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Estimating the effects of school finance reform: a framework for a federalist system

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Abstract

This paper models the effect of increased state involvement in school funding on education spending levels. Unlike previous studies that have assumed perfect sorting of voters into districts by income, this analysis assumes demand sorting. I, thus, am able to utilize the true distribution of wealth across districts to estimate tax price changes and to predict changes in district spending levels in response to a change in financing rules. I look specifically at three types of state funding programs: those in which districts receive a set per pupil grant from the state and are not allowed to raise additional funds, those in which districts are allowed to raise unlimited additional funds, and those in which this supplementation is capped. Both the model and the subsequent simulations indicate that the ostensible benefits of a system with unlimited local supplementation – that it retains much local control over funding decisions on the margin while insuring an 'adequate' level of financing for all districts – may not be sustainable because high wealth districts have no incentive to support state funding. Additionally, a system with no local supplementation may be politically difficult because it forces many voters far from their preferred spending levels. Capped supplementation provides a balance between local control and spending equity.

Keywords: School funding; Local supplementation; Education spending

1. Introduction

School finance has changed dramatically during the past 25 years. As a result of

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both litigation and the desire for property tax relief, state governments have acquired greater control over school funding decisions. Until recently, little was known about the impact of shifting from local to state funding nor the importance of the type of state finance system chosen. Several studies of the ex post effect of such reforms on the levels of school spending find mixed results (Downes and Shah, 1995; Hoxby, 1995; Silva and Sonstelie, 1995; Manwaring and Sheffrin, 1997; Murray et al., 1998). Given the lack of consensus on the consequences of shifting to state control, it is particularly important to understand the mechanisms affecting the aggregate level and inter-jurisdictional equity of spending.

This paper introduces a model that highlights the importance of the structure of the school finance system and of the distribution of tax base wealth across school districts in determining the impact of increased state control. I use district level spending before a shift to state funding to predict funding levels after such a shift under a variety of financing structures. I base these predictions on 2 assumptions: (1) when schools are locally financed residents sort themselves into districts by demand for school spending, but (2) when schools are financed at the state level the median voter is pivotal in determining funding levels. I look specifically at three types of state funding programs: those in which districts receive a set per pupil grant from the state and are not allowed to raise additional funds, those in which districts are allowed to raise unlimited additional funds, and those in which this supplementation is capped. Both the model and the subsequent simulations indicate that the ostensible benefits of a system with unlimited local supplementation – that it retains much local control over funding decisions on the margin while insuring an 'adequate' level of financing for all districts – may not be sustainable because high wealth districts have no incentive to support state funding. Additionally, a system with no local supplementation may be politically difficult because it forces many voters far from their preferred spending levels. I find that capped supplementation provides a balance between local control and spending equity.

The method introduced improves on previous models – such as those presented in Fernandez and Rogerson (1995) and Silva and Sonstelie (1995) – by utilizing the actual distribution of tax base wealth across districts, instead of assuming perfect sorting of residents into districts by income. Because this tax base distribution and the associated tax prices are important determinants of the demand for public goods, models that assume perfect income or wealth sorting generally will not be able to capture the true economic effect of a shift toward increased state funding of schools. Additionally, because the model is directly tied to observable data there is a natural empirical application.

Section 2 provides background on school finance and past literature. Section 3 develops the model of local and state spending determination. Section 4 applies the model to data on Michigan schools to demonstrate the usefulness and applicability. The final section summarizes and concludes.

2. Background

A number of forces affect the level and distribution of school funds resulting from an increase in state control of school finance. First, political factors may be important. Spending changes may occur simply from the increased prominence of education issues due to reform or litigation (Manwaring and Sheffrin, 1994, 1997; Figlio and Downes, 1997). In addition, differences in how decisions are made at state and district levels may influence these changes. Theobald and Picus (1991), for example, hypothesize that increased competition for funds in the state legislature will negatively impact average per pupil spending. There may be differences in funding due to differences in voter confidence in local versus state governments, as well.

In addition to funding changes resulting directly from increased state participation, there generally will be price and income effects associated with such changes. Prior studies that have compared state and local school finance systems in a public finance framework have assumed perfect sorting of individuals into districts by income in their estimation of price and income effects (Fernandez and Rogerson, 1995; Silva and Sonstelie, 1995). These studies have been particularly interested in the change in average spending per pupil resulting from the centralization of school finance. The 'income effect' in this case comes from the fact that the demand of the median voter determines average spending when funds are determined at the state level while the voter with average demand determines average spending when funding is determined locally. If the voter with average demand has much higher income than the median-demand voter, then the income effect will lead to lower spending at the state level. With the additional assumption that demand is proportional to income, the voter with the average demand will be the voter with the average income. Because median income is substantially below mean income in most states, these studies have postulated a large negative income effect from a shift to state funding. In Michigan in 1989, for example, the median household income was only 80% as high as average household income. However, median per pupil spending was 98% as high as mean per pupil spending. This suggests that either the assumption of perfect income sorting and/or the assumption that demand is proportional to income is inconsistent with the data. These assumptions may lead to a substantial overestimation of the negative income effect resulting from a shift to state funding.

The price effect comes from the difference in per pupil tax base available to voters locally as compared to statewide. Again, because median income is generally less than mean income both nationally and within states, models that assume perfect income sorting have concluded that the median voter will see a price decrease on a shift to state funding. This price decrease would then increase the median voter's demand. In fact, the distribution of tax base across districts, *not* the overall distribution of income, determines whether the median voter has a

positive or negative price effect. Even with an overall skewed distribution, it is possible for the tax price under local finance to equal the tax price under state finance for the median voter (if, for example, all districts have identical skewed distributions). Alternatively, the local tax price may be greater than the state tax price for the median voter (if, for example, all districts are identical except for one low-income district). Finally, the local tax price may be less than the state tax price for the median voter (if, for example, all districts are identical except for one high-income district). Thus, even though statewide mean income is greater than median income, the median voter may not experience a price decrease when funding shifts to the state level.

Empirically, the distribution of the tax base across districts and the relationship between local and state tax price for the majority of residents differs by state. According to the National Center for Education Statistics School District Data Book, in 40 of the 44 states with usable data, between 40 percent and 60 percent of residents over 20 years of age (a proxy for voters) live in districts with higher total income per pupil than the state aggregate income per pupil. Although in 26 of these states over 50% of voters face higher district than state income tax prices, the reverse is true in the other 18 states. In these cases it is quite possible that the median voter in the state will have a higher state than local tax price.

