

# INTRODUCING SCHOOL CHOICE INTO MULTI-DISTRICT PUBLIC SCHOOL SYSTEMS

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## 1. Introduction

School choice is a contentious issue in part because of the lack of agreement on many of the important empirical issues surrounding the policy debate.<sup>2</sup> Evidence regarding the role of such factors as peers and parents, class size and teacher quality, competition and bureaucracy, unionization and curriculum design remains hotly debated, and the impact of increased choice on many of these elements of school quality is still controversial. Yet we do have decades of experience with school choice of a kind somewhat different from what is pondered in many choice-based policy proposals, and it is within this current system of school choice that at least some agreement can be found. While it may therefore be difficult to fully predict the impact of new choice-based initiatives, information arising from the choices made by households in the current system may yield important evidence regarding some neglected empirical issues that are critical for policy makers to consider.

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<sup>2</sup> Voucher experiments in the U.S. are still sparse, with only limited empirical investigations possible (see, for instance, Rouse (1998)).

This paper begins by providing evidence regarding one such issue: the linkage between housing and school consumption, and the impact that private schools (and private school vouchers) can have by severing this linkage and thus setting off a series of general equilibrium effects that are quite independent from many of the more controversial issues surrounding school choice. The intuition behind these results is quite straightforward: In a residence-based public school system, the location of a family's residence directly determines which public school that family's children are eligible to attend. Housing markets are typically such that low income families may not be able to afford housing in high quality public school districts, which implies that choice among public schools is greater for some than for others. By bringing choice into low income school districts, private school vouchers sever the link between school quality and residential location thus increasing the value of living in poor public school districts and lowering the value of living in wealthy districts. Such voucher proposals therefore tend to benefit lower income households (through a variety of channels) more than high income households that are already exercising choice in the present system. The research summarized in this paper provides evidence on the potential magnitude of these benefits as well as the likely channels through which they might emerge under a variety of different assumptions regarding empirical factors that remain controversial.

In addition, the paper proceeds to predict the impact of private schools choice on school quality. While results regarding residential segregation are rather unambiguous and robust, implications for school quality are more dependent on the precise underlying assumptions regarding the impact of competition within schools. Results indicate that, under the most pessimistic assumptions, increasing school choice may lead to surprisingly small declines in

average public school quality and in the overall level of inequality in the system, while it may yield substantial gains under more optimistic assumptions. The first of these results is surprising because previous theoretical and simulation approaches have tended to compare the outcome under private school vouchers to a rather idealized outcome where all public schools provide equal educational quality, and these approaches have arrived at the conclusion that increased private school choice must necessarily lower school quality and raise inequities in an otherwise equitable public school system.<sup>3</sup> Furthermore, these approaches have tended to not model the political process through which public school spending is determined and have thus ignored potential offsetting public school spending effects as some students leave the public system.<sup>4</sup> The approach taken here, differs fundamentally in that it incorporates from the start the very forces that have led to the inequities within the public system and in that it models explicitly an underlying political process within this environment. The approach then exploits the semi-competitive nature of the current public school system (and the resulting observed inequities across school districts) in order to model the structural parameters underlying the decisions made by households. This allows for a calibration of the model that can replicate current features of the data and then come to conclusions about extending competition to private schools in an environment where political and household choices are endogenously determined. It is then

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<sup>3</sup> To be fair, the models used to arrive at these analyses were not intended to arrive at predictions of the overall impact of vouchers but rather to demonstrate some of the trade-offs involved (Manski (1992)) as well as explore such issues as the efficiency of pricing policies of private schools (Epple and Romano (1998), Caucutt (forthcoming)). Furthermore, it should be noted that previous approaches have investigated inequities within the public school system (Fernandez and Rogerson (1996), for instance) but not in the presence of private school alternatives and/or vouchers.

<sup>4</sup> Political economy models have been used extensively to analyze school finance issues (as in, for example, Fernandez and Rogerson (1999)) as well as voting on vouchers (Bears, Glomm and Ravikumar (2000), Glomm and Ravikumar (1998)), but political economy models have not previously been combined with multi-district models of public school finance as is done here.

possible to compare these predictions to actual rather than idealized pre-voucher outcomes.

Section 2 provides a basic overview of the methodological approach taken throughout the paper. While this approach is different from the reduced-form regression analysis typically employed by empirical researchers, it is an approach particularly well suited for the kinds of issues that are central to the school choice debate. Section 3 goes on to provide a non-technical summary of the details of the theoretical assumptions employed in the model, and Section 4 provides the results from a number of policy simulations under different assumptions. The remainder of the paper considers the empirical justification for the model's key assumptions and the evidence for some of its testable implications (Section 5) as well as some policy implications arising from the simulation results (Section 6). Finally, Section 7 concludes.

## **2. Predicting the Impact of Increased Choice from the Current Choice System**

While some have proposed marginal choice-based reforms to the current system, others advocate making choice the central theme around which to reform primary and secondary education. Conventional empirical approaches may be well suited to predicting some of the likely effects of small changes to the system, but one becomes less confident in such predictions as policy reforms get large and affect incentives, actions and prices throughout the system. Put differently, large and discrete policy changes in an area as central to people's lives as primary and secondary education may change incentives in a way that brings to light forces which are unlikely to be important with small policy changes and impossible to pick up with many of the commonly employed empirical techniques. The approach taken in this paper therefore uses data on outcomes under the current limited choice system to infer preference and production parameters

in a very general model that incorporates forces likely to be important under large scale reforms. Before presenting that model in Section 3, Section 2.1 begins with a brief discussion of how household choices under the current system lead to observable outcomes; Section 2.2 then argues that these observable outcomes can be used as the basis of an approach that can analyze the likely impact of large policy changes; and Section 2.3 arrives at some of the basic features that must be modeled in order to implement this approach.

### *2.1. Choice under the Current System lead to Observable Outcomes*

Choice has been a pervasive feature of school systems in most U.S. states for the past half century. Parents can participate in the local political process that shapes their schools, and they can choose among tens of thousands of school districts or neighborhood school areas in which to reside. At least in principle, choice among many public schools is therefore pervasive. Elite private schools as well as more common parochial schools offer additional options for those unhappy with the public system. And choice is clearly being exercised. Approximately twelve percent of U.S. school children attend private schools; a small but growing number are home-schooled; and most significantly, many of those households that remain within the public system consider public school quality carefully when choosing where to purchase or rent a home. Real estate agents typically come armed with information regarding public school quality associated with different neighborhoods, and such information is increasingly accessible through less formal channels. It is therefore no surprise that measures of perceived school quality can consistently explain at least a portion of the pattern of residential location that we observe, and house prices

in good school districts are consistently higher than those in bad school districts.<sup>5</sup>

At the same time, differing constraints faced by different households clearly imply that some have more choice than others. Career and job constraints, for instance, are likely to narrow the number of possible public school districts that are feasible for different households. Furthermore, either due to historical forces or because of deliberate zoning policies, lower income parents may find little or no affordable housing in some of the otherwise feasible school districts and neighborhoods.<sup>6</sup> Elite private schools are available only in some areas and are similarly unaffordable for low income families, and even parochial schools are likely to be too expensive for many. While some parents therefore clearly enjoy many school options, choice for others may be quite constrained by job considerations, housing markets and lack of affordable private school alternatives.

The combination of the exercise of these constrained political, residential and school choices then results in various outcomes that we can measure and observe. House prices differ both within and across school districts, and markets incorporate both house/neighborhood quality and school quality considerations into these prices. Differing house quality and community amenity levels result in some mixing of different income groups within districts as well as some stratification by income across districts, both of which can generally be observed in the data. Commonly reported spending levels in schools reflect the result of an aggregation of preferences (however imperfect) through political institutions and thus give an indication of the value of per

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<sup>5</sup> See, for example, Nechyba and Strauss (1998) and Bayer (1999) for discrete choice approaches, as well as a long literature on education and house prices with recent contributions such as Black (1999).

<sup>6</sup> Even when lower quality housing is available in good school district, capitalization of public school quality will tend to inflate the prices of such houses substantially.

pupil spending in household preferences. Finally, private school attendance rates in different districts give a measure of discontent within these districts with local public schools, spending levels and other features such as the quality of peer interactions within those schools.

## 2.2. *Using Observable Outcomes Today to Predict the Impact of Increased Choice Tomorrow*

While the choices that households make under the current school system – and the observed outcomes that result from these choices – are interesting in and of themselves, they also give rise to several research opportunities and challenges for those interested in predicting the impact of expanding school choice. One possible strategy takes as its starting point the empirical observation of varying degrees of choice within the current school system (across, say, metropolitan areas) and then attempts to link specific observed features of current public or private schools to the degree of competition faced by those schools.<sup>7</sup> A second strategy begins with a theoretical model that encompasses the forces we think are important for analyzing school competition, then tries to calibrate that model so as to replicate the most important outcomes (income and house price heterogeneity within and across districts, per pupil spending levels, private school attendance rates) observed in the data under the current school system, and finally introduces new policies into the calibrated model to see how such policies would change outcomes. The first of these approaches therefore attempts to infer the impact of increased choice directly from current data and is most appropriate for predicting changes resulting from marginal policy adjustments. The second approach, on the other hand, uses the data to generate parameters within a structural model and then asks that model to simulate the impact of new policies

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<sup>7</sup> This approach is exemplified in Hoxby (1994, 2000b), McMillan (1999) and others.

assuming that the underlying structural parameters (in preferences and production functions) remain unchanged. Since economists generally are comfortable with the notion that preferences and production functions themselves are exogenous, the latter approach allows a full unfolding of all the forces within a general equilibrium setting where everything else is endogenous. This approach is potentially most useful for predicting the impact of large and discrete changes in policy, and it is the approach taken in this paper.

### 2.3. *Important Features to be Modeled under this Approach*

In order to implement this approach successfully, however, one must begin by convincingly identifying the core features of the current school choice environment (as well as specifying functional forms for preferences and production processes whose parameters are then to be dictated by the data.) It is therefore worthwhile to pause and ask precisely what features a model would have to have in order to serve as an effective tool for the proposed analysis.

Given the important role of residential location and mobility in the current choice environment, one must start with a model that contains a heterogeneous housing market, with some locations inherently more desirable (apart from school considerations) than others. When applied to a specific context, such heterogeneity in housing within and across school districts is important as it serves as one of the limiting factors in school district choice. Second, in order for a relationship between housing and school choices to emerge under certain types of school financing, the heterogeneous houses must somehow be classified into different political jurisdictions. More precisely, it must be specified whether school finance decisions are made at the central level or more locally by regional or district governments; and it must be made clear

how children gain access to particular schools (i.e. whether this is by living in a given jurisdiction or by some other rationing mechanism). Third, a meaningful analysis requires the model to incorporate different types of households that face different constraints – where the most important distinction between them is their wealth and ability. Fourth, in order for parents to be able to choose a school within their constrained choice set, they must have a way of evaluating school quality based on observable features within the model. Thus, an education production process – or at least a parentally perceived production process – must be formulated, a task made particularly challenging by the continuing disagreement in the literature regarding what matters in this process. Finally, both private and public schools can potentially enter the constrained choice sets of each household, and these choice sets could be expanded by policies such as private school vouchers. Therefore, we must model the private school market carefully, allowing for supply responses in case of changing demand for private schools.

### **3. The Model**

The first challenge, then, is to construct a tractable and internally consistent model with (1) heterogeneous housing, (2) multiple jurisdictions describing how political choices regarding funding of public schools and admissions requirements are made, (3) households with different wealth and ability levels, (4) a specification of the education production process and (5) a description of the private school market. The second challenge is to use available data on outcomes in the current choice environment to infer parameters of preferences and production processes. A non-technical discussion of the elements of such a model (detailed more precisely elsewhere) is offered in Section 3.1 followed by a discussion of how an equilibrium arises in

such a model (Section 3.2) and how the various parameters can be matched to important features of the data (Section 3.3).<sup>8</sup> Once matched to the data, the model is then shown to be relatively successful in replicating the outcomes we currently observe (Section 3.4).

