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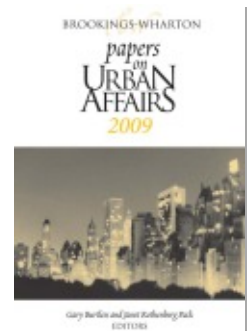
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Nechyba, Thomas J., 1968-

Brookings-Wharton Papers on Urban Affairs, 2003, pp. 139-183 (Article)

Published by Brookings Institution Press
DOI: [10.1353/urb.2003.0013](https://doi.org/10.1353/urb.2003.0013)



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Public School Finance and Urban School Policy: General versus Partial Equilibrium Analysis

THE EFFECTS OF ALTERNATIVE APPROACHES to educational finance on public school quality have attracted substantial attention from researchers and policymakers. Much of this analysis, however, focuses narrowly on the effects of financial resources on school quality in the absence of behavioral adjustments to policy changes. In contrast, this paper examines the relationship between school financing methods and school quality in a framework that explicitly links public finance issues, housing markets, and school quality. In the framework employed here, the quality of a school varies with its financial resources and the quality of students (and their families) that attend the school. Student and family quality in turn depend on both the abilities with which schoolchildren arrive at school as well as the economic status of their parents, who may be able to contribute in other ways to local schools. Households vote for public school spending and pay taxes to support schools, and they may respond to changes in school financing policy by moving or placing their children in private schools. Thus household responses to policy changes not only cover a broad range of options but also interact with the choices of other households, because school quality depends on who else attends local

Financial support from the National Science Foundation (SBR-9905706) is gratefully acknowledged, as are comments from participants at the conference, particularly the comments by discussants Rick Hanushek and Susanna Loeb, as well as those of the editors.

schools, local housing prices and private school markets reflect overall changes in demand, and local voting on public school spending is affected by all these changes.

Using this framework, this paper focuses on three widely examined policy changes: shifts from local to state financing, changes in state aid formulas, and the introduction of state-funded vouchers. The main finding is that the indirect (general equilibrium) effects of policy changes on school quality—for example, those that arise from households moving and thus alter the quality of neighborhoods and students, or those that arise from parents choosing to shift their students from public to private school or vice versa—tend in many cases to dominate the direct (partial equilibrium) effect on the amount of financial resources devoted to schools. In many ways, this should not be surprising. Public school institutions shape the way many households decide where to live and where to send their children to school, and changes in these institutions alter the fundamental trade-offs faced by families as they make these choices.

This principal finding has several implications for the analysis of educational finance issues. First, urban housing markets and residential mobility play an important role in determining the impact of many school finance policies. Given the strong link between housing markets and access to public schools, an analysis of policy should include an explicit recognition of changes in these markets brought about by household mobility. Second, the existence of private schools, and the extent to which parents are willing and able to shift their students from the public to the private sector, imposes constraints on the impacts of public school policies. In the presence of an active private school market that might respond to changes in public school policies, a focus on only public schools is furthermore incomplete because it ignores the impact of public school policies on a significant number of children. Third, the existence of likely behavioral responses to policies and the link of schools to neighborhoods place severe limits on the extent to which equalizing school financial resources will result in equalizing school quality. This implies that the court-driven focus on spending inequalities may have excessively narrowed policy discussions to only one dimension of a multidimensional problem. Finally, the results in this paper suggest that to the extent they accurately forecast the general equilibrium effects of school finance policies, many households will be more affected by

changes in their wealth (through changes in housing values) from changing school finance policies than through changes in educational opportunities for their children. This adds an important dimension to the political economy analysis of proposals such as school vouchers that would adversely affect the wealth of those who are likely to be disproportionately influential in the political process. In many cases, the politics behind school policymaking may thus have less to do with schools and more with property values.

The advantages of the framework employed in this analysis include the ability to examine effects of alternative policies within a single, internally consistent model and to isolate the relative importance of each channel through which effects occur. With key structural parameters of the model matched to real-world data in order to successfully replicate important features of actual communities and schools, the resulting computational model is used to conduct policy experiments that explicitly trace out not only the immediate impact of large policy changes but also the long-run impact of changes in the economic environment in which households make choices about schooling. Although this makes possible an explicit comparison of partial equilibrium and general equilibrium effects within a single framework, the assumptions made are in some cases tenuous enough to recommend caution in interpreting results as absolute predictions.

The analysis begins by outlining the main features of the modeling framework. The next section examines the effects of the three types of policies and breaks down the results into direct and indirect effects. I then discuss a series of caveats to interpreting the model.

An Economic Model of Equilibrium Differences in Public School Quality

The effects of school reform depend in part on the underlying causes for current public school differences in quality. Two such possible causes are differences in parental tastes for education and in parental information regarding public schools, either of which could cause parents to choose different types of schools. This paper takes another approach in that it explains differences in public school quality by incorporating

explicitly the political and economic environment within which parents make educational choices.¹

Although public schools are free in the sense that they do not charge tuition, access to each public school is typically restricted to those who reside within the attendance zone (or district) of that school.² Housing markets are such that not all house qualities are available in all school districts, thus limiting options for some families. Furthermore, the housing market capitalizes public school quality, thus explicitly introducing “tuition” to public schools through a housing price premium in the better school districts. Finally, public school inputs are at least partially linked to local community characteristics, with higher-income communities likely to spend more for each pupil as well as contribute more to the local public school in nonpecuniary inputs such as teacher quality, peer quality, and parental involvement.³

1. A preference-based explanation for the existence of systematic differences in public school quality is problematic as long as it remains divorced from an economic model of the local public finance and urban sector within which schools operate. In the absence of horizontal differentiation among schools, as long as all parents would prefer better schools to worse schools (even if the intensity of that preference differs), all parents would in fact choose the best available public school for their children because no tuition is charged in public schools to select among some parents who may value quality more than others. It is only when heterogeneous preference models are embedded into local public finance and urban models that less extreme heterogeneity can play a constructive role in identifying causes for public school quality differences. See, for example, Epple and Sieg (1999). Information-based explanations for differences in attitudes toward public school quality, however, are most plausible as stand-alone explanations for quality differences that are temporary rather than systematically present for long periods. While it may well be the case that reforms need to take account of the fact that information may be processed differently by different families, it becomes problematic to assume that some parents are consistently misinformed about which schools are good and which not when these differences persist over long periods.

2. Even when public schools are open for enrollment from outside the district, the better public schools are typically permitted to claim capacity constraints to prevent entry into the school from outside the district. It is noteworthy, for instance, that the Milwaukee school-choice program is actually one that allows choice by inner-city parents of suburban public schools and offers financial incentives for those schools to accept students from outside. In the end, however, the program became a private school choice plan because no suburban school agreed to accept children eligible in the program.

3. Empirical studies suggest that this correlation between nonpecuniary inputs and household income as well as the value of such nonpecuniary inputs into production is significant. One standard assumption is that child ability is (imperfectly) correlated with household income, thus providing a nonpecuniary input to high-income schools. Teacher quality, while perhaps not costing more due to state collective bargaining agreements,

An economic model that does not rely on preference or information differences in explaining large interdistrict variances in public school quality must therefore explicitly include empirically relevant levels of household income inequality and a housing market with uneven distributions of housing quality across districts, and it must allow for household mobility across districts. In addition, the model must contain some empirically relevant mechanism for funding public schools as well as a private school market that can account for observed levels of private school attendance. Each of these features is incorporated in this paper's underlying model.

The Structural Model

The underlying structural model accurately replicates a number of stylized features of public schools and local public finance.⁴ It begins with a continuum of households N where each household is endowed with one house, a child with a given ability, an income level and preferences over private consumption, neighborhood and house quality, and school quality consumed by the household's child. The main features of the model can then be summarized:

—Preferences of all households are assumed to be identical.⁵ But incomes, house endowments, and abilities differ across households (with income imperfectly correlated with child ability). The total number of different household types is 1,500.

—Houses are divided exogenously into neighborhoods. All houses in a neighborhood share the same quality and neighborhood characteristics,

tends to be higher in high-income districts; Loeb and Page (2000). And parental involvement and monitoring of public schools is significantly correlated with parental income; McMillan (1999).

4. Nechyba (1997a, 1997b, 1999, 2000, 2003).

5. The functional form of the utility function is $u(d, h, c, s) = k_d h c^\alpha s^\beta$, where d indicates school district, h indicates house type or neighborhood, c indicates private consumption, and s indicates school quality. The parameters α and β are calibrated so as to replicate spending levels per pupil in the data as those emerging from majority-rule voting. Any choice of utility function such as this necessarily introduces implicit assumptions about behavioral elasticities, with Cobb-Douglas forms such as this being no exception. As elasticities change, so will the magnitudes of the simulation results in tables such as those presented in this paper. In making benchmark functional form assumptions, Cobb-Douglas functional forms represent typical starting points, and therefore they feature prominently on both the preference and the technology sides of this model.

and collections of neighborhoods form school districts. There are three school districts—high-, middle-, and low-income—each with five neighborhoods. House-quality distributions potentially overlap across jurisdictions. The model takes the housing stock as given rather than explaining its evolution over time.

—Schools produce educational quality by combining per pupil spending with peer inputs.⁶ All schools, public and private, face the same production technology. Per pupil spending levels are determined through majority-rule voting in public schools and through competitive price setting in private schools. The peer input contributed to a school by a household includes a component related to household income (proxying for nonpecuniary inputs) and a separate component related to child ability.

