School Finance Reform and Voluntary Fiscal Federalism

Eric Brunner
San Diego State University

Jon Sonstelie
University of California, Santa Barbara

October 1999

Abstract

California has transferred the responsibility for financing its public schools from localities to the state, equalizing spending per pupil across school districts in the process. In response to this reform, many families have supplemented the tax revenue of their local public schools with voluntary contributions. Contributions are not equally distributed across districts, creating a type of voluntary fiscal federalism. We analyze that phenomenon in this paper. We propose a model of partial cooperation among parents in making voluntary contributions to their public schools. Under reasonable conditions, the model predicts that contributions per pupil should decline with the size of the school, measured by the number of students. We estimate this relationship using data on contributions to California schools. Our estimates reveal that contributions per pupil do decline with school size; however, the rate of decline is surprisingly slow. There can be considerable cooperation, even in large schools. Nevertheless, there is not enough cooperation to undermine school finance reform.

We thank James Andreoni, Theodore Bergstrom, Julie Cullen, Thomas Downes, William Hoyt, Heather Rose, Charles Stuart, and Stephen Trejo for useful comments on a previous version of this paper. We are also grateful to the Public Policy Institute of California for financial support.
1. Introduction

California has enacted a bold reform of public school finance. Over the last twenty-five years, it has transferred the responsibility for funding its public schools from localities to the state. Under local finance, each school district levied its own property tax rate. In its 1971 ruling in *Serrano v. Priest*, the California Supreme Court found this system unconstitutional because differences in the value of taxable property across districts caused inequities in tax revenue. The voters of California completed the transfer to state finance by passing Proposition 13, fixing the property tax rate at 1% throughout the state and giving the state legislature authority to allocate property tax revenue among local jurisdictions, including school districts. Armed with this authority, the legislature has achieved a more equitable distribution of revenue across districts, thereby satisfying the Court. It has also reduced average revenue per pupil by about 15% relative to other states.

The combination of equalization among districts and decline in average revenue has led to a sharp decline in the funding of districts that fared relatively well under local finance. Understandably, not all parents in those districts regard reform to be an improvement. It has taken away their authority to tax themselves for their mutual benefit. From the perspective of these parents, government is now failing to provide a level of service for which they are willing to pay.

In response to this government failure, many parents have turned to collective action. In 1994, local educational foundations, PTAs, and booster clubs raised nearly $200 million for public schools. The level of contributions varied widely across school districts, creating a type of voluntary fiscal federalism. Can this voluntary fiscal federalism undo the equalization achieved by school finance reform? Olson (1965) has written eloquently about the difficulties of collective action. A group of individuals may mutually benefit if they achieve a common goal, yet be unable to achieve it because cooperation is not in the self-interest of any one of them. Sandler (1992) has expanded Olson's analysis, delineating situations in which collective action may or may not be successful. Both Olson and Sandler
emphasize the fundamental difference between individuals and groups. When an outcome would be beneficial, we may expect an individual to achieve it. The same cannot be expected from a group.

The difference between individuals and groups is fundamental for determining how families respond to school finance reform. Let us illustrate with a simple conceptual experiment. First, suppose every school district were composed of just one family. Under local finance, each family is allowed to tax itself to provide the resources it demands for its children’s education. Now suppose that local finance is replaced by state finance, and the state taxes all families to provide equal revenue to each district. Families with higher demand would supplement state revenue with their own contributions, yielding the same resources for their children's education as under local finance. In the end, families would undo school finance reform through voluntary contributions.

Will they also undo reform if school districts are composed of one hundred identical families, instead of just one? Under local finance, each family is in exactly the same position as before. Using the authority of their local government, the families in each district would tax themselves to provide the same level of revenue per pupil as in the case of one-family districts. With state finance, and thus without local taxing authority, the situation could be very different. If families were to cooperate fully, each would be in the same position as under state finance with one-family school districts. If each were to contribute exactly the same amount as one-family districts, each would achieve exactly the same outcome. However, if families act only in their narrow self-interest, each attempting to free ride on the contributions of others, they will not achieve this outcome. It is now more difficult to undo reform.

How much free riding will there be? As we move from one family, where cooperation is trivial, to many families, where cooperation is difficult, how rapidly do contributions per pupil fall? How difficult is it to undo reform? That is the question that motivates this paper.

In Section 2, we propose a framework to investigate this issue. The key to that framework is a notion of partial cooperation. In our model, some individuals cooperate fully in the provision of a public good and others do not cooperate at all. The partition of individuals between those two groups is
determined by the cost of cooperating and the cost of free riding. External factors, such as the total number of individuals, can affect these costs, and thus the partition between cooperators and free riders. The percentage who cooperate determines the price of spending per pupil perceived by each cooperator. The more cooperators, the lower the price, and thus the higher are contributions to local schools.

In Section 3, we apply this framework to data on contributions to California public schools. We do not directly observe the price of spending per pupil, but our model allows us to infer how this price changes with the size of the school. We find that the price increases with school size, but at a moderate rate. Our estimates indicate that a doubling of school size will result in a 15% increase in the price of spending per pupil. Evidently, cooperation deteriorates quite slowly. Nevertheless, voluntary fiscal federalism has not substantially undermined school finance reform. Even when cooperation is substantial, as we observe, voluntary collective action is a poor substitute for the taxing authority of local government.

2. A Theory of Voluntary Contributions to Local Public Schools

One model of voluntary contributions has been developed by Olson and Zeckhauser (1966), Warr (1983), Roberts (1984), and Bergstrom, Blume and Varian (1986). In the model, individuals derive utility from a public good, and each may increase the amount of the good by making a voluntary contribution. In making a contribution, an individual is assumed to take the contributions of others as given.

Andreoni (1988) referred to this model as the “pure altruism” model, drawing attention to the assumption that individuals are motivated to contribute solely because their contributions increase the public good. While we believe this assumption realistically portrays why families contribute to California public schools, we doubt that the pure altruism model can explain the volume of those

---

1 Addonizio (1997), Bice and Hoyt (1997), and Brunner and Sonstelie (1996) have also documented voluntary contributions to governments.
contributions. In the case of public schools, the individuals in the model would be families with children enrolled in a public school. In making a contribution, a family would take as given the contributions of other families, implying that the price to the family of increasing spending per pupil by $1 would be the number of students in the school. For an average elementary school, which has about 600 students, a family would have to contribute $600 to increase spending per pupil by $1. At that price, it is hard to believe that anyone would contribute.

Others have reached similar conclusions about the predictions of the pure altruism model. Sugden (1982) and Andreoni (1988) argued that for large populations the model implies fewer contributions than we typically observe. In reviewing the results of a number of experiments involving voluntary contributions to a public good, Ledyard (1995) concluded that many experimental subjects contribute more than predicted by the model.

The limitations of the pure altruism model have led to the development of alternative models. One example is the joint-product model developed by Cornes and Sandler (1984a, 1994). In that model, a contribution produces two goods: a public good, which benefits everyone, and a private good, which only benefits the contributor. In Steinberg (1987) and Andreoni (1989, 1990), this private good is the “warm glow” that contributors derive from the act of giving. In Glazer and Konrad (1996), it is a signal of the contributor’s wealth. In Harbaugh (1998), contributions convey prestige to the giver.

Because they introduce another motive for giving, these models predict larger contributions than the pure altruism model. In our view, however, they fail to include an important element that we observe in contributions to California schools. The element is social interaction. In the pure altruism model, individuals act unilaterally, taking the contributions of others as given. In the joint-product, warm-glow, signaling, and prestige models, individuals have different motivations for contributing, but they still act unilaterally. In contrast, we observe many interactions among California parents in the process of raising funds for their schools. Neighbors talk among themselves about their contributions, creating an
expectation of how much each family ought to contribute. PTAs sponsor fund raising events that bring parents together and provide them with an opportunity to observe what others are contributing.