### 3.1. *Components of the Model*

The policy simulations in later sections are based on a model in which 1,500 types of households that differ in their wealth level and child ability simultaneously choose where among three school districts and 15 neighborhoods (or house types) to live, which school to attend and how much public school spending to support at the ballot box. The overall number of houses available in the three districts is assumed to be equal to the total number of households in the model. Thus, there is exactly one house per household, but just as households differ in wealth and ability, houses differ in quality. More precisely, the three school districts contain 5 house types (or neighborhoods) each, and the total *quantity* of houses is the same in each of the three districts. The *quality* of housing, however, differs among the three districts, with average quality lowest in district 1 and highest in district 3. In addition, housing quality varies both within and across districts, and some house types in district 1 are of higher quality than some house types in district 3 despite the fact that average quality is highest in district 3.

The house quality of a type  $h$  house in district  $d$  is indexed by a parameter  $k_{dh}$ , and this parameter enters directly into the utility function that all households (regardless of wealth and

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<sup>8</sup> The earliest theoretical development of the local public finance portion of this model is due to Dunz (1985).

ability) share.<sup>9</sup> In particular, households are assumed to value consumption  $c$  and school quality  $s$  as well as house quality  $k_{dh}$ . The utility of living in district  $d$  and house type  $h$  while consuming school quality  $s$  and private consumption  $c$  is given by

$$(1) \quad u(d,h,s,c) = k_{dh} s^\alpha c^\beta,$$

and the 15 house quality parameters as well as  $\alpha$  and  $\beta$  are derived from the data in a way described below.

School quality  $s$  depends on whether the household has chosen a private school or the local public school. For many of the initial simulations reported in the next section, both types of schools face the same production technology,<sup>10</sup> but different levels of inputs will generally result in different levels of school quality among the various schools. More precisely, two inputs are assumed to matter: (i) per pupil spending and (ii) average peer quality in the school. Per pupil spending in the public school is determined through the political process of local voting (on property taxes) combined with an exogenously specified state aid formula (financed through state income taxes), while spending in the private schools is set by the school in order to maximize profit. Similarly, the public school has no control over peer quality but must admit all students who reside in the district and choose to attend the public school, while private schools are able to set a lower bound on peer quality. (Peer quality itself is specific to each household type and is a

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<sup>9</sup> An alternative way for a model to generate heterogeneity of housing and household types within districts is to assume housing to be fully malleable and household preferences to differ in school quality (Epple and Platt (1998)). The relative merits of that approach as compared to the one taken here (where houses are assumed to not be malleable and preferences are assumed to be identical) are discussed in Section 5.

<sup>10</sup> This assumption is controversial as some have argued that private schools face different technologies than public schools. Here, however, just as preferences are assumed identical among households, production technologies are assumed identical among schools. The difference in choices for households then arises from differences in constraints, and the difference in school quality arises from different inputs to the same technology.

combination of child ability and parental income.<sup>11</sup>) Either type of school then takes its per pupil spending  $x$  and combines it with average peer quality  $q$  to produce  $s$  through the production process given by

$$(2) \quad s = f(x, q) = x^{(1-D)} q^D \text{ where } 0 \leq D \leq 1.$$

The parameter  $D$  is derived from the data in a way described below.<sup>12</sup>

In later simulations, however, additional features of this production technology are introduced to allow for a potential response on the part of public schools to increased competition from private schools. These features can be modeled as changes of the production technology for public schools, and they are discussed in more detail in Section 4 when the relevant simulation results are offered.

### 3.2. *Defining an Equilibrium in the Model*

An equilibrium in the model occurs when each actor is doing the best he/she can given the features of the economy that can be observed, and when those features are consistent with the underlying political and production processes. Thus, an equilibrium must specify those aspects that everyone can see – house prices, tax rates, public and private school quality levels – and

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<sup>11</sup> More specifically, peer quality for household  $n$  is given by  $q(n) = (z(n)^2 a(n)^{(1-2)})/7.5$  – where  $z(n)$  is household income and  $a(n)$  is child ability. The inclusion of both household income and child ability arises from different notions of peer effects. Some view the school peer effect as primarily through parents and their involvement and monitoring of schools (which we know increases in income (McMillan (1999))), while others see peer effects as operating through child ability. The empirical literature offers little guidance as to the appropriate value for  $2$  which is set to 0.5 in the simulations in this paper. Sensitivity analysis with respect to different values suggests that the precise value of  $2$  is not critical for the results.

<sup>12</sup> Note that, for purposes of predicting changes in behavior of households, it is unimportant whether per pupil spending actually matters in generating better outcomes such as test scores – a proposition that continues to be surrounded by controversy (Hanushek (1999), Krueger (1999), Hoxby (2000b)) Rather, what matters is whether households value additional spending in schools – for whatever reason, and it is rather uncontroversial to say that they might. Just how much households value spending as opposed to peer quality is determined by the parameter  $D$  as it is set in a way to replicate the data. This is described in more detail below.

these must be such (i) that no private school or potential private school could increase its profits by exiting or entering the market -- or by changing its pricing or admissions policy; (ii) that no household wants to move and/or change schools; (iii) that all tax rates are consistent with majority rule yielding balanced government budgets; and (iv) that public school quality in each district arises from the inputs allocated to the public schools through the decisions of households to attend (thus determining peer quality) and the decisions resulting from the public choice process (which determines per pupil funding levels). While the formal definition of equilibrium and the necessary mathematical proof of its existence is given elsewhere (Nechyba 1997a, 1999), this section provides a brief overview of the issues involved. In essence, we can view a full equilibrium as consisting of equilibrium in three different areas: the private school market, the housing market and the political market. I discuss each in turn.

### 3.21. The Private School Market

Recall that private schools compete along two dimensions: they set both a per pupil spending level and a minimum peer quality admissions level. The assumption of perfect competition in the private school market then leads to a relatively straightforward private school hierarchy. Specifically, private schools (to the extent that they exist in equilibrium) are composed of children from the same type of household, and the tuition charged to each household is equal to the most preferred per pupil spending level of that household. To see this, suppose either of these conditions were not satisfied in equilibrium. If the school consisted of several types of peer groups, then a new school could enter, set a higher minimum peer admissions level while charging the same tuition and make the same profit as the existing school. Similarly, if tuition

were greater than per pupil spending, a school with the same admissions rule and per pupil spending level but slightly lower tuition could enter and make positive profits.<sup>13</sup> Thus, equilibrium in the private school market simply means that, if a particular household type would demand a private school with that household's peer quality and that household's most preferred level of spending, then such a private school will be available. As a result of perfect competition, private schools make zero profits.

### 3.22. The Housing Market

When households in the model evaluate which house type (or neighborhood) in which school district to choose, they can then check easily how much utility each option offers. For example, in evaluating the utility from house  $h$  in district  $d$ , a household would calculate both the utility of residing there while attending the district's public school and the utility of residing there and attending the private school offered by the market (i.e. a private school with that household's peer quality and most preferred level of tuition). The utility household  $n$  obtains from living in this house and attending public school is given by  $u(d, h, s_d, c_{dhn})$  where  $s_d$  is district  $d$ 's public school quality and  $c_{dhn}$  is the level of private consumption that is equal to household  $n$ 's after-tax income minus the property-tax inclusive house payment required to live in house  $(d, h)$ . The utility from living in the same house and attending private school, on the other hand, is given by  $u(d, h, s_n, c_{dhn} - J_n)$  where  $s_n$  is the private school quality offered to household  $n$  by the market, and  $J_n$

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<sup>13</sup> It should be noted that I am explicitly not allowing price discrimination within a school such as that used in Epple and Romano (1998) and Caucutt (forthcoming). If private schools can observe peer effects, these papers have demonstrated that pricing of these peer effects is profit maximizing and efficient. It should also be noted that an observationally equivalent set of assumptions for the model employed here would be that private schools – rather than being profit maximizers constrained to charge a single price – are exclusionary clubs of parents who agree to an equal cost-sharing rule (Nechyba (1999)).

is the private school tuition required of household  $n$ . Thus, for a given location, *public schools have the advantage that they permit higher private consumption, while private schools might offer higher school quality* (due to their ability to tailor tuition to household demand and due to their ability to restrict access to lower peer quality students).

Given house prices, tax rates and public school quality levels, a household can therefore determine the utility of a house  $h$  in district  $d$  as simply the higher of  $u(d, h, s_d, c_{dhn})$  and  $u(d, h, s_n, c_{dhn} - J_n)$ . The housing market is in equilibrium (given public school quality and tax rates) if every household chooses its most preferred location at the prevailing house prices and, as a result, all houses are occupied.

### 3.23. The Political Market and Full Equilibrium

Finally, residents of each district are assumed to vote on local property tax rates knowing that local tax revenues, supplemented by state funds through a pre-specified state aid formula, will translate to spending on public education.<sup>14</sup> Alternatively, for versions of the model in which funding of public schools is equalized and centralized, residents of all districts vote on a state income tax rate with the understanding that revenues support equal levels of per pupil spending in all districts. Households that send their child to public school have single peaked preferences over property tax rates (Nechyba (1997)) as do those who send their child to private school (Nechyba (1999)) under certain voter myopia assumptions. For any given distribution of the

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<sup>14</sup> In addition, a state income tax rate sufficient to fund state aid (and vouchers in later simulations) is imposed.

population into districts, a political (voting) equilibrium therefore exists.<sup>15</sup> A full equilibrium is then a partition of households into house types and school districts, a price for each house type, a local property tax rate for each district, a state income tax rate, and an indication of who goes to public and who goes to private school – such that private school markets, housing markets as well as the political market are in equilibrium.

### 3.3. *Matching Parameters to Data*

The three school districts in the model are intended to be representative of the several hundred low income, middle income and high income school districts located in 4 New Jersey counties (Bergen, Hudson, Essex and Union Counties) that include the suburbs of New York City. More specifically, using 1990 School District Data Book (National Center for Education Statistics (1995)) and Census (Bureau of the Census (1992)) data from all districts in these four counties, school districts in these counties were divided into three categories by median household income such that each category ends up with roughly equal numbers of households. The features of the model to be matched to these data are: (i) the income/wealth and ability distributions; (ii) the parameters in utility and production functions of equations (1) and (2); and (iii) the formula of state aid that is taken as given by voters.

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<sup>15</sup> These myopia assumptions are relatively standard in the literature and roughly assume that households hold a variety of factors fixed when voting. The assumptions essentially require voters to hold expectations that, while accurate in equilibrium, are not accurate out of equilibrium. For details on the required voter myopia assumptions to insure this single peakedness of preferences, see Nechyba (1999). It should also be noted, however, that single-peakedness is actually a stronger condition than what is required for a voting equilibrium to exist when voters have a private alternative to the publically provided service (Epple and Romano (1996), Glomm and Ravikumar (1998)), although weaker conditions are difficult to guarantee easily within the present set-up.

### 3.31. Income/Wealth and Ability Distributions

The simulation model begins with 20 different income levels endowed with 15 different types of houses – yielding a total 300 different endowment or wealth levels. Incomes in the model range from 1 (corresponding to \$10,000) to 20 (corresponding to \$200,000) and represent a discretized version of the actual household income distribution in the data, and house values (which are properly interpreted as annualized flows of housing services) range from 0.3 to 3.5. Since income types are initially spread uniformly across the 15 house types, the addition of housing endowments has the effect of smoothing the income distribution in the model.<sup>16</sup> In addition, ability endowments take on 5 different possible discrete values which are set to range from 1 to 10. Empirical estimates of the correlation of parental and child income of 0.4 (Solon (1992), Zimmerman (1992)) are used as a proxy for the correlation of parental income and child ability.<sup>17</sup> The addition of 5 ability endowments to the 300 income/wealth endowments then yield a total of 1,500 different types of households in the model.