—Private schools have two competitive advantages over public schools: they can set a level of per pupil spending (which is equal to tuition) that reflects the desire of parents more closely, and they can select from student applicants. This gives rise to the effect that private schools seek to “cream-skim” from public schools by choosing only households of high student quality. At the same time, public schools have the advantage that they are free to anyone living within the district boundaries.⁷

The strategy in the line of research from which this paper draws is to begin by assuming there are neither efficiency gains from increased com-

6. The school production function is $s = f(x, q) = x^\rho q^{(1-\rho)}$ where x is per pupil spending and q is average peer inputs in the school (with a minimum of \$5,000 per pupil expenditure assumed to be necessary for a school to open). Although the studies of school production function are engaged in a debate over the degree to which financial resources (per pupil spending) matter for outcomes like test scores and graduation rates—see, for example, Hanushek (1999) and Krueger (1999)—this debate is not immediately relevant to the approach taken here because the approach here defines school quality more broadly in terms of parental perceptions of school quality. While spending may or may not matter for narrower school outcomes, there exists ample evidence that parents place importance on school spending. In the context of this structural model, a lack of spending in the production function would result in equal spending in all schools—and would furthermore give such an advantage to private schools that public schools could not survive.

7. In practice, the main advantage that is important for private schools is the ability to set peer inputs. Note that the specification of the private school sector implicitly assumes a perfectly elastic supply of private schools—that is, if a private school of particular characteristics is demanded and can make positive (or zero) profits, it will be supplied. The private school market modeled here therefore represents a long-run market, with short-run effects likely to include fewer private school market changes than predicted by the model.

Table 1. Housing Quality Parameters in the Model, by School District Income Level

District income level	Housing quality				
	1	2	3	4	5
Low (1)	0.820	0.882	0.930	0.978	1.021
Medium (2)	0.872	0.930	1.002	1.032	1.085
High (3)	0.930	0.950	1.063	1.182	1.267

Note: These values represent k_{sh} values in the utility functions $u(d,h,c,s) = k_{sh}e^{\alpha}5^{\beta}$ discussed in footnote 5. They were first reported in Nechyba (2003b) and are discussed in more detail there.

petition nor any private school advantages in school production.⁸ While these assumptions can easily be relaxed, this paper documents the relative importance of general equilibrium effects in the absence of such factors. In other work I have demonstrated that an introduction of such effects, while changing the *absolute* predictions, does little to alter the *relative* importance of the general equilibrium effects.⁹

Using Data to Inform the Model

The data used to calibrate the model are from the New Jersey suburbs of New York City. School districts are divided into high-, middle-, and low-income districts in such a way as to have roughly equal population in each of the three categories. Average characteristics of districts falling into these categories are used to represent the stylized high-, middle-, and low-income districts in the model.¹⁰

In calibrating the model, the following stylized features are matched by the calibration algorithm:

—House and neighborhood quality parameters are set so as to replicate the distribution of house prices observed in the data. This calibration method implicitly incorporates the impact of local externalities and public amenities into the house quality parameters of the model. Table 1 provides the calibrated house quality parameters for each of the house types in the model.

—The income distribution is set to approximate the empirical distribu-

8. Hoxby (2000) finds evidence for a competitive effect on public school productivity, and Neal (1997) documents higher productivity in Catholic schools for at least some populations.

9. Nechyba (2003a, forthcoming).

10. A complete description of the data sources is given in Nechyba (2003c).

tion observed in the data. The child ability distribution is set so as to produce a .4 correlation with household income, suggested as an upper bound.¹¹

—Household utility weights placed on private consumption and school quality are set so as to replicate the correct levels of public school spending set through majority-rule voting.

—A household's peer quality is determined by an equal weighting of the household's income with the child's ability level (in a Cobb-Douglas process). Sensitivity analysis that varies the relative weights on child ability and household income shows that the relative magnitudes of general equilibrium effects are largely unaffected by this weighting.

—The school production function is assumed to have constant returns to scale but requires a minimum of \$5,000 per pupil in expenditures.¹² The weights placed on per pupil spending and peer quality inputs are set so as to replicate the levels of private school attendance observed.¹³ The model implicitly assumes that peer contributions to school production are such that mixing of different peer-quality students results in higher overall school quality than separating peers.

—Finally, the benchmark model uses the New Jersey school financing formula; the later simulations introduce new public school financing methods holding fixed the structural parameters calibrated with the New Jersey formula and New Jersey data. Table 2 provides some key features of the data and compares them to the replicated results from the benchmark equilibrium. Most of the features in the data are replicated well by the calibrated structural model, with the level of private school attendance in district 3 being one notable exception, in part because the model does not include household incomes above \$200,000. Such households would always choose private schools in the model, and their inclusion

11. Solon (1992); Zimmerman (1992).

12. The minimum expenditure requirement has two justifications: First, it is likely that states indeed require an implicit minimum spending level even when funding is purely local. Second, the computational algorithm to determine the equilibrium of the model becomes significantly more efficient if extremely low out-of-equilibrium spending levels are ruled out.

13. This determines precisely the relative weight that households in the model place on spending versus peers. If too much weight is placed on spending, private schools do not have a sufficient competitive advantage to be able to survive; if too much weight is placed on peer quality, private schools have too much of an advantage, thus not allowing the model to accurately replicate observed levels of public school attendance.

would eliminate half the difference between the actual and the predicted private school attendance rates in district 3. Given that these households (were they included explicitly) would not be on the margin of either moving or changing schools under different policies, the results of the simulations would be largely unaffected by expanding the model to include such households.

Economic Forces Driving the Equilibrium

Having determined the structural parameters to be used in policy simulations, it is now worthwhile to briefly explore with some stylized examples how general equilibrium forces unfold in the model.¹⁴ In order to focus on the link between public schools and residential housing markets, the first row of table 3 therefore begins by simulating the distribution of households and housing prices when all households choose private schools and no public schools exist.¹⁵ The purpose is not to discuss this as a serious policy alternative but rather to determine where households would live and what prices they would pay for housing when there are no price distortions that arise from the coupling of public schools with residential location. The results suggest that a substantial amount of residential income segregation exists simply because of differences in housing quality among districts.¹⁶

The second and third rows of the table then report results from the other extreme: no private schools are permitted and only public schools operate (funded locally in row 2 and funded centrally in row 3). Thus, while no bundling between school and residential location choices exists in row 1, the bundling is complete in rows 2 and 3. This bundling—whether accomplished through a locally or a centrally financed system—

14. This subsection draws heavily on the discussion in Nechyba (2002).

15. It should be noted that there always exists such an equilibrium (without public schools) in the model. This is because households are assumed to choose their political support for public schools after selecting whether to attend a private or a public school. In the absence of public schools, all households choose private schools. Given that they choose private schools, they will show no support at the ballot box for public schools.

16. Note, however, that because the model does not address the question of how housing quality stocks arose in the first place, this does not mean that the first row of table 3 illustrates the level of segregation there would have been if no public school distortions had ever entered into the construction of housing. Rather, it simply demonstrates expected segregation levels in the absence of public school distortions *given* current housing quality in different districts.

Table 2. New Jersey Benchmark Equilibrium and Actual Data, by School District Income Level

Categories ^a	District income level					
	Low (1)		Medium (2)		High (3)	
	Model	Actual	Model	Actual	Model	Actual
Property values (dollars) ^b	117,412	157,248	205,629	192,867	292,484	271,315
Average income (dollars)	31,120	30,639	46,216	45,248	65,863	67,312
Public school per pupil spending (dollars)	6,652	6,702	7,910	7,841	8,621	8,448
Funding raised locally (percent)	52	52	77	77	87	87
Peer inputs	0.2684	...	0.4701	...	0.6521	...
Public school quality	0.4322	...	0.6178	...	0.7803	...
Students attending private schools (percent)	20	21	23	23	13	20

a. See text for definitions of terms.

b. Property values are converted from annual flows (calculated in the computational model) using a 5.5 percent discount rate.

Table 3. School Financing and Average Income and Property Value Assumptions, by Income of School District^a

Private schools allowed	Public school financing	Average income			Average property value		
		Low (1)	Medium (2)	High (3)	Low (1)	Medium (2)	High (3)
Yes	None	25,700	50,175	67,325	158,327	227,189	266,474
No	Local property tax	17,628	39,647	85,925	101,683	204,075	392,402
	State income tax	19,875	42,250	81,075	102,086	220,725	387,549
Yes	Local property tax	29,725	50,262	63,212	123,224	211,729	294,825
	State income tax	29,891	51,309	67,325	118,486	226,345	316,308

Note: Values in this table are derived from portions of table 3 in Nechyba (2003a) and table 3 in Nechyba (2003c), with property values converted from annualized flows using a 5.5 percent discount rate. This table also appears in Nechyba (2002).

introduces substantial distortions in housing prices. In poor districts, houses are depressed as they capture the low school quality (see table 4), while in rich districts they are inflated because of the high quality of the schools. This then introduces substantial increases of segregation beyond what one would expect from interdistrict housing differences alone (see row 1). The precise method of financing public schools is thus quite secondary to the bundling of public schools with residential location and urban housing markets.