In these settings, it seems reasonable to assume that a family takes into account how its contribution may affect the contributions of others. Cornes and Sandler (1984b) examine the implications of that assumption by contrasting the Nash model, in which individuals take other contributions as given, with a non-Nash model, in which individuals believe their contributions affect the contributions of others. In commenting on this model, Sugden (1984) pointed out that, under plausible assumptions, an increase in any one individual’s contribution ought to decrease the contributions of others. If individuals understand this and act accordingly, the non-Nash model predicts even lower contributions than does the Nash model. Social interactions appear to reduce contributions.

To the contrary, we believe the interactions we observe have the opposite effect. Interactions among families create a group identity, which leads to an informal, collective decision about how much families ought to contribute. In cases we have observed, a school’s PTA provides the framework for this process. With input from its active members, the PTA sets a fund raising goal for the year. The goal implies an appropriate contribution for each active member, an implication members understand as they participate in the process of setting the PTA’s goal. It is as if every active member has implicitly agreed to a share of total contributions. The share determines a family’s price for spending per pupil, which then determines the goal it prefers. The PTA mediates the different goals of its members, achieving a consensus on one goal and thus on an appropriate contribution for each member. In many respects, this process is similar to the model developed by Guttman (1987), in which individuals finance a public good through a two-stage process. In the first stage, individuals propose rates at which they will match the contributions of others. In the second, they make contributions given those matching rates. Varian (1994) analyzed a similar model.
Participation in school fund raising is voluntary, of course, leading naturally to the question of why anyone would do so. We think people participate because they believe it is wrong to free ride on the contributions of others. This view is supported by experimental evidence reported by Fehr and Gachter (1998). In a series of experiments involving voluntary contributions to a public good, subjects had the option to penalize free riders. Subjects exercised this option even though it was pointless for the play of the game and even though it was costly for a subject to impose such a penalty. Apparently, subjects penalized free riders because free riding violates a social norm.

Despite this social norm, many families do not participate in a school’s fund raising. Some differences in participation are surely due to differences in tastes. Families with a low demand for spending per pupil are unlikely to involve themselves in a process designed to increase that spending. Also, families may have different attitudes about free riding. We believe there is also a third explanation, which does not depend on such differences among individuals. To illustrate, let us assume that everyone has the same tastes, income, and attitudes. By the same attitudes, we mean that every family incurs the same psychic cost if it does not participate in the fund raising activities of its schools. On the other hand, cooperating in the fund raising process also has its cost, which is the contribution that a cooperator must make. If the cost of free riding exceeds the cost of cooperating, more families will cooperate, which will affect the fund raising goal and thus the cost of cooperating. An equilibrium is reached when the two costs are equal. At that point, some families free ride, and some cooperate, but all are equally well off. Differences in participation are the outcome of an equilibrium process, not a matter of differences in tastes, income, or attitudes.

To develop this model, consider a public school with \( n \) students. To economize on notation, we assume that each student belongs to a different family, so there are also \( n \) families, identical in every relevant respect. The school receives revenue from the state government of \( g \) dollars per student.
The families may supplement this revenue with voluntary contributions. Let $d$ denote contributions per pupil, and let $s$ denote spending per pupil. Then,

\[ d = s - g . \] (1)

If all families were to contribute to the school, contributions per pupil would equal contributions per family. However, we allow for the possibility that some families may not contribute. We refer to families who contribute as cooperators and assume that each cooperator contributes the same amount, denoted by $c$. With $m$ denoting the number of cooperators, the relationship between contributions per pupil and contributions per cooperator is

\[ c = \frac{n}{m} d . \] (2)

The ratio of students to cooperators is the price cooperators face for increasing spending per pupil. We denote this price by $p \equiv \frac{n}{m}$. The more cooperators, the lower the price.

Each family has an income of $w$, which it allocates between private consumption, denoted by $x$, and voluntary contributions. As in the pure altruism model, we assume that utility is a function of just two goods: private consumption and a public good. In this case, the public good is school spending per pupil, and the utility function is $u(x,s)$. Equations (1) and (2) imply the relationship between the public good and the contributions required of each cooperator. The relationship is

\[ c = p(s - g) . \] (3)

Using that relationship, a family’s budget constraint can be expressed in terms of the two goods as

\[ x + ps = w + pg . \] (4)

In the terminology used in Becker (1974), the term $w + pg$ is a cooperator’s social income. It is labor income plus the value of the subsidy from the government. We denote this income by $y$.

Cooperators choose the level of contributions that maximizes their utility. They determine the value of $s$ that maximizes the utility function $u(x,s)$ subject to the budget constraint in Equation (4). They
then contribute the difference between that demand and the revenue provided by the state. Let \( f(p, y) \) be the demand for \( s \) derived from that maximization problem. Contributions per pupil will be

\[
d = f(p, y) - g
\]

(5)

This assumes that the demand for spending per pupil exceeds the amount provided by the state. If demand falls short of state revenue, contributions will be zero.

The relationship between price and contributions can be derived by differentiating Equation (5) with respect to \( p \), which yields

\[
\frac{\partial d}{\partial p} = \frac{\partial f}{\partial p} + g \frac{\partial f}{\partial y}.
\]

(6)

Equation (6) can be expressed in elasticity form as

\[
\varepsilon_{d,p} = \frac{s}{d} \left( \varepsilon_{s,p} + \lambda \varepsilon_{s,y} \right),
\]

(7)

where \( \varepsilon_{i,j} \) is our notation for the elasticity of variable \( i \) with respect to variable \( j \) and where \( \lambda \) equals \( pg/y \).

Note that if \( g \) were equal to \( s \), \( \lambda \) would be the share of a family’s budget allocated to education and thus the expression in parenthesis would be equal to the elasticity of compensated demand with respect to price. In fact, \( \lambda \) will be less than this share, so the expression in parentheses will be less than that price elasticity. Note also that the expression in parentheses is multiplied by \( s/d \), which can be a large number. Suppose, for example, contributions are 10% of total spending, and the elasticity of compensated demand is \(-0.2\). Then the elasticity of donations with respect to price is less than \(-2.0\). As we will show in Section 3, most estimates of the compensated price elasticity are less than \(-0.2\), and contributions are usually less than 10% of total spending.
The contribution elasticity plays an important role in the relationship between the number of cooperators and the cost of cooperating. If that elasticity is less than negative unity, as we have argued, an increase in the number of cooperators will increase the cost of cooperating. The cost of cooperating is \( c \), which equals \( pd \). An increase in the number of cooperators decreases \( p \), which increases \( pd \), because \( d \) is an elastic function of \( p \).

Families must balance the cost of cooperating against the cost of free riding. The cost of free riding is the disutility a family suffers from violating the social norm. It seems likely that this disutility will decrease as the size of the school increases because in large schools families may feel more anonymous and thus less affected by the disapproval of other families. To include this possibility in the model, we represent the disutility of free riding as a function of the number of families. We denote this function by \( v(n) \), implying that the utility of free riders is \( u(w,s)-v(n) \).

To compare the disutility of free riding to the cost of cooperating, we define a reservation cost of free riding, which is the level of contributions that would make a family indifferent between cooperating and free riding. This cost is denoted by the function \( h(w,s,n) \), implicitly defined by

\[
\frac{\partial h(w,s,n)}{\partial n} = \frac{\partial v(n)}{\partial n}
\]

The partial derivative of reservation cost with respect to the number of families depends on the first derivative of the disutility of free riding. If that disutility decreases with the number of families, the reservation cost of free riding will also decrease.