### 3.32. Parameters in Utility and Production Functions

More challenging is the process of setting the parameters in the utility and production functions. These parameters include the housing quality parameters ( $k_{11}, \dots, k_{dh}, \dots, k_{35}$ ), the preference parameters  $\alpha$  and  $\beta$ , and the production parameter  $D$ . The methodology used to

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<sup>16</sup> It is important to note that, while this implies that some low income households in the model are initially endowed with expensive houses, this is not the case once the equilibrium has been calculated – when such houses would have been traded at market prices.

<sup>17</sup> One can also interpret the correlation between parental and child income of 0.4 as an upper bound on the correlation between parental income and child ability because of the correlation of school quality and parental income. Sensitivity analysis with versions of the model that drive the correlation to 0, however, suggest this makes little difference for the results I report.

calibrate these parameters builds on that of Nechyba (1997b,2000a) and is outlined more fully in Nechyba (2000b). The method translates a near-continuum of house qualities observed for each district type into 5 discrete quality intervals (neighborhoods) of equal sizes. It starts by assuming an underlying utility function  $u(h,s,c) = h^* s^\alpha c^\beta$  where  $h$  jointly captures housing and neighborhood quality and is interpreted as the annualized flow of housing/neighborhood services. Substituting equation (2) for  $s$ , this utility function can be re-written as

$$u(h,x,c;q) = h^* (x^{(1-D)} q^D)^\alpha c^\beta = (h^* x^{(1-D)})^\alpha c^\beta$$

where  $q$  is equal to peer quality and  $(=q^D)$ . When treating  $h$ ,  $x$  and  $c$  as choice variables in an ordinary maximization problem, the exponents  $^*$ ,  $(1-D)^\alpha$ , and  $\beta$  can then, without loss of generality, be normalized to sum to 1 and interpreted as budget shares. Thus, I calculate the budget shares for  $h$ ,  $x$  and  $c$  for a hypothetical “median household” that consumes the imputed median annualized flow of housing/neighborhood services (in the data), earns the median income and “chooses” the mean school spending level observed in the New Jersey districts, and these budget shares become our estimates of  $^*$ ,  $(1-D)^\alpha$ , and  $\beta$  (equal to 0.22, 0.12 and 0.65 respectively).<sup>18</sup>

Of course, housing in the model is not a continuous variable  $h$  but rather consists of a discrete number of house/neighborhood quality levels denoted by  $(k_{11}, \dots, k_{dh}, \dots, k_{35})$  in equation (1). I therefore combine the housing value distribution data from the School District Data Book with our estimate for  $^*$  to calibrate the fifteen values for  $k_{dh}$  across the three representative school

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<sup>18</sup> Given data on house prices rather than flows of housing services, the median annualized flow of housing/neighborhood services is calculated for the median house value in the data assuming a 5.5% interest rate.

districts.<sup>19</sup> In particular, I take the housing distribution for all houses in districts of a particular type (i.e. low, middle or high income as defined above), find house values at the 10<sup>th</sup>, 30<sup>th</sup>, 50<sup>th</sup>, 70<sup>th</sup> and 90<sup>th</sup> percentile (corresponding to neighborhoods 1 through 5 in district 1) and convert these to annualized housing flows (using a 5.5% interest rate). I then combine these annualized flow values with the exponent  $\alpha$  to arrive at the five housing (or neighborhood) quality parameters for this representative district.<sup>20</sup>

Finally, while the calibration procedure above has placed a restriction on the values of  $D$  and  $\alpha$  (given that  $(1-D)^\alpha = 0.12$  from the budget share exercise), the precise values of  $D$  and  $\alpha$  are set to match private school attendance rates. Recall from equation (2) that  $D$  is the weight on peer quality (as opposed to per pupil spending) in the school production function. When  $D$  is set to 0, school quality differences are determined solely by per pupil spending differences which, in this model, yields zero private school attendance even if private school vouchers are introduced at relatively high levels. On the other hand, if  $D$  is set close to 1, public schools cannot survive even without private school vouchers. As  $D$  rises from 0 to 1, private school attendance increases monotonically, and  $D$  is set so as to replicate as closely as possible the level of private school attendance observed in the data (yielding  $D = 0.475$ ). Given the restriction that  $(1-D)^\alpha = 0.12$ , this also determines the value of  $\alpha$  ( $= 0.229$ ).

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<sup>19</sup> Note below that when I employ price data to calibrate house qualities within districts, I capture both characteristics of the houses and characteristics of the neighborhoods in one measure. Thus, the model allows for both neighborhood externalities and amenities as well as house qualities to determine the character of neighborhoods (or house types) within school districts.

<sup>20</sup> More precisely, suppose that for houses in districts falling into district category 3 (i.e. “high income districts”), the annualized flow of housing services for a house at the 50<sup>th</sup> percentile of the distribution is 1.5 (corresponding to \$15,000). The housing quality parameter for neighborhood 3 (the “median neighborhood”) in district 3 is then just equal to  $(1.5)^\alpha$ , i.e.  $k_{23} = (1.5)^\alpha = (1.5)^{0.22} = 1.093$ . This procedure is then similarly applied to other district types to arrive at housing quality parameters for all neighborhoods in all representative districts. These parameters are reported in Nechyba (2000b).

### 3.33. State Aid Formula

As argued in MaCurdy and Nechyba (forthcoming), it is difficult to construct state aid formulae from statutory language because of the fungibility of aid and the subtle tradeoffs that local policy makers are aware of but that are unobservable to the outsider. Rather than attempting to mimic a statutory formula, I therefore implement a state aid formula that combines block grant and matching grant elements (as defined in Nechyba (1996)) in such a way as to allow the model to replicate the levels of per pupil spending observed in the data.

### 3.4. *The Calibrated New Jersey Equilibrium*

With the distributional properties and functional parameters chosen, the computer model is then asked to generate an equilibrium. If the calibration is successful, the stylized facts in the data should be approximately replicated by the computer simulation. Table 1 provides numbers for key equilibrium values generated by the computer model, and Table 2 translates these to be comparable to the numbers in the data employed to calibrate the model. Overall, the match between the predicted values from the computer model and those found in the data seems reasonably close (with some exceptions). The remaining simulations then employ the same income/wealth/ability distributions for the 1,500 household types, and the same parameters for utility and production functions. The New Jersey specific state-aid formula, however, is not employed in all simulations as some are intended to reflect results in more stylized state financed or locally financed systems..

#### **4. Policy Simulations**

Two types of predictions arise from the policy simulations reported in this section: (1) A substantial portion of the current level of income-based residential segregation can be attributed to the limits on competition inherent in the current public school system, and the fostering of additional private school choice has the potential to dramatically reduce this kind of segregation. This prediction is robust to the inclusion of various controversial assumptions regarding other forces unleashed by increased competition. (2) On the other hand, assumptions regarding the impact of competition on school behavior do matter for predicting the degree to which increased competition from private schools may impact school quality. Such policies may create winners and losers while leaving average school quality roughly unchanged, or they may create substantial increases in school quality. Section 4.1 focuses on the first of these predictions, while Section 4.2 discusses the second.

##### *4.1. Public Schools, Residential Segregation and Private School Choice*

It is apparent, both in the data as well as the benchmark equilibrium (that is relatively consistent with the data) that there is a substantial degree of residential segregation by income across school districts. Given the inter-district distribution of housing quality, this is of course no surprise. The simulation results reported in this section, however, suggest an additional role played by the rules inherent in different types of schools systems, and they suggest a large potential for private school vouchers to change the degree of residential segregation. In Section 4.11, I begin by investigating the school-related causes of segregation in the absence of vouchers, and Section 4.12 builds on these intuitions and investigates the role of vouchers.

#### 4.11. The Role of Private and Public Schools without Vouchers

The results of five simulations are reported in the five rows of Table 3. The first row establishes a benchmark for the degree of residential segregation implied simply by the housing market absent any distortion through the public school sector. This is accomplished by setting public school spending to zero in all districts, thus causing all households in the model to choose private schools. Housing price differences now reflect solely the house/neighborhood quality differences embodied in the  $k_{dh}$  values in equation (1), and no public choices regarding schooling interfere with where households choose to live.

Next, the second row reports simulation results in which private schools are prohibited and all public schools are financed at the local level through a local property tax. The difference is striking: the residence-based public school system (in the absence of private schools) introduces a substantial degree of segregation as evidenced in both average incomes and average property values across the three districts. For instance, the ratio of average income in district 3 to average income in district 1 rises from 2.62 to 4.87, and the ratio of average property values in district 3 over those in district 1 rises from 1.68 to 3.86. Capitalization of public schools (which is absent in row 1 but not row 2) raises average housing values in the wealthy district by nearly 50 percent while lowering them in the poor district by similar magnitudes.

One natural reaction to this comparison might be to suspect that the dramatic difference in the first two rows of the table is due to the decentralized nature of public school financing in the second row. Row 3 therefore reports simulation results from a state-income tax supported equalized public school system, with private schools again prohibited. Somewhat surprisingly, the results are rather similar to those of the second row – implying that the increase in

segregation from row 1 to row 2 is due primarily to the switch from a purely private to a purely public system and only secondarily due to the level of decentralization of public financing.

Finally, rows 4 and 5 repeat the previous two simulations but this time permit the emergence of a private school market. Again, the results are striking: Not only does the emergence of the private school market alleviate the segregation observed in the purely public systems, it actually produces less *income* segregation than exists in the purely private system where public schools played no role in where households chose to reside. Given that public school quality continues to increase with community wealth, however, capitalization of school differences must -- and does -- persist in equilibrium. Thus, under local public financing, capitalization still raises average property values in district 3 by 11 percent and lowers them in district 1 by 28 percent.<sup>21</sup> This yields the curious outcome that the district 3 to district 1 ratio of average district income actually falls below the pure private simulations (row 1), but the similar ratio of average property values settles well above the pure private benchmark (row 1).

These seemingly contradictory results on income segregation and capitalization, however, are closely linked. Consider a relatively high income household that resides in district 3 under both the purely public and the purely private systems. Under the public system the household chooses district 3 because this is the only way to consume high quality education. Under the private system, on the other hand, there is no reason for a household to choose any particular district -- the only factor that matters is housing/neighborhood quality. When a private market is introduced into a public system, however, an important effect emerges for households

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<sup>21</sup> These capitalization differences appear even higher in the last column (under state funding) for reasons addressed elsewhere (Nechyba (2000b)).

considering private schooling: the difference in public school quality is capitalized into house prices (albeit at a lesser rate than under pure public financing), thus making the same house (if it exists in both districts) substantially cheaper in the poor district than in the rich district. In the case of local public financing, this results in an average price difference of approximately 40% for the same type of house in district 3 versus district 1. Unlike the case of a purely private system, this capitalization of public school differences then gives rise to rather strong incentives for those choosing private schools to choose a house in the poor district -- even if that house is of sub-optimal quality. Households with high ability children receive the biggest payoff from opting out of the public system, as do middle to high income households. Thus, the introduction of private schools into a public system -- whether state or locally financed -- provides incentives to middle and high income families (with high ability children) to settle in poor districts. As a result, average income differences narrow substantially more than property value differences that continue to capitalize public school quality.<sup>22</sup>

#### 4.12. Vouchers and Segregation

Tables 4a-c report simulation results for three different public school finance regimes (local, state and the system calibrated to the New Jersey data) and two types of vouchers: the top portion of each table simulates vouchers that are universally available, while the lower portion

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<sup>22</sup> A cautionary note is perhaps in order: While the results in Table 3 suggest that segregation would be greater in a purely private system than in mixed private/public system, it would be stretching the bounds of the model to take this implication too literally. Specifically, linking public schooling to housing for decades causes housing stocks to evolve endogenously, while private schooling introduces no such distortions. Since housing is fixed at its present quality levels in this paper, the model cannot be used to infer where the segregation would have ended up under public versus private financing. Rather, the model suggests that, conditional on housing markets fixed at present levels and not being allowed to change, a purely private system would lead to higher levels of income segregation.

simulates vouchers targeted only to residents of district 1. Vouchers simply allow eligible households to redeem the face value for that level of private school tuition, and they can freely supplement the voucher amount.