The data suggest that the assumption of perfect income sorting will bias estimates of both price and income effects corresponding to a shift to state funding of schools because it does not effectively characterize the distribution of resources in many states. The advantage of assuming sorting by demand, which incorporates heterogeneity in both income and preferences, is that it allows the use of the actual resource distribution to estimate demand for school spending.

2.1. School finance systems

In order to assess the price and income effects associated with a shift to state funding, we need to know the structural details of the chosen finance mechanism. States contribute to school funds either through foundation grant programs, in which they provide a set per pupil grant to each district, or through power equalization schemes, in which districts choose their own level of funding and states supplement poorer districts so that the effective tax base per pupil is at least as great as a target amount. Some states mix the two systems.

Power equalization has the advantage of continuing local control while providing state aid to poorer districts. However, because with equal tax prices richer districts are likely to demand more per pupil spending than poorer districts, even a complete system of power equalization will not lead to equal funding nor to the elimination of the positive correlation between district wealth and school spending. A foundation system with local supplementation also will not lead to equal funding across districts. Nechyba (1995), using a computable general equilibrium model, in fact, predicts that while both power equalization and

foundation grant systems with local supplementation increase the attractiveness of lower income communities, only the power equalization system, because of its inherent price effects, is likely to lead to increased inter-jurisdictional equity. A foundation grant system with no local supplementation of funds guarantees equal spending but eliminates all local control.

Since foundation grant programs are both more common and the standard for recent reform, the following discussion addresses these systems. The focus is on three types of foundation grant systems: those in which districts receive a set per pupil grant from the state and are not allowed to raise additional funds (an approximation of the California system), those in which districts are allowed to raise unlimited additional funds (Illinois), and those in which such supplementation is capped (Michigan). The same approach may be applied to other finance systems as well.

3. A model of district and state spending determination

The framework is based on a simple model of consumer choice. When spending on education is locally determined, individuals sort themselves into districts according to their demand for school spending. When funding is determined at the state level, however, residents vote on spending levels so that the median voter's demand determines the level of state aid to districts.

Start with the assumption that individuals' utilities depend upon their tastes, as well as their consumption of non-schooling goods and of school quality. While the relationship between school quality and school expenditures is likely to vary across districts and schools, for this analysis I assume that quality can be measured by school expenditure. Assume that individual i in district k has preferences given by the utility function $U_i(X_{ik}, E_k)$, where $X_{ik}$is consumption not including public schooling and E_k is public school expenditures in district k. Tastes vary across individuals as indicated by the subscript on $U_i(\cdot)$. Person i then would prefer the spending per student that maximizes $U_i(X_{ik}, E_k)$, subject to the budget constraint, $X_{ik} + p_{ik}E_k = Y_{ik}$; where p_{ik} is individual i's tax price of a dollar of spending per student, Y_{ik} is individual i's income, and the price of private consumption is normalized to 1. As long as $U_i(\cdot)$ is strictly quasi-concave in X_{ik} and E_k, preferences are singled peaked and such maximization will result in a unique optimal demand for school expenditures, $E^*_{ik}(p_{ik}, Y_{ik})$ (Black, 1958).

I will assume that all expenditures on schools in district k come from revenues raised at either the district level or the state level. Let S_k be spending per pupil in district k (measured in dollars) that comes from state raised revenues, and let D_k be the spending per pupil that comes from district raised revenues. As long as expenditures equal revenues, $E_k = S_k + D_k$. Similarly, let s_{ik} be person i's tax price for a dollar of spending per pupil coming from state raised revenues and d_{ik} be

person i's tax price for a dollar of spending per pupil coming from district raised revenues.

First consider a system of school finance in which funding is under local jurisdiction. Call this System A. Only the district tax price is relevant because all revenues are raised locally. Person i will want D_k to maximize $U_i(Y_{ik} - d_{ik}D_k, D_k)$. Let $D_{ik}^{A*} \equiv E_{ik}^{*}(d_{ik}, Y_{ik})$ be i's optimal level of funding. If people sort themselves into school districts so that all residents receive their optimal level of school expenditures at their given tax price, we can use district expenditure data to identify individuals' demand for education spending (Tiebout, 1956).

$$D_{ik}^{A*} \equiv D_k^A \ \forall i \tag{1}$$

Next, consider the case in which all funding is done at the state level (System B). For this case the state tax price is relevant. Let $S_{ik}^{B*} \equiv E_{ik}^{*}(s_{ik}, Y_{ik})$ be i's optimal per pupil school spending level. As long as the demand function for school spending, $E_{ik}^{*}(p_{ik}, Y_{ik})$, is downward sloping, demand for expenditures will be lower under System A than System B for all those with higher district than state tax prices. Similarly, demand will be lower under System B than System A for all those with higher state than district tax prices.

Now place the additional restriction on demand that over the ranges of tax prices and incomes in question each person's demand can be estimated with constant price and income elasticities. Let α be the price elasticity of demand and β be the income elasticity of demand.[1] This leads to demand functions of the following form: $E_{ik}^{*} = \gamma_{ik} p_{ik}^{\alpha} Y_{ik}^{\beta}$, where γ_{ik} is an individual specific multiplier. This specification assumes that voters differ both in income and in their taste for education spending. In a system of complete local control, this demand function reduces to: $D_{ik}^{*} = \gamma_{ik} d_{ik}^{\alpha} Y_{ik}^{\beta}$.

For simplicity, assume that taxes are raised with a proportional tax on income at both the local and state level. An individual's tax price, then, will be her income divided by total income per pupil. If n_k is the number of public school pupils in district k and N is the total number of pupils in the state, ($N = \Sigma_l \ n_l$), then $d_{ik} = Y_{ik} n_k / \Sigma_j \ Y_{jk}$ and $s_{ik} = Y_{ik} N / \Sigma_l \ \Sigma_j \ Y_{jl}$.[2] Assume that no financial support for

[1]Constant price and income elasticity demand functions do not correspond to a single nicely behaved utility function. An alternative choice would be to use a specific utility function, such as a constant elasticity of substitution or a quasi-linear utility function, which does have properties, such as quasi-concavity, that I am interested in. However, these utility functions place severe restrictions on local elasticities, especially the income elasticity of demand, which are unlikely to correspond with consumer behavior and are theoretically unnecessary. In addition, since previous studies have tended to estimate demand elasticities instead of utility parameters, the model chosen may be more useful for empirical investigations than one based on a particular utility function.

