5) and (6) together, we have

$$e = \alpha + \sigma(\nu M) = \alpha + \beta M \tag{8}$$

Now substituting equations (3), (5), and (8) into (2), we have the voter's combined budget constraint:

$$w(T - L - M) = Z + tV + \left(\frac{1}{N}\right)\left(\frac{C\{S\}}{e} - A^*\right) = Z + tV + \left(\frac{1}{N}\right)\left(\frac{C\{S\}}{\alpha + \beta M} - A^*\right) \tag{9}$$

We can now maximize (1) with respect to (9). The first-order conditions of this problem lead to a demand function for *S*. To begin, however, let us just consider the first-order condition with respect to monitoring (*M*):

$$\lambda\left(-w + \left(\frac{1}{N}\right)\left(\frac{\beta C\{S\}}{(\alpha + \beta M)^2}\right)\right) = 0 \tag{10}$$

The Lagrangian multiplier, λ, obviously cancels out, and we can use the quadratic formula to solve this equation for *M*. Rejecting negative values of *M* as nonsensical, we find that

$$M = \frac{-\alpha + \sqrt{\dfrac{\beta C\{S\}}{wN}}}{\beta} \tag{11}$$

This result indicates that monitoring effort <u>decreases</u> with (1) α (district efficiency based on factors other than voter monitoring), (2) β (the effectiveness of monitoring multiplied by a voter's perceptions of other voters monitoring), (3) w (the wage rate), and (4) N (the number of parcels). Monitoring also <u>increases</u> with $C\{S\}$ (the cost of delivering the district's selected level of S).

Intuitively, monitoring has an opportunity cost (w), but it still must fill the gap between the spending required to obtain desired services ($C\{S\}/e$) and state revenue, A^*. This gap is smaller if α is large, and the gap is easier to close (requires less monitoring) if β is large. The number of parcels (N) is in the denominator of tax price, so its inverse indicates the cost to a voter of raising more revenue (and thus what can be saved through monitoring).

The key insight in equation (11) is that monitoring depends on two variables that can be observed, namely w and N. This simple model is quite restrictive, however, so we incorporate this insight into a more general approach in our estimating equations. In particular, we start by assuming that M is a function of w, N, and other incentives facing voters as captured by a set of variables, X:

$$M = f\{w, N, X\} \tag{12}$$

Then we assume that school district efficiency depends on incentives facing school officials, as captured by a set of variables, Z, and by voter monitoring. We also assume that this relationship is multiplicative. Thus,

$$e = f_e\{Z, M\} = f_e\{Z, w, N, X\} = k_e Z^{\phi_Z} w^{\phi_w} N^{\phi_N} X^{\phi_X} \tag{13}$$

Cost and Demand Equations

We can use these results to help derive both a cost function and a demand function for *S*. In the case of the cost function, the standard approach is to specify costs, *C*, as a multiplicative function of service quality, *S*, and cost determinants, *D*, and to specify expenditure per pupil as costs divided by an efficiency index, as in equation (4). Substituting equation (13) into an expenditure equation of this form, we obtain the following equation, which is suitable for estimation in logged form:

$$E = \frac{C\{S\}}{e} = \frac{kS^{\delta} D^{\gamma}}{f_e\{Z, w, N, X\}} = kS^{\delta} D^{\gamma} Z^{\phi_Z} w^{\phi_w} N^{\phi_N} X^{\phi_X} \qquad (14)$$

Here *k* is a constant, which contains $\underline{k_e}$, and *D* stands for teacher salaries, student enrollment, and student characteristics. This is the model we estimate.

We estimate equation (14) using two-stage least squares, with S treated as endogenous and with the variables in Z and X discussed in the text. The instruments for S are found by examining the characteristics of districts of the same type and of districts in the same county. We selected instruments that pass both weak-instrument tests and over-identification tests. See Baum et al. (2003). See Appendix A.

In the case of a demand function for *S*, we can use the two-step strategy we have used before. The first step is to derive an augmented income term and a tax-price term from the combined household budget constraint (equation (9)). The second step is to include these two terms in a multiplicative specification of the demand function.