These costs determine the number of cooperators. In equilibrium, the number of cooperators equates the cost of cooperating with the cost of free riding. If the cost of cooperating is less than the cost of free riding, some free riders will become cooperators, an action that will decrease the price of spending per pupil. Assuming that contributions are an elastic function of price, the decrease in price will increase the cost of cooperating, thus closing the gap between the costs of free riding and cooperating. However, the decrease in price may also have an indirect effect. It will increase spending per pupil, which may affect the reservation cost of free riding. For this adjustment process to be stable,
increases in the number of cooperators must decrease the difference between the cost of free riding and the cost of cooperating, that is, a decrease in \( p \) must decrease \( h(w, f(p, w + pg), n) - p \ (f(p, w + pg) - g) \). This stability condition is

\[
J \equiv \left( \frac{\partial h}{\partial s} - p \right) \left( \frac{\partial f}{\partial p} + g \frac{\partial f}{\partial y} \right) - (s - g) > 0. 
\] (9)

Assuming this condition is met, free riders will become cooperators until either all families are cooperators or the costs are equal. The first outcome is a border equilibrium, and the second is an interior equilibrium. There may also be a border equilibrium in which everyone is a free rider.

In what follows, we focus on interior equilibria. In such an equilibrium, the price of spending per pupil equates the costs of cooperating and free riding, that is,

\[
h(w, f(p, w + pg), n) - p \ (f(p, w + pg) - g) = 0. \] (10)

Assuming the conditions of the implicit function theorem are satisfied, Equation (10) defines \( p \) as a function of \( w, g, \) and \( n \). In the Appendix, we discuss those conditions and derive the partial derivatives of this function. The most important of these comparative statics results involves the effect of changing school size. We show that

\[
\frac{\partial p}{\partial n} = -\frac{\partial h}{\partial n} / J. \] (11)

Thus, if an increase in school size decreases the reservation cost of free riding, it will also increase the equilibrium price of spending per pupil, which will decrease contributions per pupil. As a result, we expect contributions per pupil to fall with school size.

This hypothesis is related to a conjecture by Olson (1965) that large groups are less likely to provide a public good than small groups. Chamberlin (1974), McGuire (1974), and Andreoni (1988) have examined this conjecture in the pure altruism, Nash model. Contrary to Olson’s conjecture, they find that the quantity of the public good increases to a finite limit as group size increases. Because the public good in our model is spending per pupil, this finding also appears to contradict our hypothesis that
contributions per pupil fall with school size. In fact, however, it does not because the public good in our model doesn’t have the same characteristics as the good in the pure altruism model. In that model, the cost of providing the public good does not vary with the number of people consuming it. In our model, the cost varies proportionately with the number of people. It is not surprising, therefore, that the two models should have different predictions about the effect of group size.

In the next section, we examine this relationship empirically by regressing contributions in a cross section of schools on enrollments in those schools. The simple model we have outlined above also provides a framework that allows us to infer how cooperation deteriorates as group size expands. The basis for that inference is our theory of how enrollment affects contributions per pupil. Enrollment affects contributions because it affects the price of spending per pupil. Expressed mathematically,

\[ \varepsilon_{d,n} = \varepsilon_{d,p} \varepsilon_{p,n}. \]

As described in the following section, there have been many estimates of the demand for school spending. Using those estimates and Equation (7), we can estimate \( \varepsilon_{d,p} \), the elasticity of contributions per pupil with respect to price. Using cross-section data on contributions and school size, we can also estimate \( \varepsilon_{d,n} \), the elasticity of contributions per pupil with respect to school size. As Equation (12) shows, the ratio of those two elasticities is the elasticity of price with respect to school size, which is a measure of how rapidly cooperation deteriorates with increases in group size.

The model implies natural limits for this elasticity. If parents are fully cooperative, the price of spending per pupil would not change with school size, implying an elasticity of zero. With no cooperation, price is proportional to school size, implying an elasticity of unity. McGuire and Groth (1985) and Sandler and Murdoch (1990) have also developed a methodology for determining whether data on contributions is consistent with either non-cooperative or fully cooperative behavior. The methodology employs data on individual contributions, however, data that we do not have. Moreover, the methodology implicitly assumes that all individuals participate in the process determining
contributions. This assumption seems perfectly acceptable for military alliances, to which the method is applied by Sandler and Murdoch, but we doubt that it is a good assumption for our case. We believe that a critical element of school fund raising is the decision of parents whether to participate.

Because we do not directly observe the number of cooperators, the empirical work in the next section is not a true test of our model. Instead, we view the model as a framework for investigating the relationship between contributions and group size. The basic concept in our model is partial cooperation. We have models of full cooperation, and we have models of no cooperation. What we often seem to observe, however, is behavior between those two extremes. Our model gives us a concrete way to conceive of this partial cooperation and to connect that concept to observable behavior.

3. Estimating the Relationship between Contributions and Enrollment

Our data on contributions come from the Internal Revenue Service. Contributions to California schools are channeled through non-profit, tax-exempt organizations, which are required to file an IRS Form 990 if their income exceeds $25,000 in a year. Each organization’s income is publicly available on the IRS Master Business File. We used data from 1994.

Using that data, we identified the non-profit organizations supporting California public schools and assigned each to the school or district it supports. At the school level, most contributions are received by PTAs, PTOs (Parent Teacher Organizations) and booster clubs. At the district level, contributions are received primarily by local educational foundations. PTAs and the schools with which they are associated were easily identified by their names on the Form 990.

For other organizations, we used information provided by the Registry of Charitable Trusts (RCT) in the California Attorney General’s Office. To obtain tax-exempt status, non-profit organizations

---

2 Froelich and Knoepfle (1996) analyze the reliability of this data.
3 A few PTAs did not include on their return the name of the school they supported. To identify the school, we matched the nine digit zip code reported on Form 990 to that of the corresponding school.
operating in California must register with the RCT. Each is assigned a code indicating its primary purpose, and we used the code to narrow the RCT database to approximately 15,000 organizations whose primary purpose is supporting educational activities. We then used the names of these organizations to further narrow the database. For example, non-profit organizations associated with colleges, universities, or private K-12 institutions often list the institution in their title, so these could be eliminated from our sample. Many other organizations were booster clubs, PTOs, or educational foundations whose title included the name of the school or school district they supported. Finally, many educational foundations are members of the California Consortium of Educational Foundations. Using information provided by the Consortium, we were able to link each of these foundations to a school or district.

After completing this process, we were left with approximately 700 non-profit organizations whose specific purpose we were unable to identify. For these, we reviewed each organization’s mission statement, which is on file at the RCT. The statements allowed us to either eliminate the organization from our database or link it with a school or district.

The model of the previous section focuses on families contributing to their children’s schools. As is evident from the description of the data, contributions are also received by local educational foundations associated with school districts. The model can be extended to incorporate these contributions. The extension is to assume that, in addition to the cost of free riding on contributions to a school, families also incur a cost of free riding on contributions to a district. Some families will therefore cooperate at the district level. The number of cooperators must equate the cost of cooperating to the cost of free riding. In equilibrium, some families may cooperate at the district level but free ride at the school level, some may free ride at the district level but cooperate at the school level, some may cooperate at both levels, and some may free ride at both levels. All four patterns are possible in theory. We also believe that all four patterns are likely to occur.

This extension of the model suggests an econometric specification. Because the cost of free riding on district contributions is a function of district enrollment, contributions to the district ought to be
a function of district enrollment. Similarly, contributions to schools ought to be a function of school enrollment. We implement this specification by using separate regressions for school and district contributions. Enrollment data for schools and districts in 1993-94 are from the California Department of Education. Following the theoretical model, we also added data on state revenue, specifically each district’s revenue per pupil from state non-categorical aid and from property taxes allocated to the district from the state.

In the theoretical model, contributions are also a function of the demand for school spending. We used two variables to capture variations in demand. The first is parental income. At the district level, this variable is the average income of families with children in public schools, as reported in the School District Data Book, the school district tabulations of the 1990 Census. At the school level, we used a proxy for income, which is the socio-economic status of public school families. The variable is from 1994 California Learning Assessment System (CLAS) records published by the California Department of Education. The primary purpose of CLAS is to report student performance on standardized tests. As part of that process, CLAS developed a composite index of the socio-economic status of parents at each school in California. The index, which is based on parents’ educational attainment and occupation, ranges from a low of 1 to a high of 5.