The impact of these private school vouchers on segregation then follows straightforwardly from the logic behind the previous results. To the extent that a voucher causes someone who previously chose public schools to switch to private schools, the same price incentive to settle in the poor rather than the rich district applies. At the same time, however, inter-district housing price differences narrow as more households choose private schools in poor districts and as voucher levels increase the value of housing in those districts. Thus two opposing effects emerge as vouchers are introduced: First, the capitalization induced price incentive for private school attending households to reside in poorer communities applies to a larger number of households, thus causing households with incomes above the average for district 1 to immigrate and raise average income. Second, this price incentive declines as housing price differences narrow and as only lower quality housing remains for private school immigrants in district 1 – thus causing lower income households with high ability children to compose the additional private school attending population.

First, consider the top portions of the three tables (which do not restrict voucher eligibility). For low levels of such vouchers the first effect dominates – thus causing decreases in income segregation as households with incomes above district 1's average immigrate to take advantage of lower house prices while sending their children to private school. For higher levels of such vouchers, on the other hand, the second effect dominates – thus causing increases in

income segregation.<sup>23</sup> The impact of universally available vouchers on income segregation is, therefore, U-shaped in the size of the voucher.

Now consider the lower parts of Tables 4a-c -- results for vouchers targeted solely to residents of district 1. For such vouchers, it appears that the second effect never materializes. Since vouchers are available only to residents in district 1, migration of private school attending households into district 1 continues despite the fact that price differences are narrowing, with higher income immigrants out-competing others for the houses that ensure voucher eligibility despite the fact that some of these houses are not of high quality. In the lower portions of Tables 4a-c, income segregation therefore continues to decline as houses in district 1 become increasingly valuable to those interested in private education. At the \$5,000 voucher level, the decline in segregation is most dramatic, with district 3 average income now only 20 percent higher than district 1 average income for the local financing simulation and property values (despite higher housing quality) only 5 percent higher.

Both types of vouchers therefore can reduce segregation, but universally available vouchers – by privatizing the system at high enough voucher levels – eventually lead to the level of segregation that would occur in a purely private system (which is higher than the segregation in the present mixed system). For universal vouchers, residential income de-segregation then occurs only at lower levels of vouchers. Vouchers targeted to poor districts, on the other hand, have the potential to increase significantly these de-segregating effects by preventing a complete privatization of the public system but rather making the poor district increasingly attractive to

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<sup>23</sup> If vouchers were to get high enough to cause all public schools to collapse, the degree of residential segregation would settle to what appears in the purely private system in row 1 of Table 3.

those seeking private education at high voucher levels. As shown elsewhere (Nechyba (2000a)), vouchers targeted at low income households rather than low income districts do not have major mobility effects and therefore do little to change residential segregation levels.

#### 4.2 *School Choice and School Quality*

Previous models of vouchers have ignored the implications of voucher policies on residential mobility and have instead focused on single community settings in which private schools compete with a homogeneous public school sector. The purpose of these models is to study the effect of vouchers on average school quality as well as the distribution of school quality across different types of students, and to investigate the likely workings of private school markets in a voucher environment. The problem with comparing pre- and post-voucher outcomes within single-district models of this kind, however, is that they abstract away from one of the defining characteristics of the U.S. public school system – the degree of inequality in existing public schools – and thus analyze the issue of vouchers from an empirically incorrect benchmark. We therefore now re-visit the competition forces analyzed in single district models here in the context of the multi-district model with heterogeneous public schools.

These competition forces are of two general kinds: first, it is argued by voucher opponents, a policy of private school vouchers will drain the public system of resources and thus leave it worse off. The term “resources” needs to be interpreted loosely to include not only financial resources (which may in fact increase on a per pupil basis<sup>24</sup>) but also peer quality

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<sup>24</sup> If the voucher amount is below per pupil spending in the public school, then, assuming no change in overall government spending on education (including spending on vouchers), per pupil spending in public school would increase as students depart with vouchers. If vouchers also go to those currently attending private schools, then the increase in per pupil spending would occur only if the number of student departing the public system is sufficiently large.

(including whatever part of peer quality is due to parental involvement (McMillan (1999)) and political support. Second, it is argued by proponents of vouchers, the increased competition for students will lead to greater effort by public schools and that the greater variety of education options will lead to a better matching of resources with student needs.<sup>25</sup> The loss of resources would, of course, lead to a decline in public school quality, while the competition-induced efficiency gains through more efficient resource uses and better matching of resources with students would lead to an increase.<sup>26</sup>

Section 4.21 begins with the version of the model (outlined in Section 3) that incorporates only the first of these forces – i.e. the cream-skimming by private schools of top students from the public schools. Again, two types of vouchers are analyzed: universally available vouchers and those targeted only to residents of district 1. Naturally, without the second counteracting force, the presence of just private school cream skimming implies that vouchers will have a tendency to lower public school quality, although -- perhaps surprisingly -- not always and not primarily in the district in which vouchers are being taken up. Section 4.22 then considers two types of potential efficiency-enhancing forces resulting from increased competition – forces that will tend to produce results more favorable for those interested in promoting vouchers.

#### 4.21. School Quality in the Absence of School Responses to Competition

Tables 5a-c present public school variables as well as private school attendance rates for

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<sup>25</sup> Chubb and Moe (1990), for instance, argue such points, as do others.

<sup>26</sup> Manski (1992) formalizes this type of tradeoff in a single district context. Epple and Romano (1998) and Cautt (forthcoming) add a different type of efficiency gain when they allow private schools to price peer externalities -- a point I do not investigate here.

each of the districts under different levels of the two types of vouchers (universal and targeted) for different public school funding systems (local, state and a system calibrated to New Jersey). The cream skimming effect of private schools is evident in the peer quality columns of these tables: higher peer quality students tend to leave the public school system as vouchers are introduced, thus decreasing the average peer quality in the public sector. However, because of the mobility forces described above, the declines in public school peer quality are not concentrated in school districts that experience a decline in public school enrollment and an increase in private school attendance. Rather, private schools are drawing high peer quality students from all public schools even though marginal private school attending households reside in poorer districts as a result of moving to take advantage of more favorable housing prices. For the same reason, vouchers targeted to the poor district have impacts similar to untargeted vouchers so long as voucher levels are modest – i.e. since marginal households who take up vouchers tend to move to the better neighborhoods in the poor district, the targeted nature of the voucher is relatively non-binding as long as voucher levels are not too high.<sup>27</sup>

Whether or not public school *quality* declines, however, depends on whether or not the declines in average peer quality are offset by increases in per pupil spending. In Table 5a (under local financing), public school quality shrinks relatively uniformly in all three districts whereas in Table 5b (under state financing), public school quality is relatively unchanged in all districts (until voucher levels become high). The intuition for these results is straightforward: As vouchers push high peer quality households into private schools, the political constituency for public

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<sup>27</sup> The differences and similarities between district targeted and universal vouchers are discussed in detail in Nechyba (2000a). That paper also demonstrates formally the clear intuition emerging from the exercise that household-income targeting has significantly different policy implications than district targeting – again because of the mobility forces that arise in a multi-district public school environment. I return to this point in Section 6.

school funding declines. At the same time, the exit of some into the private sector implies that those remaining in public schools now receive more per pupil funding for any given tax rate -- i.e. voting for public school spending has just become cheaper. The first effect causes the median voter to -- all else being equal -- prefer less public school spending, while the second effect causes him to prefer more. Under state funding, the latter effect outweighs the former -- causing increases in per pupil funding in public schools as voucher levels increase. The argument that vouchers result in a decrease in public school resources therefore holds only for peer quality and not for school spending once the political economy forces are taken into account under state financing -- and the net effect is relatively unchanged public school quality. In Table 5a, on the other hand, public school quality in the poor district falls because per pupil spending is determined by the constitutional minimum rather than the median voter -- and thus does not change to offset the decrease in peer quality. Effects in the other districts differ -- some experiencing an increase in quality and others a decrease. Finally, Table 5c presents school outcomes for the New Jersey calibrated state funding system -- a hybrid system that includes both local and state funding. Implications for public school quality are closer to these under the state system -- primarily because of the fact that state aid in New Jersey insures that the poor district is not at some constitutionally minimum spending level but rather determined in a local public choice equilibrium. Only when more than fifty percent of the population attends private school in the poor district does public school quality suffer considerably.

Including both the multi-district nature of public schools as well as a political economy model for the setting of public school spending therefore casts doubt on the common perception emerging from single-district, non-political economy models that public schools are bound to

decline in quality unless competition itself produces considerable efficiency gains. Here, the two additions to the model undo much of the negative effect of cream skimming private schools by allowing those remaining in the public school system to free ride on the contributions of others and to benefit from mobility forces that insure declines in peer quality will not be concentrated in only those districts that experience the biggest declines in public school attendance. While the model certainly does not rule out the possibility that public schools will suffer in the absence of competitive efficiency gains, it does suggest this effect to be smaller and less concentrated than one might have imagined. Variances in school outcomes (not reported in the tables) similarly do not change significantly.

#### 4.22. School Quality when Public Schools Respond to Competition

The simulation results in the absence of a competitive efficiency effect can then serve as a benchmark, and any efficiency enhancing impact of competition would be expected to improve the impact of vouchers (as in the single-district models (Manski (1992))). Efficiency enhancing effects could in principle come in many forms, but I focus in this section on two types of possible competition-induced changes in the production relationship. Essentially, the production function has two inputs, and competition could impact either one of these. In the case of peer quality, we have assumed thus far that only average peer quality matters. It is conceivable, however, that the variance matters as well. If two schools are identical in every way (i.e. average peer quality and average spending) except that school A has a greater variance in peer quality than school B, school B may well be able to more effectively target its resources to the student population's needs because those needs are more uniform across the student population. I will refer to this

effect as *curriculum targeting*. In the case of spending, on the other hand, it is often argued that the marginal product of a dollar of spending will rise in public schools as those schools face greater competition. This effect will be referred to as *competitive efficiency gain*. Each of these effects is included in separate simulations reported below.

More precisely, Tables 6a and 6b present simulation results for universal and targeted vouchers respectively, for both the case of curriculum targeting and competitive efficiency gains. The curriculum targeting effect is modeled as a constant in front of the school production function (2) that declines as the variance of peer quality increases,<sup>28</sup> while the competitive efficiency effect is modeled as a constant in the public school production function that rises in the percentage of private school attendance in all three districts combined.<sup>29</sup> Both of these changes in production functions affect only public schools, but each does so in a different way. The curriculum targeting is public school specific in that it affects the production functions in different districts differently as school population variances changed. The competitive gain, on the other hand, affects all public school production functions similarly in that it provides an overall measure of the competitive pressures faced by the public system. These changes of course require re-calibrations of various parameters of the model in order to replicate something close to the benchmark quantities in Table 2. For the sake of brevity, I forego a detailed discussion of this calibration process and instead simply note that the size of the two types of public school

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<sup>28</sup> This constant is  $(1-\delta_1 \cdot \text{variance})$ , where  $\delta_1$  is calibrated jointly with  $D$  to match private school attendance rates in the absence of vouchers. Given zero variance in peer quality for private schools, the private school production function is effectively unchanged by this.