Finally, rows 4 and 5 of table 3 introduce the combination of a public and private system—again for both locally and centrally financed public schools. The difference between rows 2 and 3 on the one hand and rows 4 and 5 on the other is striking: not only does the introduction of private schools into a publicly financed system lessen income segregation, it actually causes income segregation in the model to become less than it would be simply due to housing quality differences between districts. When private schools are allowed, demand for housing in district 1 rises as households attending private schools seek to take advantage of low housing prices that are (for them) not linked to poor public schools. Similarly, demand for housing in district 3 declines as some households who would pay high housing prices when housing is bundled with public schools now “unbundle” their choices by choosing private schools in the poor district where housing is cheap. This raises the price of housing in poor districts relative to rich districts, but not to the point where it would be if housing were not connected to public school access (as in row 1). Thus the new equilibrium provides incentives to middle- and high-income households to reside in poor districts while sending their children to private schools. Table 4 provides additional school-related information for each of these simulations.

While public finance institutions thus matter for such outcomes as public school quality differences across districts, the link between residential housing and public school access matters just as much if not more. Even under full financial resource equalization through centralized school financing, substantial interjurisdictional differences in public school quality remain, and they remain precisely because equalization takes place within an urban environment in which other economic forces are at work. Therefore, both public finance institutions and urban housing markets, as well as the interaction of public and private school markets, ultimately are key to an analysis of urban school policy. And not

Table 4. Public and Private School Quality and Attendance under Assumptions of School Financing Method and Income of School District

<i>Private schools allowed</i>	<i>Public school financing</i>	<i>Public school quality</i>			<i>Students attending private school (percent)</i>		
		<i>Low income (1)</i>	<i>Medium income (2)</i>	<i>High income (3)</i>	<i>Low income (1)</i>	<i>Medium income (2)</i>	<i>High income (3)</i>
Yes	None	100	100	100
No	Local property tax	0.3239	0.6024	0.9521	0	0	0
	State income tax	0.3940	0.6244	0.9022	0	0	0
Yes	Local property tax	0.3674	0.6192	0.8183	30	20	10
	State income tax	0.4616	0.6316	0.6841	22.5	17.5	15

only do these matter independently, they are likely to interact in important ways. Public school financing institutions, for instance, can strengthen or weaken the connection of public school access to residential location, and they can cause growth or shrinkage in the private school market. It is to these interactions that I now turn for different types of state public finance policies.

School Finance Policies: Partial versus General Equilibrium

Each section that follows begins with a fully decentralized public school system financed solely through local property taxes determined within each district through majority-rule voting. It then considers the effect of different types of reforms under different assumptions about the responsiveness of households in the model. First, I report how the combination of public school spending, public school quality in each district, and average public and private school quality (in each district) changes when no economic response by households occurs. Second, I consider how these outcomes change when household residential location and schooling choices are held fixed but voting behavior adjusts. Finally, I report the full general equilibrium outcome when households fully adjust and prices are allowed to change to support the new equilibrium. Two points are emphasized throughout: first, in some cases the general equilibrium responses are significant. Second, when policies result in households switching to or away from private schools, it may be important to consider the impact of reforms not just on the public school sector but rather on the overall education sector (including private schools).

Centralization and Equalization of Public School Financing

This section begins by investigating the partial and general equilibrium effects of an extreme change in public school financing—from a purely decentralized system financed by property taxes to one in which the state fully equalizes expenditures across districts and funds expenditures through a state income tax. Table 5 shows three key outcomes under the different assumptions regarding the responsiveness of households in the model. For each outcome, the local property tax equilibrium is reported next to the results for the policy change to facilitate comparisons.

Table 5. School Spending and Quality under Decentralized or Centralized Taxation and Behavioral Assumptions, by District Income Level

District income level	Local property tax equilibrium	Centralized tax, equalized spending		
		No behavioral change ^a	Partial equilibrium voting ^b	Full general equilibrium
<i>Public school per pupil spending (dollars)</i>				
Low (1)	5,000	7,731	7,309	7,195
Medium (2)	7,326	7,731	7,309	7,195
High (3)	10,215	7,731	7,309	7,195
All ^c	7,731	7,731	7,309	7,195
<i>Average public school quality</i>				
Low (1)	0.3674	0.4618	0.4484	0.4616
Medium (2)	0.6192	0.6370	0.6184	0.6316
High (3)	0.8183	0.7070	0.6864	0.6841
All ^c	0.6204	0.6122	0.5943	0.5960
<i>Average school quality (including private schools)</i>				
Low (1)	0.5421	0.6082	0.5989	0.5755
Medium (2)	0.6853	0.6995	0.6847	0.6904
High (3)	0.8314	0.7313	0.7127	0.7267
All ^c	0.6863	0.6797	0.6654	0.6642

a. This column assumes that the state income tax rate is set so as to keep average public school spending equal to what it is under decentralization.

b. This column assumes that voters approve a state income tax rate used to fund all public schools equally, but no household behavior changes are permitted.

c. This row calculates average statewide values. For public school figures, this is a weighted average of the remainder of the column where the weights are the fraction within each district that attend public schools. For overall school figures (the last set of columns), it is simply an average of the previous values in the columns.

First, consider the impact on spending. The simulation results labeled “No behavioral change” assume that the state government is able to maintain the pre-reform average spending in public schools but now spreads that spending equally across districts. The “Partial equilibrium voting” column, however, assumes that, holding voters fixed at their pre-reform location, equalized state spending has to be approved through majority-rule voting. This effect by itself lowers spending by approximately 6 percent because of the well-known effect caused by the skewedness of the income distribution. Under decentralized voting the median voter in each district is pivotal, while under statewide voting the

median state voter determines the outcome. In a stylized Tiebout model this implies that average spending in the state is determined by *mean* state income under decentralization while it depends on *median* income under centralization.¹⁷ So long as the median is lower than the mean (which is the case in real-world income distributions such as the one modeled in this exercise), this implies that majority rule will lead to lower average spending under centralization than under decentralization.

Finally, the third column, labeled “Full general equilibrium,” shows an additional 1.5 percent drop in average spending in public schools when the full general equilibrium effects unfold. This additional decrease in spending is due to a reduction in overall private school attendance as public school finances are centralized, thus leading to an increase in public school attendance and a decline in per pupil spending. This increase in private school attendance under centralization is counterintuitive in the sense that most would expect the decrease in local choice from centralization to lead to an increase rather than a decrease in private school attendance. However, the conventional intuition is incomplete because it does not consider two effects that may in fact lead to a decrease in private school attendance as financing of public schools is equalized.¹⁸ First, a *direct* effect occurs in the poor district where public school quality improves as a result of centralization and thus leads to switching away from private schools. Second, an *indirect* effect (which is twice the magnitude of the direct effect in the model presented here) unfolds through general equilibrium adjustments in housing prices. As the cost of housing rises in poor districts (because of higher prices due to better public schools and because of the decoupling of tax burdens from location choice), households that previously chose private schools in part because the choice allowed them to consume cheap housing in poor districts now

17. Under a stylized Tiebout model, residents segregate into districts based on their type, and districts are therefore homogeneous. Thus within each district all households agree on the spending level and each household consumes its most preferred spending level. When decentralized spending levels are then averaged across the state, the average state spending level is simply the average of the most preferred spending levels by households. But in a state election, households disagree on the best spending level, and the median household in the state is pivotal (assuming no exit from or entry into the private school sector).

18. This is demonstrated more fully in Nechyba (2003a).

have less incentive to continue in the private sector. These two effects combine in the model to result in an increase in public school attendance under centralization, and thus a decline in per pupil spending.¹⁹

The second part of table 5 reports the impact on perceived public school quality. Here, the differences between models that assume no behavioral change and those that fully incorporate all general equilibrium effects are not dramatic. In all cases, centralization leads to a narrowing of public school quality differences across districts, primarily because of equalization of spending. As peer compositions within public schools change in the general equilibrium, little additional change takes place. The increase in public school quality in districts 1 and 2 between the partial equilibrium and the full general equilibrium is 2–3 percent and is due solely to an increase in peer quality in these schools as children previously in private schools in district 1 switch to public schools because of the general equilibrium effects in the housing market. In the case of centralization of public school financing, the main effects therefore seem clustered around what happens to public school spending. And because of the decline in public school spending, overall public school quality (averaged across districts) declines by about 4 percent despite the increase in peer quality within the public schools.

The last part of table 5 tells a somewhat different story. This differs from the previous results in that we now include in the average district school quality figures the role of private schools within each district. First, note that, while public school quality in district 1 rises by 22 percent in the full general equilibrium model, overall school quality in district 1 rises by only 6 percent because private school attendance falls from 30 percent to 22.5 percent—and this increase is half what it would be if the full set of behavioral changes implied by the general equilibrium model had not been considered. Overall school quality for all children in

19. The model would predict an increase in private school attendance under centralization if centralization also led to a decline in public school efficiency (as is sometimes argued). In fact the model, combined with empirical results in the literature, suggests that it may indeed be likely that public school spending becomes less efficient the more spending is centralized and equalized. More precisely, radical centralization and equalization of public school spending seems to be correlated with higher private school attendance (as, for example, in California). The model of this paper suggests this could only happen if an additional effect was falling public school productivity.

the state declines by an amount roughly similar to the decline in public school quality, but the distribution of the decline is different when private schools are included. In particular, the ratio of public school quality in district 3 to that in district 1 declines by 50 percent (from 2.23 to 1.48), with this decline being disproportionately due to an increase in public school quality in district 1. The ratio of *overall* school quality in district 3 to that in district 1, however, falls by only 21 percent (from 1.53 to 1.26), but with this decline being disproportionately due to a decrease in overall school quality in district 3 (with only a small increase in district 1).