The second demand variable is parental education. At the district level, this variable is measured by the percentage of public school parents with a college education, as reported in the School District Data Book. At the school level, we used the Census TIGER files to link the address of every school in California with the census tract in which it is located. We then used the percentage of college graduates in that tract as a proxy for the percentage of parents who are college graduates.

The data have a number of limitations. One limitation is that we do not know the sources of contributions. For contributions to schools, this is probably not a cause for concern. School contributions are funneled through PTAs and other parental organizations, so it is safe to assume that they come from parents. We are less confident about the sources of district contributions. For example,
in describing the formation of the foundation associated with the San Francisco Unified School District, Bernholtz (1995) notes the important role played by local businesses and foundations. We suspect similar organizations may also play a role in the foundations of other large districts, making us less confident of how well our model represents fund raising at the district level.

Our immediate goal is to estimate the elasticity of contributions per pupil with respect to enrollment. For a number of reasons, we find it more convenient to estimate the elasticity of total contributions. The two elasticities are related by a simple transformation. The elasticity of contributions per pupil with respect to enrollment is the elasticity of total contributions with respect to enrollment minus unity. The null hypothesis that the elasticity of contributions per pupil is zero is therefore equivalent to the hypothesis that the elasticity of total contributions is unity. Estimates less than unity indicate that contributions per pupil decrease as enrollment increases.

We proceed by first estimating a baseline regression, which demonstrates our basic approach. Though the baseline is useful as a first analysis of the data, it also falls short in a number of areas. Consequently, we then extend the regression to address these shortcomings. For school $i$ in district $j$, the baseline regression is

$$D_{ij} = \alpha_0 + \alpha_1 N_{ij} + \alpha_2 Y_{ij} + \alpha_3 G_j + \omega_{ij}. \quad (13)$$

The variable $D_{ij}$ is the logarithm of total contributions to school $i$ in district $j$, and the variable $N_{ij}$ is the logarithm of the number of students in that school. The coefficient on enrollment, $\alpha_1$, is thus the elasticity of total contributions with respect to enrollment. The variable $Y_{ij}$ is a vector of demand variables, in particular, the logarithm of the socio-economic status of families who send their children to the school and the percentage of college graduates in the school’s tract. The variable $G_j$ is the logarithm of state
revenue per pupil in district $j$. The $\alpha$’s are the parameters to be estimated, and $\omega_j$ is a normally distributed error term.

The regression for district contributions has the same form. For district $j$, the regression is

$$D_j = \beta_0 + \beta_1 N_j + \beta_2 Y_j + \beta_3 G_j + \omega_j.$$  

(14)

The variable $D_j$ is the logarithm of total contributions to district $j$, the variable $N_j$ is the logarithm of the number of students in the district, and thus $\beta_1$ is the elasticity of total contributions with respect to enrollment. The variable $Y_j$ is a vector of the two demand variables, percentage graduated from college and the logarithm of parental income. The $\beta$’s are the parameters to be estimated, and $\omega_j$ is a normally distributed error term.

California has over 1,000 school districts and more than 7,000 schools. Of the districts, 296 have just one school. We included the single-school districts in the district-level regression. We also excluded a number of schools. The first exclusion pertains to secondary schools. A substantial share of contributions to high schools is received by athletic booster clubs. High schools are also involved in a number of other fund raising activities, which may be somewhat removed from their main educational mission. For that reason, we dropped high schools and high school districts from our sample.
Table 1
Summary Statistics

Mean
(St. Dev.)

<table>
<thead>
<tr>
<th>Variable</th>
<th>School Level</th>
<th>District Level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Entire Sample</td>
<td>With Contributions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>of $25,000 or more</td>
</tr>
<tr>
<td>Contributions per Pupil</td>
<td>40.9 (155.6)</td>
<td>203.3 (296.1)</td>
</tr>
<tr>
<td>Enrollment</td>
<td>669 (308)</td>
<td>632 (234)</td>
</tr>
<tr>
<td>SES / Income</td>
<td>3.10 (0.69)</td>
<td>3.72 (0.58)</td>
</tr>
<tr>
<td>% College</td>
<td>21.47 (15.07)</td>
<td>33.55 (15.75)</td>
</tr>
<tr>
<td>State Revenue per Pupil</td>
<td>2.827 (272)</td>
<td>2.858 (271)</td>
</tr>
<tr>
<td>Observations</td>
<td>4,840</td>
<td>972</td>
</tr>
</tbody>
</table>

The second exclusion is due to missing data. The School District Data Book excludes 14 of the 58 counties in California, which eliminated the schools and districts in these counties from our sample. After these exclusions, our sample consists of a cross section of 4,840 elementary schools and 659 elementary and unified school districts. Our data are summarized in Table 1.

---

5 The 14 counties are: Butte, El Dorado, Humbolt, Kings, Madera, Mono, Monterey, Napa, San Benito, Shasta, Siskiyou, Tehema, Trinity, and Yolo.
Figure 1
Contributions per Pupil to Schools vs. Socio-Economic Status

For schools with contributions greater than the IRS minimum, we have plotted contributions against two other variables. In Figures 1 and 2, the vertical axis measures contributions per pupil. In Figure 1, the horizontal axis measures the average socio-economic status of parents of the school’s students. As predicted by the theory, contributions per pupil appear to be positively related to socio-economic status. A handful of schools have contributions exceeding $1,000 per pupil. All of these schools have parents of relatively high socio-economic status.
In Figure 2, contributions per pupil are plotted against enrollment. Contributions per pupil appear to be negatively related to enrollment, which is consistent with the theory presented in the previous section. Appearances may be misleading, however, due to the censoring of contributions. Because of the IRS filing rules, we do not observe contributions below $25,000. For schools with 200 pupils, the smallest donation per pupil we can observe is $125. For schools of 600 students, the censoring occurs at $41. The negative relationship between the censoring point and enrollment is clearly visible in Figure 2. It would give the appearance that contributions per pupil are negatively related to enrollment, even if the two variables were unrelated.
We account for this censoring in our analysis. First, the dependent variable is contributions, not contributions per pupil, so the censoring point does not vary with enrollment. Furthermore, to estimate our regressions, we use the Tobit procedure, which accounts for the censoring at $25,000.

Our estimates are reported in the second and third columns of Table 2. In estimating both equations we included a dummy variable, indicating the grade level of a school or district. In the school-level regression, the variable is unity if the school is located in an elementary district. In the district-level regression, the variable is unity if the district is an elementary district.\footnote{We have also estimated these regressions with an expanded list of explanatory variables. To both regressions, we added the percentage of students in each of four racial and ethnic categories: Black, Hispanic, Asian/Pacific Islander, and White. The addition of these variables did not significantly change our estimates of other parameters. Results are available upon request.}
For the most part, the estimated coefficients conform to our expectations. The coefficient on enrollment in the school-level regression is 0.38 with a standard error of 0.07. Similarly, in the district-level regression, the coefficient on enrollment is significantly less than unity. Contributions per pupil fall as enrollment increases.

The coefficients on income are positive in both equations, as expected. Note, however, that the variables measuring income are quite different in the two equations. In the district-level equation, the variable is the average income of families with children in the district’s schools. In the school-level equation, the variable is an index of the socio-economic status of families with children in the school. While the index is undoubtedly correlated with income, it has a different scale, so the coefficient on this variable is not comparable with the income coefficient in the district-level equation.