<sup>29</sup> This constant is  $(1-\delta_2 \cdot \text{PUB}^2)$ , where  $\text{PUB}$  is the fraction of the population attending public schools and  $\delta_1$  is calibrated jointly with  $D$  to match private school attendance rates in the absence of vouchers. Private school production functions remain unchanged.

responses modeled in the simulations I report represents the midpoint of a feasible range of such effects.<sup>30</sup>

Table 6a focuses on curriculum targeting where improvements in public school production processes hinge on each school's variance in peer quality. Since migration patterns are similar to those discussed in Section 4.1, this effect is most pronounced in district 1 which experiences the greatest decline in student population and with it the greatest increase in peer quality homogeneity. As a result, public school quality rises most in district 1, although other districts experience a narrowing of the variance in their student population as well even though the total population in those schools does not decrease by as much. Average private school quality falls with increasing private school enrollment as the marginal private school choosers have lower peer quality and thus enjoy lower private school quality. And, while those switching to private schools increase the overall variance in school outcomes, those remaining in public schools now experience higher school quality and thus bring about a counteracting narrowing in the overall variance of outcomes. Finally, since the public school responds under these simulations, private school attendance does not rise as fast with increases in voucher amounts as it does in previous simulations without competitive effects. Results are similar for district targeted vouchers as they are for universal vouchers, although private school take-up rates are

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<sup>30</sup> The  $\delta$  constants in the curriculum targeting and the competitive gain formulations of production functions can of course be set at various levels and thus introduce competitive effects of various magnitudes. The re-calibration requires primarily a change in the value  $D$  – the strength of the peer quality as opposed to spending in production. More precisely, for any  $\delta$  constant that is chosen for either the curriculum targeting or the competitive gain specification, public school quality falls while private school quality remains constant. In order to maintain benchmark levels of private school attendance, this requires lowering the value of peer quality in production – the factor that gives private school their other competitive advantage. There is, however, an upper bound to how high  $\delta$  can be and still produce only modest private school attendance levels in the absence of vouchers. The simulations reported here set the  $\delta$  constants in both the curriculum targeting and the competitive gain specification of production processes to be the midpoint between this upper bound and the lower bound of zero.

predictably smaller when eligibility is restricted solely to one district.

Table 6b offers simulation results under the assumption of a competitive effect. Here, the effect on public school production functions is the same across all public schools as the competitive pressure on the entire public school system is modeled rather than school specific effects (as under curriculum targeting). Thus, improvements in public schools are more uniform across all districts, and private school take-up rates are lower. Again, for the same reasons as under curriculum targeting, average private school quality falls as more households choose private schools. And the overall variance in educational outcomes falls slightly. A comparison of results for targeted versus universal vouchers gives rise predictable differences in take-up rates under higher levels of the voucher.

The broad conclusion regarding school quality under vouchers in this model is then that the impact on average educational opportunities as well as the variance in such opportunities depends on what assumptions are made regarding the responses by public schools. In the base case in which cream skimming by private schools was permitted but no competitive response on the part of public schools was assumed, average public school quality remains relatively constant under some public financing and declines slightly under others (unless voucher levels become very high).<sup>31</sup> When different types of competitive effects are included, on the other hand, both average public school quality and overall average school quality can rise substantially, and the variance in outcomes may drop somewhat.

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<sup>31</sup> Overall average quality, including private schools, was not reported but stays relatively constant or rises in the benchmark cases. Overall variances rise as well.

### 4.3. *Robustness of Results on Segregation and School Quality*

Finally, we return to the issue of residential segregation. In Section 4.1, it was demonstrated that residential segregation can be affected significantly by the introduction of vouchers, especially vouchers targeted to poor districts. These results were arrived at in simulations that ignored any potential competitive effects. Table 7 then provides comparisons of indicators of residential segregation for both centralized and decentralized public school systems when the two types of competitive effects we introduced in Section 4.2 are included. These results indicate that the segregation effects raised in Section 4.1 are robust to the inclusion of such effects.<sup>32</sup>

## 5. **Empirical Foundation and Testable Implications**

The simulations reported in Section 4, and the model structure of Section 3 that gives rise to these simulation results, offer a variety of predictions regarding the policy impact of expanded private school choice. While it is difficult to test these predictions directly (due to the current lack of a sufficiently large policy experiment of this kind in the U.S.), the model itself does have testable implications that can be analyzed with current data, and some of the key foundations of the model can be empirically challenged. This section provides a brief discussion of both the empirical foundations and the testable implications arising from the model, and some of the available empirical evidence that speaks to these.

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<sup>32</sup> Results for public school finance systems calibrated to results for New Jersey show similar robustness but are not reported explicitly.

### 5.1. *Foundations of the Model: Tastes, Housing Markets, and Mobility*

In arriving at a model that has the potential to replicate both the current inter-district differences in public school quality and the heterogeneity of income and property values within jurisdictions, two possible avenues are available to the economic theorist: First, he could model the outcome as a result of taste differences, where household tastes differ over housing and/or school quality, and both high and low income households settle in jurisdictions with similar school quality as a result.<sup>33</sup> This approach is put forth by Epple and Platt (1998), empirically implemented by Epple and Sieg (1999) and will henceforth be called the Epple-Platt-Sieg (EPS) approach. A second alternative approach -- and the one taken in this paper -- is to assume that households share preferences but the housing market, whether because of zoning regulations or historical evolution, offers only a limited bundles of school quality/housing combinations. In particular, this approach assumes that low quality housing is relatively more concentrated in some districts, which then results endogenously in relatively worse public schools in those districts. Both approaches can be reconciled with the data, but both contain underlying assumptions that are problematic for policy analysis. Below we discuss several of these as they relate to some other literatures.

#### 5.11. Housing Markets

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<sup>33</sup> Without heterogeneity in preferences, this model results in perfect stratification of incomes across districts (Epple, Filimon and Romer (1993)).

The EPS approach treats housing as a good similar to other types of goods in that, at any particular location, consumption of the good can be changed in either direction as conditions change. From the urban economics literature we know, of course, that housing is a rather durable good, and while it is often possible to increase housing quantity and/or quality at a particular location, it is not similarly possible to decrease these (except through depreciation in the long run). The approach taken in this paper, on the other hand, models housing as entirely fixed and thus does not permit quality improvements of the kind that might be made under certain policy changes while precluding the unrealistic decreases in housing quantity allowed under the EPS model. Thus, one model seems to err in the direction of allowing too many types of changes in housing consumption at a particular location while the other errs in the direction of permitting too few.

Empirical discussion of this issue is primarily embedded in the literature on local property taxation, with the “New View” of the property tax arguing for the EPS model of housing markets and the “Benefit View” arguing for a model similar to that in this paper.<sup>34</sup> As a result, the New View suggests that taxation of residential property is primarily taxation of all forms of capital as higher property taxes simply imply a fleeing of capital from housing to other uses, while the Benefit View argues that the local property tax, through both direct payments and capitalization effects, approximates a local benefits tax. Unfortunately, different versions of both these views are difficult to empirically distinguish, and much of the debate therefore centers on the degree to which zoning in fact keeps housing stocks at particular locations fixed. Thus, the literature offers

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<sup>34</sup> Recent expositions of this debate can be found in Fischel (forthcoming) and Zodrow (forthcoming).

little guidance as to which model is more “correct”.<sup>35</sup>

For purposes of analyzing the forces discussed in this paper, however, the latter approach has one distinct advantage over the EPS approach. First, to whatever extent a bias in the policy prediction is introduced, it is predictable that the bias is in the direction of making the forces weaker rather than stronger. In particular, the model predicts that vouchers, by disentangling housing and schooling choices and resulting in various general equilibrium price effects, will tend to cause middle to high income households to settle in poorer districts to send their children to private schools. High quality housing in these districts is, of course, limited, and were these migrants to change housing stocks, they would be likely to improve them. This additional flexibility would cause migration forces to become more pronounced, thus causing predictions regarding mobility to represent a conservative lower bound. It is not clear that a similar direction for the bias introduced by the EPS housing model could be determined were a similar policy exercise undertaken in such a model. In addition, the model employed in this paper allows for a calibration of housing quality to include various other neighborhood features (through the use of market prices in the calibration exercise) even though it then holds these features fixed as policies change. But here again the assumption of fixed neighborhood features biases the predictions downward by not allowing middle to high income immigrants to low income districts to improve local neighborhoods in ways other than schooling.

## 5.12. Differences in Tastes

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<sup>35</sup> For a discussion of the difficulty in finding testable implications that distinguish between these views, see Nechyba (forthcoming).

Second, because of the perfect flexibility of housing choices at each location, the EPS model requires preferences to vary in order to generate heterogeneity of household income and house prices within districts.<sup>36</sup> Since housing markets themselves are calibrated to yield this within-district heterogeneity in this paper, no heterogeneity in tastes is required. While taste heterogeneity could easily be introduced into the model used in this paper, it is preferable of course not to do so unless it is either necessary in order for the model to match the important features of the data or unless there is strong empirical evidence suggesting how such heterogeneity should be introduced. The empirical literature in this area is still evolving, although recent work by Bayer (1999) suggests that the hypothesis of persistent taste differences for education in different income or racial/ethnic groups can be largely rejected.

### 5.13. Mobility and School Choice

Much of what is reported in this paper would be of little value if school choice and residential choice were not indeed closely linked. But the empirical evidence in this regard is overwhelming (and discussed in part earlier in the paper). Capitalization studies, starting with Oates (1969) and continuing with recent papers such as Black (1999) have consistently confirmed the importance school quality in housing prices – thus providing evidence that housing choices are based in part on perceptions of local public schools. Even more recently, Figlio and Lucas (2000) provide fascinating evidence of how quickly this process happens as perceptions of

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<sup>36</sup> In the absence of such heterogeneity in tastes, households segregate perfectly into districts (Epple, Filimon and Romer (1993)).

public school quality change when new information is provided.<sup>37</sup> Similarly, discrete choice studies have linked residential location choices more directly to the costs of living in particular school districts and the benefits from local public school quality.<sup>38</sup> The notion that households consider school quality when choosing residences is therefore rather uncontroversial, and the model in this paper simply assumes that this consideration of school quality does not change under new policy regimes. The only remaining issue is the speed with which it is reasonable to assume mobility to play out, an issue difficult to analyze in the static model of this paper. It is unlikely, for instance, that households would respond immediately by changing residences, but with mobility rates (for non-school related reasons) as high as they are in the U.S., the process may be shorter than otherwise expected.

## 5.2. *Testable Implications*

Section 5.1 was concerned with direct challenges to the foundations of the model underlying the simulation results. We now turn to consider more directly the testable implications of this model. A variety of such implications regarding mobility, segregation, private school formation and school quality changes from increased choice policies arise from the simulations in Section 4, but these cannot be tested directly without a large policy experiment. Several other related implications, however, are testable and are discussed below.

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<sup>37</sup> The state of Florida began assigning grades to school in order to determine who qualifies for school-targeted vouchers under the new state-wide voucher initiative. Figlio and Lucas demonstrate the immediacy with which seemingly new information that is revealed affects prices, and how these prices change as additional information becomes available.

<sup>38</sup> See Nechyba and Strauss (1998) and references therein as well as Bayer (1999).

### 5.21. Voting on Voucher Initiatives

The model has rather straightforward predictions regarding the distribution of benefits from voucher policies. Benefits arise in two areas: First, households with high peer quality can more easily improve the school quality of their children by choosing private schools, and other households may benefit from better public schools if a competitive effect of the types incorporated into some simulations arises. Second, every household – whether in the public or private system – is affected through changes in household wealth as housing prices change dramatically. Results from the model suggest that, for most households the latter effect may outweigh the former – at least for versions of the model that do not include a large competitive efficiency improvement from increased choice. More precisely, the model predicts that homeowners in good public school districts will tend to experience large capital losses while homeowners in poor school districts will tend to experience large capital gains.