[2]In fact, property taxes are the source of most local revenues. Here I assume an income tax in order to postpone discussion of the incidence of the property tax. Such a discussion appears in Section 4.

schooling comes from private donation[3] and that if there is a shift from district to state funding, people do not move among districts and property values do not change as a result of the shift.[4] Finally, assume a decisive median voter determines state level funding.

With these additional assumptions, the level of state funding under System B can be written as a function of System A funding levels:

$$S_{ik}^{B}* \equiv E_{ik}^{*}(s_{ik}, Y_{ik}) = \gamma_{ik} s_{ik}^{\alpha} Y_{ik}^{\beta} = D_k^A \left(\frac{s_{ik}}{d_{ik}}\right)^{\alpha} = D_k^A \left(\frac{N \sum_j Y_{jk}}{n_k \sum_l \sum_j Y_{jl}}\right)^{\alpha} \tag{2}$$

The optimal level of state funding is the same for each resident of district k since the ratio of state to district tax price is the same. The actual level of funding would then be the median demand of all voters in the state.

$$S^B = median(S_{ik}^{B}*) \tag{3}$$

Given the level of funding in each district under a system of local control, we can predict the level of state funding under a system of pure state financing. This approach will work for more complex social choice mechanisms as well because it gives estimates of each individual's demand.

It is useful to think about the utility gains and losses associated with a shift to state financing. There are two effects: a tax price effect and what I will call an 'off-demand-curve' effect. If a person's state level tax price is higher than his district level tax price he will always be worse off with state level funding. If he could choose his favorite level of funding given his tax price, he would be better off with district than with state level funding because the district tax price is lower than the state tax price. In addition, because he cannot choose the level of expenditure per student at the state level, he is likely to be off his demand curve and even worse off than a simple price change would indicate.

Using a similar argument, if a voter's state level tax price is lower than her district level tax price she may be either more or less well-off with state level funding than with district level funding, depending on whether the price effect or

[3] A switch to sole state funding may lead to the development of alternative means of raising private funds for schools (Brunner and Sonstelie, 1996). However, given the strong incentive to freeload, the impact of these private funds is likely to be small in most districts.

[4] A shift from local to state funding does remove one benefit of living in a high wealth district and may result in a redistribution of the population. Capitalization is likely to remove some of this incentive as house prices in previously high wealth districts fall. Assuming that state revenues are funded through an income tax and that incomes do not change as a result of a shift toward increased state funding, the partial equilibrium aspect of this model should not bias the estimates of the state grant level in a pure state finance system (System B). However, it may have some effect on funding estimates when local supplementation is allowed.

the 'off-demand-curve' effect is stronger. If the level of state expenditures is close enough to her optimal level at her state tax price then she is better off with state level funding. But, if the state funding level is sufficiently far from the desired level, she is better off with district level funding even though her tax price is lower at the state level.

Now consider two alternative systems of school finance which combine state and district raised revenues. The first of these mechanisms – call it System C – involves two steps. In the first step a social choice mechanism is used to determine the level of state funding per pupil, identical for all districts. In the second step, districts are allowed to supplement their state grant with locally raised revenues. As with most multi-stage games it is useful to work backwards. How much local supplementation would a voter want given that there are S^C dollars of per pupil funding provided by the state? He will take the state funds as given and thus on the margin the relevant tax price is his district tax price. State funding will have reduced his available income by his non-marginal state tax-bill. In addition, his optimal district spending, call it $D_{ik}^{C}*$, will be bounded below by zero. Using the model's assumptions we can express this demand for supplementation as a function of demand under System A.

$$D_{ik}^{C}* = \max\left[0, D_k^A\left(\frac{Y_{ik} + (d_{ik} - s_{ik})S^C}{Y_{ik}}\right)^{\beta} - S^C\right] \tag{4a}$$

Note that d_{ik} is the marginal tax price and $Y_{ik} + (d_{ik} - s_{ik})S^C$ is not total income but income adjusted by non-marginal dollars spent on school finance at i's state tax price. Plugging in the tax prices gives:

$$D_{ik}^{C}* = \max\left[0, D_k^A\left(1 + \left(\frac{n_k}{\sum_j Y_{jk}} - \frac{N}{\sum_l \sum_j Y_{jl}}\right)S^C\right)^{\beta} - S^C\right] \tag{4b}$$

All residents of a particular district will have the same demand for district supplementation and thus all voters will be on their demand curve for supplementation regardless of the state grant level. In the first stage of the game, each person, knowing the amount of supplementation that will result in her district given the level of the state grant, will then maximize her utility function over S^C to get an optimal level of state funding, $S_{ik}^{C}*$.

First consider residents of higher income-per-pupil districts for whom the district tax price is less than the state tax price. All voters in these districts will be better off with no state funding than with any positive level of state funding both because district spending is less costly and because district spending levels are optimal for all residents while the state spending level may not be optimal due to heterogeneous demand. Voters in lower income-per-pupil districts for whom the district tax price is greater than the state tax price may be either better or worse off with positive state funding depending on the relationship between their off-

demand-curve effect for state funding and the reduced price of state dollars. If there is no state funding, district supplementation will equal the level of funding under System A. If state funding is greater than zero but low enough for supplementation to be greater than zero then these residents are better off because of a positive income effect from non-marginal spending. State funding provides maximum benefit when it is the amount that the voters would demand under System B. The optimal level of state funding for these districts then will be the same as the optimal district spending under the System B.

While some voters for whom $s_{ik} < d_{ik}$ may be better off with complete local funding of schools when the level of state funding is far from their demanded quantity, they do not have incentive to misrepresent their demand in the decision making process. If the state supplies less than they demand, voters can simply supplement state funding with locally raised revenues and still be better off than they were with complete district funding because they received the state funds at a lower tax price. Those who demand less than the state level may be less happy with state funding than district funding even though their tax price is lower. However, these voters will not be pivotal since they are not the median voter (the median voter is by assumption on her demand curve) and they do not change from demanding more than the median to demanding less than the median. Instead they demand less in both cases and have no incentive to misrepresent their demand. Thus,

$$S_{ik}^{C}* = \begin{cases} 0 & \text{if } d_{ik} < s_{ik} \\ S_{ik}^{B}* & \text{if } d_{ik} > s_{ik} \end{cases} \tag{5}$$

Eq. (5) leads to the following result: the state funding level under a system with local supplementation will never be higher than in a system with no supplementation and will almost certainly be lower. State funding is likely to be lower because voters from high wealth districts vote for no state funding in this system while in a system without supplementation they would vote for positive funding and, most likely, for funding greater than the median demand. If the social choice mechanism was closer to a mean voter model than a median voter model then this lowered funding is sure to result because the demands of individuals from high wealth districts will drop to zero from some positive quantity. Thus, while allowing supplementation increases local control over spending, in equilibrium it reduces some, if not all, of the state government's equalizing potential.