In the school-level regression, the coefficient on state revenue is negative and statistically significant, as expected. In the district-level regression, however, this coefficient is not significantly different from zero. We believe there is an explanation for this result. Because of school finance reform, state revenue per pupil has been equalized over time, though the process is not yet complete. However, very little variation remains. The standard deviation of state revenue per pupil is $341. With this small variation and the relatively small sample size in the district level regression, it is difficult to estimate the coefficient on state revenue with any precision.
This model does not account for the potential effects of scale economies. Scale economies imply that state revenue per pupil overstates the effective resources of small school districts, and this could bias our estimates. To see the potential problem, let $G_j^*$ represent the effective revenue per pupil in district $j$, measured in logarithms. By effective revenue, we mean state revenue per pupil adjusted for scale economies. Assume the relationship between observed revenue, $G_j$, and effective revenue is

$$G_j^* = \gamma_1 G_j + \gamma_2 N_j + \mu_j,$$

(15)

where $\gamma_1$ and $\gamma_2$ are parameters and $\mu_j$ is a random error term. If there are economies of scale, $\gamma_2$ is positive. Let us also assume that it is effective revenue, not observed revenue, that matters to contributors. Thus, contributions will be a function of effective revenue, yielding the relationship

$$D_{ij} = \alpha_0 + \alpha_1 N_{ij} + \alpha_2 Y_{ij} + \alpha_3 G_j^* + \omega_{ij},$$

(16)

Substituting Equation (15) into Equation (16) yields

$$D_{ij} = \alpha_0 + \alpha_1 N_{ij} + \alpha_2 Y_{ij} + \alpha_3 \gamma_1 G_j + \alpha_3 \gamma_2 N_j + \omega_{ij} + \alpha_3 \mu_j.$$  

(17)

If there are economies of scale, which implies that $\gamma_2$ is positive, the baseline regression for schools has a missing variable, which is district enrollment, $N_j$.

To test for this possibility, we included district enrollment in the school equations. The results are reported in Table 2A in the Appendix. Including district enrollment does not have a significant effect on our estimates, and so we exclude it from subsequent specifications of the school-level regressions.
The first modification to the baseline model is to allow interaction between contributions at the school and district levels. Parents can contribute to either the PTA associated with their children’s school or the educational foundation associated with the school’s district. As a consequence, contributions at the district level may affect contributions at the school level and vice versa. We accounted for this possibility in the following way: In the school-level regression, we included the logarithm of contributions per pupil in each school’s district. This variable is \( D_j - N_j \). In the district-level regression, we included the average of the logarithms of school-level contributions per pupil. The logarithm of contributions per pupil in school \( i \) is \( D_{ij} - N_{ij} \) and the average of the logarithms is 

\[
\bar{D}_j - \bar{N}_j, \quad \text{where } \bar{D}_j \text{ is the average of the } D_{ij} \text{ and } \bar{N}_j \text{ is the average of the } N_{ij}.
\]

This specification raises a number of issues. First, the number of equations varies from district to district because the number of schools varies. To deal with this issue, we averaged the school-level regression across all schools in the district to yield

\[
\bar{D}_j = \alpha_0 + \alpha_1 \bar{N}_j + \alpha_2 \bar{Y}_j + \alpha_3 G_j + \alpha_4 (D_j - N_j) + \bar{\omega}_j, \quad \text{(18)}
\]

where \( \bar{Y}_j \) is the average of the \( Y_{ij} \) and \( \bar{\omega}_j \) is the average of the \( \omega_{ij} \). We then substitute Equation (18) into the district-level regression to yield a reduced form for district-level contributions, \( D_j \). The reduced form is then substituted into the school-level regression to yield a reduced form for school-level contributions, \( D_{ij} \). The reduced form for school-level contributions involves school-level exogenous variables, district-level exogenous variables, and the averages across all schools of school-level exogenous variables. The reduced form for district-level contributions involves district-level exogenous variables and the averages of school-level exogenous variables. Our procedure is to first estimate the reduced forms to obtain the predicted values, \( \hat{D}_{ij} \) and \( \hat{D}_j \). We average the \( \hat{D}_{ij} \) to construct \( \hat{\bar{D}}_j \) and use \( \hat{\bar{D}}_j \) and \( \hat{D}_j \) as instruments in estimating the school-level and district-level structural equations.
A second issue concerns districts with just one school. For these districts, there is no interaction between school- and district-level regressions, and so the framework we have developed doesn’t apply. We therefore dropped single-school districts from our district-level regression, leaving 466 observations.

For identification, we depend on exclusion restrictions. To identify a structural equation in a system of simultaneous equations, there must be at least one excluded exogenous variable for each included endogenous variable. This condition is easily met. The exogenous variables, represented at both the school and district level, are enrollments, parental income, and parental education. The school-level structural equation has one included endogenous variable, district-level contributions, and at least three excluded exogenous variables, district enrollment, district parental income, and district parental education. The enrollments, incomes, and educations in other schools are also excluded. For the district-level structural equation, contributions at all schools are included. However, the coefficients of these variables are restricted to be equal. That is equivalent to having one unrestricted endogenous variable, implying that at least one excluded exogenous variable is sufficient for identification. School-level enrollments, parental incomes, and parental education are excluded.

There are two additional statistical issues. First, because the dependent variables in both regressions are censored from below, we use the Tobit procedure to estimate both the reduced-form and structural equations. Nelson and Olson (1978) show that this two-stage Tobit procedure yields consistent parameter estimates. Second, the complexity of our specification makes it difficult to derive standard errors for parameter estimates. We overcome this problem by using a modification of the bootstrap procedure for simultaneous equation systems developed by Freedman and Peters (1984) and Flood (1985). This procedure yields consistent standard errors and confidence intervals for our parameter estimates.\footnote{The coefficient estimates for the school-level and district-level regressions are listed in Table 3.} A detailed description of the bootstrapping technique is available upon request.
### Table 3

**Coefficient Estimates Allowing for Interactions**

<table>
<thead>
<tr>
<th>Variable</th>
<th>School Level</th>
<th></th>
<th>District Level</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>95% Confidence</td>
<td>Coefficient</td>
<td>95% Confidence</td>
</tr>
<tr>
<td></td>
<td>(St. Error)</td>
<td>Interval</td>
<td>(St. Error)</td>
<td>Interval</td>
</tr>
<tr>
<td>Enrollment</td>
<td>0.40</td>
<td>[ 0.28, 0.51 ]</td>
<td>0.47</td>
<td>[ 0.30, 0.64 ]</td>
</tr>
<tr>
<td></td>
<td>(0.07)</td>
<td></td>
<td>(0.10)</td>
<td></td>
</tr>
<tr>
<td>SES / Income</td>
<td>3.57</td>
<td>[ 3.38, 4.11 ]</td>
<td>1.33</td>
<td>[ -0.51, 2.02 ]</td>
</tr>
<tr>
<td></td>
<td>(0.22)</td>
<td></td>
<td>(0.76)</td>
<td></td>
</tr>
<tr>
<td>% College</td>
<td>2.70</td>
<td>[ 2.18, 3.00 ]</td>
<td>6.51</td>
<td>[ 3.22, 8.51 ]</td>
</tr>
<tr>
<td></td>
<td>(0.24)</td>
<td></td>
<td>(1.60)</td>
<td></td>
</tr>
<tr>
<td>State Revenue per Pupil</td>
<td>-1.66</td>
<td>[ -2.36, -0.95 ]</td>
<td>2.14</td>
<td>[ 0.01, 4.04 ]</td>
</tr>
<tr>
<td></td>
<td>(0.42)</td>
<td></td>
<td>(1.22)</td>
<td></td>
</tr>
<tr>
<td>District-level</td>
<td>0.10</td>
<td>[ 0.05, 0.14 ]</td>
<td>----</td>
<td>----</td>
</tr>
<tr>
<td>Contributions</td>
<td>(0.03)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>School-level</td>
<td>----</td>
<td>----</td>
<td>-0.29</td>
<td>[ -0.62, 0.64 ]</td>
</tr>
<tr>
<td>Contributions</td>
<td></td>
<td></td>
<td>(0.40)</td>
<td></td>
</tr>
<tr>
<td>Elementary District</td>
<td>-0.22</td>
<td>[ -0.33, -0.09 ]</td>
<td>-0.21</td>
<td>[ -0.63, 0.16 ]</td>
</tr>
<tr>
<td></td>
<td>(0.07)</td>
<td></td>
<td>(0.24)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(3.46)</td>
<td></td>
<td>(9.28)</td>
<td></td>
</tr>
</tbody>
</table>

Including interactions between donations at the two different levels has little effect on the estimated coefficients. In particular, the enrollment coefficients in Table 3 are not much different from those in Table 2. The coefficient in the school-level regression increases from 0.38 to 0.40, and the coefficient in the district-level regression decreases from 0.56 to 0.47.