The empirical implication for homeowners is therefore straightforward: One would expect support for broad based private school vouchers to vary inversely with local public school quality. Of course a similar implication for homeowners arises from a different model that simply generates a greater desire for vouchers in districts with worse public schools as parents in those districts are more dissatisfied with public education. The two models can be empirically distinguished, however, by drawing a distinction between renters and owners who are similarly affected by public schools but differently affected by changes in property values. In particular, renters in poor school districts would be adversely affected by higher rents resulting from vouchers under the model in this paper, while renters in good school districts would benefit from lower rents. At the same time, renters and homeowners go to the same public schools and thus

would not differ in their support for vouchers under the alternative model.

Thus, the testable implication arising from this model is that renters and homeowners will differ in their support for vouchers, with homeowners in good districts opposing vouchers due to the fear of capital losses and homeowners in poor districts favoring vouchers due to anticipated capital gains. Renters would be expected to exhibit the reverse preferences, with those in good school districts looking forward to lower rents and those in poor districts anticipating higher rents. These implications are formalized by Brunner, Sonstelie and Thayer (2000) and tested for the case of the California state-wide voucher initiative that was defeated in the election of 1994. Their results point to a strong and statistically significant difference in precincts along the lines consistent with the predictions of this paper.

#### 5.22. Residential Location, School Choice and Family Size

Although the model assumes each family has a single child, the implications of the model for families with different numbers of children is straightforward but, to my knowledge, remains untested. In particular, the choice of private school is one that brings with it a relatively constant marginal cost per child, while this may not be the case for the choice of high quality public schools to which a family can gain access by residing in that school's district. A family with three children, for instance, must pay roughly the same private school tuition for each of its children if private schools are chosen, while the same family pays a lump sum "capitalization fee" when choosing a house in the good public school district. Of course house size also increases with family size, and thus the marginal cost of sending an additional child to public

school is not zero. Nevertheless, it is likely to be less than private school tuition,<sup>39</sup> giving the implication that, all else being equal, families with more children would choose good public schools while families with few children would more likely choose private schools in poorer public school districts.

### 5.23. Evidence from Current Experiments

While private school choice experiments in the U.S. at this point are too small to give rise to effects such as those simulated in this paper, there are other types of choice arrangements for which the model has similar testable implications. For instance, large numbers of charter and magnet schools in various states do not use residence-based admissions criteria so common in the rest of the public school system. Although clearly different from private school choice in that no tuition requirements are made of parents and various regulations inhibit the more extreme forms of cream-skimming, the introduction of such choice vehicles within the public system does weaken the link between residential and school choices. If such arrangements are wide-spread in a given geographic region, then mobility and price effects similar to those predicted in the simulations of Section 4 should emerge.

Similarly, public school choice programs (such as those in Minnesota) – to the extent that they offer true choice rather than having good public schools close their doors by claiming capacity constraints – similarly alter the link between residential location and school choice. As a result, a model similar to that applied to private school choice in this paper would suggest

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<sup>39</sup> In principle this can also be tested and, were it not the case, the implication would run in the opposite direction.

capitalization effects that reflect this change. Research on this topic, to my knowledge, has been limited, although Reback (2000) provides preliminary evidence that mobility forces of the type raised in Section 4.1 may play an important role.

Finally, the model offers predictions regarding private school formation, residential segregation, housing price differences, etc. for different types of state funding systems for public schools, but these are explored elsewhere (Nechyba (1999, 2000b)). Given the diversity of such state system as well as their changing nature over the past few decades, such state differences provide yet another opportunity to test predictions other than those related to increasing choice. One notable test comes out of the 1970's California experience, where school finance changed rapidly and gave rise to a large number of private schools in a relatively short period of time. Downes and Greenstein (1996) present evidence on these private school formation and particularly the location of new private schools. Consistent with predictions arising from the model in this paper, they show that private schools tended to form in lower income districts and near poorly performing public schools.

## **6. Policy Implications**

The large policy implication emerging not only from the simulations reported in this paper but also from the broader research project referenced throughout is that, given the evidence that the links of residential, political and school choices are strong in the current system, these links are potentially important for a variety of school finance policies including the proposal of expanding choice through vouchers. When models abstract away from these links, the debate on vouchers becomes a stylized argument over which of two forces – the cream-skimming of private

schools or the efficiency enhancements of increased choice – is likely to dominate. As a matter of theoretical exploration, limiting models to considering only some forces in isolation is, of course, extremely valuable and has provided numerous insights, some of which are included in the simulation exercises above. But, as a matter of policy analysis, forces that are best analyzed in isolation for conceptual clarification must ultimately be analyzed in a single framework.

The exercise in this paper is therefore one of expanding the framework within which we analyze the merits of vouchers to include components that move us away from a narrow debate and toward utilizing empirical facts that are less controversial than those asserted in much of the debate. These include (1) a recognition of the fact that the current public school system is far from a homogeneous ideal and full of inequities that are commonly acknowledged in the literature; (2) that these inequities are due largely to a linkage of residential and school choices that offer real school choice to only those who can afford to live in multiple types of school districts; (3) that the forces which have shaped current schools under the current choice environment are unlikely to change as choice is expanded; (4) that political processes are important and will likely continue to be important in setting school quality and school quality differences; and (5) that private schools arising from voucher policies are likely to search out high peer quality students over low peer quality students. It is only after finding implications from these primitives that we have moved on to consider additional forces that are more controversial.

### *6.1. Winners and Losers from Vouchers*

Most policies have clear winners and losers. In the case of private school vouchers,

however, the problem of identifying precisely who wins and who loses is not an easy one. The analysis in this paper, offers an opportunity to suggest which households are likely to definitely win, which might win under different assumptions, and which are most likely to lose. The gains and losses to households in the model arise from two different effects: First, most households will experience some change in the school quality consumed by their children, and second, homeowners are likely to experience capital gains or losses as changing school choice affects market prices.<sup>40</sup> We can then discuss each of these in turn.

#### 6.11. Winners and Losers in School Quality

With respect to winners and losers in terms of educational quality, the intuitions arising from this model are similar to those in the current single-district literature. Because private schools are assumed to gain a competitive advantage through their ability to exclude low peer quality students, it is clearly high peer quality students that are most likely to experience improvements in their school quality. In the context of the model in this paper, peer quality arises from both family income and child ability. Thus, relatively high ability children from high income households who do not choose private schools before vouchers are put in place are the first to benefit from higher private school quality. Conversely, low ability children from low income households are likely to see little benefit or modest declines in their school quality as either public schools decrease in quality or they are forced to choose a private school with only their peer type. Similarly, low ability children from higher income households do not switch to

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<sup>40</sup> A third avenue through which households are affected is through changing tax burdens, but we forego a detailed analysis of these effects here. Furthermore, households already attending private schools benefit from lump sum transfers through the voucher.

private schools unless voucher amounts become high, and they, too, experience similar modest declines in their public school quality. The main additional insight offered by the model here over previous single-district models is that declines in public school quality are likely to be spread across districts even if private schools themselves arise primarily in poor districts, and because of this they are not likely to be as large as might otherwise be predicted (or may in fact be absent for some school financing systems).

The prediction becomes significantly more rosy, however, as competitive effects are introduced. Since public school quality now generally increases, all children can in principle benefit from the introduction of vouchers. The precise nature of this competitive effect is, of course, important. Particular concern for children who remain in poor public schools is warranted both because they are most likely to suffer in the absence of a competitive effect within the context of this model, and because of empirical evidence from abroad suggesting the possibility that choice may leave those children behind even when benefitting most other children.<sup>41</sup> The ambiguity regarding the likely impact of vouchers on those children that remain in low-income public school districts therefore suggests that voucher initiatives -- especially those motivated by concerns for poor children -- ought to be accompanied by strong efforts to independently improve public schools in those districts.

## 6.12. Winners and Losers in Housing Markets

Winners and losers in housing markets are more easily identified. As already discussed in

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<sup>41</sup> In particular, Fiske and Ladd (2000) present compelling evidence that this has occurred under the public school choice reforms in New Zealand.

Section 5.21, and despite the fact that renters are not specifically included in the model of this paper, we can predict from the results in this model that homeowners and renters are impacted differently.<sup>42</sup> In particular, homeowners in good districts experience relatively large capital losses while homeowners in poor school districts experience capital gains. Renters, of course, do not experience such gains and losses. Finally, to the extent that neighborhood effects may spread beyond school buildings, the de-segregating effect of vouchers may have additional benefits for poor districts that are not modeled in this paper.

## 6.2. *Implications for Targeting Vouchers*

After the failure of broad based vouchers to pass the political test in several state referenda, it now seems likely that voucher policies – to the extent that they will be enacted – will be targeted in some way. Current experiments at the city-level are following that pattern with only low income families qualifying for vouchers, and the only state-wide plan to pass a legislature and be enacted (Florida) has targeted vouchers to underperforming schools, as does the Bush proposal at the national level. The two kinds of targeting – toward low income households or low income/underperforming schools, however, are predicted to have very different implications within the framework of this paper.

More precisely, while I did not report simulation results for vouchers targeted to low income families in this paper, I have demonstrated elsewhere (Nechyba (2000a)) that such vouchers would have relatively little impact in the context of this model unless the voucher

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<sup>42</sup> Including renters does not alter the positive predictions of the model significantly as the capital gains and losses for homeowners (which are absent for renters) produce only income effects that do not alter behavior in major ways. Renters would have similar incentives to settle in poor districts if they choose private schools.

amount was set quite high. The reason for this is that household-targeted vouchers do not unleash similar mobility and capitalization effects as moving would have little value to anyone whose income is too high to receive the voucher. District targeting, on the other hand, creates the incentive to move in order to take advantage of private schools. Vouchers targeted to low income households would therefore not give rise to the forces that a multi-district model picks up, and single-district models illustrating the tradeoffs between cream skimming private schools and benefits from competition would give predictions similar to models of the kind employed in this paper. The clear policy implication, then, is that higher response rates are to be expected from district targeting than from household targeting.

### *6.3. Designing Politically Feasible Vouchers*

The difference in implications for different types of targeting thus rests on the fact that district targeting takes advantage of mobility forces while household targeting does not, and this may lead policy makers to view district targeting as a more effective tool to infuse competition into the public school system. On the other hand, this same difference makes district targeting considerably less politically palatable to the population as a whole unless large competitive gains in public schools are expected. More specifically, district targeting affects homeowners in ways very similar to no targeting at all, with homeowners in wealthy districts suffering and homeowners in poor districts gaining. If voters are aware of such effects when expressing political preference for or against vouchers (as Brunner et. al. (2000) suggest California voters were in 1994), homeowners in good school districts are almost as likely to be opposed to district targeted vouchers as they are to universal vouchers. Put differently, targeting to households

instead of districts would in effect isolate homeowners in such districts from capital losses.

Thus, the same factors that cause district targeting to be a more potent policy tool are likely to make it politically more difficult to implement. A trade-off between policy impact and political feasibility therefore emerges for policy makers. This tradeoff is unlikely to be optimally resolved at either extreme (i.e. pure district targeting or pure household targeting) and is more likely to involve a combination of district targeting with income phase outs. To the extent that higher income households are ineligible for vouchers, this reduces the mobility and capitalization effects but may increase their willingness to agree to the proposal. On the other hand, if competitive effects are sought, these too are diminished as income phase outs become more severe. A detailed analysis of this tradeoff is, however, beyond the scope of this paper.