Finally, consider System D, an alternative funding mechanism combining local and state raised revenues. In System D, no district's supplement can exceed a set limit, call it $D_k^{\max}$. Here assume that the supplementation limit is set exogenously, not determined by voter demand. This system is modeled on the system recently implemented in Michigan in which the foundation level is determined by the legislature each year but the additional dollars districts are allowed to raise locally are fixed. Given a chosen level of state funding, call it S^D, individual i will

determine her demand for local supplementation by conditioning on this level of state funding. The optimal level of district funding will depend on district tax price and income net of spending on state raised revenues. Supplementation will be limited by $D_k^{\max}$ and by non-negativity. In other words, under System D, each district's demand for local revenue is the same as under System C. However, that demand is limited to $D_k^{\max}$. Incorporating that limit, demand is:

$$D_{ik}^{D}* = \max\left[0, \min\left[D_k^A\left(\frac{Y_{ik} + (d_{ik} - s_{ik})S^D}{Y_{ik}}\right)^{\beta} - S^D, D_k^{\max}\right]\right] \tag{6a}$$

By plugging in state and local tax price, I find again that the optimal level of supplementation is the same for all members of the same district.

$$D_{ik}^{C}* = \max\left[0, \min\left[D_k^A\left(1 + \left(\frac{n_k}{\sum_j Y_{jl}} - \frac{N}{\sum_l \sum_j Y_{jl}}\right)S^D\right)^{\beta} - S^D, D_k^{\max}\right]\right] \tag{6b}$$

Because, as in System C, residents are on their constrained demand curve for supplementation, those for whom district tax price is less than the state tax price will want as much funding as possible to come from the district. Residents with lower state than district tax price, on the other hand, will want funding to come from the state. Thus, demand will be the same as under System B for those whose district tax price is greater. However, those with a greater state tax price, will want to adjust their demand downward, assuming that they will supplement locally.

$$S_{ik}^{D}* = \begin{cases} \max\left[0, S_{ik}^{B}*\left(\frac{Y_{ik} + (S_{ik} - d_{ik})D_k^{\max}}{Y_{ik}}\right)^{\beta} - D_k^{\max}\right] & \text{if } d_{ik} < s_{ik} \\ S_{ik}^{B}* & \text{if } d_{ik} > s_{ik} \end{cases} \tag{7}$$

A comparison of Eqs. (5) and (7) shows that the demand of all voters for state funding is at least as great under System D as in a system of unlimited local supplementation. All those with greater district than state tax price still demand state funding equivalent to that in System B; but not all voters (or any, given a low enough supplementation limit) with greater state tax price will demand no funding. Fig. 1 gives a graphical presentation of this result. In the figure, point **A** is the optimal that a voter with greater state than district tax price can achieve with unlimited supplementation. The voter prefers no state funding in this case. However, under System D, her optimal is point **B**. The dotted line that contains point **B** is her effective budget constraint under this system because it incorporates the maximum allowed supplementation with the state level tax price. This voter prefers positive state funding when System D is in place.

Under any reasonable assumptions concerning income elasticities and tax prices, the level of state funding demanded by an individual with higher state than district

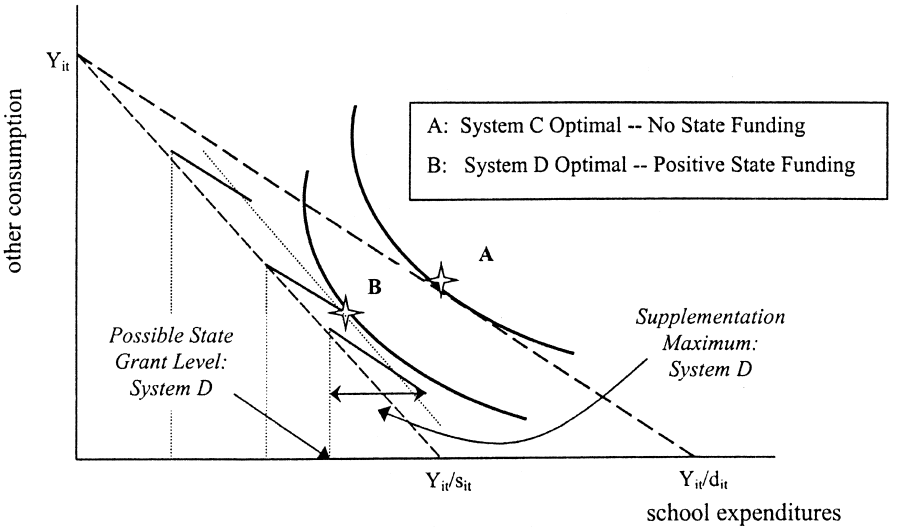

Fig. 1. Under a system of grants with limited supplementation residents of high wealth districts are likely to prefer positive state funding though they prefer no state funding when supplementation is not limited.

tax price will decrease as the supplementation limit increases.[5] Demand will be highest when the maximum is zero, i.e. System B, and lowest when the maximum is infinite, i.e. System C. Therefore, state funding levels will be at least as high, and generally higher, in a system with limited supplementation than in a system with unlimited supplementation, but state funding levels will not be as high in a system with no supplementation. In addition, total funding levels in each district will be weakly closer to those demanded by district residents in a system of state funding with limited supplementation than in a system with no supplementation.

The basic model can be extended to include the option of voters choosing to send their children to private schools and then withdrawing their support for public school funding. High demand voters may opt for private schooling when they are forced too far from their demand curve. Fig. 2 illustrates this situation for System B in which no local supplementation is allowed. The voter in Fig. 2 must pay state taxes for public schools; therefore, his income is reduced by the cost of these taxes. After this income reduction, he can choose to send his child to public school, consuming the remainder of his income and the low level of school

[5]The derivations of the results discussed here are available from the author.