Before accepting those estimates, there are two further issues to investigate. First, families in a school district have a choice between public and private schools, and that choice may bias our estimates. The potential for bias is best explained with an example. Suppose a school district is blessed with a wealthy benefactor who annually donates a large sum to the district. The donation improves the quality of schools in the district, attracting some students who would otherwise attend private school. Because
private school enrollment is correlated with parental income and education, the parents of these students are likely to be wealthier and more educated than average. In terms of our district-level regression, the benefactor’s annual donation is a positive realization of the error term. It causes higher enrollment, higher parent income, and a higher parent education in the district. Consequently, it also induces correlation between the error term and the enrollment, income, and education variables in the district-level regression, correlation which may bias coefficient estimates.

To address this potential problem, we have re-estimated the equations using instrumental variables. For public school enrollment in a district, our main instrument is the number of all pupils, public and private school, in the district. For the average income of public school families, our main instrument is the average income of all families residing in the district who have children attending either a public or private school. Likewise, for the percentage of public school parents with a college education, our main instrument is the percentage of all parents residing in the district with a college education. All three variables are taken from the School District Data Book.

In addition to the three main instruments, we also included three other variables that may affect the percentage of families who send their children to public schools. The first is the percentage of Catholics living in the district. We formed a proxy for this variable using the ancestry variable from the Census. The second variable is the average number of children per family. We included this variable because the cost of private education is higher for families with many children. The third variable is the number of private schools per square mile in the county, which is a measure of proximity to private schools.

The choice between public and private schools may also affect variables at the school level. In particular, it may affect both school enrollment and our measure of parental income. We do not expect it to affect our proxy for parental education because that proxy is the percentage of college graduates in the tract, not the percentage of public school parents with a college degree. For average income, our main instrument is the income of families in the school’s census tract. We also included the average number
of children per family in the tract and our proxy for the percentage Catholic in the tract. Our main instrument for school enrollment is the ratio of the school’s enrollment to the district’s enrollment. Our rationale for this instrument is that a district will attempt to balance the usage of its facilities by transferring students from overcrowded schools to other schools that are not fully utilized. As a consequence, the ratio of school enrollment to district enrollment will remain approximately constant as district enrollment changes.

To form instrumental variables for endogenous variables, we followed the two-stage least squares approach, with modifications to account for the variation in the number of schools across districts. In forming instruments for district enrollment, income, and percentage college, we regressed those three variables on all of the district-level instruments and exogenous variables and the averages of school-level instruments and exogenous variables. In forming instruments for the socio-economic status of a school’s parents and school enrollment, we regressed those variables on the school-level exogenous variables, the school-level instruments, the averages of the school-level instruments for all schools in the district, and the district-level instruments and exogenous variables. We follow the same procedure to form instruments for district-level contributions in the school-level regressions and for school-level contributions in the district-level regressions.
## Table 4

**Coefficient Estimates Controlling for Private School Choice**

<table>
<thead>
<tr>
<th>Variable</th>
<th>School Level</th>
<th></th>
<th>District Level</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>95% Confidence Interval</td>
<td>Coefficient</td>
<td>95% Confidence Interval</td>
</tr>
<tr>
<td></td>
<td>(St. Error)</td>
<td></td>
<td>(St. Error)</td>
<td></td>
</tr>
<tr>
<td>Enrollment</td>
<td>0.29</td>
<td>[ 0.17, 0.38 ]</td>
<td>0.54</td>
<td>[ 0.41, 0.74 ]</td>
</tr>
<tr>
<td></td>
<td>(0.06)</td>
<td></td>
<td>(0.10)</td>
<td></td>
</tr>
<tr>
<td>SES / Income</td>
<td>5.94</td>
<td>[ 5.41, 6.57 ]</td>
<td>0.50</td>
<td>[ - 0.94, 1.38 ]</td>
</tr>
<tr>
<td></td>
<td>(0.35)</td>
<td></td>
<td>(0.74)</td>
<td></td>
</tr>
<tr>
<td>% College</td>
<td>1.04</td>
<td>[ 0.51, 1.42 ]</td>
<td>4.62</td>
<td>[ 3.33, 6.65 ]</td>
</tr>
<tr>
<td></td>
<td>(0.28)</td>
<td></td>
<td>(1.04)</td>
<td></td>
</tr>
<tr>
<td>State Revenue per Pupil</td>
<td>- 1.00</td>
<td>[ - 1.61, -0.29 ]</td>
<td>2.90</td>
<td>[ 0.93, 4.37 ]</td>
</tr>
<tr>
<td></td>
<td>(0.40)</td>
<td></td>
<td>(1.07)</td>
<td></td>
</tr>
<tr>
<td>District-level</td>
<td>0.003</td>
<td>[ - 0.05, 0.04 ]</td>
<td>----</td>
<td>----</td>
</tr>
<tr>
<td>Contributions</td>
<td>(0.03)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>School-level</td>
<td>----</td>
<td>----</td>
<td>0.25</td>
<td>[ - 1.30, 0.74 ]</td>
</tr>
<tr>
<td>Contributions</td>
<td></td>
<td></td>
<td>(0.27)</td>
<td></td>
</tr>
<tr>
<td>Elementary District</td>
<td>- 0.21</td>
<td>[ - 0.31, - 0.09 ]</td>
<td>- 0.08</td>
<td>[ - 0.45, 0.25 ]</td>
</tr>
<tr>
<td></td>
<td>(0.07)</td>
<td></td>
<td>(0.23)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(3.43)</td>
<td></td>
<td>(9.68)</td>
<td></td>
</tr>
</tbody>
</table>

The coefficient estimates using those instruments are reported in Table 4. The most notable change is the enrollment coefficient in the school-level equation, which decreases from 0.40 to 0.29. On the other hand, the enrollment coefficient in the district-level equation increases from 0.47 to 0.54, nearly its value in the baseline model.

The second issue to investigate is Tiebout bias: Does the choice of school districts by families bias our results? To understand the potential for bias, consider again the example of the school district with a wealthy benefactor. Because of the benefactor’s contribution, the district attracts families with school children. There is competition for space in the district, which is rationed by housing prices, and higher income families tend to win the competition. Just as in the case of private school choice, this may
create a positive correlation between the error term and the enrollment, income and percentage college variables in the regression.

To account for this potential bias, we have re-estimated our contributions regressions using a different set of instruments. As the main instrument for public school enrollment in a district, we chose the total number of housing units in the district. The idea behind our choice is that, while families may move in response to differences in contributions, the housing stock in a district is more or less fixed, at least in the short run. As a consequence, that stock is not likely to be correlated with the error terms in the contribution regressions, which is necessary for a valid instrument.