#### 6.4. *Short Run versus Long Run*

A final issue worth raising involves the timing of changes and their impact. The model in this paper has little to offer in regard to this as it does not include a multi-period analysis during which households adjust to policies. Rather, the model provides a snapshot of the pre-voucher world and another of the post-voucher prediction but is not equipped to analyze the transition. The most critical issue is, of course, that of the speed at which mobility forces come into play. While I have cited evidence that price adjustment to new education-related information are relatively fast, residential moves are typically undertaken for multiple reasons, with education being only one. Thus, a likely transition would include household relocations for a variety of job or family related reasons, where the considerations related to schools come into play once the decision to move has been made on other grounds. As a result, those predictions related to

mobility are likely to take some time to unfold and require reasonable confidence on the part of households that policy changes are not just transitory.

In the short run, it may therefore be prudent to place some weight on results emerging from single-district models in which residential location is, in effect, assumed to be fixed. As is mentioned throughout this paper, this would imply considerably more negative short run effects of vouchers because the more positive effects arise primarily from multi-district considerations. In addition, voucher take-up rates would be considerably more muted in the short run, and decreases in public school quality more concentrated. Therefore, while the model has little to offer in terms of predicting the length of time between short run and long run effects, it does suggest that a full evaluation of the impact of large scale voucher programs will require a considerable period of maintaining the policy in place.

## **7. Conclusion**

In summary, this paper has placed the previously analyzed forces related to private school vouchers into a multi-district context that is capable of more accurately establishing a pre-voucher benchmark from which to conduct policy analysis. I have then argued that this gives rise to a number of general equilibrium effects which are important to such an analysis. Two main conclusions emerge: First, voucher policies have profound implications for how the broader set of choices that households make are undertaken and how residential districts are likely to evolve – with vouchers offering a large potential for reducing income segregation across district boundaries. Second, the likely impact of private school vouchers on public school quality depends on a number of assumptions regarding public school responses – assumptions that all

remain controversial. Under the more pessimistic set of assumptions, public school quality may suffer as a result of vouchers, although this decline would not be as large or as concentrated as predicted by a narrower single-district analysis. Under more positive assumptions, on the other hand, public school quality may improve through private school competition. In one case overall school quality (including private schools) remains relatively unchanged with clear winners and losers (in terms of educational opportunities), while in the other cases both average quality and the variance in quality can improve significantly. Since the potential losers (in terms of school quality) under the more pessimistic assumptions of the model are the very poorest children who remain in public schools in poor districts, an important implication arising from these simulations is that caution would dictate that strong efforts to independently improve public schools in poor districts accompany any vouchers intended to help poor children. More empirical analysis is of course required in order to narrow the range of likely school quality outcomes under different types of voucher policies.

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**Table 1: Benchmark Equilibrium to Replicate New Jersey Data**

	Average Income	Avg Property Values	Fraction Private	Per Pupil Spending	School Quality
District 1	3.1120	0.6121	0.2000	0.6652	0.4322
District 2	4.6216	1.0720	0.2250	0.7910	0.6178
District 3	6.5863	1.5248	0.1250	0.8621	0.7803

**Table 2: Predictions versus Data**

	Representative School Districts		
	Low Income (d=1)	Middle Income (d=2)	High Income (d=3)
Mean Land Value	\$157,248	\$192,867	\$271,315
Predicted Mean Land Value*	\$117,412	\$205,629	\$292,484
Median Household Income	\$30,639	\$45,248	\$67,312
Predicted Mean Household Inc.	\$31,120	\$46,216	\$65,863
Per Pupil Spending	\$6,702	\$7,841	\$8,448
Predicted Per Pupil Spending	\$6,652	\$7,910	\$8,621
Fraction Choosing Private S.	0.21	0.23	0.20
Predicted Fraction in Private S.	0.20	0.23	0.13
Fraction Raised Locally	0.52	0.77	0.87
Fraction Raised Locally in Model	0.52	0.77	0.87

\*Calculated from static values assuming 5.5% interest rate.

**Table 3: Schools and Residential Segregation**

		INCOME				PROPERTY VALUES			
	Public Financing	Average Income			Ratio: Dist.3 Avg./ Dist. 1 Avg.	Avg. Property Values*			Ratio: Dist.3 Avg./ Dist. 1 Avg.
		Dist. 1	Dist. 2	Dist. 3		Dist. 1	Dist. 2	Dist. 3	
	<b>None</b>	\$25,700	\$50,175	\$67,325	<b>2.62</b>	\$8,254	\$11,844	\$13,892	<b>1.68</b>
<b>No Private Schools</b>	<b>Local Tax</b>	\$17,628	\$39,647	\$85,925	<b>4.87</b>	\$5,301	\$10,639	\$20,457	<b>3.86</b>
	<b>State Tax</b>	\$19,875	\$42,250	\$81,075	<b>4.08</b>	\$5,322	\$11,507	\$20,204	<b>3.80</b>
<b>Private Schools</b>	<b>Local Tax</b>	\$29,725	\$50,262	\$63,212	<b>2.13</b>	\$6,424	\$11,038	\$15,370	<b>2.39</b>
	<b>State Tax</b>	\$29,891	\$51,309	\$62,000	<b>2.07</b>	\$6,177	\$11,800	\$16,490	<b>2.67</b>

\*Property Values here are expressed as annualized flows.

**Table 4a: Private School Vouchers under Local Public Financing**

	Vouch. Amount	Average Income		Property Values*		Ratio: Dist. 3/Dist. 1		Percent Private	
		Dist. 1	Dist. 3	Dist. 1	Dist. 3	Income	Property	Dist. 1	Dist. 3
All Eligible for Voucher	\$0	\$29,725	\$63,212	\$6,424	\$15,370	2.1266	2.3926	30%	10%
	\$1,000	\$31,925	\$59,800	\$7,122	\$14,654	1.8731	2.0576	40%	10%
	\$2,500	\$33,425	\$58,000	\$9,097	\$14,468	1.7352	1.5904	62.5%	25%
	\$4,000	\$33,125	\$57,425	\$8,256	\$13,339	1.7336	1.6157	87.5%	30%
	\$5,000	\$32,900	\$56,425	\$8,027	\$11,816	1.7150	1.4720	100%	37.5%
Voucher Targeted to District 1	\$0	\$29,725	\$63,212	\$6,424	\$15,370	2.1266	2.3926	30%	10%
	\$1,000	\$34,050	\$59,950	\$7,124	\$14,974	1.7606	2.1019	37.5%	10%
	\$2,500	\$37,125	\$54,125	\$9,979	\$14,804	1.4579	1.4835	70%	10%
	\$4,000	\$43,275	\$52,950	\$13,741	\$15,141	1.2236	1.1019	100%	17.5%
	\$5,000	\$44,624	\$53,632	\$14,282	\$15,041	1.2019	1.0531	100%	19.84%

\*Property values are expressed as annualized flows.

**Table 4b: Vouchers under Cental Public Financing**

	Vouch. Amount	Average Income		Property Values*		Ratio: Dist. 3/Dist. 1		Percent Private	
		Dist. 1	Dist. 3	Dist. 1	Dist. 3	Income	Property	Dist. 1	Dist. 3
All Eligible for Voucher	\$0	\$29,891	\$62,000	\$6,177	\$16,490	2.0742	2.6696	22.5%	15%
	\$1,000	\$33,375	\$60,350	\$6,215	\$15,599	1.8082	2.5099	30%	25%
	\$2,500	\$34,188	\$58,254	\$6,431	\$15,851	1.7039	2.4648	35%	27.5%
	\$4,000	\$33,500	\$61,225	\$7,710	\$14,908	1.8276	1.9336	62.5%	30%
	\$5,000	\$28,775	\$64,875	\$8,327	\$14,016	2.2546	1.6832	100%	100%
Voucher Targeted to District 1	\$0	\$29,891	\$62,000	\$6,177	\$16,490	2.0742	2.6696	22.5%	15%
	\$1,000	\$33,400	\$59,645	\$6,242	\$15,711	1.7858	2.5170	30%	12.5%
	\$2,500	\$39,326	\$59,825	\$6,720	\$15,940	1.5213	2.3720	42.5%	11.25%
	\$4,000	\$43,202	\$53,861	\$8,652	\$16,805	1.2467	1.9423	70%	0.10%
	\$5,000	\$44,225	\$58,850	\$12,509	\$16,100	1.3307	1.2871	100%	37.5%

\*Property values are expressed as annualized flows.

**Table 4c: Vouchers under New Jersey Financing System**

	Vouch. Amount	Average Income		Property Values*		Ratio: Dist. 3/Dist. 1		Percent Private	
		Dist. 1	Dist. 3	Dist. 1	Dist. 3	Income	Property	Dist. 1	Dist. 3
All Eligible for Voucher	\$0	\$31,120	\$65,863	\$6,121	\$15,248	2.1164	2.4911	20%	12.5%
	\$1,000	\$32,845	\$63,100	\$6,534	\$14,921	1.9211	2.2836	32.5%	15%
	\$2,500	\$35,525	\$60,050	\$8,692	\$14,312	1.6904	1.6466	40%	22.5%
	\$4,000	\$33,350	\$61,340	\$9,342	\$13,164	1.8393	1.4091	67.5%	30%
	\$5,000	\$32,533	\$61,788	\$8,210	\$12,329	1.8992	1.5017	100%	32.5%
Voucher Targeted to District 1	\$0	\$31,120	\$65,863	\$6,121	\$15,248	2.1164	2.4911	20%	12.5%
	\$1,000	\$33,250	\$61,125	\$6,623	\$15,120	1.8383	2.2830	35%	12.5%
	\$2,500	\$38,466	\$56,380	\$9,922	\$14,792	1.4657	1.4908	47.5%	15%
	\$4,000	\$43,620	\$52,890	\$12,331	\$14,910	1.2125	1.2091	82.5%	15%
	\$5,000	\$44,130	\$54,210	\$12,910	\$14,225	1.2284	1.1019	100%	17.5%

\*Property values are expressed as annualized flows.

**Table 5a: Vouchers and Public School Quality under Local Financing and Cream Skimming**

<b>All Eligible for Voucher</b>												
	Peer Quality			Per Pupil Spending			School Quality			Percent Attending Private		
Voucher	Dist. 1	Dist. 2	Dist. 3	Dist. 1	Dist. 2	Dist. 3	Dist. 1	Dist. 2	Dist. 3	Dist. 1	Dist. 2	Dist. 3
\$0	0.2613	0.5142	0.6404	\$5,000	\$7,326	\$10,215	0.3674	0.6192	0.8183	30%	20%	10%
\$1,000	0.2292	0.4745	0.6000	\$5,000	\$7,593	\$9,768	0.3452	0.5961	0.7743	40%	27.5%	10%
\$2,500	0.2211	0.3036	0.5419	\$5,000	\$7,645	\$9,555	0.3326	0.4813	0.7245	62.5%	40%	12.5%
\$4,000	0.1054	0.1370	0.3373	\$5,000	\$5,000	\$9,388	0.2387	0.2704	0.5773	87.5%	82.5%	30%
\$5,000	***	***	0.2626	***	***	0.9696	***	***	0.5336	100%	100%	37.5%
<b>Voucher Targeted to District 1 Residents Only</b>												
	Peer Quality			Per Pupil Spending			School Quality			Percent Attending Private		
Voucher	Dist. 1	Dist. 2	Dist. 3	Dist. 1	Dist. 2	Dist. 3	Dist. 1	Dist. 2	Dist. 3	Dist. 1	Dist. 2	Dist. 3
\$0	0.2613	0.5142	0.6404	\$5,000	\$7,326	\$10,215	0.3674	0.6192	0.8183	30%	20%	10%
\$1,000	0.2097	0.4026	0.4943	\$5,000	\$7,065	\$9,539	0.3309	0.5389	0.7633	37.5%	25%	10%
\$2,500	0.2015	0.2984	0.4944	\$5,000	\$6,346	\$8,333	0.3247	0.4370	0.6594	70%	40%	10%
\$4,000	***	0.2174	0.3993	***	\$5,000	\$7,774	***	0.3366	0.5665	100%	40%	17.5%
\$5,000	***	0.2152	0.3937	***	\$5,000	\$7,777	***	0.3350	0.5628	100%	40%	19.8%