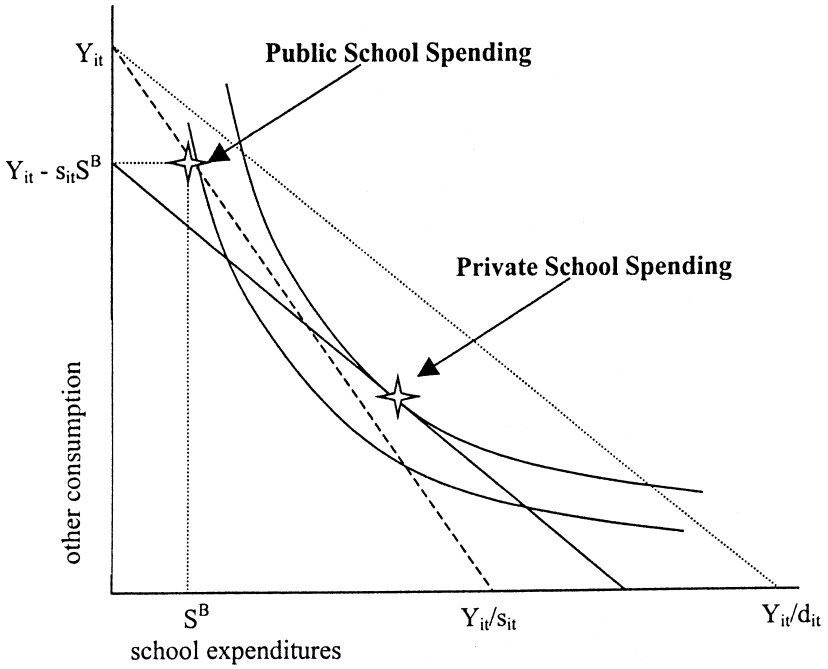

Fig. 2. Under a system with no supplementation high demand voters may opt for private schools if state spending levels are low.

expenditures S^B. His other choice is to not consume S^B but, instead, to pay for private schooling at a price of approximately \$1. Fig. 2 depicts the case in which the private school option leads to higher utility. System D allows voters to be closer to their preferred level of funding and thus reduces the probability that they will choose a private alternative.

3.1. Relaxing the perfect sorting assumption

The assumption of perfect sorting by income, prevalent in the earlier literature, is clearly violated. However, given that local millage votes for school funding are not unanimous, it is evident that the assumption of perfect sorting by demand is also violated. What happens if it is relaxed? Assuming that local spending is determined by the district resident with the median demand and that other individual's demands are distributed around this median voter, $D_{ik}^{A*} = D_k^A + \varepsilon_{ik}$ where ε_{ik} is an error term with a median of zero, I find that the direction of bias is

unclear for estimated demand under System B. The bias depends on the distribution of demand around the median in each district. The results are unbiased if an additional symmetry assumption is introduced.[6]

Estimates of demand for state funding under System C which rely on the assumption of perfect sorting by demand are likely to be biased downward. This bias arises because some high demand members of districts with greater district than state tax prices may vote for more state funding than that of the median voter in their district. However, the low demand voters will not vote for less because they realize that their district will choose to supplement those state dollars with the more costly district raised revenues. Similarly in high wealth districts, low demand voters cannot vote for less than the median demand for state funding because this demand is already zero. The extent of the bias again depends on the distribution of demand.

For System D, the direction of the bias is difficult to assess. In the income-poor districts, more than half of the voters will vote for less than the median while less than half will vote for more than the median. However, those who do vote for more state funding will vote for substantially more since they will assume that their district will not choose to supplement. Similarly, in high wealth districts, more than half the people will vote for more than the median and less than half will vote for less than the median demand. But those that do vote for less will vote for substantially less since they will assume maximum district supplementation. Again, the direction of the bias depends on the distribution of the error term.

I use the assumption of perfect demand sorting because it allows me to estimate changes in demand at the district level using available data. Similarly, because there is little individual level data available on income and property values that allow the researcher to identify district of residence, it is often necessary to use estimates of individuals' characteristics derived from district measures such as median income and median property value. These derivations may again lead to biases. In the following simulations I will assume that the ratio of state to district tax price is the same for all residents of a given district. An analysis of the potential biases arising from this assumption suggests that my estimates of state funding levels under systems of no supplementation and of unlimited supplementation may somewhat underestimate actual levels when there is not perfect demand sorting. The direction of the System D bias in determining the level of state funding is unclear. However, estimates of district supplementation for both

[6]The derivation of the results discussed here is available from the author. The symmetry assumption is that the number of voters with demand less than S^B who reside in districts with median demand greater than S^B is equal to the number of voters with demand greater than S^B who reside in districts with median demand less than S^B.

System C and System D given state funding levels should be unbiased because the district median voter remains the same.[7]

4. Michigan

Thus far this paper has introduced a model for estimating an individual's demand for state and district spending on public schools under three alternative systems of state financing. The analysis made clear that the distribution of tax base among districts plays an important role in determining the changes in district funding levels resulting from increases in the state government's role in school finance decisions. Because of the importance of resource distribution, it is difficult to make long term predictions of the effect of school finance policies without information on the distribution of resources in the particular state in question. In this section, I use the model to estimate the equilibrium levels of state and local funding in Michigan under the three funding systems discussed above.[8]

In order to use the model to predict future spending I need information on demand for expenditures under a system of local control. Prior to the 1994–95 academic year, such a system existed in Michigan. A power equalization system was in place that provided state funds to lower wealth districts without restricting local decision making power. I use information on spending under the power equalization system to estimate the spending that would have occurred under a system of complete local finance and from there predict expenditures under the three state-determined regimes. The following discussion expands the initial model by starting with a power equalization system and by assuming that funds are raised through a property tax at the local level. The resulting equations are identical to those derived in Section 3 except for these two differences.

4.1. Local control

A power equalization system provided the equivalent of a tax base per pupil, call it G, for each district that had an actual tax base per pupil, call it A_k, less than G. Most other districts received no state funds for general operating expenditures. For the 1993–94 academic year the school aid formula for district k was $aid_k = \max(0,\ \$400 + mills_k \times (\$102\,500 - A_k))$, where $mills_k$ is the millage rate for operating expenditures in district k. The state gave each district \$400 plus their

[7]The analysis of relaxing the tax price ratio assumption is not included in this paper but I will provide it upon request. The analysis assumes that actual ratios of state to district tax price are symmetrically distributed around the ratio of median district to median state tax price for district residents.