As main instruments for average income and the percentage of parents with a college education, we chose four variables. The first is the average number of rooms per house in the district. The rationale for the first instrument is that large houses will tend to attract wealthy families. Furthermore, as long as the housing stock is more or less fixed, this variable is not likely to be correlated with the error terms. The second instrument is a dummy variable indicating whether the district is in a metropolitan area with more than 500,000 inhabitants. This variable proxies for land prices, which affect the price of housing and thus the demand for house size. The third instrument is the district’s 1982-83 scores on the California Assessment Program math test. The rationale here is that school districts develop reputations for quality that persist over time and attract parents with high income and educational attainment. Test scores from a decade ago may capture this reputation, yet would not be affected by current contributions received by the district. For a similar reason, we included the fourth instrument, which is the district’s revenue per pupil in 1979-80 from property taxes and state non-categorical aid.

Tiebout sorting may also affect the enrollment, income, and education variables at the school level. Our approach is similar to that for the district-level regression. Our instruments for the

---

8 Tiebout bias in estimating public school demand is analyzed by Rubinfeld, Shapiro and Roberts (1987) and by Reid (1990).
9 The areas are the Bakersfield MSA, the Fresno MSA, the Los Angeles-Anaheim-Riverside CMSA, the Sacramento MSA, the San Diego MSA, and the San Francisco-Oakland-San Jose CMSA.
school-level regression are the school’s third-grade 1982-83 math scores on the California Assessment Program test and the average number of rooms per house in the school's census tract. As our main instrument for school enrollment, we continue to use the ratio of the school's enrollment to the district's enrollment.

We do not have data on these instruments for several schools and districts. In particular, we have test score data for only 4,066 of the 4,840 schools and revenue data for only 437 of the 466 school districts. We deleted from our sample observations with missing data.

The choice between public and private schools is part of a family’s choice of school district. If it chooses the private sector, a family is more likely to reside in a district with mediocre public schools and thus lower housing prices. The attractiveness of this option also depends on the quality and quantity of private schools. To account for this factor, we continue to use the density of private schools (private schools per square mile) as an instrument. To form instrumental variables, we use the same two-stage least squares approach as in the regressions reported in Table 4.
Table 5

Coefficient Estimates Controlling for Tiebout Bias

<table>
<thead>
<tr>
<th>Variable</th>
<th>School Level</th>
<th>District Level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>95% Confidence Interval</td>
</tr>
<tr>
<td></td>
<td>(St. Error)</td>
<td></td>
</tr>
<tr>
<td>Enrollment</td>
<td>0.25</td>
<td>[ 0.10, 0.39 ]</td>
</tr>
<tr>
<td></td>
<td>(0.08)</td>
<td></td>
</tr>
<tr>
<td>SES / Income</td>
<td>3.38</td>
<td>[ 2.54, 4.45 ]</td>
</tr>
<tr>
<td></td>
<td>(0.58)</td>
<td></td>
</tr>
<tr>
<td>% College</td>
<td>5.53</td>
<td>[ 4.05, 6.71 ]</td>
</tr>
<tr>
<td></td>
<td>(0.81)</td>
<td></td>
</tr>
<tr>
<td>State Revenue per Pupil</td>
<td>- 3.70</td>
<td>[ - 4.76, -2.35 ]</td>
</tr>
<tr>
<td></td>
<td>(0.72)</td>
<td></td>
</tr>
<tr>
<td>District-level Contributions</td>
<td>0.05</td>
<td>[ - 0.01, 0.11 ]</td>
</tr>
<tr>
<td></td>
<td>(0.03)</td>
<td></td>
</tr>
<tr>
<td>School-level Contributions</td>
<td>----</td>
<td>----</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elementary District</td>
<td>- 0.39</td>
<td>[ - 0.55, -0.23 ]</td>
</tr>
<tr>
<td></td>
<td>(0.09)</td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>31.67</td>
<td>[ 19.88, 40.77 ]</td>
</tr>
<tr>
<td></td>
<td>(6.21)</td>
<td></td>
</tr>
</tbody>
</table>

The results using this new set of instruments are reported in Table 5. The estimates of the elasticity of contributions with respect to enrollment are similar to those in Table 4.

These estimates allow us to infer how group size affects the extent of cooperation. That effect is measured by the elasticity of price with respect to enrollment. From Equation (12), this elasticity is the elasticity of contributions per pupil with respect to enrollment divided by the elasticity of contributions per pupil with respect to price. The formula for the latter is in Equation (7). In the last row of Table 6, the two equations are combined to yield a formula for the elasticity of price with respect to enrollment. The Table summarizes our calculation of that elasticity.
Table 6

Estimates of the Elasticity of Cooperation

<table>
<thead>
<tr>
<th>Description</th>
<th>Source</th>
<th>Average</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\frac{d}{s}$ Contributions as a fraction of total spending</td>
<td>Table 1</td>
<td>0.07</td>
<td>(0.04, 0.10)</td>
</tr>
<tr>
<td>$\epsilon_{s,p} + \lambda \epsilon_{s,y}$ Elasticity of compensated demand with respect to price</td>
<td>Published Sources*</td>
<td>-0.31</td>
<td>(-0.54, -0.13)</td>
</tr>
<tr>
<td>$\epsilon_{d,n}$ Elasticity of contributions per pupil with respect to enrollment</td>
<td>Regressions reported in Tables 2, 3, 4, and 5</td>
<td>-0.67</td>
<td>(-0.90, -0.48)</td>
</tr>
<tr>
<td>$\epsilon_{p,n}$ Elasticity of cooperators with respect to enrollment</td>
<td>$\frac{d}{s} \left( \frac{\epsilon_{d,n}}{\epsilon_{s,p} + \lambda \epsilon_{s,y}} \right)$</td>
<td>0.15</td>
<td>(0.06, 0.48)</td>
</tr>
</tbody>
</table>

*Bergstrom, Rubinfeld, and Shapiro (1982), Rubinfeld and Shapiro (1989), and Rubinfeld, Shapiro, and Roberts (1987).

The first row of Table 6 concerns the share of total school spending due to contributions. As reported in Table 1, for schools with contributions exceeding $25,000, the average contribution per pupil is $203, and the average for state revenue is $2,883, yielding a share of approximately 7%. To test the sensitivity of our calculations, we also report calculations using a share of 4% and a share of 10%.

The second row of Table 6 presents calculations of $\epsilon_{s,p} + \lambda \epsilon_{s,y}$. This expression can be approximated by the price elasticity of compensated demand for spending per pupil. The parameter $\lambda$ is $pg/y$. Because contributions are a small fraction of total school revenue, $g$ will be approximately equal to $s$, and $\lambda$ will be approximately equal to $ps/y$, which is the share of income devoted to school spending. With that approximation, $\epsilon_{s,p} + \lambda \epsilon_{s,y}$ is the price elasticity of parents’ compensated demand for public school spending.

Several studies have estimated the demand function for public school spending. Bergstrom, Rubinfeld, and Shapiro (1982) estimated the price and income elasticities of that function and reported estimates from seven other studies. Rubinfeld and Shapiro (1989) and Rubinfeld, Shapiro and Roberts (1987) also estimated those elasticities, giving us ten estimates in total. Using the Slutsky equation and...
the fact that spending on public elementary and secondary education is about 4% of personal income, we calculated the compensated price elasticity implied by each of the estimates of price and income elasticities. The compensated elasticities ranged from a low of −0.70 to a high of −0.11. In the following calculations, we represent the range of those estimates as well as their central tendency. We drop both the lowest and highest estimates and present calculations based on the remaining eight. The lowest, highest, and average of the eight are presented in the second row of Table 6.

The third row summarizes our estimates of the elasticity of contributions per pupil with respect to enrollment. The regressions reported in Tables 2, 3, 4, and 5 give estimates of the elasticity of total contributions with respect to enrollment. We use the estimates from the school-level regression because we have more confidence in the school-level data. There are four estimates using that data, and the average of the four is 0.33. For the range of this elasticity, we have used the union of the 95% confidence intervals for the four estimates. The resulting range is (0.10, 0.52). Converting these estimates to elasticities of contributions per pupil yields an average of −0.67 and a range of (−0.90, −0.48).