Thus, when viewed through the lens of only the public school system, centralization leads to a substantial narrowing of interdistrict quality differences primarily because schools get better in poor districts. However, when viewed through the lens of the combined public and private school system, the narrowing of interdistrict average school quality occurs primarily because of a reduction in school quality in the rich districts.

State Grants-in-Aid

The extremes of full decentralization and full centralization modeled in the previous sections are rarely found in school systems in the United States. Rather, most states have designed complicated formulas for determining state aid. This results in hybrid systems of partial local funding (typically through the property tax) combined with some state funding (typically through state income or sales taxes). This section therefore provides some examples of state grant programs to investigate how partial and general equilibrium effects may affect an analysis of such hybrid systems. In particular, it begins with a comparison of state block grants (of \$3,000 per pupil) to all school districts with a state matching grant program that requires roughly the same level of state funding. (The latter simulations match local spending by 40 cents for every dollar of local spending.) It then proceeds to an analysis of more targeted state aid, again simulating both block and matching grants. It is well understood that block and matching aid have rather different built-in incentives, with the block grants giving rise to an income effect while matching aid adds a substitution effect because it changes the relative price of funding local schools. In addition, however, these programs have general equilibrium effects that have not typically been treated in policy analysis. In each

case, the results are presented in tables 6 and 7 in a format similar to that used in table 5.

STATEWIDE GRANTS. The top half of table 6 provides simulation results for the introduction of a \$3,000 per pupil state block grant to all districts. The first column in each subsection (labeled “No behavior change”) simply assumes districts will spend an additional \$3,000 per pupil with no change in voter or household behavior. Naturally, a large increase in public school (and overall school) quality would then take place. The second column in each subsection (labeled “Partial equilibrium voting”) assumes voters now vote on local taxes knowing that the state will provide an additional grant funded by income tax, but no additional household behavior changes are allowed. In district 1, per pupil spending then falls back to its original level while it changes slightly in the other districts. As a result, overall public school quality rises slightly. Finally, the third column in each subsection (labeled “Full general equilibrium”) includes household behavior changes, which include most notably a small shift out of private schools and into public schools (private school enrollment in districts 1 and 3 drops by 2.5 percentage points) accompanied by small changes in house prices that cause additional marginal adjustments in household location choices. The full general equilibrium effect on public school quality is marginal, with the exception of district 3, where the small switch of households with high peer quality to public schools causes a significant increase in public school quality. Overall school quality changes similarly to show a small overall gain in school quality from the state block grant program. The interdistrict variance in both public and overall school quality, however, increases.

Marginal changes under block grants turn into much more significant changes under a matching grant program that results (in full equilibrium) in the same level of state spending as a \$3,000 block grant. Again, the initial column simply assumes that local taxes remain constant under the block grant, but because of the substitution effect arising from the change in the relative price of public school spending, the “naïve” initial estimates of spending increases are essentially correct for districts 2 and 3. Only in district 1 does public school spending not rise as much when political adjustments by voters are taken into account (primarily because the constraint of a minimum spending level of \$5,000 was initially binding on district 1). Thus the partial equilibrium political adjustment pre-

Table 6. School Spending and Quality under Two Grants-in-Aid Assumptions, by District Income Level

District income level	\$3,000 Universal block grant					Equivalently funded matching grant						
	Local property tax equilibrium	No behavioral change ^a	Partial equilibrium voting ^b	Full general equilibrium	Local property tax equilibrium	No behavioral change ^c	Partial equilibrium voting ^b	Full general equilibrium	Local property tax equilibrium	No behavioral change ^c	Partial equilibrium voting ^b	Full general equilibrium
<i>Public school per pupil spending (dollars)</i>												
Low (1)	5,000	8,000	5,000	5,000	5,000	7,000	5,824	5,373	5,000	7,000	5,824	5,373
Medium (2)	7,326	10,326	7,281	7,267	7,326	10,256	10,386	10,062	7,326	10,256	10,386	10,062
High (3)	10,215	13,215	10,861	10,545	10,215	14,301	14,421	14,042	10,215	14,301	14,421	14,042
All ^d	7,731	10,731	7,958	7,834	7,731	10,823	10,569	9,944	7,731	10,823	10,569	9,944
<i>Average public school quality</i>												
Low (1)	0.3674	0.4704	0.3674	0.3781	0.5421	0.6142	0.5421	0.5384	0.5421	0.6142	0.5421	0.5384
Medium (2)	0.6192	0.7415	0.6172	0.6042	0.6853	0.7831	0.6837	0.6756	0.6853	0.7831	0.6837	0.6756
High (3)	0.8183	0.9368	0.8451	0.9056	0.8314	0.9309	0.8556	0.9098	0.8314	0.9309	0.8556	0.9098
All ^d	0.6204	0.7357	0.6298	0.6511	0.6863	0.7761	0.6938	0.7079	0.6863	0.7761	0.6938	0.7079
<i>Average school quality (including private schools)</i>												
Low (1)	0.3674	0.4383	0.3980	0.3992	0.5421	0.5917	0.5635	0.4821	0.5421	0.5917	0.5635	0.4821
Medium (2)	0.6192	0.7388	0.7437	0.7575	0.6853	0.7810	0.7849	0.7880	0.6853	0.7810	0.7849	0.7880
High (3)	0.8183	0.9765	0.9808	1.0951	0.8314	0.9738	0.9809	1.0934	0.8314	0.9738	0.9809	1.0934
All ^d	0.6204	0.7419	0.7317	0.7601	0.6863	0.7822	0.7764	0.7878	0.6863	0.7822	0.7764	0.7878

a. Assumes that any state block grant to the district simply raises total spending in the district by the amount of the block grant.

b. Assumes that voters approve a new local property tax rate after learning of the state aid program.

c. Assumes that local property taxes remain unchanged as the matching program is introduced and that the matched funds are simply spent on local public schools.

d. Calculates average statewide values. For public school figures, this is a weighted average of the remainder of the column where the weights are the fraction within each district that attend public schools. For overall school figures (the last set of columns), it is simply an average of the previous values in the columns.

dicts substantial increases in public school quality, especially in districts 2 and 3. Finally, the full-equilibrium adjustment results in additional large changes. With public school quality increasing in all districts, substantial switching from private schools into public schools takes place, as well as migration of previous private-school-attending households from poor districts to wealthier districts as house prices adjust to reflect changes in public schools.²⁰ However, the decline in private school attendance in district 1 does not result in a large influx of high-peer-quality households into district 1 public schools because more than two-thirds of those leaving the private schools in district 1 migrate to other districts to use public schools there. Thus the full equilibrium simulations suggest small additional increases in public school quality in districts 1 and 2 and large increases in district 3. Overall school quality (which incorporates the impact of the disappearance of good private schools) actually drops by 12 percent in district 1 (even though public school quality rises by almost 9 percent), while it increases by over 30 percent in district 3.

The primary showing of table 6, then, is that universal state aid programs that are not targeted to struggling districts may result in some overall improvements in school quality but may simultaneously cause significantly larger inequities across districts. A \$3,000 block grant improves public school quality by barely 3 percent in district 1 but by over 10 percent in district 3. Similarly, overall school quality (including that provided by private schools) declines slightly in district 1 while increasing by over 9 percent in district 3. For matching grants the results are even more dramatic. Partial equilibrium results that do not incorporate the general equilibrium household adjustments in residential location and private school choice tend to understate these effects.

TARGETED STATE AID. Grants specifically targeted to poor public school districts, those represented by district 1 in the model, are examined in table 7. The top part of the table reports results from a \$7,000 per pupil block grant to district 1 public schools. The lower part focuses on results from an equally funded matching grant targeted only to district 1 with the aim of achieving the same level of spending in district 1 public schools as would emerge from the \$7,000 targeted block grant. Districts 2 and 3 remain funded solely through local property taxes.

20. Private school attendance drops by over 50 percent in district 1, from 30 percent to 12.5 percent. In districts 2 and 3, it drops by 50 percent.