[8]For descriptions of the change in Michigan school finance and an estimate of the equilibrium funding levels across districts given no change in the foundation grant see Addonizio et al. (1995), Courant et al. (1994) and Courant and Loeb (1997).

millage rate times the difference between their per pupil tax base and the state guaranteed tax base of \$102 500 per pupil. Those districts with tax base per pupil greater than this had their \$400 'taxed' away until the total grant from the state was zero. After that point, districts received none of these state funds and were termed 'out of formula.' At the local level school funds were raised through a flat rate property tax on both residential and business property. The total tax base per pupil was then the sum of the state equalized property value (SEV), which in Michigan is one-half market value, of all property in the district. $A_k = (r_k + \Sigma_j P_{jk})/n_k$ where r_k is the total non-residential SEV in district k for which district residents do not bear the property tax burden and P_{jk} is the SEV attributable to person j in district k (including all property for which i bears the burden indirectly). For renters, P_{jk} represents the value of property that residents pay taxes on through rent plus other property for which they bear the burden indirectly. The tax price for individual i in a district k under this power equalization plan was then $P_{ik}/\max(A_k, G)$.[9]

Under power equalization, income adjusted for non-marginal spending would be person i's income minus the amount of taxes she pays so that the state can fund the schools.[10] Assume these state taxes are paid in proportion to income. Then, i's payment to the state would be $Y_{ik}/\Sigma_k \Sigma_j Y_{jl}(\Sigma_l S_l^{PE} n_l)$, where S_l^{PE} is the per pupil state revenues for district l under the power equalization system. Define D_{ik}^{PE*} to be i's demand for per pupil spending under this system. In keeping with the model discussed above:[11]

$$D_{ik}^{PE*} = \gamma_{ik}\left(\frac{P_{ik}}{\max(A_k,G)}\right)^{\alpha}\left(Y_{ik} - \frac{Y_{ik}}{\sum_l \sum_j Y_{jl}} \sum_l S_l^{PE} n_l\right)^{\beta}$$

This equation is not in reduced form since the level of state funding in district k is partially a function of the demand for funding of person i. However, for this

[9]One complication of the Michigan system which is not addressed in this model is the circuit breaker which returns 60% of the difference between the property tax paid on the principal household residence and 3.5% of total income if that tax exceeds 3.5% of household income. The circuit breaker is capped at \$1200 and reduced for incomes over \$73 300. In addition, this discussion ignores the deductibility of income and property taxes from federal income taxes. If revenues at both the state and local level are raised through income and/or property taxes this deductibility may not have a large effect. However, in Michigan the state sales tax is an important source of funds for state support of schools. The non-deductibility of the sales tax makes state dollars even more expensive than district dollars for high-income individuals who deduct income and property taxes from their federal income tax and thus further may decrease support for state funding among high-income voters.

[10]For simplicity, the following discussion ignores the additional adjustment to income associated with the \$400 in the power equalization formula. This turns out to be economically insignificant.

[11]In a system of solely district level funding, no power equalization, and with local spending funded through the property tax, the desired spending, call it D_{ik}^*, would be: $D_{ik}^* = \gamma_{ik}(P_{ik}/A_k)^{\alpha} Y_{ik}^{\beta}$. Thus, under this power equalization system residents of 'in-formula' districts have a positive price-effect (lower tax price) and a negative income effect as compared with a pure local financing system, while residents of 'out-of-formula' districts have only a negative income effect.

analysis I will assume that the total level of state funding is given and can not be influenced by an individual's demand. Because both i's influence over the level of his district funding and the contribution of one district's state revenues to the total amount of state funding are small, this is not an unreasonable simplification. Let F be the total state funds under the system of power equalization: $F \equiv \Sigma_l S_l^{PE} n_l$.

4.2. State control

Given that residents sort themselves into districts so that they are on their demand curve for education spending under this power equalization system, $D_k^{PE} = D_{ik}^{PE}*$, where D_k^{PE} is the level of spending in district k under the power equalization system. Then, if district level taxes are raised through a flat rate property tax on both homestead and non-homestead property while state level funds are raised through a flat rate personal income tax, the equation for demand for state funding under System B is:

$$S_{ik}^{B}* = D_k^{PE}\left(\frac{Y_{ik}N\Big/\sum_l\sum_j Y_{jl}}{P_{ik}/\max(A_k, G)}\right)^{\alpha}\left(\frac{Y_{ik}}{Y_{ik}-\left(Y_{ik}F\Big/\sum_l\sum_j Y_{jl}\right)}\right)^{\beta}$$

Adding the additional assumption that the ratio of Y_{ik} to P_{ik} is the same as the ratio of median income to median property value for all residents of district k:

$$S_{ik}^{B}* = D_k^{PE}\left(\frac{Y_{\mathrm{med}_k}}{P_{\mathrm{med}_k}}\left(\frac{N\max(A_k, G)}{\sum_l\sum_j Y_{jl}}\right)\right)^{\alpha}\left(1-\left(\frac{F}{\sum_l\sum_j Y_{jl}}\right)\right)^{-\beta}$$

For System C in which unlimited supplementation is allowed, the relevant district tax price has A_k and not the maximum of G and A_k in the denominator because power equalization is no longer relevant.

$$S_{ik}^{C}* = \begin{cases} 0 & \text{if } \dfrac{P_{\mathrm{med}_k}}{A_k} < \dfrac{Y_{\mathrm{med}_k}N}{\sum_l\sum_j Y_{jl}} \\ S_{ik}^{B}* & \text{if } \dfrac{P_{\mathrm{med}_k}}{A_k} > \dfrac{Y_{\mathrm{med}_k}N}{\sum_l\sum_j Y_{jl}} \end{cases}$$

The district supplementation level is:

$$D_{ik}^{C}* = \max\left[0, D_k^{PE}\left(\frac{\max(A, G)}{A_k}\right)^{\alpha}\left[\frac{1+\left(\dfrac{P_{\mathrm{med}_k}/Y_{\mathrm{med}_k}}{A_k}-\dfrac{N}{\sum_l\sum_j Y_{jl}}\right)S^C}{1-\dfrac{F}{\sum_l\sum_j Y_{jl}}}\right]^{\beta} - S^C\right]$$

For System D, individual i's optimal state funding level is:

$$S_{ik}^{D}* = \begin{cases} \max\left[0, S_{ik}^{B}*\left(1+\left(\dfrac{N}{\sum_l \sum_j Y_{jl}} - \dfrac{P_{\mathrm{med}_k}/Y_{\mathrm{med}_k}}{A_k}\right)D^{\max}\right)^{\beta} - D^{\max}\right] & \text{if } \dfrac{P_{\mathrm{med}_k}}{A_k} < \dfrac{Y_{\mathrm{med}_k}N}{\sum_l \sum_j Y_{jl}} \\ S_{ik}^{B}* & \text{if } \dfrac{P_{\mathrm{med}_k}}{A_k} > \dfrac{Y_{\mathrm{med}_k}N}{\sum_l \sum_j Y_{jl}} \end{cases}$$

And, the optimal supplementation amount is then,

$$D_{ik}^{D}* = \max\left[0, \min\left[D_k^{PE}\left(\frac{\max(A_k, G)}{A_k}\right)^{\alpha}\left(\frac{1+\left(\dfrac{P_{\mathrm{med}_k}/Y_{\mathrm{med}_k}}{A_k} - \dfrac{N}{\sum_l \sum_j Y_{jl}}\right)S^{D}}{1-\dfrac{F}{\sum_l \sum_j Y_{jl}}}\right)^{\beta} - S^{D}, D_k^{max}\right]\right]$$

I use the above equations to predict the results of implementing these funding systems.