The augmented income term, *Y*, in this case is $(wW + A^{*}/N)$. Aside from the change from standard tax price to $(1/N)$, the only difference from previous models is that this income term should be income at the 67th percentile, not median income, because decisions at the margin (i.e. about the parcel tax) require a two-thirds vote. Foundation income, say *F*, could also be added to this model. It would enter as *F*/*N*.

The tax-price term (*TP*) is the derivative of the right side of (9) with respect to *S*, or

$$TP = \frac{\partial(\text{spending})}{\partial S} = \left(\frac{1}{N}\right)\left(\frac{\frac{\partial C}{\partial S}}{e}\right) = \left(\frac{1}{N}\right)\left(\frac{MC}{e}\right) \qquad (15)$$

In this model, tax price depends on the number of parcels, not the property tax share, as in a standard model. (This has been pointed out by Brunner, 2001.) Note that *MC* is the marginal cost of *S*, that is, the derivative of *C*{*S*} with respect to *S*. Equation (14) indicates that this derivative depends on *S* and *D*.

This tax-price term has three components, 1/N, MC, and e. In the text, we refer to the first component as the tax-price, but one could also call that component the tax-share and the product of the three components the tax price. In any case, we estimate a separate price elasticity for each component.

A multiplicative demand model takes the following form

$$S = \kappa Y^{\theta}(TP)^{\mu} R^{\eta} = \kappa\left(wW + \frac{A^{*}}{N}\right)^{\theta} N^{-\mu_1}(MC)^{\mu_2} e^{-\mu_3} R^{\eta} \qquad (16)$$

where κ is a constant and *R* is a set of preference variables. The values of *MC* and *e* come from the cost equation. That is, these variables are indexes computed from the estimated cost coefficients (and the values for the corresponding variables). In the case of *e*, the index also includes the error term, under the assumption that unobserved factors are related to efficiency, not cost.

More formally, the cost index is calculated by multiplying the coefficients on cost factors (enrollment, teacher salary, and student need variables) in the cost function by the actual values for each district, and multiply the coefficients on the other variables by the state average. The (antilog of) the sum of the products is the predicted spending for each district to reach an average API with average efficiency. Predicted spending is divided by spending in a district with average characteristics and then multiplied by 100 to get a cost index.

The efficiency index is calculated by multiplying the coefficients of efficiency-related variables in the cost function by the actual values for each district and multiplying the coefficients on the other variables by the state average. The (antilog of) the sum of the products plus the error term is the predicted spending for each district to reach an average API with average costs at their actual efficiency level. The minimum of this predicted spending is divided by predicted spending in each district and then multiplied by 100 to get a efficiency index.

This equation is estimated in logarithmic form. To facilitate estimation, we rewrite the logged income term as follows:

$$\theta \ln\left\{ wW + f\frac{A^*}{N} \right\} = \theta \ln\left\{ wW\left(1 + f\frac{A^*/N}{wW}\right)\right\} \cong \theta \ln\{wW\} + \theta f\left(\frac{A^*/N}{wW}\right) \qquad (17)$$

where f is the flypaper effect. We also use this approach to incorporate contributions from education foundations into our estimating equation.

Modeling the Capital-Operating Link

Because Proposition 13 places such strict limits on local revenues, districts may be tempted to fund some portion of their operating expenses through borrowing. This is possible because districts are allowed to raise property taxes to back bonds, although a super-majority vote is needed (2/3 before November 2000, 55% since then).

We do not know how strict the rules are on the use of borrowed funds. Let us assume that they can be used for some expenses that used to be covered by operating funds, such as lab equipment and furniture.

The problem is that this is not a standard two-input production problem. Districts are turning to a presumably imperfect funding source because their preferred funding source is not available. If both funding sources were unconstrained, standard methods would work fine.

Moreover, we cannot simply assume that \$1 raised through property-tax-backed borrowing is equivalent to some fraction of \$1 raised through current revenue sources. If that were the case, then voters would have an incentive to raise either all or none of their revenue through property-tax-backed borrowing. (As shown below, this result can be formally demonstrated with the first-order condition for the property tax rate in a model based on this assumption.)