Table 7. School Spending and Quality under Grants Targeted to Low-Income Districts and Behavioral Assumptions, by District Income Level

District income level	\$7,000 Block grant to district 1					Equivalent matching grant (match = 1.98)						
	Local property tax equilibrium	No behavioral change ^a	Partial equilibrium voting ^b	Full general equilibrium	Local property tax equilibrium	No behavioral change ^c	Partial equilibrium voting ^b	Full general equilibrium	Local property tax equilibrium	No behavioral change ^c	Partial equilibrium voting ^b	Full general equilibrium
<i>Public school per pupil spending (dollars)</i>												
Low (1)	5,000	12,000	7,000	7,000	5,000	9,938	7,824	7,021	5,000	9,938	7,824	7,021
Medium (2)	7,326	7,326	7,326	8,496	7,326	7,326	7,326	8,461	7,326	7,326	7,326	8,461
High (3)	10,215	10,215	10,215	11,211	10,215	10,215	10,215	9,324	10,215	10,215	10,215	9,324
All ^d	7,731	9,773	8,314	9,026	7,731	9,171	8,555	8,277	7,731	9,171	8,555	8,277
<i>Average public school quality</i>												
Low (1)	0.3674	0.5817	0.4383	0.4457	0.3674	0.5269	0.4647	0.4721	0.3674	0.5269	0.4647	0.4721
Medium (2)	0.6192	0.6192	0.6192	0.6883	0.6192	0.6192	0.6192	0.6423	0.6192	0.6192	0.6192	0.6423
High (3)	0.8183	0.8183	0.8183	0.9369	0.8183	0.8183	0.8183	0.7855	0.8183	0.8183	0.8183	0.7855
All ^d	0.6204	0.6829	0.6411	0.7047	0.6204	0.6669	0.6488	0.6380	0.6204	0.6669	0.6488	0.6380
<i>Average school quality (including private schools)</i>												
Low (1)	0.5421	0.6758	0.5647	0.5704	0.5421	0.6537	0.6102	0.5578	0.5421	0.6537	0.6102	0.5578
Medium (2)	0.6853	0.6763	0.6763	0.7350	0.6853	0.6853	0.6853	0.6997	0.6853	0.6853	0.6853	0.6997
High (3)	0.8314	0.8319	0.8319	0.9416	0.8314	0.8314	0.8314	0.7855	0.8314	0.8314	0.8314	0.7855
All ^d	0.6863	0.7280	0.6910	0.7490	0.6863	0.7235	0.7090	0.6810	0.6863	0.7235	0.7090	0.6810

a. Assumes that any state block grant to the district simply raises total spending in the district by the amount of the block grant.

b. Assumes that voters approve a new local property tax rate after learning of the state aid program.

c. Assumes that local property taxes remain unchanged as the matching program is introduced and that the matched funds are simply spent on local public schools.

d. Calculates average state-wide values. For public school figures, this is a weighted average of the remainder of the column where the weights are the fraction within each district that attend public schools. For overall school figures (the last set of columns), it is simply an average of the previous values in the columns.

Column 1 in each subsection again assumes no adjustment by voters or households. It is noteworthy that even under this “naïve” assumption—implying an increase of fully \$7,000 (under the targeted block grant) in per pupil spending in district 1 with no change in spending in other districts—public school quality in district 1 would still not have risen to the level of public school quality in districts 2 and 3 (which spend considerably less). The calibrated production function of the model gives a substantial role to spending in public schools, but there is a limit to how much spending alone can accomplish. Furthermore, the political adjustment (holding all other household behavior fixed) implies that spending from heavily funded state programs targeted at poor districts will rise considerably less than dollar for dollar.

Since programs modeled in table 7 are strictly targeted to only the poor district, one might initially think that a partial equilibrium analysis may in fact not fall far short of a more general equilibrium approach. This, however, does not seem to be the case. In fact, a series of general equilibrium effects is set off by the introduction of such targeted grant programs, causing the effects of these programs to spill over into private school markets, housing markets, and public schools in other districts. Specifically, with schools improving substantially in district 1 under the partial equilibrium assumptions, and with property taxes falling as states pay for public schools, depressed housing prices rise in that district. This causes marginal households attending private schools (previously residing in district 1 to take advantage of low housing prices to send their children to private schools) to emigrate to other districts, often switching to their public schools and replacing residents that value schooling less.²¹ Substantial declines in private school attendance then occur, particularly in district 1 but also in districts 2 and 3, as public schools there improve both through more spending (because of a larger political constituency for schools) and a better public school peer group. Despite the state block grant targeted solely at district 1, the general equilibrium model predicts increases in per pupil public school spending of 10 to 16 percent in the other districts. This spending increase is accompanied by an increase in public school peer quality within districts 2 and 3 (from households that

21. Private school attendance falls from 30 percent to 22.5 percent in district 1, from 20 percent to 15 percent in district 2, and from 10 percent to 7.5 percent in district 3.

previously attended private schools in district 1), pushing public school quality in those districts up by 12 to 15 percent. Public school quality in district 1, however, is virtually unchanged from its partial equilibrium level as only a few households switch from private schools in district 1 to the public school in that district.

Compared to results for a universal \$3,000 block grant analyzed in table 6, the targeted \$7,000 block grant in fact achieves universally preferable outcomes in terms of school quality (while requiring significantly less state funding). This is not the case under a partial equilibrium model where only district 1 experiences higher public and overall school quality under the larger targeted program than under the smaller universal grants. However, when the full general equilibrium effects are taken into account, both public and overall school quality levels are substantially higher in *all* districts under the targeted program. The significantly larger general equilibrium effects for the targeted program arise precisely because the program is targeted and thus causes larger relative price changes than does a nontargeted program.

An additional surprising result appears when targeted block grants are compared to targeted matching grants that result in the same level of public school spending in district 1. Because matching grants continue to require local property tax effort, general equilibrium increases in housing prices in district 1 are more muted, thus setting off smaller overall general equilibrium effects. While private school attendance also falls by similar magnitudes, the decline is different because it involves significantly less migration between districts than what arises under a targeted block grant. Average public school and overall school quality then do not change nearly as much as under a targeted block grant aimed at achieving the same increase in public school spending in district 1.

Thus while partial equilibrium adjustments in public school quality are more dramatic under a matching formula, general equilibrium adjustments are significantly larger under block grants. Overall, then, it seems that extending the analysis of school finance reforms from a partial to a general equilibrium context becomes more important the more targeted the aid programs and the more they contain block rather than matching elements.

STATE-FUNDED VOUCHERS. A final set of school reforms that is gaining increasing attention encompasses the state funding of private school

vouchers or other state-funded choice programs.²² Table 8 focuses on private school vouchers funded by state income taxes. For this set of school finance policies the general equilibrium effects are more immediately apparent and have been explored in more detail elsewhere.²³ This section simply illustrates the impact of two types of vouchers, both set at \$2,500 per pupil. The first type is unrestricted with any household eligible, while the second is restricted to only those households residing in poor districts.²⁴ For purposes of the analysis that follows, a voucher is defined as a state subsidy of \$2,500 or the full private school tuition (whichever is lower) for households choosing to send their child to a private school.

The first two columns under each subsection of table 8 differ slightly from those in the previous tables while the rest of the table follows a similar format. In particular, columns labeled “Little behavioral change” allow private schools to adjust tuition levels (and thus spending levels) in response to the introduction of the voucher, but no adjustment on the part of households or voters is allowed. Columns labeled “No migration equilibrium” allow for both the adjustment of political choices by households and the formation of new private schools to meet any additional demand by households seeking to switch from public to private schools in response to the voucher. However, no migration is permitted under this set of simulations. Finally, columns labeled “Full general equilibrium” report simulations that allow for all household choices to change, including most importantly the choice of residential location.

The difference between a partial and a general equilibrium model is perhaps starkest for the case of private school vouchers. Since no additional state money is provided to public schools, no change in public school spending occurs under the first column in both voucher scenarios. With households permitted to switch to private schools in the second column (labeled “No migration equilibrium”), the potential for a change in per pupil spending in public schools emerges as those households that switch to private schools are assumed to no longer support taxes going to public schools. However, only in district 1 do any households switch to

22. Although this is not explicitly explored here, publicly funded charter schools—to the extent that they do not base admission on residential location—would have general equilibrium effects similar to those reported here for private school vouchers.

23. Nechyba (1999, 2000, 2002, 2003a, c).

24. The latter type of voucher (targeted to districts) is one that has been proposed at the national level by the Bush administration and has been passed at the state level in Florida.

Table 8. School Spending and Quality under Universal and Targeted Private School Vouchers and Three Behavioral Assumptions, by District Income Level

District income level	\$2,500 voucher				\$2,500 voucher to district 1			
	Local property tax equilibrium	No behavioral change ^a	No migration equilibrium ^b	Full general equilibrium ^c	Local property tax equilibrium	No behavioral change ^a	No migration equilibrium ^b	Full general equilibrium ^c
<i>Public school per pupil spending (dollars)</i>								
Low (1)	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000
Medium (2)	7,326	7,326	7,326	7,326	7,326	7,326	7,326	6,346
High (3)	10,215	10,215	10,215	10,215	10,215	10,215	10,215	8,333
All	7,731	7,731	7,731	7,731	7,731	7,731	7,731	7,115
<i>Average public school quality</i>								
Low (1)	0.3674	0.3674	0.3522	0.3393	0.3674	0.3674	0.3522	0.3247
Medium (2)	0.6192	0.6192	0.6192	0.4930	0.6192	0.6192	0.6192	0.4435
High (3)	0.8183	0.8183	0.8183	0.7299	0.8183	0.8183	0.8183	0.6503
All	0.6204	0.6204	0.6160	0.5739	0.6204	0.6204	0.6160	0.5271
<i>Average school quality (including private schools)</i>								
Low (1)	0.5421	0.5481	0.5623	0.6318	0.5421	0.5481	0.5623	0.6137
Medium (2)	0.6853	0.6963	0.6963	0.6187	0.6853	0.6963	0.6963	0.5973
High (3)	0.8314	0.8452	0.8452	0.7396	0.8314	0.8452	0.8452	0.6794
All	0.6863	0.6965	0.7013	0.6634	0.6863	0.6965	0.7013	0.6368

a. The only behavioral change permitted under these simulations is for existing private schools to alter their tuition level in response to the voucher.
b. Households can choose to switch to private schools and vote differently in the political process, new private schools can form, and existing private schools can alter their tuition policies.
c. All households and private school choices can change in response to the changed economic environment.

private schools. Because public schools in district 1 are already spending the minimum per pupil (\$5,000), no further erosion in public school spending is possible.²⁵ Public school quality, however, falls slightly in district 1 as higher-peer-quality families exit the public schools. At the same time, overall school quality increases in district 1 as the average quality of new private schools is greater than that in public schools. Similar increases in overall school quality occur in districts 2 and 3 even though no household switches to private schools because existing private schools raise their spending slightly in response to the introduction of vouchers.²⁶ Since only households in district 1 switch from public to private schools as a result of a voucher universally available in all districts, results are identical for the partial equilibrium simulations when vouchers are targeted only to district 1.