4.3. Data

I obtain the needed data from National Center for Education Statistics (NCES) School District Data Book (SDDB) and from the Integrated Database on Michigan Education. Historically, an obstacle to estimating demand for education has been the lack of data that matches information on individuals' characteristics with information on the school districts in which they live. SDDB makes this much easier. It contains social, economic and administrative data for each of the 15 274 public school districts in the United States. Most of the data come from the 1990 Census School District Tabulation. Additional information on teachers, schools and students comes from the NCES 1989–90 Common Core of Data, and additional financial information on school districts comes from the 1989–90 Survey of School District Finances produced by the Census Bureau for the Department of Education. There are limitations to this data set. In particular, while SDDB provides the distribution of individual characteristics (say income or property value) within each district, it does not provide individual information. This limitation motivates the focus above on ways of using district level information to estimate the effects of policy changes.

Table 1 provides means and standard deviations for the district level variables used in the simulations both unweighted and weighted by the number of voters in each district. From the Integrated Database on Michigan Education, I use the 1995 district enrollment, the state equalized property value per pupil in 1995, the percent of this property value that is homestead property, the 1994 millage rate, and the 1994 district operating expenditures. From the SDDB, I use the number of voters in the district (defined as the number of persons 20 years of age or older),

Table 1
Means and standard deviations for the 555 Michigan districts. 1994 dollars

	Weighted by district	Weighted by voters
From the integrated database on Michigan education		
District enrollment in 1995	2876	23 902
	(7702)	(49 536)
SEV per pupil 1995	122 475.10	112 097.14
	(152 901.57)	(68 299.65)
Percent homestead	59.00	55.78
Max (A_k, G)	141 368.62	132 013.98
	(146 669.55)	(53 897.53)
1994 millage rate	32.83	35.50
	(5.98)	(5.04)
1994 Operating expenditures	4894.16	5349.88
(power equalization system)	(1111.30)	(1177.56)
Percent from local revenues	78.04	77.80
From the school district data book		
Voters per district	11 797	101 328
(persons 20 or older)	(32 529)	(204 579)
Median household income	34 308.52	37 536.21
	(10 973.98)	(13 053.73)
Median property value	64 434.72	73 795.60
	(27 529.65)	(37 497.53)
Per capital income	14 669.68	16 649.80
	(4621.81)	(6012.62)
Population	16 767	148 281
	(47 813)	(304 891)

the median household income and property value, income per capita, and the district population.[12]

4.4. Results

The percent of voters with greater district than state tax price affects the relative, as well as the absolute, expenditure levels under the systems of state finance described above. As noted in Section 2, the percent of voters with higher district tax price is determined by the distribution of wealth across districts and is specific to each state. Given an income tax at both the state and district level, this percent is straightforward to measure. Based on residents 20 years or older (the proxy used for voters throughout this analysis) and a proportional income tax at the state and

[12]While 1990 data from Michigan may match more closely with the 1990 Census data, I choose to use 1994 Michigan data instead because the formulas for the reform are based on 1994 expenditure levels. In addition, 1994 is the most recent year under local control and, thus, is likely to provide the best estimate of individuals' demand.

district level, 54.63% of voters in Michigan have higher district than state tax price. However, once a property tax is introduced at the district level, this percent becomes more difficult to estimate because it depends largely on the incidence of the non-residential property tax. For example, over the range from district residents bearing no burden to district residents bearing the burden of all non-residential property in their district the percent of state residents with higher district than state tax price ranges from 44.19% to 65.48%. This estimate assumes that among district residents burden is borne in proportion to income. I use the full range of possible values in the simulations, concentrating on percentages of residents with greater district than state tax price surrounding 50% both because this is the crossover point for System C and because most states are likely to fall close to this range.

Table 2 summarizes the results of simulations using an income elasticity of 0.6 and a price elasticity of -0.3.[13] Under the power equalization system that was in effect prior to the 1994–95 academic year in Michigan, the mean per pupil revenue was $5215 with a standard deviation of $1085 (all revenues are given in

Table 2
Simulation results for dollars per pupil of spending varying the percent of residents with greater district than state tax price (assuming a price elasticity of demand of -0.3, an income elasticity of demand of 0.6, and a maximum supplementation level of $1000)[a]

% Burden for non-residential property	Tax price: % $d > s$	System B State	System C			System D		
			State	District	Total	State	District	Total
0	44.19	4648	0	4821	4821	4222	449	4671
				(1264)	(1264)		(412)	(412)
10	47.62	4699	0	4821	4821	4271	420	4691
				(1264)	(1264)		(417)	(417)
20	49.99	4749	0	4821	1264	4348	384	4732
				(1264)	(1264)		(420)	(420)
30	51.57	4798	3739	1116	4855	4391	367	4758
				(1175)	(1175)		(417)	(417)
40	55.84	4846	3963	926	4889	4493	330	4823
				(1147)	(1147)		(409)	(409)
50	56.86	4892	4028	880	4908	4540	313	4853
				(1136)	(1136)		(405)	(405)
70	61.32	4982	4259	733	4992	4668	273	4941
				(1032)	(1032)		(393)	(393)
100	65.48	5111	4459	630	5089	4859	227	5086
				(1032)	(1032)		(375)	(375)

[a] The numbers in parentheses are standard deviations.

[13] Full results, allowing substantial variation in income and price elasticities of demand, are available from the author.