Thus, we need an ac-hoc model in which the first dollar raised through property-tax-backed borrowing is equivalent to \$1 raised through current revenue sources but in which \$1 raised through the borrowing route makes a smaller and smaller contribution to operating expenses as the reliance on this route increases.

Finally, this issue is complicated because it introduces another margin—whether or not to increase property taxes. All existing models have a single margin and that margin determines the tax price. We don't think it makes sense to have two tax prices. It might it make sense for a voter to pick the smallest tax price (that is, to increase the revenue source with the smallest impact on her). But this adds amazing complexity to the model and to the empirical work. We would have to calculate two tax prices and use the smallest—both in determining monitoring and in the demand model.

To keep the analysis manageable, we assume that voters do not perceive borrowing for operating expenses to be the relevant margin when they make their monitoring decisions. Instead, they see money raised through this route as a contribution to augmented income. This assumption is somewhat awkward because the alternative margin, the parcel tax, requires a 2/3 vote and is rarely used. But the restrictions on borrowing for operating expenses are severe and the parcel tax logic is straightforward, so we keep the parcel tax at the core of the model.

This leaves open the possibility that borrowing for operating expenses is a "margin" in the demand equation. In other words, the possibility of borrowing for operating expenses might influence the demand for school quality either through a price incentive or though augmented income, depending on voter perceptions. We can estimate it both ways.

A Simple Model of Capital Fund Spillovers into Operating Spending

The key to setting this up is to distinguish between the operating fund and operating spending. The idea is that districts may be able to use their capital fund for operating spending. Let $C\{S\}$ be the total operating cost of providing service level S and $C\{S\}/e$ be total required operating spending with efficiency e. Let operating spending consist of spending through the operating fund, E_O, and spending through the capital fund, E_C. If \$1 spent through either fund had the same impact on operating performance, then

$$\frac{C\{S\}}{e} = E_O + E_C = E_O\left(1 + \frac{E_C}{E_O}\right) \tag{18}$$

Now what we observe is E_O, not $C\{S\}$, so to do empirical work we must re-arrange this to be:

$$E_O = \frac{C\{S\}}{e} - E_C = \left(\frac{C\{S\}}{e}\right)\left(\frac{1}{1 + \frac{E_C}{E_O}}\right) \tag{19}$$

Moreover, we observe E_C: it is simply the property tax levy to back borrowing, say tV. (In this part of our notes, t is the property tax rate to support borrowing only!) So equation (2) becomes:

$$E_O = \frac{C\{S\}}{e} - t\overline{V} = \left(\frac{C\{S\}}{e}\right)\left(\frac{1}{1 + \frac{t\overline{V}}{E_O}}\right) \tag{20}$$

Now we have to add key feature to the model, namely, that spending through the capital fund does not have the same impact on effective operating spending as does spending through the operating fund.

$$E_O = \frac{C\{S\}}{e} - f\{t\overline{V}\} = \left(\frac{C\{S\}}{e}\right)\left(\frac{1}{1 + \frac{f\{t\overline{V}\}}{E_O}}\right) \tag{21}$$

Taking logs, we have

$$\ln\{E_O\} = \ln\{C\{S\}\} - \ln\{e\} - \ln(1 + \frac{f\{t\overline{V}\}}{E_O}) \cong \ln\{C\{S\}\} - \ln\{e\} - \frac{f\{t\overline{V}\}}{E_O} \tag{22}$$

To estimate this cost function, we must insert our standard forms for $C\{S\}$ and e and then find a function, f, that makes sense. In addition, we must deal with the endogeneity that comes with having E_O and t on the right side.

We could, of course, just try the ratio of $t\bar{V}$ to E_O, but, as noted above and shown below, that approach has the nonsensical theoretical property that a district will go all-or-nothing with the capital fund.

A plausible and tractable form with plausible implications is $\ln\{t\bar{V}\}/E_O$. With this form, the marginal operating impact of money raised through the capital fund declines as the amount of money raised in this way increases.

We also can derive a compelling instrument. The model gives a prediction for the optimal value of t (details in the next section). Most of the revenue that supports E_O is exogenous (revenue limit plus categorical). So predicted t multiplied by $\bar{V}$, plugged into the right f, and divided by exogenous revenue is an excellent instrument.