While partial equilibrium effects are therefore small, the general equilibrium effects reported in the last column of each subsection in table 8 are large and driven almost solely by migration effects and housing price adjustments. Given the depressed housing prices in district 1 (and the similarly inflated housing prices in district 3), the model does not predict large increases in private school attendance unless households interested in switching from public to private schools are able to move in order to take advantage of lower housing prices when making the switch. Thus marginal households in districts 2 and 3 previously were willing to pay inflated housing prices to gain access to good public schools but are now more easily able to afford private school tuition. As a result, there is no reason for them to continue to pay relatively high housing prices when more housing of the same quality is available in district 1 at lower prices. Private school attendance in district 1 therefore increases dramatically (from 30 percent to 62.5 percent under the universal voucher and from 30 percent to 70 percent under the targeted voucher), primarily because

25. In models where local public school spending is not at its minimum level, private school vouchers could actually have the effect of raising per pupil public school spending despite a decline in political support for public schools because the existing public school budget is spread over fewer school children when many in the district attend private schools. In effect, the exit of some families into the private market makes per pupil spending cheaper, therefore acting like a matching grant for voters who continue to send their children to public school.

26. The increase in spending in existing private schools is predicted to be small because the \$2,500 voucher only gives rise to a small income effect for households that already choose private schools.

households of high peer quality leave public schools in districts 2 and 3 to reside in district 1 to use the voucher. Increases in private school attendance in districts 2 and 3 are more modest.²⁷

One of the more notable findings from this line of research is that the feared negative impact of vouchers on public schools is strongest not in districts where most private school vouchers are used (district 1) but rather in districts from which those who switch from public to private school originate. Their loss in districts 2 and 3 causes decreases in public school peer quality as well as declining political support for public schools (in district 3). While public school quality thus falls by 8 percent in district 1 under universal vouchers, it falls by 26 percent in district 2 and by 12 percent in district 3. Even more dramatically, under a voucher targeted solely to district 1, public school quality falls by 13 percent in district 1—a modest effect compared to declines of 40 percent and 26 percent in districts 2 and 3. The impact on district 2 is particularly large because residents of district 2 can more easily find appropriate housing choices in district 1 as they switch to private schools than can residents of district 3 (because the house-quality distribution of district 1 overlaps more with that of district 2 than with that of district 3.) Migration and general equilibrium price effects then cause cream-skimming by private schools to affect disproportionately public schools in districts other than those in which the vouchers are used, particularly middle-income districts. And, as in the previous section, these general equilibrium effects are stronger when the policy is targeted.

Although it is certainly the case that the impact of private school vouchers on public schools is of independent importance, the last column of table 8—reporting results for overall school quality (including private schools)—is nevertheless striking. Because of the disproportionate use of vouchers in district 1, average school quality in district 1 actually surpasses average school quality in district 2 and comes remarkably close to that of district 3. Given the results for public school quality, this clearly masks an enormous heterogeneity in school quality within the poor district between private and public schools. Nevertheless, if good private schools, and the high-peer-quality households that choose them, have

27. Under both types of vouchers, private school attendance increases to 40 percent in district 2. In district 3, private school attendance rises from 10 to 12.5 percent under the universal voucher but does not rise under the targeted voucher.

independent positive effects (which are not modeled) on communities, the last column of the table may hold other important lessons for urban policymakers.

Although these results are striking, the importance of general equilibrium effects in general, and in the case of vouchers in particular, should not be that surprising. Local policymakers have long been aware of the close connection between residential housing markets, local school quality, and local tax rates. Each of the policies analyzed has altered this connection in some way and has given rise to general equilibrium effects that are often absent from policy analysis. For vouchers these effects are particularly large in comparison to partial equilibrium effects because vouchers most directly affect the key reason identified earlier for why public schools can be so different in equilibrium. This reason was found in the bundling of residential housing and school choices, a bundling that arises because of residence-based admission to local public schools. Vouchers, more than any other policy, unbundle this connection by making it easier for households to choose housing and school quality separately. If the bundling is important (as I argue it must be), unbundling must be important as well. The same forces play a similar but less dramatic role for the other types of school finance reforms analyzed in this paper.

Finally, it is noteworthy that overall (public and private) school quality is shown to decline with private school vouchers. This is a direct result of two assumptions in the model: first, the model assumes no competitive gains from increased competition. As noted earlier, if such an effect were included in the model, the general equilibrium effects emphasized in this paper remain, while overall school quality would improve (as would public school quality in each district if the competitive effect is sufficiently large).²⁸ Second, the role of peer inputs into the school production model is specified in such a way as to cause average school quality to increase (all else being equal) the more households with different peer quality mix within schools. Because private schools seek to skim high-peer-quality households from public schools, an increase in private school attendance implies less mixing of household types within schools. Again, it is shown elsewhere that the general equilibrium effects emphasized here do not change if this model of peer inputs into school produc-

28. See Nechyba (2003c).

tion is altered to make mixing less efficient, but overall school quality would then increase with higher private school attendance.²⁹

Perceived and Real Limits of the Analysis

Although the computational approach used in this paper provides a powerful engine for analyzing questions of the kind tackled here, the approach has inherent limits. Any structural model that attempts to merge all of the relevant economic forces for urban school policy must by definition make explicit assumptions that are almost certainly only crude approximations of complex real-world processes. While, in the words of one commentator on this work, the engine that drives the analysis can be “intoxicating” by providing explicit numerical estimates for policy alternatives, it is thus not appropriate to interpret the results too literally. The advantage of the approach is that it provides a single, internally consistent method for comparing policies and tracing partial and general equilibrium effects, and it therefore provides a useful guide for thinking about the *relative* quantitative importance of different real-world economic forces. At the same time, the assumptions made in the process of modeling complex forces are tenuous enough to recommend caution in interpreting results as firm absolute predictions.

Some Common Concerns and Misunderstandings

Some of the caution arises from technical details such as implicit elasticities embedded in functional form assumptions of preferences and production. The empirical literature has often not provided a firm sense of what these elasticities should be, and the approach therefore takes standard functional forms as a starting point. Sensitivity analysis suggests that the relative magnitudes of general and partial equilibrium results are unlikely to change dramatically as these implicit assumptions are changed. Similarly, concerns may arise from the assumption that housing stocks are taken as given in the model and do not change as general equilibrium effects cause migration of some households within and across districts. In other work I have argued that, while such concerns are cer-

29. Nechyba (2003c).

tainly valid, the assumption actually tends to understate the kinds of general equilibrium effects highlighted in most of this paper.³⁰ Thus as housing stocks are more flexibly modeled, general equilibrium effects are likely to become more rather than less important.

The same is true for a concern that non-school-related externalities from migration are not explicitly modeled as migration takes place. Some commentators, for instance, have mistakenly argued that the model assumes too great a willingness of households to seek lower housing costs because the model does not take into account such factors as the characteristics of neighbors, other neighborhood amenities, and so forth. Since housing prices are used to calibrate benchmark housing and neighborhood quality levels, all such factors *are* taken into account in the initial benchmark model because all such factors would indeed be capitalized into prices. While it is true that the model then holds non-school-related neighborhood externalities fixed as migration occurs, any movement of high-income households into low-income areas would tend to raise non-school-related neighborhood quality, increasing rather than decreasing the migration effects highlighted in many of the simulations. Thus, to the extent that policies like private school vouchers cause high-income households in the model to move to low-income districts, the model understates rather than overstates the willingness of households to move. It is only in simulations where migration occurs from poor to rich areas that the exclusion of changes in neighborhood externalities would bias the general equilibrium results upward.

Finally, many of the results reported here highlight general equilibrium effects that include migration of households between districts as well as switching behavior from public to private schools or vice versa. Such effects would not emerge if households generally faced high moving costs, and concerns may arise that general equilibrium effects in the model depend too much on the assumption of an absence of such costs. I view such concerns as very valid in the short run but largely unimportant in the long run for urban economies in the United States. American households move often, typically for reasons other than schools. Such moves occur because of job-related changes or because changes in family size or income dictate a discrete change in housing consumption. The appropriate interpretation of the mobility behavior observed in this paper

30. Nechyba (1999, 2000, 2003c).

is one that emphasizes that as families move for a variety of reasons, the economic environment in which they make their new housing decision matters. School policy changes that environment, and thus alters the way in which housing and schooling decisions are simultaneously made as families find themselves moving for reasons that may have little to do with schooling. Given the frequency with which American families move, the “long run” in which these general equilibrium effects become important may then not be very long at all.

Some Effects That Are Not Modeled but Might Be Important

Other concerns may arise from the fact that certain possible effects that are sometimes claimed but are not firmly established empirically are excluded from this analysis. For instance, the simulations reported here do not include a “competitive productivity effect” in public schools resulting from increased private or public school competition. In other work, I have shown that the presence and *relative* size of the general equilibrium effects highlighted in this paper are not affected by the inclusion of such a competitive effect, although the *absolute* value of school quality predictions does depend on it.³¹ Thus, in simulations of private school vouchers, for instance, public and overall school quality may well improve with vouchers if competition causes productivity gains in public schools. But the simulations reported in this paper do not show such an improvement because the competitive effect is not modeled. Similarly, it is sometimes argued that decentralized school finance results in better use of local information and thus greater school productivity than does centralized finance. Again, while this may certainly be the case, the effect is not modeled here and may therefore affect the *absolute* value of some of the outcome variables even as the *relative* importance of partial and general equilibrium effects remains roughly the same.