In Row 4, the estimates in Rows 1, 2 and 3 are combined to give estimates of the elasticity of cooperators with respect to group size. For an average estimate, we used the averages in Rows 1, 2 and 3. For the range, we calculated the elasticity for each combination of the end points for the ranges reported in Rows 1, 2 and 3. We then took the lowest and highest numbers for the range of $\epsilon_{p,n}$. The average is 0.15, and the range is (0.06, 0.48). According to our average estimate, a doubling of school enrollment increases the price of spending per pupil by 15%. Cooperation does decline with increases in school size, but the rate of decline is relatively slow.

The relationship between contributions and group size has been examined in four empirical papers. In their study of contributions to public television stations, Goetze, Glover, and Biswas (1993) find that contributions per viewer are inversely related to the number of viewers. However, because public television is arguably a pure public good for which the marginal cost of adding another viewer is zero, this finding is not evidence of less than fully cooperative behavior. Even if the good were financed
through a purely cooperative Lindahl equilibrium, contributions per person would fall with the number of viewers if the price elasticity of demand were less than unity. In his study of contributions to public radio, Brunner (1998) finds similar results. In addition, he is able to compare his results to the prediction of the non-cooperative, Nash equilibrium model. He finds, while contributions per listener fall with the size of the audience, they do not fall as rapidly as predicted by the non-cooperative model, a result that is consistent with our findings.

There are also two empirical studies of the effect of congregation size on contributions to churches. Lipford (1995) finds that contributions per church member do not fall with the size of the congregation, which is evidence that cooperation does not deteriorate with group size. In contrast, Zaleski and Zech (1996) find that contributions per member do fall with congregation size. Because there is no independent estimate of the price elasticity of church contributions, it is not possible to infer the extent of cooperation implied by this estimate.

Isaac and Walker (1988) and Isaac, Walker, and Williams (1994) report the results of several experiments involving group size and contributions to a public good. Through their experimental design, they are able to isolate two different effects of group size. The first is the effect on the marginal payoff an individual receives from contributing to the public good, and the second is the effect of size alone, holding marginal payoff constant. They find that the first effect is significant, but the second is not. At one level, the results of these two experiments are consistent with the results reported in this paper. It is the marginal payoffs that count, not the size of the group itself. This is exactly the way in which we have interpreted the data we observe. On a somewhat deeper level, however, the connection between the experimental studies and our results is not so clear. In the theory of partial cooperation we have presented, there is not a simple relationship between group size and marginal payoff. The marginal payoff depends also on a behavioral response. It depends on how the number of cooperators changes in response to an increase in the size of the total group. We have found this response to be considerable.
4. Conclusion

As several newspapers have discovered, contributions to California’s public schools make a good story. In the typical article, an affluent neighborhood raises several thousand dollars for an array of educational services at its public school. Meanwhile, in a less affluent neighborhood, another school has no contributions and none of those services. The article describes California’s school finance reform and its relatively low level of spending per pupil. Who can fault the affluent neighborhood for supplementing its school’s revenues? Yet, is it fair that the other school has no supplemental revenue? In a state where equity in school spending has been the policy for nearly thirty years, this story has a receptive audience.

We wondered whether this story is an accurate characterization of general conditions. Has voluntary fiscal federalism undermined the fiscal equity achieved by school finance reform? We talked with school principals, foundation organizers, and PTA leaders, and we collected data on contributions. The data revealed that voluntary fiscal federalism has not seriously undermined school finance reform. There are schools in which contributions exceed $1,000 per pupil, but they are small in number. Though we suspect there may be large variations across schools in volunteer time, we have no direct evidence of this. However, based on the evidence we do have, we conclude that voluntary contributions are a small percentage of revenue in all but a handful of schools.

Why hasn’t voluntary fiscal federalism been a more significant factor? Parents certainly have unmet demands for school services. Why haven’t they contributed more to their schools? The answer comes from our theories of collective action, theories that explain why groups of individuals may fail to act in their common interest. In fact, from that perspective, the surprise may be that contributions are as large as they are. Certainly, parents do not act as predicted by the Nash model of contributions. They do not act as if the price of spending per pupil were \( n \), the number of pupils. They seem to act as if the price were considerably less than \( n \).

In Section 2, we outlined a simple model that would rationalize this observed activity. In the model, there are cooperators and free riders, and the price of spending per pupil is determined by the
percentage who cooperate. We hypothesized that this price would increase with the size of the school.

In Section 3, we estimated the relationship between this price and school size. We found that the
elasticity of price with respect to school size was relatively low. Our best estimate is 0.15, indicating that
a doubling of school size would result in only a 15% increase in the price of spending per pupil. Based
on that estimate, cooperation appears to deteriorate quite slowly.

Our estimate is based on a range of enrollments that fall mostly between 100 and 1,000 students.
To get a better feel for the implications of our estimates, let us make the admittedly heroic assumption
that the elasticity is constant for all sizes. In combination with the condition that price must converge to
unity as enrollment decreases, that assumption implies the following formula for price: \( p = n^{0.15} \).
According to that formula, the price of spending per pupil for a school of 300 students is $2.35. For a
school of 600 students, the price rises to $2.61. At 900 students, the price is $2.70. To us, the price at a
large school does not seem that much higher than at a small school, reflecting our conclusion that
cooperation deteriorates slowly.

From another perspective, however, the prices at all schools are quite high. They are more than
twice as high as they would be if families could tax themselves to raise revenue for their schools. In that
sense, even if cooperation is considerable, voluntary fiscal federalism is a poor substitute for the taxing
authority of government.
Appendix

The condition for an interior equilibrium is

\[ h(w, f(p, w + pg), n) - p(f(p, w + pg) - g) = 0. \]  \hspace{1cm} (A1)

If the conditions of the implicit function theorem hold, this equation defines \( p \) as a function of \( w, g, \) and \( n \). Those two conditions are that the partial derivatives of the function on the left of (A1) are continuous and that the partial derivative of this function with respect to \( p \) is not equal to zero. We assume that the partial derivatives are continuous. The second condition is satisfied by the stability condition in (9).

The implicit function theorem implies the following partial derivatives:

\[ \frac{\partial p}{\partial n} = -\frac{\partial h}{\partial n}/J \]  \hspace{1cm} (A2)

\[ \frac{\partial p}{\partial w} = \left( p - \frac{\partial h}{\partial s} \right) \frac{\partial f}{\partial y} - \frac{\partial h}{\partial w}/J \]  \hspace{1cm} (A3)

\[ \frac{\partial p}{\partial g} = p \left( \left( p - \frac{\partial h}{\partial s} \right) \frac{\partial f}{\partial y} - 1 \right)/J \]  \hspace{1cm} (A4)

The denominators in (A2), (A3), and (A4) are positive from the stability condition (9). If the reservation cost of free riding declines with enrollment, the numerator of (A2) is also positive, and the price of spending per pupil rises with enrollment. The numerators of (A3) and (A4) could be either positive or negative, and thus the theory does not predict how changes in income and government spending affect equilibrium price.
Table 2A

Coefficient Estimates with Economies of Scale Correction

School-Level Regression

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient (St. Error)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enrollment</td>
<td>0.39 (0.07)</td>
</tr>
<tr>
<td>SES</td>
<td>3.77 (0.22)</td>
</tr>
<tr>
<td>% College</td>
<td>3.12 (0.25)</td>
</tr>
<tr>
<td>State Revenue per Pupil</td>
<td>-1.18 (0.42)</td>
</tr>
<tr>
<td>Elementary District</td>
<td>-0.15 (0.08)</td>
</tr>
<tr>
<td>District Enrollment</td>
<td>-0.02 (0.02)</td>
</tr>
<tr>
<td>Constant</td>
<td>10.94 (3.50)</td>
</tr>
</tbody>
</table>
References