Implications for Voter Model

Now we can add equation (4) into our model of voter choice (in part 1 of these notes). The district budget constraint becomes:

$$E_O = \frac{C\{S\}}{e} - f\{t\bar{V}\} = t^*\bar{V} + A + PN = A^* + PN \qquad (23)$$

where t^* is the property tax rate set by Proposition 13. With this change, the combined budget constraint becomes:

$$w(T - L - M) = Z + (t^* + t)V + \left(\frac{1}{N}\right)\left(\frac{C\{S\}}{\alpha + \beta M} - f\{t\bar{V}\} - A^*\right) \qquad (24)$$

This combined budget constraint leads to exactly the same first-order condition for *M* as the previous version, so the formula for *M* remains unchanged.

The new condition is the one for *t*, which, like *M*, does not appear in the utility function. After cancelling the Lagrangian multiplier, this condition becomes:

$$-V+\left(\frac{\bar{V}}{N}\right)\left(\frac{df}{d(t\bar{V})}\right)=0 \text{ or } \frac{V}{\bar{V}}=\left(\frac{1}{N}\right)\left(\frac{df}{d(t\bar{V})}\right) \tag{25}$$

Now we can see that setting there is no solution for *t* if $df/d(t\bar{V})$ is a constant.

Estimating the cost model

The form for *f* discussed above is a log form:

$$f\{t\bar{V}\}=\phi\ln\{t\bar{V}\} \tag{26}$$

Following equation (5), this form implies that we include $\ln(t\bar{V})/E_O$ as an explanatory variable in the cost model. To find the needed instrument note that $df/d(t\bar{V})=\phi/(t\bar{V})$ and equation (8) implies that

$$t=\frac{\phi}{NV} \tag{27}$$

The numerator of the instrument required to estimate a cost model is therefore $\ln\{\bar{V}/(NV)\}$ and the denominator is, as indicated earlier, exogenous operating revenue.

Estimating a Demand Model

According to equation (7) (and the assumption that the capital fund is not the marginal revenue source for operating spending), the use of the capital fund for operating spending adds another term to augmented income, namely, $f\{t\bar{V}\}/N$. Using our standard approximation to estimate (additive) components of augmented income in a multiplicative model, this term also needs to be divided by *Y*. As with the cost model, we can use the first-order condition for *t* to derive the appropriate instruments. For each assumption about the form of *f*, the numerators of the instruments are the same in the demand model as in the cost model. The denominator, however, is *NY* instead of exogenous operating spending.

An alternative approach is to assume that voters recognize that the price of raising money through borrowing depends on their tax share—but that they do not recognize this margin when making their monitoring decisions. In this case, we need to add tax-share (median house value divided by property value per pupil) to the demand equation.

Conclusions about Capital Spending in an Operating Model

When estimated with our data for California, these models indicate that the lower cost of raising money through tax levies for capital spending has no impact on operating spending or on student performance. These results indicate either that voters do not use capital funds as a substitute for operating funds or else that our model does not adequately capture this type of substitution.

Understanding the Incentives in California's Education Finance System

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Appendix D: The Cost of Reaching the 800 API Target

California's accountability system has set a target of 800 for the API in every district. Some school districts already meet this target, but many do not. This appendix presents our estimates of the minimum amount it would cost the state to bring every district up to this target.

These estimates are based on the cost equation results presented in Table 11 in the text of this report. This equation indicates that a 10 percent increase in the API requires a 7.1 percent increase in spending, all else equal. We combine this result with various assumptions about school district efficiency to obtain estimates of the cost of reaching the 800 API target.

More specifically, we examine cost estimates under three different assumptions about efficiency.

1. All districts remain at their current level of efficiency.
2. All districts have at least the current median level of efficiency.
3. All districts with API below 800 increase their efficiency by 5 percent.

These are all optimistic scenarios. As discussed in the text, providing extra aid through categorical grants is likely to lower efficiency in the average school district and therefore increase the cost of reform, perhaps by as much as 100 percent. The simulations in this appendix are based on the view that the state can devise an accountability system that will at least preserve current efficiency levels in all school districts and might, in the case of the second and third assumptions, improve efficiency to some degree. This view is optimistic in the sense that no state has so far developed an accountability system that is known to have had such a positive impact on school district efficiency.