Two additional features of the real world that are not modeled should add to one’s skepticism of the immediate applicability of the absolute predictions of the model to contemporary urban settings. First, the model currently does not include any heterogeneity in household preferences. In some sense, this is in part a strength of the current approach because it keeps out of the analysis any unnecessary appeal to preference hetero-

31. Nechyba (2002, 2003c).

geneity in explaining heterogeneous outcomes within the public school sector. At the same time, however, measurable characteristics such as religious preferences of households are important determinants of school choices made by households. In fact, when religious heterogeneity is added to the model used in this paper, structural estimates demonstrate that this heterogeneity carries considerable explanatory power.³² Second, it is difficult to ultimately provide true predictions of the impact of school policies in urban settings unless not just income heterogeneity but also racial heterogeneity is modeled explicitly. The inclusion of race in the model used in this paper, however, remains a project for future research.

Conclusions

The approach taken in this paper has allowed for an explicit comparison of partial and general equilibrium effects from school finance policy reforms in a single, internally consistent framework that can successfully replicate important features of the data under current school finance policies. On a number of occasions the approach has led to the conclusion that general equilibrium effects may alter conclusions drawn from a partial equilibrium analysis in surprising and large ways. This implies that school finance policy cannot easily be analyzed without explicitly taking the link to housing markets and private school markets into account. Furthermore, when analyzing the politics of school reform, it may be the case that policy change (or lack thereof) arises not so much because of the impact of such change on schools but rather because of the implied general equilibrium effects on housing values and thus household wealth distributions. In the case of vouchers, for instance, high-income residents in good school districts could suffer substantial capital losses while low-income residents in poor school districts might experience capital gains.

32. Ferreyra (2002).

Comments

Eric A. Hanushek: Public and professional debate about the best way to fund schools have been going on for a very long time, but their intensity has increased enormously over the past three decades. Yet this debate remains resistant to careful and thorough analysis. The paper by Thomas Nechyba provides a clear statement of the value of systematic analysis of important policy issues. This paper, which provides an overview of a series of papers by Nechyba, is a dramatic departure from most previous discussions. It provides specific insights into the likely outcomes of a number of policies currently being discussed. But more important, it develops a structure for thinking about the entire funding matter. I am a great fan of this line of research, and I think it has provided considerable clarity to an area clouded in slogans, emotions, and vested interests.

This powerful analysis introduces economic theory into policy evaluation. In some areas such as regulatory policy or monetary and fiscal policy, economic analysis is common. Such is not the case when it comes to schools and their finance. Moreover, while Nechyba describes this work as “applied theory,” he has now developed a machine that goes beyond theory and gets close to the details of actual policy proposals.

The central theme of this line of research is that school finance cannot be analyzed in isolation from other choices and behavior. In various other subjects of interest, partial equilibrium analysis gives very satisfactory answers. This is not true for school finance, where general equilibrium effects almost certainly dominate. This line of research, which is clearly presented in the paper, shows the importance of considering the outcomes for schools of individual behavior.

Nechyba identifies the key interactions among household location, school finance policies, and school outcomes. Public schooling that is linked to the residence of a family implies that location and schools are a joint decision. This jointness implies that policies that affect people's evaluation of the finance and quality of schools can change their evaluation of a particular residential location, and families are likely to respond to policy changes by adjusting their location. A theme that weaves throughout the analysis is that the role of private schooling has been misunderstood. Private schooling allows some families to break the link between household location and the schools that their children attend. Thus, for example, we find that there is less income segregation by jurisdictions when private school alternatives are available. This general equilibrium finding contrasts sharply with the common public view and the typical policy debates that suggest private schools are a segregating influence.

Who is surprised by these results? For the most part, economists who study public finance and urban location are not. Although many of these people have not spent much time thinking about the institutional details and the general equilibrium effects that might be expected, with a little thought they would likely come up with the overall conclusions that Nechyba reaches. Of course, they would not have a good sense of the magnitude of any effects, but that is also where Nechyba cautions us to be careful. The magnitudes are a direct function of some key parameters that are not fully analyzed or known.

The group that would be surprised most completely by this analysis is today's decisionmakers on school finance—the state courts, the state legislatures, and the state education departments. School finance issues have been near the top of the policy agenda for at least the past three decades. This represents the confluence of two different streams of thinking. First, growing out the 1960s with the concerns about poverty and equity, a series of lawsuits directly attacked the common mode of school finance. The beginning was the California suit, *Serrano v. Priest*, which argued that it was a violation of the Fourteenth Amendment of the U.S. Constitution to make “the quality of one's school based on the wealth of neighbors.” With the common use of local property taxes to fund schools, jurisdictions with larger tax bases could more easily fund their schools. Although the U.S. Supreme Court declared in 1974 that this local funding did not violate the Constitution, these suits have entered a majority of

state courts under the separate state constitutions. Second, in part propelled by the report, *A Nation at Risk*, policymakers became very concerned with the quality of the schools. This concern, which has continued for the two decades since release of the report, appears to dovetail neatly with the issues of providing funding for schools.

As a result, issues of funding have been debated intensely in all states. The debates in courts and legislatures take a very simple view. People are stuck in their current jurisdictions. The rich take advantage of their wealth and superior purchasing power to buy better schools, while the poor are relegated to underfunded schools. The debates virtually never acknowledge that households might generally be choosing both locations and schools. Nor do they consider the possibility that these decisions would change with different funding arrangements and that these changes might yield a variety of capital gains and losses for homeowners. As a result, virtually everybody in the center of these debates would be surprised by the thinking and the analysis in Nechyba's work.

Another element of Nechyba's analytical framework deserves note. His modeling incorporates decisions to attend private schools and includes the educational outcomes observed in private schools. In most debates, students choosing the private schools are written out of the discussion.

This work extends Nechyba's previous analyses of school finance. Simply comparing the modeling advances reported here with what was possible just a few years ago shows the remarkable strides of this effort. My only plea is that he speed up the development of this work, and in that spirit I want to suggest some areas for development.

There are some issues on which Nechyba is at the mercy of other researchers. Specifically, he must build the behavior in his model on parameters and models that he gets from other sources. In some key areas, the other research does not help him out very much. His modeling stresses the role of peers in developing the quality of schools. The direct modeling of peers, however, has not been very precise on the strength and form of any such relationships. Part of this is explicable, because the identification and estimation of peer effects is notoriously difficult.³³ But Nechyba also extends the view of peer influences in what I believe to be productive ways. The empirical studies on peers concentrate almost

33. Hanushek and others (2003).

exclusively on individual peer interactions in the classroom. This view ignores the larger political economy issues surrounding how parents interact with schools to improve schools' performance, set their agenda, and the like. Thus while his specifications depend on the quantitative and qualitative interaction of peers in determining school quality, he does not get much guidance from existing research.

A second area where existing research is not very helpful is the determinants of private school attendance. Research on private schools has focused almost exclusively on their quality and not on the determinants of attendance rates.³⁴ A central innovation in the current generation of modeling by Nechyba is the inclusion of private schools as an important component of the behavior. This extension of previous work is nontrivial from a modeling perspective, but it greatly enriches the models. Indeed, the adjustment on the private school margin is one of the significant aspects of the policy changes he considers. Yet, at least over the past thirty years, the overall rate of private school attendance has been virtually constant at 11 to 12 percent. It has been constant in the face of significant centralization of school funding at the state level (largely as a result of earlier school finance cases). It has also been constant in the face of a more than doubling of the real spending per pupil on public schools. These kinds of changes would lead to noticeable private school adjustment in Nechyba's model, but one does not see them in the data. This suggests that even though the introduction of private schooling is, in my opinion, a great stride forward, more thought has to be given to the form and extent of behavioral reactions in that area.

There are obviously complex forces at work in the private school market. For example, while the overall rate of attendance has been constant, the character of private schools has changed considerably. There has been a dramatic decrease in Catholic school attendance, for instance, but this has been offset by increases in attendance at other religious schools. Some of the complicated influences on overall attendance may indeed be masking some of the changes on which Nechyba focuses his modeling efforts.

There are two clear areas of extension that I would like to see Nechyba pursue. The first is consideration of commercial and industrial property. His current modeling has only residential property in the prop-

34. Neal (1998).

erty tax base. This approach greatly simplifies both the modeling and policy discussion, because property-wealthy districts tend also to be income-wealthy districts, and everything tends to move together. However, the reality differs from the modeling in important ways. For example, New York City is a property-wealthy school district that has very large concentrations of poor people. This pattern varies by state; New Jersey has more property-poor central cities than most, so that property tax base and income of residents are more positively correlated. The distinction between the wealth of the community (tax base) and the income of the residents has been blurred, perhaps intentionally at times, in much of the actual debate on school finance. It would be very useful if Nechyba could extend his work to capture the differences between the taxable property and the income and wealth of the residents. This wish is, of course, easier for a discussant to call for than for a researcher to carry out. It greatly complicates some of the adjustments that must be accounted for in the model, and not a lot of research would indicate how commercial and industrial locations might themselves adjust.