1994 dollars).[14] The average district received $4894 with a standard deviation of $1111, indicating that higher spending districts tend to be larger districts. Table 2 shows that under a system of state funding with no district supplementation the revenues per pupil for all districts would fall between $4648 and $5111 depending on the percent of residents with lower state than district tax prices. As this percent rises so does the corresponding revenue level since more voters experience a decrease in tax price after the shift to state funding. At a percent equal to that corresponding to the income distribution for Michigan (54.63%), the expenditure level would be a little over $4800 per pupil. This indicates an approximately $400 decrease in the mean level of spending in comparison to the power equalization system, but a substantial drop, to zero, of the variation among districts. These results are dependent on the price elasticity of demand. The smaller (in absolute value) the price elasticity, the higher the estimated demand for funding. For example for a price elasticity of -0.1, the estimated demand ranges from $5057 to $5183; while for a price elasticity of -0.5 the range is from $4253 to $4969. At 54.63% of residents with higher local than state tax price the range is approximately $4500 (for a price elasticity of -0.5) to $5095 (for a price elasticity of -0.1) suggesting anywhere from a $100 drop to a $700 drop in mean per pupil spending arising from the shift to state finance. Again, the standard deviation falls to zero. Residents from previously high expenditure districts are clearly pushed far off their demand curve for spending under this system

The simulations for System C display the expected trend in that state funding falls to zero when more than half of voters have higher state than district tax prices. In this case, the expenditure levels are what they would have been under pure district financing with no power equalization. With the assumption that residents bear none of the tax burden for non-residential property in their district, the mean per pupil spending would be $4821 with a large standard deviation of $1264. There would be no state grant, in this case, and district spending would range from $2600 to $13 703. In comparison, under System B the state grant level would be $4648 for all districts with no supplementation.

For the case in which residents bear all the non-residential property tax burden, and thus more have a higher district than state tax price, the state grant level under System C would be $4459 with an average total spending of $5088.57. Spending would range from $4459 to $13 379 with 57 percent of districts choosing not to supplement. The System B grant level would be $5111. It should be noted that not only is the standard deviation substantially larger in System C, but the mean spending level is actually lower than under System B. This result is not robust to variation in the price elasticity of demand, however. In general, average spending

[14]These figures include all local funds, unrestricted state funds from the power equalization mechanism, and those state categorical grants which were included in the foundation grant under the new system.

in Systems B and C are similar (usually somewhat greater in System C), while the variance is much greater when unlimited supplementation is allowed.

Finally, consider the results of simulations for System D with a maximum district supplementation of $1000 per pupil. As expected, the state grant tends to be substantially higher and the mean spending level slightly lower than in System C. In all cases, the standard deviation is much lower than in System C, with supplementation ranging from zero to $1000. Table 3 summarizes results of simulations that allow the maximum supplementation to vary from $1000 to $5000. Higher supplementation caps correspond to lower state funding grants and greater standard deviations in spending. In all cases, the state grant level is at least as great as in System C, and for low supplementation caps and low percentages of residents with higher district than state tax prices, substantially greater. Average spending does not change appreciably with increases in the level of supplementation allowed, but the standard deviation rises sharply.

I ran simulations using a range of elasticities based on results of previous research estimating these parameters (see Bergstrom et al., 1982 for a review). The magnitude of the income effects is small enough for the variation in income elasticity to make little difference in the predicted expenditure level. The size of the price elasticity of demand, on the other hand, does have substantial effect. In all cases, as the absolute value of the price elasticity increases, the predicted level of state funding decreases. This decrease is likely due to the skewed distribution of wealth among districts in Michigan and the positive relationship between wealth and per pupil spending. As a result, the tax price change due to centralization is greatest for previously high-spending/high-wealth districts and demand in these districts will fall more than that in low wealth districts will rise as a result of a shift to state funding. Increases in the absolute value of the price elasticity of demand increase this effect. As expected, the decrease in state grants from

Table 3
Finance system with limited district supplementation varying maximum supplementation level and percent of voters with greater state than district tax price (income elasticity = 0.6, price elasticity = −0.3)

% $d > s$	State funding Maximum district supplementation					District supplementation Maximum district supplementation				
	1000	2000	3000	4000	5000	1000	2000	3000	4000	5000
47.62	4271	3976	3689	3174	2142	420	779	1109	1636	2648
						(417)	(688)	(879)	(979)	(1001)
49.99	4348	4061	3839	3371	2334	384	716	979	1446	2464
						(420)	(695)	(888)	(992)	(1019)
51.57	4391	4113	3923	3753	3739	367	676	907	1090	1127
						(417)	(699)	(890)	(999)	(1080)
55.84	4493	4230	4101	3974	3963	330	597	767	898	929
						(409)	(703)	(887)	(989)	(1064)

increases in the price elasticity is substantially lessened as the percentage of voters with higher district than state tax prices increases, because more voters experience a positive tax price effect. As noted, in Tables 2 and 3, I use a price elasticity of −0.3 and an income elasticity of 0.6. Similar trends are apparent using other elasticities.

5. Conclusions

In summary, the preceding discussion explores school-funding allocation under a variety of finance systems – pure state funding, state funding with unlimited local supplementation, and state funding with limited local supplementation. It improves on previous methods by relaxing the perfect sorting by income assumption and, thereby, allowing the use of the actual wealth distribution across districts in a given state. In the process, I am able to look at the variance, as well as the mean level of spending under each finance program.

The results of this analysis indicate that the often touted system of state grants with unlimited local supplementation, while allowing maximum local control over funding decisions, may provide little if any cross-district equalization. Simulations using data on Michigan schools indicate that this system is likely to result in substantially greater variance in school funding levels and lower minimum spending than the other two systems considered, without an appreciable increase in average spending per student in the state. A system of state grants with limited supplementation, while not as equalizing as pure state funding, leads to higher state grants and smaller variance in spending than one with unlimited supplementation. This type of system also may have political advantages in comparison to a system of pure state funding, because it allows higher spending in those high demand districts which may be especially dissatisfied when forced to spend much less on schools than their optimal level.[15]

While the above analysis adds to previous models that look at the effects of a shift from local to state financing of public education, elements that would be useful to add include alternative social choice mechanisms, general equilibrium effects of capitalization and cross-district migration, and expanded utility functions. Yet, even with these additions, it seems likely that the basic results of this analysis will hold: the type of state funding system implemented, not just the increase in the state's roles, will strongly affect education spending. Specifically, a foundation grant system that allows limited local supplementation may end up providing substantially more equalization than could be gained through a system

[15]Courant and Loeb (1997) provide a more detailed description of this effect and the ability of the recent finance reform in Michigan to address both equalization and the political pressures of high demand districts.

with unlimited supplementation while allowing more district control than available in a system of pure state funding.

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