The first assumption is implemented in two different ways. The first way is very simple. For districts below the 800 API target, we calculate the percentage increase in API needed to reach 800 and multiply this number by 0.71, which yields the required percentage increase in spending holding everything else, including efficiency, constant. The required dollar increase in spending equals current spending multiplied by this percentage. The total cost of reaching the 800 API target is then the sum of the required dollar spending increases across all districts currently below this target. This method can be implemented for all districts, including those that are not included in our regression because of missing information.

The second way we implement the first assumption, which is included to facilitate comparisons with the other estimates, predicts spending with API set at 800, all other variables set at their current values, and the error term set at its value in the regression. Because this calculation requires information on the error term, it can be applied only to districts with full information. If there were no missing information, these two methods for implementing the first assumption would lead to the same answer.

The second assumption is implemented by first determining the median value of our efficiency index for the districts in our sample. We then identify districts that fall below the 800 API target and below median efficiency and raise their efficiency indexes up to the median. Finally, we calculate the required spending using the method in the previous paragraph with these new efficiency indexes instead of the actual ones.

The third assumption is implemented by first multiplying the efficiency index by 1.05 in every district that currently falls below the 800 API target. We then use the method describe two paragraphs earlier with these new efficiency indexes instead of the actual ones.

The results are in Table D-1. This table presents required spending increases in the mean and median school district, along with the total spending increase in the state as a whole, that are required to reach the 800 API target. Under the first assumption, no change in efficiency, the total cost of bring all districts up to the 800 API target is about $3.8 billion. Under the second assumption, at least median efficiency, this cost drops to about $3.0 billion and under the third assumption, a 5 percent efficiency increase, it drops even more, to about $1.0 billion.

In interpreting these figures for policy purposes, two points need to be kept in mind. First, these figures assume that any additional state assistance is given to exactly the set of districts that need it. Districts with API values currently above 800 are assumed to receive no more money and districts with API values currently below 800 are assumed to receive exactly the amount of money they would need (given the assumptions about efficiency) to reach the 800 API target. We do not know of any large state aid increase in any state that has been so focused on the districts that need help the most. Any aid increases to districts with API values above 800 or any unnecessary aid increases to districts with API values below 800 obviously would obviously increase the cost to the state of reaching the 800 API target in every district.

Second, as emphasized above, these figures assume that the state can devise a method for distributing new aid, perhaps combined with a new accountability system, that does not result in lower school-district efficiency. We think this is unlikely.

Analysis of data from New York (Duncombe and Yinger, 1998, 2001; Eom, Duncombe and Yinger, 2005) indicates that additional state aid results in lower school district efficiency. The evidence presented in the text of this report indicates that the categorical aid programs currently used in California lead to lower school district efficiency, most likely because they limit a district's flexibility and impose red tape.

Overall, therefore, these calculations should not be interpreted to mean that all districts would reach the 800 API target if the state increased its education aid budget by $3.8 (let alone $3.0 or $1.0) billion. Instead, they simply indicate the magnitude of the minimum possible spending required to reach this target based on various assumptions about efficiency—and making the best use of available information about educational costs in California.

Table D-1: Spending Increases Required to Reach the 800 API Target

	Mean District	Median District	Total Spending Increase for the State	Sample Size
Required % Change in API	13.3	13		963
Assumption 1: Maintain Current Efficiency Level				
Spending increase based on API change to reach 800 and coefficient on API				
Dollars per pupil	$618.1	$587.8	$3.83 billion	939
Percent	9.2	9.0		963
Spending increase based on cost model results and actual efficiency				
Dollars per pupil	$624.7	$587.8	$3.79 billion	914
Percent	9.31	9.27		914
Assumption 2: Bring Efficiency Up to the Current Median				
Spending increase based on cost model results and median efficiency				
Dollars per pupil	$497.0	$433.0	$3.01 billion	914
Percent	7.5	6.9		914
Assumption 3: Increase Efficiency by 5%				
Spending increase based on cost model results and 5% efficiency increase				
Dollars per pupil	$177.0	$0.4	$1.07 billion	914
Percent	2.9	0.0066		914