Nechyba's current housing prices of course capture a variety of locational advantages that exist in his basic data. Thus other elements of the property tax base are implicitly included. The difficulty comes in policy discussions that treat household income and tax base as being close to synonymous.

The second major consideration that seems crucial is the inclusion of race. Constraints on housing location that go with race are undoubtedly more real and important than those on income.³⁵ If true, this implies that a specific subgroup may in fact have less opportunity to adjust to optimal locations. Additionally, my own work points to the importance of peer groups in terms of race (higher black concentrations hurt black students). Thus it would be important to bring these elements into the analysis. Nechyba of course recognizes this, so my mentioning it is more along the line of trying to help him set his future research agenda.

The final issue that I cannot help but underscore is the interpretation of the equilibrium outcomes of this modeling effort. Nechyba builds his analysis on the idea of perceptions and behavior of parents. He stops short of making welfare comparisons on the basis of any improved or deteriorating school quality. This corresponds to my view of the current

35. Hanushek, Kain, and Rivkin (2002).

structure of schools. There is little evidence that spending on schools is a good index of school quality, even if parents might tend to use that index. Thus his model predicts behavior of parents based on their preferences, but it does not provide guidance on the educational quality issues that weave around the school finance debates. Current court cases and legislative actions are propelled by both equity and quality issues, but they have been unable to describe any quality changes that might result from policy changes. Nechyba recognizes this clearly.

The overall judgment: this is an exceptionally clear and important line of research. Nechyba has taken the analysis to new heights, and we can only hope that he continues rapidly with this development.

Susanna Loeb: In “Public School Finance and Urban School Policy,” Thomas Nechyba summarizes his research using computational models to estimate the impact of policies on schooling and residential location decisions. Perhaps because of the fixed costs of developing sufficiently complex and accurate models, computational models are rarely used for educational policy analysis, even though they have the potential to greatly enrich our understanding of policy dynamics and our ability to predict the impact of policy choices. Nechyba’s work stands out because it applies such models to estimate conditions under a variety of policy alternatives. His framework assumes that families’ utility is a function of house quality, private consumption, and school quality, which is itself a function of per pupil spending and average peer inputs. Housing, both quality and quantity, is fixed. Using data on suburban New Jersey districts, he chooses the parameters of the utility function and the school quality function so that the sorting of families into districts and into public or private schools most accurately matches the sorting in the data. Three points are worth noting. First, understanding general equilibrium effects is central to understanding the impact of education policy. Second, there is a wide variety of potential general equilibrium effects worth considering when one attempts to predict the impact of education finance reforms. Finally, there are reasons to be cautious about using the estimates from these models to predict the impact of specific policy changes, especially in urban areas.

Nechyba’s work demonstrates the importance of understanding general equilibrium effects if we are to predict the impact of education finance reforms. For example, the models show that a shift from local to

state funding decreases income segregation slightly when private schooling is not an option for families, but increases income segregation when private schooling is an option. Private schooling decreases in low-income communities and increases in high-income communities as a result of the change in finance, which increases segregation.

General equilibrium effects are evident in empirical studies as well. For example, while the Tennessee Star experiment showed positive effects on student learning of reducing class size, especially in the early grades, large-scale reduction in California increased the demand for teachers and resulted in a new sorting of teachers across schools.³⁶ The re-sorting of teachers reduced teacher quality in some schools enough to reverse the potentially positive impact of smaller classes.³⁷ The example of class size points more generally to a concern that while experiments have become the standard in education research, the prevalence of general equilibrium effects may make experiments poor predictors of the impacts of large-scale policy changes. Certainly it is agreed that the small-scale voucher demonstrations are unlikely to force public schools to respond to market pressures in the same way that a larger reform might. Similarly, private schools that open in response to a large-scale voucher program may differ from those already in place or those that respond to a small-scale experiment. In Cleveland, for example, the secular private schools that did open in response to demand were unable to survive; only Catholic schools remained to serve voucher students.³⁸ Thus an understanding of general equilibrium effects is essential for predicting the impact of education reforms: the reduction in class size in 15,000 districts will not have the same result as the reduction in one district or one classroom; vouchers for 10 will not have the same result as vouchers for 10,000 or 10 million; and an increase in spending in one school will not have the same impact as an overall increase. By allowing families to move and choose their private school and by allowing housing prices to change, Nechyba introduces general equilibrium considerations into the assessment of education policy and demonstrates their importance.

There are many possible general equilibrium effects worth considering. Nechyba's paper focuses on three of them: capitalization or changes

36. Mosteller (1995); Bohrnstedt and Stecher (1999).

37. Jepsen and Rivkin (2002).

38. Carnoy (2001).

in property values, cross-district mobility, and the choice of public or private school. Studies provide evidence that housing prices change in response to education policy. Jeffrey Guilfoyle, for example, found substantial capitalization as a result of the 1994 Michigan school finance reform.³⁹ Randall Reback, looking at the introduction of open enrollment in Minnesota, found that increased property values in net sending districts (probably those with previously lesser-quality schools) was enough that if property tax rates did not change, the change in property tax revenues would compensate for the loss in students.⁴⁰

However, while the evidence on capitalization is substantial, the evidence of the responsiveness of private schooling decisions to school finance reform is less clear. Thomas Downes and David Schoeman did find some change in private school enrollment after the implementation of Proposition 13 in California, which dramatically altered the state's school finance system.⁴¹ Yet the exodus to private schools has not been substantial.⁴² As an indication that the model may not capture the true responsiveness of the public/private choice, table 2 shows that the model does a good job of replicating most of the distributions in the data. It somewhat underestimates property values in low-income districts and overestimates them in high-income districts, but the differences are small. The difference between predicted and actual private school enrollment in high-income districts, however, is significant. Specification checks show that if private schooling were fixed at the actual levels, the predictions of the model would not change. But the lack of consistency with the data when this element is not fixed may indicate problems with the underlying assumptions. There are a number of reasons that the responsiveness of private schooling may not be great. The supply side of the private school market, in particular, may limit this responsiveness. The model currently assumes perfectly elastic private schooling, but this is unlikely to be realistic. The charter school movement demonstrates the difficulty of scaling up successful programs. New private schools will differ from private schools already in operation.

It is worth considering whether there are indirect effects other than those considered by Nechyba that may significantly bias policy predic-

39. Guilfoyle (1998).

40. Reback (2002).

41. Downes and Schoeman (1998).

42. Sonstelie, Brunner, and Ardon (2000).

tions if ignored. There probably are. For example, when constrained by school finance policies in the purchase of education through taxes, districts may respond by encouraging increased private donations.⁴³ Alternatively, districts may reduce public spending in other agencies, such as county or city parks and recreation departments, to substitute for education spending.⁴⁴ Housing quality may adjust; even parents' contribution to education in the home may change. Political support for education (demand) also may be influenced by the structure of the finance reform. In the case of the implementation of a voucher program, for example, voter support for public schooling may shift if part of voters' willingness to pay for public education in the current system stems from a desire to support shared institutions (public schools with teams and concerts) in the community.

A priori, it is difficult to know which of the many possible responses are important for accurately predicting policy effects. The computational models are complex enough that it is difficult to incorporate all possible responses into a single model. Here, there is a role for empirical research that uses policy changes to estimate the magnitude of various possible responses and to identify those indirect mechanisms most likely to affect final outcomes. This empirical work alone would not accomplish what Nechyba's work does. Empirical studies do not predict, prior to implementation, the effect of policies in different communities and under different conditions. Computational general equilibrium models can incorporate characteristics, such as housing stocks and income distributions, to simulate how effects of policy may vary. We, however, do need to know which general equilibrium effects to incorporate.

When using Nechyba's model to predict the absolute or relative impact of school finance policy, especially in urban environments, there are reasons to be cautious. The first reason stems from my previous discussion. The models only incorporate some indirect effects. They may be missing influential mechanisms. Second, the effects that it does incorporate, particularly the choice of private or public school, may not be as responsive as the model assumes. This is important, given that many of the policy dynamics described in the paper appear dependent on the public-private school mechanism. Finally, this model assumes multiple dis-

43. Brunner and Sonstelie (1996).

44. Cullen and Loeb (2002).

tricts and smoothly functioning social choice mechanisms. These assumptions may be more applicable to suburban areas, such as the New Jersey region where the data come from, than to true urban areas, where race, patronage, politics, and central leadership can play far greater roles in determining policy effects than the Tiebout mechanisms captured by the model. Clearly race plays a significant role in families' residential location decisions, even in suburban areas.⁴⁵ These cautions do not imply that the simulations are not worthwhile, but that it is essential to assess the sensitivity of the models to underlying assumptions. Varying the structural framework of the models is likely to take substantial effort. Yet it may be worth the effort to see whether other mechanisms may be key to understanding policy dynamics. Other specification checks, such as varying the details of the policies analyzed and varying the data, may not require as much work. Even slightly different policies may have different effects. For example, Nechyba's finding that targeted block grants are more effective than targeted matching grants may not apply if the grant size is smaller so that the block grant does not exceed the minimum allowed spending level. Different data, with different income distributions and different housing stocks, may also lead to alternative conclusions. This is clearly too large an agenda for a single researcher. Nechyba's work can serve as an example for the expanded use of computable general equilibrium models in education policy research.

45. Lankford and Wyckoff (2000); Barrow (forthcoming).

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