**Table 5b: Vouchers and Public School Quality under State Financing and Cream Skimming**

<b>All Eligible for Voucher</b>												
	Peer Quality			Per Pupil Spending			School Quality			Percent Attending Private		
Voucher	Dist. 1	Dist. 2	Dist. 3	Dist. 1	Dist. 2	Dist. 3	Dist. 1	Dist. 2	Dist. 3	Dist. 1	Dist. 2	Dist. 3
\$0	0.2826	0.5469	0.6470	\$7,195	\$7,195	\$7,195	0.4616	0.6316	0.6841	22.5%	17.5%	15%
\$1,000	0.2619	0.5688	0.5727	\$7,363	\$7,363	\$7,363	0.4506	0.6514	0.6535	30%	10%	25%
\$2,500	0.2570	0.5040	0.5652	\$7,781	\$7,781	\$7,781	0.4633	0.6346	0.6652	35%	22.5%	27.5%
\$4,000	0.2055	0.3117	0.4713	\$8,831	\$8,831	\$8,831	0.4418	0.5385	0.6553	62.5%	40%	30%
\$5,000	***	***	***	***	***	***	***	***	***	100%	100%	100%
<b>Voucher Targeted to District 1 Residents Only</b>												
	Peer Quality			Per Pupil Spending			School Quality			Percent Attending Private		
Voucher	Dist. 1	Dist. 2	Dist. 3	Dist. 1	Dist. 2	Dist. 3	Dist. 1	Dist. 2	Dist. 3	Dist. 1	Dist. 2	Dist. 3
\$0	0.2826	0.5469	0.6470	\$7,195	\$7,195	\$7,195	0.4616	0.6316	0.6841	22.5%	17.5%	15%
\$1,000	0.2762	0.5582	0.5962	\$7,336	\$7,336	\$7,336	0.4612	0.6443	0.6648	30%	10%	12.5%
\$2,500	0.2529	0.5048	0.5969	\$7,416	\$7,416	\$7,416	0.4454	0.6200	0.6679	40%	12.5%	11.3%
\$4,000	0.2208	0.3314	0.5447	\$7,904	\$7,904	\$7,904	0.4313	0.5244	0.6614	70%	27.5%	10%
\$5,000	***	0.2301	0.3204	***	\$4,250	\$4,250	***	0.3153	0.3693	100%	40%	37.5%

**Table 5c: Vouchers and Public School Quality under New Jersey Funding System and Cream Skimming**

<b>All Eligible for Voucher</b>												
	Peer Quality			Per Pupil Spending			School Quality			Percent Attending Private		
Voucher	Dist. 1	Dist. 2	Dist. 3	Dist. 1	Dist. 2	Dist. 3	Dist. 1	Dist. 2	Dist. 3	Dist. 1	Dist. 2	Dist. 3
\$0	0.2684	0.4701	0.6989	\$6,652	\$7,910	\$8,621	0.4322	0.6178	0.7803	20%	22.5%	12.5%
\$1,000	0.2422	0.4698	0.6521	\$6,923	\$7,734	\$8,354	0.4204	0.6103	0.7427	32.5%	22.5%	15%
\$2,500	0.2212	0.4110	0.5910	\$7,054	\$7,221	\$8,111	0.4066	0.5525	0.6979	40%	27.5%	22.5%
\$4,000	0.1124	0.3302	0.4127	\$5,000	\$6,939	\$7,781	0.2461	0.4876	0.5757	67.5%	40%	30%
\$5,000	***	0.1425	0.2921	***	\$5,000	0.8004	***	0.2754	0.4959	100%	82.5%	32.5%
<b>Voucher Targeted to District 1 Residents Only</b>												
	Peer Quality			Per Pupil Spending			School Quality			Percent Attending Private		
Voucher	Dist. 1	Dist. 2	Dist. 3	Dist. 1	Dist. 2	Dist. 3	Dist. 1	Dist. 2	Dist. 3	Dist. 1	Dist. 2	Dist. 3
\$0	0.2684	0.4701	0.6989	\$6,652	\$7,910	\$8,621	0.4322	0.6178	0.7803	20%	22.5%	12.5%
\$1,000	0.2416	0.4623	0.5881	\$6,992	\$7,812	\$8,572	0.4221	0.6089	0.7167	35%	22.5%	12.5%
\$2,500	0.2183	0.3945	0.4916	\$6,859	\$7,696	\$8,210	0.3982	0.5603	0.6435	47.5%	30%	15%
\$4,000	0.1058	0.2772	0.4122	\$5,000	\$7,102	\$8,114	0.2391	0.4543	0.5882	82.5%	42.5%	15%
\$5,000	***	0.2294	0.4097	***	\$6,910	\$7,761	***	0.4093	0.5730	100%	47.5%	17.5%

**Table 6a: School Quality and Vouchers under New Jersey Calibration  
and Universally Available Vouchers**

<b>Schools Become more Efficient through Curriculum Targeting</b>						
<b>VOUCHER AMOUNT</b>	<b>PUBLIC SCHOOL QUALITY</b>			<b>AVERAGE PRIVATE SCHOOL QUALITY</b>	<b>VARIANCE BEFORE/ VARIANCE AFTER</b>	<b>PERCENT ATTENDING PRIVATE SCHOOL</b>
	<b>District 1</b>	<b>District 2</b>	<b>District 3</b>			
\$0	0.4167	0.5922	0.7761	1.1628	***	18.67%
\$1,000	0.4528	0.6012	0.7705	1.1167	0.9721	23.50%
\$2,500	0.4770	0.6216	0.7679	1.0335	0.9512	29.25%
\$4,000	0.4833	0.6277	0.7802	0.9411	0.9481	36.33%
\$5,000	0.4551	0.6014	0.7522	0.8623	0.9551	46.66%
<b>Schools Become more Efficient through More Efficient Resource Utilization</b>						
<b>VOUCHER AMOUNT</b>	<b>PUBLIC SCHOOL QUALITY</b>			<b>AVERAGE PRIVATE SCHOOL QUALITY</b>	<b>VARIANCE BEFORE/ VARIANCE AFTER</b>	<b>PERCENT ATTENDING PRIVATE SCHOOL</b>
	<b>District 1</b>	<b>District 2</b>	<b>District 3</b>			
\$0	0.4023	0.6121	0.7629	1.1711	***	<b>19.25%</b>
<b>\$1,000</b>	<b>0.4127</b>	<b>0.6233</b>	<b>0.7771</b>	<b>1.1018</b>	<b>0.9891</b>	<b>24.33%</b>
<b>\$2,500</b>	<b>0.4273</b>	<b>0.6421</b>	<b>0.7849</b>	<b>1.0911</b>	<b>0.9821</b>	<b>27.25%</b>
<b>\$4,000</b>	<b>0.4351</b>	<b>0.6591</b>	<b>0.8033</b>	<b>1.0300</b>	<b>0.9755</b>	<b>32.66%</b>
<b>\$5,000</b>	<b>0.4391</b>	<b>0.6718</b>	<b>0.8116</b>	<b>1.0029</b>	<b>0.9812</b>	<b>33.00%</b>

**Table 6b: School Quality and Vouchers under New Jersey Calibration  
and District 1 Targeted Vouchers**

<b>Schools Become more Efficient through Curriculum Targeting</b>						
<b>VOUCHER AMOUNT</b>	<b>PUBLIC SCHOOL QUALITY</b>			<b>AVERAGE PRIVATE SCHOOL QUALITY</b>	<b>VARIANCE BEFORE/ VARIANCE AFTER</b>	<b>PERCENT ATTENDING PRIVATE SCHOOL</b>
	<b>District 1</b>	<b>District 2</b>	<b>District 3</b>			
<b>\$0</b>	<b>0.4167</b>	<b>0.5922</b>	<b>0.7761</b>	<b>1.1628</b>	<b>***</b>	<b>18.67%</b>
<b>\$1,000</b>	<b>0.4613</b>	<b>0.5892</b>	<b>0.7783</b>	<b>1.1218</b>	<b>0.9721</b>	<b>23.25%</b>
<b>\$2,500</b>	<b>0.4852</b>	<b>0.5923</b>	<b>0.7811</b>	<b>1.0613</b>	<b>0.9512</b>	<b>26.12%</b>
<b>\$4,000</b>	<b>0.4925</b>	<b>0.6011</b>	<b>0.7734</b>	<b>1.0015</b>	<b>0.9481</b>	<b>26.12%</b>
<b>\$5,000</b>	<b>0.4727</b>	<b>0.5985</b>	<b>0.7692</b>	<b>0.9476</b>	<b>0.9551</b>	<b>35.25%</b>
<b>Schools Become more Efficient through More Efficient Resource Utilization</b>						
<b>VOUCHER AMOUNT</b>	<b>PUBLIC SCHOOL QUALITY</b>			<b>AVERAGE PRIVATE SCHOOL QUALITY</b>	<b>VARIANCE BEFORE/ VARIANCE AFTER</b>	<b>PERCENT ATTENDING PRIVATE SCHOOL</b>
	<b>District 1</b>	<b>District 2</b>	<b>District 3</b>			
<b>\$0</b>	<b>0.4023</b>	<b>0.6121</b>	<b>0.7629</b>	<b>1.1711</b>	<b>***</b>	<b>19.25%</b>
<b>\$1,000</b>	<b>0.4096</b>	<b>0.6186</b>	<b>0.7685</b>	<b>1.1102</b>	<b>0.9932</b>	<b>24.25%</b>
<b>\$2,500</b>	<b>0.4111</b>	<b>0.6322</b>	<b>0.7774</b>	<b>1.1033</b>	<b>0.9906</b>	<b>26.00%</b>
<b>\$4,000</b>	<b>0.4171</b>	<b>0.6456</b>	<b>0.7813</b>	<b>1.0731</b>	<b>0.9843</b>	<b>29.50%</b>
<b>\$5,000</b>	<b>0.4219</b>	<b>0.6555</b>	<b>0.7938</b>	<b>1.0663</b>	<b>0.9892</b>	<b>30.25%</b>

**Table 7: District 3/District 1 Variables for Different Assumptions regarding School Quality**

	No Private School Markets Permitted		Private Schools Markets Permitted									
			No Vouchers		Non-Targeted Vouchers				Targeted Vouchers			
					Voucher=0.25		Voucher=0.50		Voucher=0.25		Voucher=0.50	
	Local	Cent.	Local	Cent.	Local	Cent.	Local	Cent.	Local	Cent.	Local	Cent.
<b>School Quality as Modeled in Section 4.1</b>												
Income	4.874	4.079	2.126	2.074	1.735	1.704	1.715	2.255	1.458	1.521	1.202	1.331
Property	3.859	3.796	2.392	2.667	1.590	2.465	1.472	1.683	1.484	2.372	1.053	1.287
<b>Schools Become more Efficient through Curriculum Targeting</b>												
Income	4.505	4.188	2.076	2.033	1.798	1.921	1.832	2.119	1.397	1.510	1.193	1.279
Property	3.791	3.586	2.222	2.512	1.553	2.213	1.394	1.762	1.427	2.181	1.081	1.231
<b>Schools Become more Efficient through More Efficient Resource Utilization</b>												
Income	4.771	3.892	2.231	2.100	1.751	1.691	1.802	2.387	1.424	1.478	1.249	1.414
Property	3.712	3.603	2.469	2.702	1.539	2.568	1.528	1.732	1.329	2.292	1.103	1.302